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Graduate

The Graduate catalog is a comprehensive reference for your academic career. It provides a list of programs and courses offered at The University of Alabama in Huntsville. In addition, it gives you valuable information such as suggested and required degree plans and information about tuition, financial aid, and support services.

While we encourage you to follow the pathways outlined in this catalog, it is also recommended that you consult with your academic advisor to ensure that you are taking advantage of courses and university resources that will help you reach your educational and career goals by graduating on time. Please contact your department to learn who can assist you with your academic advising.

For questions regarding the content of this catalog please contact the Graduate School at 256.824.6002, DeanGrad@uah.edu, or SSB 222.

Academic Information

This section provides important information on the following topics for Graduate Students:

• Collaborative Programs
• Cooperative Education and Career Development Program
• Intensive Language and Culture
• JUMP
• Online Learning
• Study Abroad

Collaborative Programs

Between Auburn University and the University of Alabama System (UA, UAB, UAH)

In some designated programs, a student enrolled in either Auburn University or any campus of the University of Alabama System may register as a transient student at the other institution with the approval of both graduate deans, or their representatives, and the department or school in which the student wishes to take the courses. The amount of coursework that may be taken by a student under such an arrangement will be determined by the supervisory committee, with appropriate approvals at the other university. A student earning a master's degree at either institution must complete a majority of the required coursework at the institution granting the degree. For a course to be applicable for credit beyond the hours presently transferable toward a master's degree or beyond the master's, the course must be approved in advance by the student's major department and the graduate dean. The deans of the graduate schools will serve as liaison officers in arranging programs for which the additional hours may be transferred.

Between UAH and Alabama A&M University

A visiting student policy has been established between Alabama A&M University and UAH. Under this arrangement, a graduate student at one institution may request permission to attend a course at the other. Conditions governing the granting of permission include the following:

1. The student is in good graduate standing.
2. The course desired is unavailable to the student at the home institution.
3. A visiting student is limited to one graduate course a semester at the host institution except where the second course is a laboratory required to accompany the first course.
4. A visiting student must have prerequisites for the course.
5. The number of courses taken under this plan cannot exceed those allowed in the policy on transferred credit.
6. The student's request requires the approval of the advisor, department chair, and graduate dean.
7. Permission of the host institution is dependent upon availability of space for the visitor after its own students are accommodated.

Interested students should contact the Office of the Registrar for appropriate forms.

Between UAH and The University of Alabama at Birmingham (UAB)

A collaborative program in engineering exists between UAH and UAB for the pursuit of doctoral degrees. A student at UAB may earn the doctoral degree at UAH with a major in electrical engineering, or mechanical engineering; while a UAH student may pursue the master's or the doctoral degree with a major in biomedical engineering at UAB. An interested student must first be admitted at the principal institution, i.e. the one offering the degree, but may
take courses and satisfy the residency requirements at either campus. All degree requirements must be satisfied at the principal institution. More details are available through the participating departments.

Cooperative Education and Career Development Program

Student Services Building 205
256.824.6741
chargerjobs@uah.edu
www.uah.edu/career-services

Career Center

Career Services
Career Services assists students in all phases of career planning and preparation including resume writing and critique, interview preparation, developing networking skills, career assessments and career coaching through one-on-one appointments as well as workshops and information sessions. Our services provide students with the knowledge and resources to make informed career choices and the personal skills to reach their objectives.

Career Services coordinates on and off campus recruiting opportunities and hosts two comprehensive career fairs each fall and spring semester for students in all majors. Career Fair allows our students the opportunity to speak with multiple employers in one location about cooperative education (co-op), internships and degree positions. Attendees are required to dress professionally and bring copies of their resumes for distribution.

Cooperative Education and Internships
Cooperative Education and Internships provide a unique, structured educational experience that allows students to gain practical, professional work experience while completing degree requirements. Through the integration of classroom theory and professional practices, students increase their understanding of the world of work.

The Cooperative Education program offers alternating and parallel options. Students working on an alternating schedule rotate semesters of full-time study with semesters of full-time work in their majors. Some students may complete continuous parallel (part-time work) assignments concurrently with a reduced class load. Cooperative Education work experiences are progressive in responsibilities, monitored by the University, and directly related to the students' academic and career goals. Students participating in Cooperative Education are required to register their Cooperative Education through the Career Center.

Internships are one semester degree-related employment opportunities where students work one-on-one with professionals to gain practical experience in their field. Several academic programs on campus offer credit for internships; students should check with their academic advisor to learn about any credit bearing internship opportunities within their program of study.

Charger Path
Charger Path is UAH’s exclusive comprehensive career management system and all newly enrolled students receive an account during their first week of classes. In this system, students update their profiles, upload their resumes and apply for positions including co-ops, internships, and professional degree opportunities. Through Charger Path, students receive career announcements, view upcoming workshops and information sessions, have access to on-campus recruiting schedules and make appointments with the Career Center.

Intensive Language and Culture

SST 146
256.824.2370
ilc@uah.edu
http://www.uah.edu/ilcp

Mission
The Intensive Language and Culture Program (ILC) is an academically-oriented language and culture program that prepares students for engagement in the classroom, on the campus, and across the community. In the ILC, nonnative speakers of English can develop language skills for study in an English-medium university such as UAH. With a rigorous curriculum and strict attendance requirements, the program supports students as they progress in their acquisition of academic/professional English.

Overview
The ILC includes 18-20 hours of classroom instruction per week. Students develop their skills in both oral and written academic English. Instruction adheres to principles of communicative language teaching.
Students are instructed in the four component skills of listening, speaking, reading, and writing. Additional work in pragmatics, grammar and pronunciation supports progress in both accuracy and fluency, with special attention paid to interaction in a U.S. university context.

The Intensive Language and Culture Program (ILC) serves the needs of non-native speakers of English at UAH. Students in Levels 010-040 (High Beginning - High Intermediate) prepare for study at English-medium universities, such as UAH. Students in Level 050 (Advanced) polish their language skills and transition into undergraduate, graduate, or non-degree programs at UAH.

Additional Information
ILC Program information is also available on the program website (http://www.uah.edu/ilcp). If you are interested in applying to the ILC or receiving additional information, please email the director of the ILC at ilc@uah.edu.

Requirements

Students applying to the ILC at UAH should submit the following documents.

1. Official transcripts from secondary and/or postsecondary institutions attended, translated into English and certified.
2. TOEFL or IELTS scores (if not available, contact the director regarding options for demonstrating language proficiency, at ilc@uah.edu)
3. Financial support documentation (F-1 students only)

To apply online, visit the UAH Admissions Login (https://sierra.uah.edu:9021/PROD/bwskalog.P_DispLoginNon), choose APPLY FOR ADMISSION. On that page, choose First Time User Account Creation. Next, create a Login ID and PIN. Then, log in to the system and select Intensive English Program Application.

For a downloadable copy of the application form, select the UAH ILC Application (http://www.uah.edu/images/administrative/ilc/IEP%20application.pdf).


If you have questions or need additional information, contact the director via email at ilc@uah.edu.

ILC 010 - INT LANG & CULT I
Semester Hours: 4-20
Course designed to improve nonnative speaker's ability in their overall language proficiency at the high beginning level.

ILC 020 - INT LANG & CULT II
Semester Hours: 4-20
Course designed to improve nonnative speaker's ability in their overall language proficiency at the low intermediate level.

ILC 030 - INT LANG & CULT III
Semester Hours: 4-20
Course designed to improve nonnative speaker's ability in their overall language proficiency at the intermediate level.

ILC 040 - INT LANG & CULT IV
Semester Hours: 4-20
Course designed to improve nonnative speaker's ability in their overall language proficiency at the high intermediate level.

ILC 050 - INT LANG & CULT V
Semester Hours: 4-20
Course designed to improve nonnative speaker's ability in their overall language proficiency at the advanced level.

ILC 060 - ENGLISH FOR ACADMC PURP PRGM
Semester Hours: 1-3
This course aims to help students achieve a greater level of success academically and professionally. Three types of evaluative and consultation tracks are offered: accent modification, oral communication and literacy. A speech pathology model is used toward the accent modification and oral communication tracks, and a consultation approach utilizing a modified multi-sensory method focusing on comprehensive literacy is used toward the literacy track. By the end of the course, students typically exhibit a strong improvement in self-confidence and ability to proceed with their studies and professional dealings.

ILC 090 - ILC: SPECIAL TOPICS
Semester Hours: 1-3
JUMP

UAH's Joint Undergraduate Master's Program (JUMP) allows undergraduate students to study at the graduate level. By taking graduate courses in your senior year, you could reduce the time taken to get a graduate (M.S. or M.A.) degree.

Benefits for you:

1. No entrance exam!
2. Double count undergrad classes for grad degree!
3. Pay undergrad tuition for grad classes taken as a JUMP student!
4. No application fee!

How to JUMP!

• Apply any time before your last semester.
• Meet with your college JUMP advisor and submit application.

Official Rules for JUMP!

• For admission to JUMP, student must meet overall GPA requirements\(^1\) of the college. GPA includes all transfer coursework.
• Only courses taken at UAH and listed on JUMP application are eligible.
• Student must receive a B minimum in each JUMP course for it to count towards graduate degree.
• Student must maintain minimum overall GPA throughout JUMP program until graduation.
• All coursework must be completed within six years of taking first JUMP class.
• Students are considered undergraduate students until all requirements for undergraduate degree are met.
• Students cannot hold a GTA, GRA, or graduate scholarship or fellowship until undergraduate degree is completed.
• If a change is made to initial JUMP application both a JUMP change form and a change to student's undergraduate Program of Study (POS) must be submitted for approval.
• If student's GPA upon graduation is less than the required minimum, the student does not receive admission to the graduate degree program automatically. Student must apply to the graduate school with admission test score and graduate application. Courses will be counted as if the student had been a non-degree seeking graduate student.
• Students must notify the Graduate School when submitting an application for undergraduate graduation.

More information available at http://uah.edu/jump

\(^1\) Minimum GPA requirements by college or program

Online Learning

The University of Alabama in Huntsville offers a number of academically challenging online and hybrid-online programs. Please review a listing of available programs here: http://www.uah.edu/online-learning

State Authorization:

The state of Alabama is a member of the SARA compact. The State Authorization Reciprocity Agreement is an agreement among member states, districts and territories that establishes comparable national standards for interstate offering of postsecondary online education courses and programs. It is intended to make it easier for students to take online courses offered by postsecondary institutions based in another state. For more information, including a current list of states in the SARA compact, please visit http://www.nc-sara.org/. The University of Alabama in Huntsville is an approved SARA institution.

For further information regarding SARA requirements on the UAH campus please see http://www.uah.edu/academic-affairs/offices/oira/state-authorizations

Topics include: Timeline for approval, International Residents, Territories and Provinces, Military Bases, Additional Resources, Professional Licensure, & Grievance Procedures
Study Abroad

The Office of Study Abroad within the Office of International Services serves as the coordinating office for study-abroad opportunities at UAH.

Faculty-Led Courses: Each year, UAH offers a number of faculty-led study abroad courses typically ranging from two to four weeks in length and conferring three to six academic credit hours in the course(s) offered.

Summer, Semester, and Academic-Year Programs: UAH works with international partners and education abroad organizations to offer students summer, semester, or academic-year study abroad programs at sites in Africa, Asia, Australia, and Europe. You can participate in these programs and earn academic credit toward your degree at UAH.

The Office of Study Abroad is located in the Student Services Building, Room 218M. Students can obtain additional information by visiting our website (www.uah.edu/ois), by emailing studyabroad@uah.edu, or by calling 256-824-6055.

Admissions

Graduate Admissions

The University of Alabama in Huntsville welcomes inquiries and applications from interested persons who wish to further their education. Email inquiries are welcome and should be addressed to the specific department/program or to the Office of Graduate Admissions at deangrad@uah.edu. Further information is available at: http://www.uah.edu/graduate

The graduate student body is composed of individuals of all ages—traditional full-time college students and other adults who are combining their educational pursuits with work, family, and various activities. Prospective students should apply well in advance of the date of proposed entrance. Application deadlines can be found on the admissions website.

Faculty members and academic advisors for the various graduate programs are available to confer with interested individuals to discuss their enrollment plans and opportunities at UAH. Students may telephone or email departments or program offices directly or call the Office of Graduate Admissions (domestic students call 256.824.6198; international students call 256.824.6199).

Application Procedure

An applicant for a master’s, doctoral or certificate program must submit a completed graduate application form and a nonrefundable application fee to the Office of Graduate Admissions. Application may be completed online or downloaded at http://www.uah.edu/admissions/graduate/admission-process. Printed applications can be mailed to:

The Office of Graduate Admissions
Student Services Building 222
The University of Alabama in Huntsville
Huntsville, AL 35899

Paper copies of the application are available in the Graduate School and in departmental offices. There is a non-refundable application fee of $60 for domestic students and international students which must accompany the application. Applicants who have previously enrolled at UAH will pay a $30 fee and should submit a paper application.

In addition, the student must request that the following items be sent to the Office of Graduate Admissions:

1. One official copy of the academic record from each collegiate institution attended;
2. For most programs, applicants should submit scores of the Graduate Record Examination (GRE) from Educational Testing Service (ETS). The institutional code for UAH is 1854. College of Business Administration applicants should submit scores for the Graduate Management Admissions Test (GMAT). Applicants for English, Nursing and Public Affairs should submit either a set of GRE scores or a score for the Miller Analogies Test (MAT); These scores must be submitted directly to UAH from the testing service.
3. The GRE/MAT requirement may be waived by the Graduate Dean upon recommendation of the department or program chair if at least one of the following conditions holds and other departmental requirements are met:
   a. the applicant is the holder of a graduate degree from an accredited institution;
   b. the applicant presents evidence of having taken the GRE/MAT over five years ago and hence cannot obtain official scores;
   c. the applicant graduated from an accredited college or university five or more years ago and has not subsequently been enrolled since that time, and has a record of consistent professional and/or academic achievement as documented on a submitted resume;
   d. FE exam - pass and show proof;

An applicant for an additional graduate program (including a different degree in the same discipline, e.g. adding a master’s program to a Ph.D. program, or adding a certificate) who has been previously admitted to the Graduate School must submit a new application form to the Office of Graduate
Admissions for the new program. The student must inform the chairs of both departments/programs that he/ she is pursuing the two degree programs concurrently.

Students who fail to enroll in classes within one year of their date of admission must submit a new application.

Conditional Admission

The Graduate School may conditionally admit applicants who do not satisfy all of the requirements for unconditional admission, but who do show reasonable potential for doing graduate work. Conditional admission requires the approval of both the Graduate Dean and the chair of the department in which the applicant plans to pursue an advanced degree.

If a conditionally admitted student has an overall grade average of B (3.0) or better for all graduate work attempted up to and including the semester in which the student completes 12 semester hours of graduate work at UAH, then the student assumes the status of an unconditionally admitted student. Otherwise, the student is dismissed from the Graduate School. Under exceptional cases, a student may be readmitted upon justified recommendation of the faculty in the student's major department and approval of the Graduate Dean.

Graduate Admission Requirements

For admission to the Graduate School, applicants must hold a bachelor's degree, or equivalent, from an approved institution. The following minimum requirements are acceptable to the graduate school; individual colleges and/or departments may require higher grade point averages and test scores or additional or more specific requirements. See college/departmental sections for specific admissions information.

Unconditional Admission

To qualify for unconditional admission, applicants must satisfy the following minimum criteria:*

All programs except those in the College of Business
1. Have a minimum grade-point average of B (3.0) on the undergraduate record, and
2. Have a minimum total score of 300 on the Graduate Record Examination (GRE) and a minimum score of 3.0 on the analytical writing portion. For the English, Nursing, and Public Affairs programs, applicants must have a minimum total score of 410 on the MAT.

*Individual programs may have higher GPA and score requirements for unconditional admission.

College of Business
1. Have a minimum total score of 500 on the Graduate Management Admissions Test (GMAT).
2. Have a minimum index score of 1080, (determined by taking the undergraduate GPA multiplied by 200 + the GMAT score + 10 x the years of professional work experience up to 2 years).
3. Have a minimum grade-point average of 3.0 on the undergraduate record.

Graduate Assistantships

Graduate assistantships are offered to encourage graduate work, to promote teaching, and to promote research. Graduate assistants have a graduate degree as their primary goal, and the assistantships are part of their graduate education. Assistantships are available through various departments of instruction, under the auspices of the Graduate School. Any student qualified for admission to the Graduate School is eligible to apply for a graduate assistantship.

A student eligible for an assistantship may be appointed as a Graduate Teaching Assistant (GTA), Graduate Research Assistant (GRA), or Graduate Administrative Assistant (GAA). Full assistantships usually require 20 hours per week service to the University, but may require more or fewer hours per week in exceptional cases. All full-time graduate assistants must be registered for a minimum of 9 semester hours (6 semester hours in the summer term) during any semester in which an appointment is held. Exceptions require permission of the Graduate Dean. Normally, all courses for which the student is registered shall be graduate credit courses. Exceptions must be approved by the Department Chair and Graduate Dean.

Benefits

Tuition
A graduate assistant who holds a full assistantship (20 hours per week) appointment will receive tuition and fees for 9 to 12 hours per semester (6 hours in the summer term). Tuition and fees for students who hold less than a full assistantship appointment are prorated accordingly.
Stipend
Assistantship stipends vary in amount by type, program, and student academic progress. Students receive an offer letter indicating the amount of the stipend.

Further information may be obtained in the department or in the Graduate School.

Two kinds of assistantships are available:

Graduate Teaching Assistantships
As the title implies, Graduate Teaching Assistants (GTAs) share the faculty’s responsibility for teaching. The purpose of this assistantship is twofold: one is to support the departmental teaching program, and the other is to aid the student’s professional development. The teaching assistant may have duties assigned as a classroom instructor, laboratory instructor, tutor, grader or other activities related to the educational mission of the department. Only students in good academic standing are eligible for and may be awarded a teaching assistantship. The GTA’s teaching load will necessarily vary from one department to another, and the load should be proportional to the normal full-time teaching load carried by other faculty members in the department.

If a student holding an assistantship withdraws from courses during the semester such that his/her course load is below the minimum required hours, that student can be required to reimburse the University for tuition and health insurance prorated on the remaining course load. Students holding an assistantship that do not continue to make satisfactory progress toward their degree may have their assistantship revoked.

A mandatory online GTA workshop for all new GTAs is held prior to the beginning of classes each fall and spring semester.

For students whose native language is not English, English proficiency, as determined by the director of the ESL program, is a prerequisite for classroom or laboratory instruction. More information about international teaching assistants is available on the graduate web site at http://www.uah.edu/graduate. GTAs must have completed at least 18 semester hours of graduate coursework in their discipline to qualify as the instructor of record in any class.

Graduate Research Assistantships
A Graduate Research Assistant (GRA) performs research under the supervision of a faculty member. At times, a research project to which the research assistant is appointed may eventually lead to a thesis or dissertation topic; however, a research supervisor cannot guarantee that a particular project will provide suitable material for a thesis or dissertation. All assistantship appointments are subject to the continuing availability of funds. Appointments are made only when resources to support them are assured, but a financial emergency in the University could cause positions, including those of graduate assistants, to be terminated prior to the end of the appointment period. Assistantship support normally will not continue past the end of the semester in which the assistant expects to complete degree requirements. Some contracts or grants may specify U.S. citizenship as a prerequisite for appointment.

Graduate Administrative Assistants
A GAA performs administrative duties under the supervision of a faculty/staff member.

As a condition of an administrative assistantship appointment, a 20-hour per week graduate assistant must be registered for at least nine semester hours of graduate, credit courses during any semester (Fall or Spring), and for at least six hours during the Summer term. Minimum course loads for appointments of lesser work-hours per week are prorated accordingly. A student with a graduate administrative assistantship may be permitted to enroll in appropriate, relevant, undergraduate courses only with the approval of the supervisor, the department/program chair, and the Graduate Dean.

All assistantship appointments are subject to the continuing availability of funds. Appointments are made only when resources to support them are assured, but students are cautioned that a variety of circumstances could cause positions to be terminated prior to the end of the appointment period. All assistantships are awarded contingent upon satisfactory progress toward a graduate degree. Assistantship support may continue through one additional semester after the semester in which degree requirements are completed.

Further Information
If a student holding an assistantship withdraws from courses during the semester such that his/her course load is below the minimum required hours, that student can be required to reimburse the University for tuition prorated on the remaining course load. Students holding an assistantship that will not continue to make satisfactory progress toward their degree may have their assistantship revoked.

All GTA/GRAs are required to submit proof of health insurance to the Graduate School.

Graduate Fellowships
Several fellowship award programs exist, which can provide graduate student stipends, tuition allowances, and funds for other purposes (e.g., equipment purchase). Examples of such fellowships are the NASA Graduate Student Research Program (GSRP), National Science Foundation Fellowships, and Space Grant Fellowships. Announcements of these fellowships are typically made annually, both as brochures and on sponsoring websites. Interested students may also obtain information on such fellowships from departmental offices or http://www.uah.edu/graduate.
In addition, the Graduate Student Fellowship is awarded to newly admitted first-time, full-time students who have demonstrated superior academic achievement in their undergraduate education and who have submitted an application for admission, official transcripts, and standardized test scores to UAH are automatically considered for a Graduate Student Fellowship. Online students are ineligible for consideration. For more information, visit http://www.uah.edu/admissions/graduate.

Endowed fellowships for graduate study exist in several departments. See the graduate website at http://www.uah.edu/admissions/graduate for the most current listing.

International Students

Additional Admission Requirements for International Students

All applicants whose native language is other than English must demonstrate the linguistic proficiency necessary to function in degree programs at UAH.

1. Unconditional admission to degree programs.*
   a. In order to be considered for admission to degree programs with no additional English language training required, applicants must meet the following minimums on the TOEFL or IELTS.
      TOEFL (iBT): all sub-scores greater than or equal to 18 OR
      IELTS: all sub-scores greater than or equal to 6.0
   b. Students with two or more sub-scores below these minimum qualifications must enroll in the UAH Intensive Language and Culture (ILC) Program before they can enroll in graduate course work.
      *Language proficiency is only one factor in admission decisions. To confirm the full admission requirements for specific degree programs, please contact the department directly.

2. Admission to the ILC Program.
   a. Applicants who do not currently meet the requirements for admission to a degree program at the university are encouraged to apply for admission to the UAH Intensive Language and Culture (ILC) Program. Successful completion of the UAH ILC meets the language proficiency standard for admission to degree programs at the university.
   b. To be considered for admission to the UAH Intensive Language and Culture Program, applicants must have the following minimums on the TOEFL or IELTS.*
      TOEFL (iBT): Overall of at least 50 with no sub-score below 12 OR
      IELTS: Overall of at least 4.0 with no sub-score below 3.5
      *NOTE: If an applicant does not have a TOEFL or an IELTS score, he/she may request a pre-assessment and be considered for admission to the ILC. He/she will then be formally assessed upon arrival at UAH and will be placed in appropriate classes in the ILC program.

Nonnative English-speaking Graduate Teaching Assistants

To be considered for positions as teaching assistants or graduate assistants, students must have the following minimums on the TOEFL or IELTS.

TOEFL (iBT): no sub-score below 22 OR
IELTS: no sub-score below 6.5

*IBT = internet-based TOEFL; IELTS = International English Language Testing System

Official TOEFL or IELTS scores must be sent directly to the Graduate School from Educational Testing Services (ETS) or IELTS. College and/or departments may require a higher minimum TOEFL score for admission. All international applicants must apply for admission by the posted deadlines for the term in which they wish to enroll and all application materials must be received in the Office of Graduate Admissions by April 1 (September 1) for admission for the following Fall (Spring) semester.

In addition, all international students must request that:

1. One official copy in English of college or university transcripts be forwarded to UAH directly from the institution(s) attended. Do not send personal copies;
2. Graduate Record Examination (GRE) or Graduate Management Admission Test (GMAT) or Miller Analogies Test (MAT) scores, as appropriate, be sent directly to UAH from the testing service;
3. A certified financial statement be submitted as evidence of sufficient finances to cover fees and personal expenses while attending UAH. An Affidavit of Financial Support form is available at the Graduate School website. The completed affidavit form must be accompanied by a bank statement which indicates that there are sufficient funds to sponsor the student for one calendar year. This affidavit must be received before an I-20 can be issued. For more information about health insurance please see the following link http://www.uah.edu/health-and-wellness/student-health-center/student-insurance-plan. Proof of continued health insurance coverage must be presented by the student during each semester of enrollment.

Students who have earned a bachelor's or higher degree from an accredited U.S. institution will be exempted from the TOEFL, IELTS, TSE requirements above. Students with degrees from non-U.S. institutions that have English as their primary language of instruction (e.g. United Kingdom, Canada, Australia, etc.) may petition the Dean of the Graduate School for an exemption from the English Language Placement Test (ELPT).

For information about English language courses visit http://www.uah.edu/ilcp.
Non-Degree Admission

Students who are interested in earning graduate credit but who are not applicants for a graduate degree program at UAH may be admitted as non-degree graduate students. Admission in this category requires proof of a bachelor's degree from an accredited institution and department and/or college approval. This category is not available to students with non-immigrant visa status. Non-degree students are not eligible for federal financial aid.

All courses taken while in non-degree status require approval of the instructor. Students must maintain the same grade point average requirements expected of conditionally admitted graduate students. Graduate courses numbered 500 and above may be taken while in this category provided that all prerequisites have been met.

Individuals admitted as graduate non-degree students may decide to make formal application to a graduate degree or certificate program. If admitted, credit earned as a non-degree graduate student may be applied toward a graduate degree or certificate program subject to the following conditions and limitations:

- All grades earned in 500-level courses or above during non-degree status and applied to a graduate degree or certificate program must have been B or higher;
- No more than twelve (12) graduate semester hours for courses taken as a non-degree student may be applied to a degree program.
- Courses used to satisfy degree or certificate requirements are subject to approval by the major department and grades for those courses become part of the student's graduate program GPA.

Provisional Admission

A student (other than an individual with non-immigrant visa status) whose application to the Graduate School is not complete, or is pending approval, may, with departmental recommendation, be admitted to UAH on a provisional basis. Students admitted in this category may register for graduate level courses for one semester with approval from the department(s), provided that all prerequisites for those courses have been met. Students admitted provisionally are not eligible for federal financial aid.

Students admitted provisionally are not eligible for federal financial aid. Students may be admitted provisionally for one semester only unless specified otherwise by the Graduate Dean. Within that period they must complete their application materials in time to be considered for regular admission prior to the start of the next semester, usually by the 10th week of the semester. Students who do not complete the application process within the allowed period, or are subsequently not admitted to the graduate program, will not be allowed to take additional graduate classes as a degree-seeking student.

Once a student gains regular admission to the Graduate School, all policies regarding conditional or unconditional admission become effective in the provisionally admitted semester. Graduate credit for courses at the 500-level or above taken as a provisional student may, with approval of the major department, be applied toward a graduate degree program only if the grades earned in such courses were B or higher.

Seniors Taking Graduate Courses

UAH seniors may take up to 9 semester hours of courses (500 or 600 level) for graduate credit while completing requirements for the baccalaureate if they meet the following qualifications:

1. An approved degree application is on file;
2. Overall GPA, or GPA for the last 40 semester hours, is at least 3.5;
3. Fewer than 13 semester hours remaining for degree completion;
4. A total course load of no more than 12 semester hours a semester;
5. Permission of the instructor.

Students initiate the request process by filling out the Request for Approval of Graduate Credit by UAH Senior, (Form 16), which is available on the Graduate School website or in the Graduate School and which requires the approval of the department chair and graduate dean. Graduate tuition and fee rates apply to courses taken in this category. A student may not use courses taken for graduate credit as part of the baccalaureate degree under this option.

JUMP

UAH’s Joint Undergraduate Master’s Program (JUMP) allows undergraduate students to study at the graduate level. By taking graduate courses in your senior year undergraduates can reduce the time taken to get a graduate (MS) degree. For more information, please visit: http://www.uah.edu/jump

Tuition Scholarships

A limited number of tuition scholarships may be awarded to students without assistantship appointments who have unconditional admission status and are in good academic standing. Such scholarships may be awarded for up to 9 graduate semester hours per semester (6 semester hours in the summer term). Students receiving tuition scholarships are bound by the same rules as graduate assistants with respect to course withdrawal, contingency of the award on satisfactory performance toward the graduate degree, general eligibility, and special department requirements.
The departmental faculty select the proposed awardees from qualified applicants. An appointment letter, similar to a graduate assistantship letter but without assigned duties, is prepared by the department chair and sent through the college dean to the graduate dean for approval at least one month prior to the start of the semester in which the scholarship is proposed.

Additional scholarships may be available. Please visit our financial aid website to learn more: http://www.uah.edu/admissions/graduate/financial-aid

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**College of Arts, Humanities, and Social Sciences**

256 Morton Hall
Telephone: 256.824.6200
Email: dean-la@uah.edu

**Degree**

Master of Arts

**Interim Dean:** Andy Cling, Ph.D., Professor of Philosophy

**Mission**

The College of Arts, Humanities, and Social Sciences is committed to excellence in teaching, research, and service in the following disciplines:

• fine arts,
• humanities,
• the social and behavioral sciences, and
• teacher education.

For its own majors, as for those in the professional schools, the College strives to provide superior liberal arts education characterized by close interaction between teachers and learners. Its goals are to impart to each student

• a spirit of intellectual curiosity,
• critical thinking skills,
• abilities in writing and oral communication,
• aesthetic awareness and creativity,
• familiarity with human history and behavior,
• a knowledge of languages and cultures, and
• an understanding of the bases of ethical behavior and the duties of citizenship.

Believing in the centrality of liberal learning to the mission of a university, the College is committed to maintaining a diverse community of teacher-scholars of the highest quality and to providing an environment that encourages personal and professional growth. It considers teaching and research
mutually enriching activities and strives to make its knowledge and expertise available to professional programs on campus and to the educational needs of society. Through its graduates and programs, the College contributes to the cultural, intellectual, and economic growth of the state and nation.

Accreditation

UAH is accredited by the Southern Association of Colleges and Schools Commission on Colleges (SACSCOC) to award bachelor's, master's, and doctoral degrees. Contact the Commission on Colleges at 1866 Southern Lane, Decatur, Georgia 30033-4097 or call 404.679.4500 for questions about the accreditation of UAH. The College of Arts, Humanities, and Social Sciences thus offers baccalaureate and master's programs under the auspices of that accrediting body. In addition, The University of Alabama in Huntsville is an accredited institutional member of the National Association of Schools of Art and Design and the National Association of Schools of Music. Teacher education programs are approved by the Alabama State Board of Education, according to standards of the National Association of the State Directors of Teacher Education and Certification (NASDTEC), for the issuance of appropriate professional certificates for service in public schools, and the Department of Education at The University of Alabama in Huntsville is accredited by the National Council for Accreditation of Teacher Education (NCATE).

Facilities

The College of Arts, Humanities, and Social Sciences utilizes the facilities and resources of the entire university. However, the College is housed primarily in two buildings, namely Morton Hall and Roberts Hall. Critical to study of the liberal arts is the Salmon Library, located in close proximity to both Morton and Roberts Halls. Supporting facilities include the instructional computer laboratories on the second floor of Salmon Library, art galleries in several buildings, and Union Grove Gallery and Meeting Hall, an historic church moved to campus in 1974 and currently used as an art gallery and a meeting place for students and faculty.

The Humanities Center

The Humanities Center was established in 1991 with the aid of an award from the National Endowment for the Humanities (NEH). The NEH award was a challenge grant that was subsequently matched by funds from other sources, including public, corporate, and private giving, to create the three endowments that support the Center's activities in five areas:

1. hiring of eminent and visiting scholars,
2. library enhancement grants,
3. public programming grants,
4. faculty travel, and
5. faculty research.

The Humanities Center is located on the second floor of Morton Hall.

Degrees and Programs

Graduate study in the College of Arts, Humanities, and Social Sciences brings together faculty and advanced students to share the excitement of creative learning. All degree candidates plan a Program of Study with faculty members who share the student's intellectual interests. Students design, in consultation with a faculty advisor, a graduate program fitted to their particular interests and needs.

The College of Arts, Humanities, and Social Sciences offers programs of study leading to the Master of Arts degree in

- English,
- History,
- Professional Communication,
- Psychology, and
- Public Affairs.

Class A teacher certification is available with degree programs in English and History, as well as the disciplines of Biology, Chemistry, Mathematics and Physics (offered within the College of Science).

Teacher certification may be achieved through either traditional (including the Strengthened Subject Matter Option or the Technology Option) or non-traditional "fifth year" approaches. Those students who have earned graduate degrees in appropriate disciplines may be eligible for certification only programs.

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<tr>
<th>Discipline</th>
<th>Degree</th>
<th>Focus</th>
</tr>
</thead>
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<td>English</td>
<td>M.A.</td>
<td>Literature, Teacher Preparation, Teaching English to Speakers of Other Languages, Technical Communication</td>
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History

Professional Communication

Public Affairs

Psychology

Teacher Preparation Graduate Programs

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<th>Discipline</th>
<th>Degree</th>
<th>Focus</th>
<th>Teacher Certification</th>
<th>Traditional</th>
<th>Strengthened Subject Matter Option</th>
<th>Traditional w/ Technology</th>
<th>Nontraditional Fifth Year</th>
<th>Certification Only¹</th>
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<td>English</td>
<td>M.A.</td>
<td>English Language Arts</td>
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<td>History</td>
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<td>6-12</td>
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<td>Biology²</td>
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<td>Chemistry²</td>
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</tbody>
</table>

¹ For those who have already earned appropriate graduate degrees, but who seek teacher certification.
² Offered within the College of Science.

Master’s Programs in Arts, Humanities, and Social Sciences

- English, MA (p. 18)
- History, MA (p. 22)
- Political Science - Public Affairs, MA (p. 24)
- Professional Communication, MA (p. 25)
- Psychology, MA (p. 27)
- Psychology, MA - Industrial/Organizational Psychology Specialization (p. 28)

Certificates in Arts, Humanities, and Social Sciences

- Technical Communication (p. 21)
- TESOL Certificate (p. 22)

English

Students wishing to pursue graduate work in English have a number of options, ranging from certificates (http://catalog.uah.edu/grad/colleges-departments/arts-humanities-social-sciences/english-ma/#programtext) that prepare them to pursue professional opportunities in technical writing (http://catalog.uah.edu/grad/colleges-departments/arts-humanities-social-sciences/english-ma/tech-writing) or teaching (either in English (http://catalog.uah.edu/grad/colleges-departments/arts-humanities-social-sciences/english-ma/fifth-year) or English as a Second Language (http://catalog.uah.edu/grad/colleges-departments/arts-humanities-social-sciences/english-ma/tesol)), to more standard M.A. programs with (http://catalog.uah.edu/grad/colleges-departments/arts-humanities-social-sciences/english-ma/thesis) or without (http://catalog.uah.edu/grad/colleges-departments/arts-humanities-social-sciences/english-ma/capstone) a thesis. Students are encouraged to consult with their advisors or the Director of Graduate Studies (laurel.bollinger@uah.edu) to select the program that best meets their needs. Specific requirements for each program are available under the Programs tab on this page.

Master of Arts in English:

- English, MA Thesis Option (Plan I) (p. 19)
- English, MA Capstone Project (Plan II) (p. 19)
- English, MA with Technical Communication Certificate (p. 20)
English, MA Plan I - Thesis Option

Thesis Requirements:
All Master of Arts in English Programs share certain basic requirements (http://www.uah.edu/ahs/departments/english/graduate-program/74-main/arts-humanities-social-sciences/english/7076-graduate-program-in-english-ma)(listed below).

This program leads to an M.A. in English, and includes the thesis option. You take 24 hours of coursework (8 courses) in English, plus a minimum of six hours of thesis credit (EH 699). The six hours would ordinarily be spread across a minimum of two semesters, generally toward the end of your program. If you are not finished with the thesis at the end of those 6 hours, you may take additional thesis hours, subject to the rules about time-to-completion of the degree. You must register for thesis hours in the semester you complete and defend the thesis, and in any other semester or term where you anticipate requiring your advisor's assistance. Other than basic requirements overviewed below, there are no other specific courses required. For more on the thesis, contact the Director of English Graduate Studies (laurel.bollinger@uah.edu).

Basic Requirements:
- At least one third of the hours you take toward your degree should be at the 600 level.
- At least 18 hours in your program should be in literature. To count, a course should deal with literature directly, rather than with writing or other topics. Please check to confirm if you have any questions about a specific course. Special certificate programs require additional hours that are determined in consultation with the appropriate program advisors.
- You must complete all work toward your degree within thirty semesters of the first course you take (counting summers). Courses taken between eighteen and thirty semesters prior to your degree program completion date may be re-validated by departmental exams negotiated with the specific faculty member who has responsibility for that course; any graduate course more than thirty semesters old may not be used.
- EH 540 and EH 649 indicate “Special Topics” courses. Often these are new courses, or courses taught by visiting faculty. You may include any number of these classes in your program of study, as long as you meet other requirements.
- Up to nine hours of graduate work in English may be transferred from other institutions with the approval of the Director of Graduate Studies (laurel.bollinger@uah.edu). At least nine hours in English courses numbered 500 or above must be completed here at UAH (exclusive of thesis hours).
- To be a full-time student, you will need to take a course load of 9 hours per semester. While you are permitted to take up to 13 semester hours per term, you should consult with the Director of Graduate Studies (laurel.bollinger@uah.edu) about doing so.
- You must maintain a 3.0 G.P.A. in all courses taken at the graduate level. If in any semester your cumulative G.P.A. falls below that 3.0 level, you will be on probation. You might also wish to assess your commitment to a graduate program.
- All students complete either a thesis or a capstone project. For more information, see the FAQ (https://www.uah.edu/ahs/departments/english/programs/graduate/faq) on the English Department Graduate page.

English, MA Plan II - Capstone Option

Capstone Requirements:
This option leads to an M.A. in English but does not require a thesis. Instead, you will take 33 hours (11 courses) in English, subject to the basic requirements overviewed below. At the end of your program, generally in the final semester you anticipate being enrolled, you would complete a Graduate Capstone Project. For more information contact the Director of English Graduate Studies (laurel.bollinger@uah.edu) or review the FAQ (https://www.uah.edu/ahs/departments/english/programs/graduate/faq) page on the Graduate section of the English Department’s webpage.

Basic Requirements:
- At least one third of the hours you take toward your degree should be at the 600 level.
- At least 18 hours in your program should be in literature. To count, a course should deal with literature directly, rather than with writing or other topics. Please check to confirm if you have any questions about a specific course. Special certificate programs require additional hours that are determined in consultation with the appropriate program advisors.
- You must complete all work toward your degree within thirty semesters of the first course you take (counting summers). Courses taken between eighteen and thirty semesters prior to your degree program completion date may be re-validated by departmental exams negotiated with the specific faculty member who has responsibility for that course; any graduate course more than thirty semesters old may not be used.
- EH 540 and EH 649 indicate “Special Topics” courses. Often these are new courses, or courses taught by visiting faculty. You may include any number of these classes in your program of study, as long as you meet other requirements.
- Up to nine hours of graduate work in English may be transferred from other institutions with the approval of the Director of Graduate Studies (laurel.bollinger@uah.edu). At least nine hours in English courses numbered 500 or above must be completed here at UAH (exclusive of thesis hours).
- To be a full-time student, you will need to take a course load of 9 hours per semester. While you are permitted to take up to 13 semester hours per term, you should consult with the Director of Graduate Studies (laurel.bollinger@uah.edu) about doing so.
- You must maintain a 3.0 G.P.A. in all courses taken at the graduate level. If in any semester your cumulative G.P.A. falls below that 3.0 level, you will be on probation. You might also wish to assess your commitment to a graduate program.
- All students complete either a thesis or a capstone project. For more information, see the FAQ (https://www.uah.edu/ahs/departments/english/programs/graduate/faq) on the English Department Graduate page.

Graduate Capstone Project. For more information contact the Director of English Graduate Studies (laurel.bollinger@uah.edu) or review the FAQ (https://www.uah.edu/ahs/departments/english/programs/graduate/faq) page on the Graduate section of the English Department’s webpage.

Technical Communication Certificate (p. 21)
TESOL Certificate (p. 22)

- English, MA with TESOL Certificate (p. 20)
- JUMP Program (http://catalog.uah.edu/undergrad/academic-information/jump)
• Up to nine hours of graduate work in English may be transferred from other institutions with the approval of the Director of Graduate Studies (laurel.bollinger@uah.edu). At least nine hours in English courses numbered 500 or above must be completed here at UAH (exclusive of thesis hours).

• To be a full-time student, you will need to take a course load of 9 hours per semester. While you are permitted to take up to 13 semester hours per term, you should consult with the Director of Graduate Studies (laurel.bollinger@uah.edu) about doing so.

• You must maintain a 3.0 GPA in all courses taken at the graduate level. If in any semester your cumulative GPA falls below that 3.0 level, you will be on probation. You might also wish to assess your commitment to a graduate program.

• All students complete either a thesis or a capstone project. For more information, see the FAQ (https://www.uah.edu/ahs/departments/english/programs/graduate/faq) on the English Department Graduate page.

English, MA with Technical Communication Certificate

Technical Communication Certificate Requirements:

This program leads to an M.A. in English with a Graduate Certificate in Technical Communication. In addition to the basic requirements listed below, this program requires additional coursework in technical writing and editing as well as coursework in a technical or allied field. Those courses will be determined in consultation with the Director of Technical Writing (rw0019@uah.edu). The program requires 12 courses (36 hours) for completion, 6 of which (18 hours) will be in literature. You will need to complete either a Capstone Project or a Thesis. The other course requirements are as follows:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH 501</td>
<td>THRY &amp; PRACTICE TECHNICAL COMM</td>
<td>3</td>
</tr>
<tr>
<td>EH 603</td>
<td>EDITING FOR PUBLICATION</td>
<td>3</td>
</tr>
<tr>
<td>EH Technical Writing Elective, 600 level</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>EH Technical Writing Elective</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Allied Field Course</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Allied Field Course</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Literature Electives</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td><strong>Total Semester Hours</strong></td>
<td><strong>36</strong></td>
<td></td>
</tr>
</tbody>
</table>

Basic Requirements:

• At least one third of the hours you take toward your degree should be at the 600 level.

• At least 18 hours in your program should be in literature. To count, a course should deal with literature directly, rather than with writing or other topics. Please check to confirm if you have any questions about a specific course. Special certificate programs require additional hours that are determined in consultation with the appropriate program advisors.

• You must complete all work toward your degree within thirty semesters of the first course you take (counting summers). Courses taken between eighteen and thirty semesters prior to your degree program completion date may be re-validated by departmental exams negotiated with the specific faculty member who has responsibility for that course; any graduate course more than thirty semesters old may not be used.

• EH 540 and EH 649 indicate “Special Topics” courses. Often these are new courses, or courses taught by visiting faculty. You may include any number of these classes in your program of study, as long as you meet other requirements.

• Up to nine hours of graduate work in English may be transferred from other institutions with the approval of the Director of Graduate Studies (laurel.bollinger@uah.edu). At least nine hours in English courses numbered 500 or above must be completed here at UAH (exclusive of thesis hours).

• To be a full-time student, you will need to take a course load of 9 hours per semester. While you are permitted to take up to 13 semester hours per term, you should consult with the Director of Graduate Studies (laurel.bollinger@uah.edu) about doing so.

• You must maintain a 3.0 GPA in all courses taken at the graduate level. If in any semester your cumulative GPA falls below that 3.0 level, you will be on probation. You might also wish to assess your commitment to a graduate program.

• All students complete either a thesis or a capstone project. For more information, see the FAQ (https://www.uah.edu/ahs/departments/english/programs/graduate/faq) on the English Department Graduate page.

English, MA with TESOL Certificate

TESOL Certificate Requirements:

This program leads to an M.A. in English with a certificate in Teaching English as a Second Language (TESOL). In addition to the basic requirements for the M.A. listed below, this program requires additional coursework in TESOL. The program offers tracks that prepare students for one of two opportunities: A) instruction at post-secondary/adult levels, or B) technical communication in corporate/non-profit settings. Either program might prepare a student to pursue doctoral work in applied linguistics or other areas of English Studies. Specific decisions should be reached in consultation with the
The University of Alabama in Huntsville - DRAFT COPY

The program requires 12 courses (36 hours) for completion, 6 of which (18 hours) will be in literature. You will need to complete either a Capstone Project or a Thesis in addition to a Practicum Project (EHL 610). The other course requirements are as follows:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHL 505</td>
<td>SURVEY OF GENERAL LINGUISTICS</td>
<td>3</td>
</tr>
<tr>
<td>EHL 507</td>
<td>ADV ENGLISH GRAMMAR STUDIES</td>
<td>3</td>
</tr>
<tr>
<td>ED 640</td>
<td>DIFD STRGTY RES &amp; TEACH ELL</td>
<td>3</td>
</tr>
<tr>
<td>EHL 610</td>
<td>AP EH LI VI:PRACTICUM TESOL</td>
<td>3</td>
</tr>
</tbody>
</table>

Choose one option below

Option A: Instruction
- EH 500 COMPOSITION STUDIES TCHRS
- EH 601 ACTION RESCH WRITING STUDIES

Option B: Technical Communication
- EH 501 THRY & PRACTICE TECHNICAL COMM
- EH 603 EDITING FOR PUBLICATION

Literature Electives
18

Total Semester Hours
36

Basic Requirements:

- At least one third of the hours you take toward your degree should be at the 600 level.
- At least 18 hours in your program should be in literature. To count, a course should deal with literature directly, rather than with writing or other topics. Please check to confirm if you have any questions about a specific course. Special certificate programs require additional hours that are determined in consultation with the appropriate program advisors.
- You must complete all work toward your degree within thirty semesters of the first course you take (counting summers). Courses taken between eighteen and thirty semesters prior to your degree program completion date may be re-validated by departmental exams negotiated with the specific faculty member who has responsibility for that course; any graduate course more than thirty semesters old may not be used.
- EH 540 and EH 649 indicate “Special Topics” courses. Often these are new courses, or courses taught by visiting faculty. You may include any number of these classes in your program of study, as long as you meet other requirements.
- Up to nine hours of graduate work in English may be transferred from other institutions with the approval of the Director of Graduate Studies (laurel.bollinger@uah.edu). At least nine hours in English courses numbered 500 or above must be completed here at UAH (exclusive of thesis hours).
- To be a full-time student, you will need to take a course load of 9 hours per semester. While you are permitted to take up to 13 semester hours per term, you should consult with the Director of Graduate Studies (laurel.bollinger@uah.edu) about doing so.
- You must maintain a 3.0 GPA in all courses taken at the graduate level. If in any semester your cumulative GPA falls below that 3.0 level, you will be on probation. You might also wish to assess your commitment to a graduate program.
- All students complete either a thesis or a capstone project. For more information, see the FAQ (https://www.uah.edu/ahs/departments/english/programs/graduate/faq) on the English Department Graduate page.

Technical Communication Certificate

The English Department offers an 18-credit-hour Graduate Certificate in Technical Communication. This Certificate prepares students for careers in technical communication, technical editing, graphic design, proposal writing, and user experience. In preparation for future employment, certificate students get exposure to real-world documents and writing opportunities, both in class and through optional internships. The programs routinely offers special studies courses in topics including Proposal Writing, Document Design, and Writing about Science and Technology. Students also use current technical communication software, such as Adobe and MadCap products.

The Graduate Certificate requires four graduate English courses in technical writing or editing, including EH 501 and EH 603 as well as two English Electives (including EH 542, EH 552, EH 554, EH 601, EH 602, EH 649, and EH 662). In addition, students take two related graduate courses outside of English in an allied field (http://www.uah.edu/la/departments/english/graduate-program/74-main/liberal-arts/english/7080-graduate-certificate-in-technical-writing-allied) selected in consultation with the Director of Business and Technical Writing (rw0019@uah.edu). Graduate Certificate in Technical Communication students enroll in the following Program of Study (POS):

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH 501</td>
<td>THRY &amp; PRACTICE TECHNICAL COMM</td>
<td>3</td>
</tr>
<tr>
<td>EH 603</td>
<td>EDITING FOR PUBLICATION</td>
<td>3</td>
</tr>
</tbody>
</table>
Students who wish to earn the Graduate Certificate in Technical Communication must be admitted to the Graduate School (http://grad.uah.edu), but may pursue the certificate independent of a master’s degree program. These courses may also count toward a master’s degree in English if the student meets admission requirements for the M.A.

No more than six credit hours taken at another institution may be applied to the certificate, and certificate courses taken at UAH must include EH 501 and EH 603.

For further information about UAH programs in technical communication, contact Dr. Ryan Weber, Director of Business and Technical Writing, at rw0019@uah.edu.

### TESOL Certificate

This program leads to a graduate certificate in Teaching English as a Second Language (TESOL). The program offers tracks that prepare students for one of two opportunities: A) instruction at post-secondary/adult levels, or B) technical communication in corporate/non-profit settings. Specific decisions should be reached in consultation with the director of TESOL (worda@uah.edu). The program requires 6 courses (18 hours) for completion. You will need to complete a Practicum Project (EHL 610). The course requirements are as follows:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHL 505</td>
<td>SURVEY OF GENERAL LINGUISTICS</td>
<td>3</td>
</tr>
<tr>
<td>EHL 507</td>
<td>ADV ENGLISH GRAMMAR STUDIES</td>
<td>3</td>
</tr>
<tr>
<td>ED 640</td>
<td>DIFD STRGTY RES &amp; TEACH ELL</td>
<td>3</td>
</tr>
<tr>
<td>EHL 610</td>
<td>AP EH LI VI: PRACTICUM TESOL</td>
<td>3</td>
</tr>
<tr>
<td>Allied Field Course</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Allied Field Course</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Total Semester Hours</td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

### History, MA

In addition to the requirements of UAH’s graduate school, the History Department requires the following for the Master of Arts degree:

**Plan A: Thesis with Language**

1. 30 semester hours total.
2. HY 605 is required.
3. At least nine additional semester hours in courses numbered 600 or above (excluding thesis semester hours at UAH). At least 50 percent of the semester hours for a graduate degree (excluding thesis semester hours) in courses numbered 600 or above.
4. At least twelve additional semester hours in courses numbered 500 or above (excluding thesis semester hours at UAH).
5. Within the 24 non-thesis semester hours, eighteen semester hours of graduate work in history.
   a. Equal course distribution of U.S. and non-U.S. history is expected within these 18 semester hours.
   b. Twelve semester hours may be transfer credit approved by the departmental graduate committee.
   c. Six semester hours of elective graduate courses in a related subject approved by the graduate committee.
6. Master's thesis carrying a minimum of six semester hours credit; In order to write a thesis, the student must have a 3.75 GPA in the first twelve semester hours taken, or permission of the department chair.
7. Reading proficiency in French, German, Latin, Russian, or Spanish.
8. Oral comprehensive examination covering courses and thesis. Students must demonstrate competency in at least two fields of history.

**Plan B: Thesis without Language**

Same as above, excluding language requirement.
Plan C: Non-Thesis
1. 33 semester hours total.
2. HY 605 is required.
3. Fifteen additional semester hours in courses 600 or above. At least 50 percent of the semester hours for a graduate degree (excluding thesis semester hours) in courses numbered 600 or above.
4. At least fifteen additional semester hours in courses numbered 500 or above (excluding thesis semester hours at UAH).
5. Within thirty-three semester hours total,
   a. Eighteen semester hours equally distributed between U.S. and non-U.S. history.
   b. Twelve semester hours in history may be transfer credit approved by the departmental graduate committee.
   c. Six semester hours of elective graduate courses a related subject approved by the graduate committee.
6. Oral and written comprehensive examination covering coursework. Students must demonstrate competency in at least two fields of history.

The requirements for the Master of Arts degree for those students seeking Class A certification are the same as above with the following exceptions:

Class A Teacher Certification in History (non-thesis)
1. 33 semester hours total;
2. Nine semester hours in courses 600 or above in Education;
3. HY 605 is required;
4. Six additional semester hours in courses 600 or above are required. At least 50 percent of the semester hours for a graduate degree (excluding thesis semester hours) in courses numbered 600 or above;
5. At least fifteen additional semester hours in history courses numbered 500 or above (excluding thesis semester hours at UAH);
6. Within twenty-four semester hours in history sub-total,
   a. Eighteen semester hours equally distributed between U.S. and non-U.S. history.
   b. Twelve semester hours in history may be transfer credit approved by the departmental graduate committee.
   c. Six semester hours of elective graduate courses a related subject approved by the graduate committee.
7. Oral and written comprehensive examination covering coursework. Students must demonstrate competency in at least two fields of history.
8. The College of Education will coordinate and direct any supplementary requirements.

The History Department does not recommend undertaking an MA thesis in History and teacher certification. If a student wishes to pursue this option, they should consult with the History Department Chair.

Graduate Certificates

• Comparative Cultures and Conflicts (p. 23)

Comparative Cultures and Conflicts Certificate

The Comparative Cultures and Conflicts certificate program offers post-baccalaureate students a program of study that will establish a global context for their careers in the civilian and military sectors. The program will contextualize the cultural, diplomatic, military, and economic variables that influence various societies around the world and explain how these societies interact with the United States and the global community as a whole.

CCC STUDENT LEARNING OUTCOMES

Upon completion of the certificate, students will be able to:

1) Analyze contemporary global patterns to show how various regions and cultures develop over time.
2) Explain the historical causes and contexts of contemporary conflicts, both within and among states.
3) Discuss the historical context of U.S. relations and interactions with the world.
4) Compare the ways nations, groups, and individuals experience conflict.
5) Practice historical thinking as central to engaged citizenship and leadership.
6) Communicate historical knowledge and interpretation coherently in writing and in oral presentations.

CCC REQUIREMENTS
Course Requirements: To complete the CCC program, students must complete 15 semester hours selected from the following History classes:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY 538</td>
<td>MODERN AMERICA</td>
<td>3</td>
</tr>
<tr>
<td>HY 539</td>
<td>RECENT AMERICAN HISTORY</td>
<td>3</td>
</tr>
<tr>
<td>HY 540</td>
<td>FOREIGN REL U.S. SINCE 1920</td>
<td>3</td>
</tr>
<tr>
<td>HY 545</td>
<td>COMPTVE MILITARY PLCY &amp; STRAT</td>
<td>3</td>
</tr>
<tr>
<td>HY 572</td>
<td>US MILITARY HISTORY SINCE 1920</td>
<td>3</td>
</tr>
<tr>
<td>HY 573</td>
<td>US-LATIN AMERICAN RELATIONS</td>
<td>3</td>
</tr>
<tr>
<td>HY 575</td>
<td>SECTARIANISM ISLAMIC WORLD</td>
<td>3</td>
</tr>
<tr>
<td>HY 576</td>
<td>BEING YOUNG MODERN MIDDLE EAST</td>
<td>3</td>
</tr>
<tr>
<td>HY 585</td>
<td>NAZI GERMANY AND THE HOLOCAUST</td>
<td>3</td>
</tr>
<tr>
<td>HY 586</td>
<td>COMMUNISM &amp; LEGACY IN RUS/E-EUR</td>
<td>3</td>
</tr>
<tr>
<td>HY 620</td>
<td>STUDIES 20TH CENT AM HY</td>
<td>3</td>
</tr>
<tr>
<td>HY 645</td>
<td>READINGS AMERICAN MILITARY HY</td>
<td>3</td>
</tr>
<tr>
<td>HY 690</td>
<td>STUDIES IN MODERN EUROPE</td>
<td>3</td>
</tr>
<tr>
<td>HY 695</td>
<td>STUDIES IN WORLD HISTORY</td>
<td>3</td>
</tr>
</tbody>
</table>

Three of the 15 semester hours may be from Political Science, selected from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSC 540</td>
<td>REGIONAL STUDIES</td>
<td>3</td>
</tr>
<tr>
<td>PSC 562</td>
<td>DECISION-MAKING FORGN &amp; SEC PLY</td>
<td>3</td>
</tr>
<tr>
<td>PSC 564</td>
<td>AMERICAN FOREIGN POLICY</td>
<td>3</td>
</tr>
<tr>
<td>PSC 566</td>
<td>NATIONAL SECURITY STRGY &amp; PLY</td>
<td>3</td>
</tr>
<tr>
<td>PSC 570</td>
<td>ISSUES IN SECURITY POLICY</td>
<td>3</td>
</tr>
</tbody>
</table>

Portfolio Requirements: In the final term of study, certificate candidates will prepare a Capstone Portfolio and Presentation for the Comparative Conflicts and Cultures Steering Committee, which consists of the department chair and three additional participating faculty members. The committee will assess the portfolio and presentation. This portfolio will feature three papers or projects prepared for three different classes completed as part of the certificate program, as well as a cover letter which specifically discusses how the papers included within the portfolio address the first five Student Learning Outcomes (see above). It is not expected that each individual paper address all SLOs, but the portfolio as a whole must display the student’s mastery of each SLO. Students will complete a Capstone Presentation of approximately 20 minutes in length, which will discuss the papers within the portfolio and the cover letter. Following the Presentation, the Comparative and Cultures Steering Committee will ask the student questions about the student’s broader experience within the program.

Political Science - Public Affairs, MA

The Master of Arts in Public Affairs (public policy) requires 36 semester hours of approved graduate work from the following courses. Select a minimum of 12 semester hours at the 600-level.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSC 600</td>
<td>THE AMERICAN POLITY</td>
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</tr>
<tr>
<td>PSC 601</td>
<td>THE PUBLIC POLICY PROCESS</td>
<td></td>
</tr>
<tr>
<td>PSC 610</td>
<td>PUBLIC MANAGEMENT PROFESSIONS</td>
<td></td>
</tr>
<tr>
<td>PSC 635</td>
<td>PROGRAM EVALUATION AND METHODS</td>
<td></td>
</tr>
</tbody>
</table>

Political Science Electives: 21

Select 21 semester-hours from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSC 520</td>
<td>FEDERALISM &amp; INTERGOV RELATION</td>
<td></td>
</tr>
<tr>
<td>PSC 540</td>
<td>REGIONAL STUDIES</td>
<td></td>
</tr>
<tr>
<td>PSC 551</td>
<td>LAW, COURTS &amp; PUBLIC POLICY</td>
<td></td>
</tr>
<tr>
<td>PSC 562</td>
<td>DECISION-MAKING FORGN &amp; SEC PLY</td>
<td></td>
</tr>
<tr>
<td>PSC 564</td>
<td>AMERICAN FOREIGN POLICY</td>
<td></td>
</tr>
<tr>
<td>PSC 566</td>
<td>NATIONAL SECURITY STRGY &amp; PLY</td>
<td></td>
</tr>
</tbody>
</table>
PSC 570  ISSUES IN SECURITY POLICY  3  
PSC 580  SPECIAL TOPICS IN POLITICAL SC  
PSC 611  PUBLIC PERSONNEL ADMINIS  
PSC 612  BUDGETARY PROCESS  
PSC 615  SPEC TOPICS IN PUBLIC AFFAIRS  
PSC 630  PUBL VALUES/PUBL POLICY  
PSC 695  INTERNSHIP IN GOVERNMENT  
PSC 698  DIRECTED READINGS & RESEARCH  
PSC 699  MASTER'S THESIS  

Capstone Course  
PSC 690  CAPSTONE  3  

Other Options  

**Total Semester Hours**  36  

1. Although these courses are required, they are not strictly prerequisites for other courses in the program. However, it is advised that students complete them as early in their program as practical.  
2. The Capstone course is required and should be taken during the last year of the program.  
3. Students may take or transfer a maximum of nine hours of coursework from outside of the department, including from other universities. Students must consult with the department chair to determine the appropriate coursework from other disciplines.  

The International Security Policy (ISP) Certificate Program provides students with a shorter graduate program experience. The ISP certificate is awarded upon the completion of 12-15 semester hours of graduate courses from the following schedule:  

Prerequisites for the Certificate:  
• If a student does not have at least three courses in Political Science as an undergraduate (including American Government), prior to taking the required coursework he or she must take PSC 600.  

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td>PSC 540</td>
<td>REGIONAL STUDIES</td>
<td>3</td>
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<tr>
<td>PSC 562</td>
<td>DECISION-MAKING FORGN &amp; SEC PLY</td>
<td>3</td>
</tr>
<tr>
<td>PSC 566</td>
<td>NATIONAL SECURITY STRGY &amp; PLY</td>
<td>3</td>
</tr>
<tr>
<td>or PSC 564</td>
<td>AMERICAN FOREIGN POLICY</td>
<td></td>
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</tbody>
</table>

Electives (Choose one):  
• PSC 564  AMERICAN FOREIGN POLICY  3  
• PSC 566  NATIONAL SECURITY STRGY & PLY  3  
• PSC 570  ISSUES IN SECURITY POLICY  3  
• PSC 601  THE PUBLIC POLICY PROCESS  3  

**Professional Communication, MA**  
The Master of Arts in Professional Communication prepares students to work in communication intensive jobs, including social media management, user experience, advertising, public relations, professional writing, human resources, fundraising, event management, general management, training, and consulting, among other things. It fosters basic understanding of communication processes, including:  
• Understanding of the major theoretical concepts and practical applications associated with the study of human communication  
• The ability to conduct scientific research ethically and effectively, to interpret statistical information, and to assess its practical import for understanding communication in the world.  
• Understanding of variables in communication situations, including the number (especially as it impacts interaction), background, interests, and values of participants; language, communication purposes, and contextual factors.  
• Understanding of the implications of a multicultural world on appropriate and effective forms of communication.  
• Understanding of how to adapt to variable communication situations for informative and persuasive purposes.
• Understanding of special forms of communication such as that related to advertising, public relations, social media, technical writing, and communication technology, among others.

• The ability to effectively produce and critically analyze persuasive messages.

Students in the MA in Professional Communication must complete 33 total hours, including the core requirements and either Plan I (non-thesis) or Plan II (thesis). They may select electives freely or follow one of the suggested emphases below. All students must complete 33 hours, including 18 hours of 600-level coursework (excluding CM 699).

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM 555</td>
<td>COMMUNICATION AND CULTURE</td>
<td>3</td>
</tr>
<tr>
<td>CM 631</td>
<td>ADVANCED COMMUNICATION THEORY</td>
<td>3</td>
</tr>
<tr>
<td>CM 633</td>
<td>INTERPERSONAL COMMUNICATION</td>
<td>3</td>
</tr>
<tr>
<td>CM 670</td>
<td>ADVANCED COMMUNICATION METHODS</td>
<td>3</td>
</tr>
<tr>
<td>CM 675</td>
<td>RHETORICAL CRITICISM</td>
<td>3</td>
</tr>
</tbody>
</table>

**Plan I: MA without Thesis**

Choose 18 hours of electives from the list below (including at least 3 hours of 600-level coursework, excluding CM 699), which may be freely chosen or may follow one of the suggested emphases identified below.

**Plan II: MA with Thesis**

• Choose 12 hours of electives from the list below (including at least 3 hours of 600-level coursework excluding CM 699), which may follow one of the suggested emphases identified below.

• Six (6) hours of CM 699 Master’s Thesis

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM 505</td>
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</tr>
<tr>
<td>CM 535</td>
<td>SOCIAL MEDIA</td>
<td></td>
</tr>
<tr>
<td>CM 540</td>
<td>PUBLIC RELATIONS CAMPAIGNS</td>
<td></td>
</tr>
<tr>
<td>CM 554</td>
<td>NEW MEDIA WRITING &amp; RHETORIC</td>
<td></td>
</tr>
<tr>
<td>CM 552</td>
<td>USER-CENTERED DESIGN</td>
<td></td>
</tr>
<tr>
<td>EH 542</td>
<td>USABILITY STUDIES</td>
<td></td>
</tr>
<tr>
<td>CM 662</td>
<td>INFORMATION ARCHITECTURE</td>
<td></td>
</tr>
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</table>

**Suggested Emphases for Selecting Electives**

**Social Media**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM 505</td>
<td>ADVANCED MEDIA WRITING</td>
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</tr>
<tr>
<td>CM 635</td>
<td>Course CM 635 Not Found</td>
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</tr>
<tr>
<td>CM 535</td>
<td>SOCIAL MEDIA</td>
<td></td>
</tr>
<tr>
<td>CM 540</td>
<td>PUBLIC RELATIONS CAMPAIGNS</td>
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</tr>
<tr>
<td>CM 554</td>
<td>NEW MEDIA WRITING &amp; RHETORIC</td>
<td></td>
</tr>
</tbody>
</table>

**User Experience**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM 552</td>
<td>USER-CENTERED DESIGN</td>
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<tr>
<td>EH 542</td>
<td>USABILITY STUDIES</td>
<td></td>
</tr>
<tr>
<td>CM 662</td>
<td>INFORMATION ARCHITECTURE</td>
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</tbody>
</table>

**Approved Elective**

**Advertising/Public Relations**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td>CM 505</td>
<td>ADVANCED MEDIA WRITING</td>
<td></td>
</tr>
<tr>
<td>CM 544</td>
<td>ADVERTISING</td>
<td></td>
</tr>
<tr>
<td>CM 520</td>
<td>PUBLIC RELATIONS WRITING</td>
<td></td>
</tr>
</tbody>
</table>

**Professional Writing**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH 554</td>
<td>NEW MEDIA WRITING &amp; RHETORIC</td>
<td></td>
</tr>
<tr>
<td>EH 601</td>
<td>ACTION RESCH WRITING STUDIES</td>
<td></td>
</tr>
</tbody>
</table>

Six hours selected from one of the following areas:

**Technical Writing**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH 501</td>
<td>THRY &amp; PRACTICE TECHNICAL COMM</td>
<td></td>
</tr>
<tr>
<td>EH 502</td>
<td>PROBS TECHNICAL EDITING</td>
<td></td>
</tr>
</tbody>
</table>

**Media Writing**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM 505</td>
<td>ADVANCED MEDIA WRITING</td>
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</tr>
<tr>
<td>EH 554</td>
<td>NEW MEDIA WRITING &amp; RHETORIC</td>
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</table>
Communication Studies

<table>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>CM 509</td>
<td>CONTEMPORARY RHETORICAL THEORY</td>
<td></td>
</tr>
<tr>
<td>CM 526</td>
<td>BURKEIAN THEORY &amp; CRITICISM</td>
<td></td>
</tr>
<tr>
<td>CM 610</td>
<td>COMMUNICATION PEDAGOGY</td>
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</table>

Human Resources Management

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>MGT 600</td>
<td>ORGAN THRY, BEHAV &amp; ENVIRONMEN</td>
<td></td>
</tr>
<tr>
<td>MGT 560</td>
<td>EMPLOYEE STAFFING &amp; DEVELOP</td>
<td></td>
</tr>
<tr>
<td>MGT 562</td>
<td>EMPLOYMENT LAW FOR MANAGERS</td>
<td></td>
</tr>
<tr>
<td>MGT 561</td>
<td>STRATEGIC COMPENSATION MGMT</td>
<td></td>
</tr>
<tr>
<td>or MGT 631</td>
<td>HRM &amp; ORGANIZATIONAL BEHAVIOR</td>
<td></td>
</tr>
</tbody>
</table>

Other Areas of Emphasis

Students in the MA in Professional Communication program may request to take up to four courses from other graduate programs that cover areas not included here. For example, Alabama A&M University has graduate emphases in Counseling and in Telecommunications that would be suitable. The Graduate Adviser must approve such courses.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>CM 505</td>
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<td>CM 508</td>
<td>CLASSICAL RHETORICAL THEORY</td>
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<td>CM 509</td>
<td>CONTEMPORARY RHETORICAL THEORY</td>
<td>3</td>
</tr>
<tr>
<td>CM 518</td>
<td>LEGAL ARGUMENT</td>
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<tr>
<td>CM 520</td>
<td>PUBLIC RELATIONS WRITING</td>
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</tr>
<tr>
<td>CM 526</td>
<td>BURKEIAN THEORY &amp; CRITICISM</td>
<td>3</td>
</tr>
<tr>
<td>CM 530</td>
<td>MASS MEDIA IN AMERICA</td>
<td>3</td>
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<tr>
<td>CM 533</td>
<td>DARK SIDE INTERPERSONAL COMM</td>
<td>3</td>
</tr>
<tr>
<td>CM 540</td>
<td>PUBLIC RELATIONS CAMPAIGNS</td>
<td>3</td>
</tr>
<tr>
<td>CM 544</td>
<td>ADVERTISING</td>
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</tr>
<tr>
<td>CM 551</td>
<td>ORGANIZATIONAL TRAIN &amp; DEVELOP</td>
<td>3</td>
</tr>
<tr>
<td>CM 610</td>
<td>COMMUNICATION PEDAGOGY</td>
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<tr>
<td>CM 640</td>
<td>SPECIAL TOPICS</td>
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<tr>
<td>CM 670</td>
<td>ADVANCED COMMUNICATION METHODS</td>
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<tr>
<td>EH 500</td>
<td>COMPOSITION STUDIES TCHRS</td>
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<tr>
<td>EH 501</td>
<td>THRY &amp; PRACTICE TECHNICAL COMM</td>
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<td>EH 502</td>
<td>PROBS TECHNICAL EDITING</td>
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<tr>
<td>EH 512</td>
<td>SP STUDIES IN CREATIVE WRITING</td>
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<tr>
<td>EH 554</td>
<td>NEW MEDIA WRITING &amp; RHETORIC</td>
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</tr>
<tr>
<td>EH 601</td>
<td>ACTION RESCH WRITING STUDIES</td>
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</tr>
<tr>
<td>EH 602</td>
<td>PRACTICUM/TECHNICAL COMM</td>
<td>3</td>
</tr>
<tr>
<td>EH 603</td>
<td>EDITING FOR PUBLICATION</td>
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<tr>
<td>MGT 560</td>
<td>EMPLOYEE STAFFING &amp; DEVELOP</td>
<td>3</td>
</tr>
<tr>
<td>MGT 561</td>
<td>STRATEGIC COMPENSATION MGMT</td>
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</tr>
<tr>
<td>MGT 562</td>
<td>EMPLOYMENT LAW FOR MANAGERS</td>
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</tr>
<tr>
<td>MGT 600</td>
<td>ORGAN THRY, BEHAV &amp; ENVIRONMEN</td>
<td>3</td>
</tr>
<tr>
<td>MGT 631</td>
<td>HRM &amp; ORGANIZATIONAL BEHAVIOR</td>
<td>3</td>
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</tbody>
</table>

Psychology, MA

1. The thesis student must complete at least 30 semester hours of graduate work, including a minimum of 6 semester hours of thesis.

Only 6 semester hours may be transfer courses that are approved by the graduate committee of the department.

2. The student’s Program of Study must include
Psychology, MA - Industrial/Organizational Psychology Specialization

Within our M.A. in Experimental Psychology program, students who are interested in applying psychology in business settings may choose an Industrial/Organizational psychology specialization. The courses in this specialized sequence prepare students for jobs in industry or more extensive study in a Ph.D. program. Graduates with this background are prepared for jobs that require the following skills:

- training
- psychometrics
- job analysis
- personnel selection
- interviewing
- performance appraisal
- empirical research
- statistical analysis
- technical writing

The projected job growth in these areas, nationally, is higher than average.

We welcome both full-time and part-time students. Two of our courses are available through Distance Learning: PY 502 and PY 503. Students will have opportunities to work in faculty research labs in our small, personalized department.

Prerequisites for the M.A. program are a Bachelor's degree in Psychology, including coursework in experimental design and statistics. Prospective students who do not yet have these pre-requisites can take the necessary pre-requisites in our undergraduate curriculum prior to applying to the graduate program; students should contact the Chair of the Psychology Department to discuss this possibility.

Program Requirements

The student's program of study must include:
The University of Alabama in Huntsville - DRAFT COPY

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>PY 502</td>
<td>INDUSTRIAL &amp; ORGANIZATIONAL PSY</td>
<td>3</td>
</tr>
<tr>
<td>PY 530</td>
<td>PSYCHOMETRICS</td>
<td>3</td>
</tr>
<tr>
<td>PY 607</td>
<td>PROFESSIONAL DEV IN RES &amp; TCHG</td>
<td>1</td>
</tr>
<tr>
<td>PY 608</td>
<td>GRAD PRACT TCHG &amp; CAREER EXPLO</td>
<td>1</td>
</tr>
<tr>
<td>PY 610</td>
<td>EXPERIMENTAL DESIGN</td>
<td>3</td>
</tr>
<tr>
<td>PY 611</td>
<td>STAT FOR EXPERI METHODS</td>
<td>4</td>
</tr>
<tr>
<td>PY 641</td>
<td>CONC READ/RES SPECIALIZ AREA</td>
<td>3</td>
</tr>
<tr>
<td>PY 699</td>
<td>MASTER'S THESIS</td>
<td>6</td>
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</table>

**Elective Courses**

Select 6 semester hours of the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PY 503</td>
<td>HUMAN FACTORS PSYCHOLOGY</td>
<td>3</td>
</tr>
<tr>
<td>PY 508</td>
<td>TEAMWORK &amp; TEAM PROCESSES</td>
<td>3</td>
</tr>
<tr>
<td>PY 650</td>
<td>SUPERVISED RESEARCH</td>
<td>3-6</td>
</tr>
<tr>
<td>PY 675</td>
<td>INTERNSHIP IN APPLIED PSYCHOLOGY</td>
<td>1-3</td>
</tr>
<tr>
<td>EM 664</td>
<td>TEAMS IN ACTION</td>
<td>3</td>
</tr>
<tr>
<td>MGT 560</td>
<td>EMPLOYEE STAFFING &amp; DEVELOP</td>
<td>3</td>
</tr>
<tr>
<td>MGT 600</td>
<td>ORGAN THRY, BEHAV &amp; ENVIRONMENTS</td>
<td>3</td>
</tr>
<tr>
<td>MGT 629</td>
<td>LEADERSHIP: THRY &amp; PRACTICE</td>
<td>3</td>
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<tr>
<td>MGT 631</td>
<td>HRM &amp; ORGANIZATIONAL BEHAVIOR</td>
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<tr>
<td>ISE 790</td>
<td>ADV STATISTICAL APPLICATIONS</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Semester Hours** 30

---

**College of Business**

**Dean's Office**
Jason.Greene@uah.edu (jason.greene@uah.edu)
256.824.6735
BAB 202

**Graduate Advising**
GradBiz@uah.edu (gradbiz@uah.edu)
256.824.6787
BAB 102

**Mission**

The UAH College of Business serves business and society through the expertise of our alumni, students, and faculty. We provide academically rigorous programs emphasizing the application of theory and skills in scientific, technological, and traditional business environments. We are committed to offering degree programs that build analytical skills, develop an entrepreneurial mindset, and provide opportunities to engage with practice through projects, practica, and internships.

**Accreditation**

The College of Business is accredited by AACS International - The Association to Advance Collegiate Schools of Business.* AACSBI provides the highest standard of accreditation offered to business schools worldwide, with fewer than 25% of U.S. business schools and fewer than 5% of worldwide business schools achieving the distinction. To maintain AACSBI accreditation, we must have a specific plan and sufficient resources to support high quality undergraduate and graduate programs, a highly qualified faculty who maintain credentials through continuous research or engagement with practice, and a process for assessing that our students are learning what we teach. We report to AACSBI annually and undergo a comprehensive review every five years.

*AACSB International is a not-for-profit corporation comprised of member organizations and institutions devoted to the promotion and continuous improvement of higher education for business administration and management. Organized in 1916, AACSB International is the premier accrediting agency for bachelor's, master's and doctoral degree programs in business administration and accounting.
Graduate Degrees and Certificates

The College of Business offers seven graduate degrees and seven graduate certificates.

- Master of Accountancy (MAcc) (p. 31)
- Master of Business Administration (MBA) (p. 32)
- M.S. in Cybersecurity (Management Track) (p. 35)
- M.S. in Information Systems (p. 34)
- M.S. in Management-Human Resource Management (p. 38)
- M.S. in Management Science-Business Analytics (p. 39)
- M.S. in Supply Chain & Logistics Management (p. 37)
- Graduate Certificate in Business Analytics (http://catalog.uah.edu/grad-colleges-departments/business/graduate-certificate-business-analytics)
- Graduate Certificate in Cybersecurity Studies (http://catalog.uah.edu/grad-colleges-departments/business/graduate-certificate-information-assurance)
- Graduate Certificate in Enterprise Resource Planning (http://catalog.uah.edu/grad-colleges-departments/business/graduate-certificate-enterprise-resource-planning)
- Graduate Certificate in Federal Contracting & Procurement Management (http://catalog.uah.edu/grad-colleges-departments/business/graduate-certificate-federal-contracting-procurement-management)
- Graduate Certificate in Human Resource Management (http://catalog.uah.edu/grad-colleges-departments/business/graduate-certificate-hrm)
- Graduate Certificate in Supply Chain Management (http://catalog.uah.edu/grad-colleges-departments/business/graduate-certificate-supply-chain-management)
- Graduate Certificate in Technology & Innovation Management (http://catalog.uah.edu/grad-colleges-departments/business/graduate-certificate-technology-innovation-management)

Expectations about Degree Progress

Course Load: The usual semester course load for a full-time graduate student is 9 to 12 semester hours. The usual semester course load for a student employed full-time is 3 to 6 semester hours.

Time limit: All requirements toward the master's degree, including transfer credit, must have been earned during the six years (18 semesters over fall, spring, and summer) immediately preceding the date on which the master's degree is to be awarded. Credit for individual graduate courses at UAH completed more than 6 years (18 semesters) but less than 10 years (30 semesters) before the completion of all requirements for the degree must be validated by the department that offered the course through the administering of a written or oral examination. Once a course is validated, it is considered valid through the tenth year only. Credit for courses more than ten years old cannot be validated. Up to six hours of transfer courses that are more than 6 years (18 semesters) but less than 10 years (30 semesters) before the completion of all the requirements for the degree may be validated by a committee of at least three members of the graduate faculty appointed by the department or program chair, with the results reported to the graduate dean.

Graduate Assistantships

A limited number of graduate assistantships are available to select full-time students on a competitive basis. Graduate assistantships are awarded at either a 10 or 20 hour per week service to the College, carry a stipend, and have up to 9 semester hours of tuition paid. Assistantship applications are available from the Director of Graduate Programs or at http://www.uah.edu/admissions/graduate/financial-aid/assistantships.

Graduate Teaching Assistantships (GTA) are awarded to a few students who assist with the College's undergraduate teaching mission as tutors, graders, and coordinators of program activities. Graduate Research Assistantships (GRA) are made available through externally funded grants or contracts. GRAs do research under the supervision of a faculty member or center director. Because GRAs assist with specific research activities, the ability of applicants to assist with these specific activities is considered when awarding assistantships.

Master's Programs in Business:

- Accountancy, MAcc (p. 31)
- Master of Business Administration, MBA (p. 32)
- Information Systems, MS-IS (p. 34)
- Cybersecurity, MS Interdisciplinary - Management Track (p. 35)
- Supply Chain and Logistics Management, MS (p. 37)
- Management - Human Resources Management, MS (p. 38)
- Management Science - Business Analytics, MS (p. 39)

Certificates in Business:
• Business Analytics
• Cybersecurity Studies
• Enterprise Resource Planning
• Federal Contracting and Procurement Management
• Human Resource Management
• Supply Chain Management
• Technology and Innovation Management

Accountancy, MAcc

For additional information about graduate programs within the College of Business, please contact the Director of Graduate Programs, Jennifer Pettitt, at GradBiz@uah.edu. Information about the application process can be found in the Admissions section of the Graduate catalog.

Degree Requirements

The MAcc program normally consists of 33 semester hours of graduate coursework. The program includes a minimum of 18 semester hours of accounting (including at least 15 semester hours at the 600-level) and a minimum of 12 semester hours in other disciplines (including at least 9 semester hours at the 600-level). The accounting theory class, ACC 680, should be taken toward the end of the student's program, must be taken at UAH, and must be completed with a grade of A or B (including an average of at least B on all individual components). A maximum of 12 semester hours of graduate work may be transferred from another institution.

Program prerequisites may be satisfied by either of the following:

1. possession of a Bachelors degree in accounting from an AACSB accredited institution or
2. possession of a Bachelors degree and satisfactory (i.e., "C" or higher) completion of the following list of basic skills, business foundation, and accounting courses.

Basic skills and business foundation:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Program Prerequisites</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Written and oral communications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calculus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Computer Applications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Statistical analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Legal environment of business</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Principles of accounting (financial and managerial)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Principles of economics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Principles of finance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Principles of marketing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operations management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organizational theory, behavior, and environment</td>
<td></td>
</tr>
</tbody>
</table>

The MAcc curriculum consists of three required courses and eight elective courses. A sample program is presented below including four specific required courses needed to be eligible to sit for the CPA exam in Alabama.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accounting Prerequisites</td>
<td></td>
</tr>
<tr>
<td>ACC 307</td>
<td>ACCOUNTING INFORMATION SYS</td>
<td></td>
</tr>
<tr>
<td>ACC 310</td>
<td>INTERM FINANCIAL ACCT I</td>
<td></td>
</tr>
<tr>
<td>ACC 311</td>
<td>INTERM FINANCIAL ACCT II</td>
<td></td>
</tr>
<tr>
<td>ACC 313</td>
<td>INDIVIDUAL/SMALL BUS INCOME TA</td>
<td></td>
</tr>
<tr>
<td>ACC 414</td>
<td>COST ACCOUNTING</td>
<td></td>
</tr>
<tr>
<td>ACC 431</td>
<td>PRINCIPLES OF AUDITING</td>
<td></td>
</tr>
</tbody>
</table>
Master of Business Administration, MBA

MAcc Required Courses 1

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC 614</td>
<td>COST MANAGEMENT</td>
<td>3</td>
</tr>
<tr>
<td>ACC 607</td>
<td>ADV ACC INFORMAT SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td>ACC 680</td>
<td>FINANCIAL ACCOUNTING THEORY</td>
<td>3</td>
</tr>
</tbody>
</table>

MAcc Electives 1

<table>
<thead>
<tr>
<th>Electives</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounting elective or thesis 2,3</td>
<td>6</td>
</tr>
<tr>
<td>Accounting elective, 500- or 600-level 3</td>
<td>3</td>
</tr>
<tr>
<td>Non-Accounting electives 600-level courses</td>
<td>9</td>
</tr>
<tr>
<td>Non-accounting elective, 500- or 600-level</td>
<td>3</td>
</tr>
<tr>
<td>Free elective, 500- or 600-level</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Semester Hours 33

1 Students must take a minimum of 18 semester hours of Accounting with at least 15 of those semester hours at the 600-level. They must also take a minimum of 12 semester hours of non-accounting courses with at least 9 semester hours at the 600-level.

2 Thesis option reduces the required semester hours to 30 semester hours. Students may eliminate a 500-level non-accounting elective.

3 ACC 600 or ACC 602 may not be used in the MAcc program.

CPA Examination in Alabama

Students planning to sit for the CPA examination in Alabama must complete the subject matter shown below. The courses can be counted as electives in the MAcc.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLS 511</td>
<td>BUS LAW FOR ACCOUNTANTS</td>
<td>3</td>
</tr>
<tr>
<td>ACC 513</td>
<td>CORP/PARTNERSHIP/ESTATE TAXES</td>
<td>3</td>
</tr>
<tr>
<td>or ACC 520</td>
<td>STATE AND LOCAL TAXATION</td>
<td>3</td>
</tr>
<tr>
<td>ACC 517</td>
<td>ACC FOR STATE/LOCAL GOV/NON-PR</td>
<td>3</td>
</tr>
</tbody>
</table>

The MBA program was fashioned to be an interdisciplinary program in business for practicing administrators, primarily for early- and mid-career managers. The typical student aspires to managerial positions. The curriculum is designed to accommodate students from engineering, science, the liberal arts and other non-business backgrounds. Students in this program typically have five to fifteen years of full-time work experience. They aspire to upward career mobility or are seeking to change career paths.

The MBA program emphasizes the development of integrative systems thinking skills in order to build capable, creative managers able to face successfully both external challenges such as rapid technological change and increasing environmental complexities, and internal issues such as changing employee expectations and methods of increasing productivity.

The program orient students to the rigors of holistic thinking about technology-driven problems and opportunities, introduces students to concepts and tools from all the business disciplines to operate in a technological environment, and instills a commitment to teamwork. The curriculum provides

Purpose

The Master of Business Administration (MBA) program is designed as a general management graduate degree, offering a unique management of technology theme. The educational emphasis of the program builds upon knowledge and skills in all of the business disciplines to prepare students for careers in organizations that face opportunities and challenges afforded by technological change.

For additional information about graduate programs within the College of Business, please contact the Director of Graduate Programs, Jennifer Pettitt, at GradBiz@uah.edu. Information about the application process may be found in the Admissions section of the Graduate catalog.

Thesis Option

A thesis option requiring 30 semester hours of graduate work, including 6 semester hours of thesis credit is available. Students interested in this option should contact the Director of Graduate Programs, BAB 102, 256.824.6681, before completing 12 semester hours of graduate study.

Transfer Credit

Up to 12 semester hours of graduate credit taken at other universities may be transferred to meet MAcc degree requirements. Inquiries about the transferability of specific courses should be directed to the Director of Graduate Programs, who will consult with the faculty to determine whether the content of the class will be accepted for transfer credit.
instruction in financial reporting, analysis and markets; domestic and global economic environments of organizations; creation and distribution of goods and services; and human behavior in organizations. It provides advanced study in decision science and human aspects of organizational problem-solving. It provides education in managing technological innovations and processes, and integrating technology into the organization’s strategic objectives. It addresses such issues as analyzing problems through economic and financial frameworks, developing and using information systems, providing information on accounting costs, marketing, managing the development of technology, reducing new product development time, managing technical professionals, and integrating technology into the overall strategic objectives of the organization.

Degree Requirements

Program Prerequisites

(1) written and oral English communications

(2) quantitative analysis/statistics

(3) computer proficiency achieved either through prior experience and education or as part of the student’s MBA program of study

Program Foundation Courses

The MBA curriculum includes a group of six courses (18 credit hours) that serves as the program foundation. A student’s transcripts will be evaluated by the Director of Graduate Programs to determine if any of these courses can be waived.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC 600</td>
<td>FOUNDATIONS ACC MANAGERS &amp; ENG</td>
<td>3</td>
</tr>
<tr>
<td>ECN 600</td>
<td>FOUNDATIONS OF ECONOMICS</td>
<td>3</td>
</tr>
<tr>
<td>IS 600</td>
<td>INFORMATION SYSTEMS MANAGEMENT</td>
<td>3</td>
</tr>
<tr>
<td>MGT 600</td>
<td>ORGAN THRY, BEHAV &amp; ENVIRONMEN</td>
<td>3</td>
</tr>
<tr>
<td>MKT 600</td>
<td>SURVEY OF MARKETING MGMT</td>
<td>3</td>
</tr>
<tr>
<td>MSC 600</td>
<td>QUANTITATIVE METHODS</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Semester Hours 18

Program Core Courses

The program core courses focus on the management of technology, and consist of the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MGT 601</td>
<td>TECH &amp; INNOVATION MGMT</td>
<td>3</td>
</tr>
<tr>
<td>MSC 605</td>
<td>OPERATIONS MANAGEMENT</td>
<td>3</td>
</tr>
<tr>
<td>ACC 602</td>
<td>MANAGERIAL ACCOUNTING</td>
<td>3</td>
</tr>
<tr>
<td>ECN 626</td>
<td>MANAGERIAL ECON &amp; TECH</td>
<td>3</td>
</tr>
<tr>
<td>FIN 601</td>
<td>FIN DECIS UNDER UNCERTAINTY</td>
<td>3</td>
</tr>
<tr>
<td>MGT 604</td>
<td>NEW PRODUCT DEVELOPMENT</td>
<td>3</td>
</tr>
<tr>
<td>MGT 631</td>
<td>HRM &amp; ORGANIZATIONAL BEHAVIOR</td>
<td>3</td>
</tr>
<tr>
<td>MGT 698</td>
<td>STRATEGIC MANAGEMENT</td>
<td>3</td>
</tr>
</tbody>
</table>

Select 9 semester hours of graduate electives 9

Select one of the following plans:

Plan I:

Thesis: 6 Semester Hours

Select 3 semester hours of graduate electives

Plan II:

Select 9 semester hours of graduate electives

Total Semester Hours 33

1MGT 698, Strategic Management, is the capstone course and should be taken toward the end of the student’s program. A student must earn a grade of B or better in MGT 698.
Electives Area
MBA students take nine semester hours of graduate electives consistent with their professional development aspirations. Sample areas of study available are accounting, cybersecurity, information systems, finance, human resource management, business analytics, federal contracting and procurement, engineering management, or supply chain and logistics management.

MBA Thesis Option
MBA students interested in research may choose to pursue a thesis. Students who choose to pursue a thesis, substitute six semester hours of electives with six thesis hours.

Information Systems, MS-IS

For additional information about graduate programs within the College of Business, please contact the Director of Graduate Programs, Jennifer Pettitt, at GradBiz@uah.edu (gradbiz@uah.edu). Information about the application process may be found in the Admissions section of the Graduate catalog.

Purpose
The purpose of the MS-IS degree program is to prepare students to enter the information technology (IT) profession in a wide variety of positions. While the curriculum emphasizes both managerial and technical aspects of IT, its overall structure is designed to prepare students for a career leading to managerial- and/or executive-level positions related to IT and Business Information Systems. Students will learn to design, implement, and operate information systems with the purpose of providing organizational decision-makers with the information needed to manage effectively and efficiently. In addition, students will learn to obtain new business insights by using various business analytics and data management tools.

Program prerequisites are kept to a minimum and the program is designed to meet the needs of students with a wide variety of educational backgrounds.

Program Prerequisites
Program prerequisites include a bachelor’s degree in any field and demonstration of competency in each of the following three areas:
1. Computer Applications Competency. Students must demonstrate this competency by passing an on-line computer applications competency exam or by successful completion of the IS 146 or its equivalent. IS 146 or its equivalent will not count towards the requirements of the MS-IS degree.
2. Computer Programming Competency. Students must demonstrate this competency by passing an on-line computer programming exam or by successful completion of IS 210 or its equivalent. IS 210 or its equivalent will not count towards the requirements of the MS-IS degree.
3. Information Systems Competency. Students must demonstrate this competency by passing an on-line IS competency exam or by successful completion of IS 600 - Information Systems Management, or its equivalent. IS 600 or its equivalent will not count towards the requirements of the MS-IS degree.

Degree Requirements
The MS-IS program consists of 30 semester hours of graduate coursework. The coursework includes an 18 credit hour core that is required of all students, nine credit hours of directed electives, and three credit hours of business electives. The directed elective choices are designed to provide students a broader understanding of multiple business functions normally expected for executive-level positions in an organization.

IS 691, Information Systems Strategy and Applications, is the capstone course and should be taken toward the end of the student’s program. A student must earn a grade of B or better in IS 691.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 512</td>
<td>MODERN SYSTM ANALYSIS &amp; DESIGN</td>
<td>3</td>
</tr>
<tr>
<td>IS 560</td>
<td>TELECOMMUNICATIONS &amp; NETWRK'G</td>
<td>3</td>
</tr>
<tr>
<td>IS 571</td>
<td>BUSINESS INTELLIGENCE &amp; ANALYT</td>
<td>3</td>
</tr>
<tr>
<td>IS 640</td>
<td>DATA MGT AND DATA MINING</td>
<td>3</td>
</tr>
<tr>
<td>IS 680</td>
<td>ENTERPRISE RESOURCE PLNG SYS</td>
<td>3</td>
</tr>
<tr>
<td>IS 691</td>
<td>INFORMATION SYS STRATEGY &amp; APP</td>
<td>3</td>
</tr>
</tbody>
</table>

Directed Electives (9 credit hours), choose 3 courses with no more than one in any of the following groupings:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 660</td>
<td>CYBERSECURITY MANAGEMENT</td>
</tr>
<tr>
<td>IS 522</td>
<td>SUPPLY CHAIN MANAGEMENT SY</td>
</tr>
<tr>
<td>IS 577</td>
<td>NETWORK DEFENSE &amp; OPERATING SY</td>
</tr>
</tbody>
</table>
### IS 663  COMPUTER FORENSICS

#### Economics Electives:
- ECN 511  ECONOMICS OF INFORMATION TECH
- ECN 545  GAMES & NETWORKS
- ECN 600  FOUNDATIONS OF ECONOMICS
- ECN 626  MANAGERIAL ECON & TECH

#### Management/Marketing Electives:
- MGT 600  ORGAN THRY, BEHAV & ENVIRONMEN
- MGT 631  HRM & ORGANIZATIONAL BEHAVIOR
- MGT 640  PRIN OF PROJECT MGMT
- MKT 600  SURVEY OF MARKETING MGMT
- MKT 604  NEW PRODUCT DEVELOPMENT

#### Accounting/Finance Electives:
- ACC 600  FOUNDATIONS ACC MANAGERS & ENG
- ACC 602  MANAGERIAL ACCOUNTING
- FIN 601  FIN DECIS UNDER UNCERTAINTY

#### Operations/Quant Methods/SCM Electives:
- IS 522  SUPPLY CHAIN MANAGEMENT SYS
- MGT 611  SUPPLY CHAIN MANAGEMENT
- MSC 600  QUANTITATIVE METHODS
- MSC 605  OPERATIONS MANAGEMENT

#### Business Elective, select one course from the five groupings above.  

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 512</td>
<td></td>
</tr>
<tr>
<td>IS 560</td>
<td></td>
</tr>
<tr>
<td>IS 571</td>
<td></td>
</tr>
</tbody>
</table>

1. MS-IS students whose previous studies include the undergraduate equivalents of IS 512, IS 560, and/or IS 571 must substitute a 3-credit-hour graduate-level IS course for each of the latter.

2. Students are required to satisfy the prerequisites for any elective they choose. Students who wish to substitute some other courses as directed electives may seek prior approval for such a substitution by contacting the Director of Graduate Programs.

### Additional Information
#### Thesis Option
A thesis option is available. Students interested in this option should contact the both the faculty member who the student wants to serve as the thesis advisor and the Director of Graduate Programs in the College of Business before completing 12 hours of graduate study. If selected, the student will register for the IS 699 Masters Thesis course for 6 credit hours in lieu of 6 credit hours of directed and business electives.

#### Transfer Credit
Up to 12 semester hours of graduate credit taken at other universities may be transferred to meet MS-IS degree requirement. Inquiries about the transferability of specific courses should be directed to the Director of Graduate Programs, who will consult with the IS faculty to determine whether the content of the class will be accepted for transfer credit.

### Cybersecurity, MS Interdisciplinary - Management Track

#### Purpose
The MS-CBS degree is a unique program in that it is an interdisciplinary program of study among three colleges: Business, Engineering, and Science. Due to this collaboration between the colleges, students will be exposed to a diversified core curriculum with a choice of 3 different elective tracks; having in-depth curriculum in their track while gaining familiarity in the other two. Upon graduation students will be able to perform Cybersecurity Analysis of vulnerabilities and threats to network environments, Network Penetration Testing, Auditing for Certification & Accreditation, and Technical Project Management in Information Technology. Students will also be able to integrate the business and scientific underpinnings of information technology trends related to the System Development Life Cycle and understand the federal, state & local statutory requirements associated with Information and cybersecurity through the Information Assurance Technical Framework (IATF).

Program prerequisites are kept to a minimum and the program is designed to meet the needs of students with a wide variety of educational backgrounds. The admission and program requirements for those pursuing the Management track are described below.
Degree Requirements

Prerequisites

Program prerequisites include a bachelor’s degree in any field and demonstration of competency in each of the following three areas:

1. Computer Applications Competency. Students must demonstrate this competency by passing an on-line computer applications competency exam or by successful completion of the IS 146 or its equivalent. IS 146 or its equivalent will not count towards the requirements of the MS-CBS degree.

2. Computer Programming Competency. Students must demonstrate this competency by passing an on-line computer programming competency exam or by successful completion of the IS 210 or its equivalent. IS 210 or its equivalent will not count towards the requirements of the MS-CBS degree.

3. Computer Science and Networks competencies. Students must be competent to be enrolled in graduate level core courses including those in computer science and networks. If a student does not have these competencies, s/he may be required to either self-prepare by reviewing online tutorials and passing a competency exam or to register for additional courses which will not count towards the 30 credit hours required for this degree.

The MS-CBS program consists of 30 semester hours of graduate coursework. The coursework includes a five-course core that is required of all students, 9 credit hours of management track required courses, and 6 credit hours of electives. The directed elective choices are designed to provide students a broader understanding of multiple cybersecurity functions normally expected in an organization.

IS 692/CPE 692/CS 692 is the capstone course and should be taken toward the end of the student’s program. Students must earn a grade of B or better in the capstone course.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 660</td>
<td>CYBERSECURITY MANAGEMENT</td>
<td></td>
</tr>
<tr>
<td>IS 663</td>
<td>COMPUTER FORENSICS</td>
<td></td>
</tr>
<tr>
<td>CPE 549</td>
<td>INTRO TO CYBERSECURITY ENGINRG</td>
<td></td>
</tr>
<tr>
<td>CS 585</td>
<td>INTRO TO COMPUTER SECURITY</td>
<td></td>
</tr>
<tr>
<td>IS 692</td>
<td>CYBERSECURITY PRACTICUM</td>
<td></td>
</tr>
<tr>
<td>IS 692</td>
<td>or CPE 692</td>
<td></td>
</tr>
<tr>
<td>IS 692</td>
<td>or CS 692</td>
<td></td>
</tr>
<tr>
<td>IS 692</td>
<td>COMPUTER SECURITY</td>
<td></td>
</tr>
<tr>
<td>IS 560</td>
<td>TELECOMMUNICATIONS &amp; NETWRK’G</td>
<td></td>
</tr>
<tr>
<td>IS 577</td>
<td>NETWORK DEFENSE &amp; OPERATING SY</td>
<td></td>
</tr>
<tr>
<td>IS 670</td>
<td>BUSINESS CONTINGENCY PLANNING</td>
<td></td>
</tr>
<tr>
<td>IS 571</td>
<td>BUSINESS INTELLIGENCE &amp; ANALYT</td>
<td></td>
</tr>
<tr>
<td>IS 640</td>
<td>DATA MGT AND DATA MINING</td>
<td></td>
</tr>
<tr>
<td>IS 691</td>
<td>INFORMATION SYS STRATEGY &amp; APP</td>
<td></td>
</tr>
<tr>
<td>CPE 534</td>
<td>OPERATING SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>CPE 647</td>
<td>UBIQUITOUS COMPUTING</td>
<td></td>
</tr>
<tr>
<td>CPE 648</td>
<td>ADVANCED COMPUTER NETWORKS</td>
<td></td>
</tr>
<tr>
<td>CS 687</td>
<td>DATA BASE SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>CS 553</td>
<td>CLIENT/SERVER ARCHITECTURES</td>
<td></td>
</tr>
<tr>
<td>CS 617</td>
<td>DES &amp; ANALY OF ALGORITHM</td>
<td></td>
</tr>
<tr>
<td>CS 650</td>
<td>SOFT’W ENGINEERING PROC</td>
<td></td>
</tr>
<tr>
<td>CS 670</td>
<td>COMPUTER NETWORKS</td>
<td></td>
</tr>
<tr>
<td>CS 690</td>
<td>ADVANCED OPERATING SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>CPE 649</td>
<td>ADV CYBERSECURITY ENGINEERING</td>
<td></td>
</tr>
<tr>
<td>CPE 645</td>
<td>COMPUTER NETWORK SECURITY</td>
<td></td>
</tr>
<tr>
<td>CPE 646</td>
<td>MOBILE &amp; WIRELESS NETWORKS</td>
<td></td>
</tr>
<tr>
<td>CS 565</td>
<td>NETWORK SECURITY</td>
<td></td>
</tr>
<tr>
<td>CS 570</td>
<td>INTRO TO COMPUTER NETWORKS</td>
<td></td>
</tr>
</tbody>
</table>

1. Management Track-required Courses

2. Elective, select two courses from the following:
CS 685  COMPTER SECURITY

Total Semester Hours  30

1. MS-CBS students whose previous studies include the undergraduate equivalents of IS 560 and IS 577 must substitute a 3-credit-hour graduate-level IS course for each of the latter.

2. Students are required to satisfy the prerequisites for any elective they choose. Students who wish to substitute some other courses as directed electives may seek prior approval for such a substitution by contacting the Director of Graduate Programs in UAH College of Business.

Additional Information

Thesis Option

A thesis option is available. Students interested in this option should contact the both the faculty member who the student wants to serve as the thesis advisor and the Director of Graduate Programs in the College of Business before completing 12 hours of graduate study. If selected, the student will register for the IS 699 Master’s Thesis course for 6 credit hours in lieu of 6 credit hours of electives.

Transfer Credit

Up to 12 semester hours of graduate credit taken at other universities may be transferred to meet MS-CBS degree requirement. Inquiries about the transferability of specific courses should be directed to the College of Business Director of Graduate Programs, who will consult with the IS faculty to determine whether the content of the class will be accepted for transfer credit.

Supply Chain and Logistics Management, MS

For additional information about graduate programs within the College of Business, please contact the Director of Graduate Programs, Jennifer Pettitt, at GradBiz@uah.edu (gradbiz@uah.edu). Information about the application process may be found in the Admissions section of the Graduate catalog.

Purpose

The Master of Science in Supply Chain and Logistics Management (MS-SCLM) program is designed as a specialized management graduate degree to serve working professionals who are interested in developing and/or enhancing their knowledge and skills in supply chain management.

The MS-SCLM program aims to graduate students who will use supply chain management theories and methods to make significant contributions in solving strategic and managerial supply chain problems. Students learn supply chain theories and methods – including supply chain strategy, supply chain design, supply chain management, transportation and logistics, supply chain risk management & mitigation, and decision modeling – and how to apply those methods to solve business problems in technology-oriented, government, and industry organizations.

Students are introduced to such issues as understanding supply chain dynamics; conducting analyses necessary for the design of a supply chain management system that fulfills an organization’s supply chain strategy; modeling and interpreting supply chains and processes for identifying problems, improving efficiencies, and improving service to stakeholders; translating data from supply chain systems into useful information for improved decision making; and managing all aspects of an integrated supply chain across an organization.

Program prerequisites are kept to a minimum and the program is designed to meet the needs of students with a wide variety of educational backgrounds.

Prerequisites

Program prerequisites include a bachelor’s degree in any field and demonstration of competency in basic skills in statistical analysis and computer usage must be achieved either by prior experience and education or as part of the MS-SCLM curriculum.

Degree Requirements

The MS-SCLM program consists of 30 semester hours of graduate coursework. The coursework includes an eight-course core that is required of all students and two elective courses. MGT 693, Supply Chain Strategy & Practicum, is the capstone course and should be taken toward the end of the student’s program. A student must earn a grade of B or better in MGT 693.

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<th>Code</th>
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<td>ACC 600</td>
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<td>MSC 600</td>
<td>QUANTITATIVE METHODS</td>
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<td>MSC 605</td>
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<td>MGT 611</td>
<td>SUPPLY CHAIN MANAGEMENT</td>
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Additional Information

Thesis Option

A thesis option is available. Students interested in this option should contact the both the faculty member who the student wants to serve as the thesis advisor and the Director of Graduate Programs in the College of Business before completing 12 hours of graduate study. If selected, the student will register for the IS 699 (http://catalog.uah.edu/search/?P=IS%20699) Masters Thesis course for 6 credit hours in lieu of 6 credit hours of directed and business electives.

Transfer Credit

Up to 12 semester hours of graduate credit taken at other universities may be transferred to meet MS-SCLM degree requirement. Inquiries about the transferability of specific courses should be directed to the Director of Graduate Programs, who will consult with the faculty to determine whether the content of the class will be accepted for transfer credit.

Management - Human Resource Management, MS

For additional information about graduate programs within the College of Business, please contact the Director of Graduate Programs, Jennifer Pettitt, at GradBiz@uah.edu (gradbiz@uah.edu). Information about the application process may be found in the Admissions section of the Graduate catalog.

Purpose

The Master of Science in Management – Human Resource Management (MSM-HRM) program is designed as a specialized management graduate degree to serve working professionals who are interested in developing and/or enhancing their knowledge and skills in Management with a specific focus on Human Resources.

The purpose of this program is to prepare individuals to be professionals in human resource management (HRM). This curriculum provides a generalist program of study. Specifically, the program addresses and HRM theories and methods - including organizational behavior, employment law, employee staffing and development, strategic compensation management, and strategic human resource management. The program content also gives students the general business tools that HRM professionals need to align HRM practices with the broader strategic orientation of the organization. Although the MSM-HRM program prepares students for an HRM career in any industry, there is a focus on the unique human resource challenges encountered in a technological environment. Students will gain valuable experience in the field of HRM by completing a practicum prior to graduation.

Degree Requirements

The MSM-HRM program consists of 30 semester hours of graduate coursework. The coursework includes a five-course management core, nine credit hours of Human Resource Management courses, and six credit hours of electives.

MGT 694, Human Resource Management Practicum, is the capstone course and should be taken toward the end of the student’s program. A student must earn a grade of B or better in MGT 694.

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Additional Information

Thesis Option
A thesis option is available. Students interested in this option should contact the both the faculty member who the student wants to serve as the thesis advisor and the Director of Graduate Programs in the College of Business before completing 12 hours of graduate study. If selected, the student will register for the MGT 699 Master's Thesis course for 6 credit hours in lieu of 6 credit hours of electives.

Transfer Credit
Up to 12 semester hours of graduate credit taken at other universities may be transferred to meet MSM-HRM degree requirements. Inquiries about the transferability of specific courses should be directed to the Director of Graduate Programs, who will consult with the Management faculty to determine whether the content of the class will be accepted for transfer credit.

Management Science - Business Analytics, MS

For additional information about graduate programs within the College of Business, please contact the Director of Graduate Programs, Jennifer Pettitt, at GradBiz@uah.edu. Information about the application process may be found in the Admissions section of the Graduate catalog.

Purpose
The Master of Science in Management Science-Business Analytics (MS-MSBA) program is designed as a specialized management graduate degree to serve career starters and working professionals who are interested in developing and/or enhancing their knowledge and skills in Management Science with a specific focus in Business Analytics.

The MS-MSBA program aims to graduate students who will use business analytic theories and methods to make significant contributions in solving managerial and technical problems. Students learn about business analytical theories and methods # including (big) data management, business intelligence, data mining, predictive modeling, machine learning, descriptive analytics and other quantitative methods # to solve business problems, focusing on problems faced in technology-oriented, government, and government contractor organizations in the northern Alabama region. Students are introduced to such issues as translating business problems into analytical problems, developing analytical models, managing big volumes of data, analyzing data for providing solutions across business functional areas, interpreting analytical solutions for managerial decision-making, and communicating analytical results to novice and advanced technical audiences in a business environment.

Degree Requirements

Prerequisites
The program is designed to meet the needs of students with a wide variety of educational backgrounds. Program prerequisites include a bachelor’s degree in any field and demonstration of competency in basic skills in statistical analysis and computer usage must be achieved either by prior experience and education or as part of the MS-MSBA curriculum.

The MS-MSBA program consists of 30 semester hours of graduate coursework.

MSC 692, Business Analytics Practicum, is the capstone course and should be taken toward the end of the student’s program. A student must earn a grade of B or better in MSC 692.

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MSC 600  QUANTITATIVE METHODS
MOD 501  SVY MODELING & SIMULATION
MSC 615  DECISION MODELING

**Business Analytics Core**

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<th>Course Code</th>
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<tr>
<td>IS 571</td>
<td>BUSINESS INTELLIGENCE &amp; ANALYT</td>
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<tr>
<td>IS 640</td>
<td>DATA MGT AND DATA MINING</td>
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<td>MSC 641</td>
<td>ADVANCED ANALYTICS</td>
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<td>MSC 692</td>
<td>BUSINESS ANALYTICS PRACTICUM</td>
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**12**

**Program Electives**

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<td>ACC 607</td>
<td>ADV ACC INFORMAT SYSTEMS</td>
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<td>ECN 545</td>
<td>GAMES &amp; NETWORKS</td>
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<tr>
<td>ECN 580</td>
<td>INTRODUCTION TO ECONOMETRICS</td>
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<td>IS 522</td>
<td>SUPPLY CHAIN MANAGEMENT SYS</td>
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<td>IS 680</td>
<td>ENTERPRISE RESOURCE PLNG SYS</td>
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<td>MSC 605</td>
<td>OPERATIONS MANAGEMENT</td>
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**6**

**Additional Information**

**Thesis Option**

A thesis option is available. Students interested in this option should contact the both the faculty member who the student wants to serve as the thesis advisor and the Director of Graduate Programs before completing 12 hours of graduate study. If selected, the student will register for the MSC 699 Master’s Thesis course for 6 credit hours in lieu of 6 credit hours of electives.

**Transfer Credit**

Up to 12 semester hours of graduate credit taken at other universities may be transferred to meet MS-MSBA degree requirements. Inquiries about the transferability of specific courses should be directed to the Director of Graduate Programs, who will consult with the Business Analytics faculty to determine whether the content of the class will be accepted for transfer credit.

**College of Education**

323 Roberts Hall  
Telephone: 256.824.6180  
Email: education@uah.edu  
Dean: Beth N. Quick, Ed.D.

**Degrees**

Master of Arts in Teaching (initial teaching certification only)

Master of Education (advanced teaching certification)

**Mission**

The College of Education at The University of Alabama in Huntsville is a member of a diverse academic community of teacher scholars that challenges teacher candidates to strive for excellence in all aspects of their lives. The professional environment affords the College of Education unique opportunities to make a difference in the lives of elementary, middle, and high school students regardless of socio-economic backgrounds. In addition, the College educates teacher candidates who will live and work effectively in increasingly complex societies. Consistent with the mission of the university, the College of Education defines its mission through three focal elements:

1. to prepare teachers and other school personnel who are academically strong, competent in both theory and practice, and prepared to contribute to the needs of a dynamic, complex world;
2. to provide an environment that encourages the department faculty to model sound pedagogy, engage in research and scholarly activities, and become leaders in their area of expertise; and
3. to make our teaching, research, and service available to the entire community in order to meet the changing needs of schools, organizations, and professional communities in our region, state, nation, and international community.

The mission of the College of Education is communicated through our shared vision and articulated in our theme, Through Teaching, We Lead. The establishment of this theme codifies the major purpose of our College: to graduate teachers who are exceptionally well-prepared in disciplinary,
pedagogical, and professional knowledge, who understand and are prepared to address the needs of all learners, and who are committed to serving as leaders in the educational community to ensure that all students receive a high-quality public or private education.

**Master of Education (M.Ed.)**
The Department of Curriculum and Instruction provides the Master of Education (M.Ed.) for teachers already certified at the baccalaureate level and seeking advanced level (Alabama Class A) certification. The M.Ed. has five concentration areas that include:

- Differentiated Instruction in Elementary Education (K-6);
- Special Education/Collaborative Teaching: Autism Spectrum Disorder (K-6 or 6-12);
- Reading Education (Reading Specialist P-12);
- English Speakers of Other Languages (ESOL; P-12); and,
- Differentiated Instruction in Secondary Education (6-12) (biology, chemistry, English language arts, history, mathematics, and physics)

**Master of Arts in Teaching (MAT) Alternative Fifth Year**
The Alternative Fifth Year Program Master of Arts in Teaching (MAT) is available to individuals who have completed a baccalaureate degree from a regionally accredited institution in a field other than teacher education. Students eligible for this program do not have a Class B (baccalaureate level) teaching certificate. Students should contact the Teacher Certification Officer and the advisor in the chosen teaching field for an individual evaluation concerning undergraduate deficiencies prior to initial registration in this program. The Alabama State Department of Education requires all applicants for the alternative fifth year program to have an academic major in the teaching field (EHLA) or if an academic major is not on the official transcript, 32 semester hours appropriate to the teaching field including at least 19 semester hours of upper-division credit.

Certification for alternative fifth-year programs is available in the following areas: biology, chemistry, English language arts, English Speakers of Other Languages, history, mathematics, and physics.

**Accreditation**
Teacher education programs in the College of Education at The University of Alabama in Huntsville are accredited by the National Council for Accreditation of Teacher Education (NCATE) and approved by the Alabama State Board of Education, according to standards of the National Association of the State Directors of Teacher Education and Certification (NASDTEC), for the issuance of appropriate professional certificates for service in public schools.

**Master of Arts in Teaching (MAT) Degree Program**

**Admission Requirements**
1. Unconditional admission to UAH and major department (if applicable).
2. GPA of 3.0 or higher in undergraduate teaching field courses and education courses; no grade lower than C.
3. Passing score on required Praxis II Content Area Exam.
4. Program of Study (POS) on file in Education.

**Master of Education (M.Ed.) Degree Program**

**Admission Requirements**
1. Unconditional admission to UAH and major department (if applicable).
2. Valid Alabama Class B Teaching Certificate in same or broader field in which advanced certification is sought.
3. GPA of 3.0 or higher in undergraduate teaching field courses and education courses; no grade lower than C.
4. Program of Study (POS) on file in Education.

**Additional Requirements for Reading Specialist (P-12) Candidates**
1. Two years of successful classroom teaching experience
2. A valid baccalaureate certificate (Class B) in an area of education
3. Certification in Early Childhood, Elementary, or Collaborative Teacher Education; or two reading courses, one of which is introductory.

**Mid-Point Review (After Completion of 19-21 Semester Hours)**
1. Maintain 3.0 or higher GPA in Education and in teaching field courses with no grade lower than C.
2. Interview with College of Education advisor and/or faculty to determine pacing in program of study.
Completion Requirements
1. Completion of all education and teaching field courses with GPA of 3.0 or higher.
2. Pass comprehensive written examinations in teaching field and education, and on Praxis II when required.
3. Satisfactory Completion of Capstone Action Research Project.

Certification Requirements for All Master’s Degree Programs

Alabama teaching certificates are the legal responsibility of the Alabama State Department of Education. Colleges and universities cannot issue professional teaching certificates. In order to be recommended for certification, candidates must complete a state approved program. Approved graduate certification programs offered by the UAH College of Education are designed to prepare candidates for professional Class A certification with a master’s degree.

It is the candidate’s responsibility to initiate the application for the teaching certificate by meeting with the Certification Officer. Candidates must provide official transcripts of all undergraduate and graduate coursework, complete all forms required by the Alabama State Department of Education, and pay appropriate fees. Candidates who expect to teach in states other than Alabama are responsible for knowledge of the licensure requirements of those states. Such candidates should inform the certification officer of their intentions.

Certificate Renewal

1. The Class A certificate is valid for five years. This certification may be renewed upon verification of successful teaching for three years and completion of an approved professional development program or additional graduate level credits in the certification area.
2. Individuals who allow their certificates to lapse for more than 6 months will also be required to renew their certificates and to obtain another background clearance for the issuance of a renewed certificate or license. The UAH College of Education in accordance with the Alabama State Board of Education provides courses for persons who hold expired certificates and wish to reinstate them.

Master of Arts in Teaching (initial teaching license for grades 6-12)

- Biology (http://catalog.uah.edu/grad/colleges-departments/education/biology)
- Chemistry (http://catalog.uah.edu/grad/colleges-departments/education/chemistry)
- English Language Arts (http://catalog.uah.edu/grad/colleges-departments/education/english-language-arts)
- English Speakers of Other Languages (http://catalog.uah.edu/grad/colleges-departments/education/esol)
- History (http://catalog.uah.edu/grad/colleges-departments/education/history)
- Mathematics (http://catalog.uah.edu/grad/colleges-departments/education/mathematics)
- Physics (http://catalog.uah.edu/grad/colleges-departments/education/physics)

Master of Education (leads to Class A licensure)

- Autism Spectrum Disorders (Collaborative K-6 or 6-12) (http://catalog.uah.edu/grad/colleges-departments/education/autism)
- Elementary Education - Differentiated Instruction (Elementary K-6) (http://catalog.uah.edu/grad/colleges-departments/education/elementary-education)
- English Speakers of Other Languages (P-12) (http://catalog.uah.edu/grad/colleges-departments/education/english-other)
- Reading Specialist (P-12) (http://catalog.uah.edu/grad/colleges-departments/education/reading)
* Secondary Education - Differentiated Instruction (6-12) (http://catalog.uah.edu/grad/colleges-departments/education/secondary)

1 Pending Alabama State Department of Education approval

- Autism Spectrum Disorders (http://catalog.uah.edu/grad/colleges-departments/education/autism-certificate)

ED 500 - SPEC TOPICS EDUCATION
Semester Hours: 1-3

Independent study, special projects, and special in-service programs.

ED 501 - INTRO TO EDUCATION
Semester Hour: 1

Initial practicum experience designed to provide the opportunity to explore the role of the classroom teacher in today’s diverse school settings. Required for graduate students receiving their initial certification.
ED 510 - FOUNDATIONS OF LITERACY  
Semester Hours: 3

This course includes a study of methods, materials, and strategies for reading instruction. Components of the course will include but not be limited to the five pillars of reading instruction identified by the National Reading Panel (2000): phonemic awareness, phonics, fluency, vocabulary, and comprehension. Emphasis is placed on the various stages of and approaches to literacy development, knowledge of which is required for the Alabama Reading Specialist licensure.

ED 513 - LITERATURE FOR CHILDREN & ADOL  
Semester Hours: 3

Course content will include the study of various genres of children's and adolescent literature and their relationship to beginning reading, enhancement of reading comprehension, and intervention instruction in the various content areas. (Same as EH 613) Must be admitted to the Teacher Education Program.

ED 520 - COMPUTER BASED INSTRUCT'L TECH  
Semester Hours: 3

Introduces prospective teachers to current state of the art in educational technology. Extensive hands-on experiences with microcomputers and other emerging technology. Emphasis on effectively integrating technology into instructional setting for both special and regular students.

ED 521 - TCHNG ENGLISH MID & SEC SCHLS  
Semester Hours: 3

This course is designed to provide graduate level English Education majors with the theory, tools and techniques for teaching middle and secondary students. The focus of the course is primarily, though not exclusively, on designing lessons that allow for maximum student participation and control while remaining aligned to Alabama Content Standards. Students will study, discuss, and implement a variety of environments middle and secondary students reside in, special attention will be given to the use of various technologies as a means of content exploration and student evaluation. As this is a graduate level course, students are expected to engage in substantive scholarly research. Admissions to the Teacher Education Program of permission of instructor is required before registering for this class.

ED 522 - TCHNG MATH MID & SEC SCHLS  
Semester Hours: 3

The math methods course provides background for middle school and secondary teaching from the perspective of theory, research, and practice. It is designed to provide an introduction to and practice in ways in which to engage students in learning in mathematics in middle and secondary classrooms. Topics include specific educational philosophies of mathematics equation, lesson and unit planning, instructional strategies, use of mathematics manipulatives and technology, and student assessment within the content area. Applications will include microteaching and intensive school-based experiences in area schools. Intensive field experience required. Must be admitted to Teachers Education Program or permission of instructor required before registering for this course.

ED 523 - TCHNG SCIENCE MID & SEC SCH  
Semester Hours: 3

This course is designed for students who are pursuing teaching certification in middle and/or secondary science. The course will first focus on how middle and secondary students learn science, and then from this knowledge base, the class context will focus on how to plan, design, and implement inquiry-based science instruction. Assessment development in science, the interpretation, and the use of assessment results to guide student understanding will also be incorporated in teaching methodology.

ED 524 - TCHNG SOC STUD MID & SEC SCH  
Semester Hours: 3

This course is designed to study effective techniques and strategies employed by social science teachers at the middle and secondary levels. As well as learning theoretical foundations in social studies education, students will learn pedagogic skills, instructional strategies, and modes of reasoning unique to the social studies classroom. Intensive field experience required. Students are required to observe, participate, and teach a lesson in a secondary social studies classroom. Admission to the Teacher Education Program or permission of chair is required for this course.

ED 530 - APPLIED MULTICULTURALISM  
Semester Hours: 3

Through an examination of constructs such as race, ethnicity, social class, gender, sexual orientation, and religious affiliation, students will develop an understanding of the connections between identify, difference, power, and privilege and the role(s) school (could/should) play in perpetuating or ending discriminatory practices. Furthermore and more importantly, students will develop an understanding of the ways research in both the humanities and social sciences can be used to interpret, analyze, and critique multiculturalism. Students will leave the course with research-based pedagogical practices designed to help all students learn to the best of their abilities.
ED 532 - SPACE ORIENTATION TEACHERS
Semester Hours: 3
A weeklong course at the U.S. Space and Rocket Center in Huntsville, Alabama for pre-service and in-service teachers. The inquiry based workshops are taught around the theme of space exploration include activities to be done across the curriculum. All activities are correlated to National Math, Science, Technology, Social Studies, and Reading Standards. Activities based on curriculum developed by NASA, CAP, NSATA, and the USSRC. Topics include moon, mars, rocketry, propulsion, hydroponics, math, biology, history and literature.

ED 535 - INTRO APPLIED EDUCATIONAL RES
Semester Hours: 3
Introduction to the nature of research and its relationship to educational thought and practice. Primary focus will be on planning and executing research activities (i.e. action research, thesis development) in the diverse classroom and analyzing the collected data to improve instruction, educational performance, and adding to the body of knowledge in educational practices.

ED 540 - COGN DEV THEORIES LEARNING
Semester Hours: 3
The course is designed to inform students about recent developments in Cognitive Psychology and their implications for teaching and learning. Students will leave the course with a variety of "cognitive understandings" for use in differentiated classrooms.

ED 545 - CURR & INSTR IN SEC SCHOOLS
Semester Hours: 3
This course is designed to address various contemporary teaching and learning strategies, as well as related issues, assessments strategies, and applicable theories related to secondary teaching and learning.

ED 560 - CURR/EMERGING INSTR TECH
Semester Hours: 3
Designed to build competency in computer technologies appropriate to instructional use. Concepts of authoring and scripting will be used to unify course materials. (Same as CS 560.)

ED 565 - INTRO DIFFERENTIATED INSTRUCTI
Semester Hours: 3
The course provides an introduction to the philosophy and practice of differentiation. Students will examine the elements, content, process, product, affect and environment by which instruction can be differentiated to address the complex challenges of meeting the diverse learning needs of all students.

ED 570 - DIFF INSTRUCTION SPEC POP
Semester Hours: 3
The course provides practical strategies to maximize learning for all students, particularly those with disabilities, gifted/talented, and English language learners (ELL).

ED 575 - READING PRIMARY GRADES
Semester Hours: 3
An introduction to the basic principles of literary instruction in culturally and linguistically diverse primary grade classrooms, including theoretical bases for instruction, methods of instruction and organization, developmentally appropriate strategies and materials, and assessment of children's literacy. Class activities include mini-lessons, discussions, group activities, and presentations. An intensive school-based practicum in grades preK-2 is required.

ED 580 - PROJECT BASED LEARNING
Semester Hours: 3
Develop a robust understanding of Project Based Learning (PBL) through critiquing, evaluating, and synthesizing PBL's core theoretical concepts.

ED 593 - ED EXCEPT CHILD & YOUTH
Semester Hours: 3
Introduction to the field of exceptional children and youth, including observations. This course, or equivalent, is a prerequisite to certification. Intensive field experience required.

ED 600 - SPEC PROB IN EDUCATION
Semester Hours: 1-3
Independent study, special projects, and in-service programs.
ED 604 - CONTRIBUTION PSY TO EDUC  
Semester Hours: 3  
Principles, theory, and practice of psychology for teaching and administrative service in educational institutions. Factors that determine learning and conditions of effective teaching. Administrator and supervisor as organizer of the milieu wherein teaching, learning, and growth occur. Intensive field experience required.

ED 605 - READING RESEARCH & INSTRUCTION  
Semester Hours: 3  
Elements of effective reading instruction for beginning readers as supported by current research and practice. Topics include balance, language-rich/print-rich environment, language development, phonemic awareness, print awareness, phonics, writing, spelling, and comprehension. Intensive field experience required.

ED 607 - EDU LEADER AS EVALUATOR  
Semester Hours: 3  
Procedures and techniques of evaluation and research approaches. Emphasis on teachers as evaluators; based on action research in the classroom. Intensive field experience required.

ED 608 - EXPAND RDG ABIL CONT AREA INST  
Semester Hours: 3  
Strategies to enhance reading comprehension when using materials in all subject areas. Teacher-directed, integrated instruction; extensive use of authentic printed materials; discussion at literal and higher levels of understanding, motivation, vocabulary, and writing. Intensive field experience required.

ED 609 - CLASSROOM & BEHAVIOR MGMT  
Semester Hours: 3  
A focus on the variety of instructional management options to meet classroom and individual student needs to ensure success in school is integrated throughout all course activities. A range of management practices, including strategies for diverse and special populations is offered. Theoretical and reflective practices are incorporated during classroom meetings. Students will observe, research, and discuss current classroom approaches. After reflections, effectiveness of observed practices will be assessed. Student will discuss and develop alternative activities that promote successful management techniques. Intensive field experience required. Admission to the Teacher Education program or permission of chair is required for this class.

ED 612 - DIAGNOSIS & ASSMNT OF READING  
Semester Hours: 3  
Focuses on ways to address the needs of students who do not read at grade level. Intervention strategies such as on-going assessment and evaluation, explicit instruction in phonemic awareness and phonics, extensive practice, comprehension strategies, and writing, along with careful examination of standardized state assessment measures. Intensive field experience required.

ED 615 - READING INTERMEDIATE GRD  
Semester Hours: 3  
This course provides an in-depth study in and application of the process of reading and reading instruction, theoretical approaches, instructional strategies, classroom organization, and the formal/informal assessment of reading in intermediate grades. This course is required of all elementary education majors and secondary education candidates who are pursuing a middle school endorsement. Intensive field experience required. Prerequisites: Admission to the Teacher Education Program.

ED 620 - USING TECH REACH SPEC POP  
Semester Hours: 3  
Prepares teachers to plan curriculum integration by using computer technology and software in various curriculum areas for both regular and special students. Students will develop competency in instructional design and production skill techniques and implement instructional events using long-distance technologies.

ED 635 - ASMT GUIDE DIFFRNT INSTRUCTION  
Semester Hours: 3  
The focus of this course would be to use a variety of norm-referenced, criterion-referenced and other assessment data to inform instruction for a diverse classroom within the RTI model. Students would learn to use formative and summative assessments to determine the type of strategies needed to teach content.
ED 640 - DIFD STRGTY RES & TEACH ELL  
Semester Hours: 3  
The course is designed to provide current educators the foundation for informed and effective classroom teaching in diverse classrooms with ELL students. The course includes theoretical underpinnings of historical and contemporary ELL education, instructional methods, analysis and critique of methodologies, and strategies for pedagogically sound classroom instruction and lesson planning within linguistically and culturally diverse classrooms.

ED 650 - DIFFNT ELEM MATH & SCI INSTRUC  
Semester Hours: 3  
This course will focus on guiding the learner to apply the concepts of differentiated instruction within mathematics and science contexts. Participants will learn how to implement effective strategies for managing flexible groups, acquire ideas for providing students with a variety of options to successfully target mathematics and science standards and understand how to plan strategically in order to reach the needs of diverse learners within the classroom through inquiry-based learning.

ED 665 - DIFFNT ELEM LITERACY (R & W)  
Semester Hours: 3  
This course will focus on guiding the learner to apply the concepts of differentiated instruction to elementary literacy concepts. Advanced teacher candidates will develop and implement differentiated instructional plans that utilize individual and flexible grouping strategies and resources to support the growth of strategic, independent readers and writers.

ED 671 - TCHG ELEM LANGUAGE ARTS  
Semester Hours: 3  
Introduction to current practices in language arts instruction with emphasis on the development of an integrated curriculum using children's literature as a foundation. Includes appropriate techniques for teaching of grammar, spelling, and handwriting. Intensive field experience required. Prerequisites: Admission to the Teacher Education Program.

ED 672 - TCHG ELEM SOCIAL STUDIES  
Semester Hours: 3  
Teaching social studies in grades K-6. Helping beginning teachers acquire background skills in organizing and teaching units of work. Intensive field experience required. Prerequisites: Admission to the Teacher Education Program.

ED 673 - TCHG NATURAL/HLTH SCIENCE  
Semester Hours: 3  
Integrates concepts from reflective practice with elementary science teaching. Opportunity to refine teaching skills in the planning, implementation, and evaluation of science lessons and units of instruction. Intensive field experience required. Prerequisites: Admission to the Teacher Education Program.

ED 674 - TCHG ELEM. MATHEMATICS  
Semester Hours: 3  
Overview of the mathematics concepts and skills taught in grades K-6 with an emphasis on the principles, methods, and materials used in the teaching and evaluation of elementary school mathematics. Focuses on the attitudes and behaviors of students and teachers in the actual planning and implementation of mathematics instruction for an elementary school classroom. Intensive field experience required. Prerequisites: admission to the teacher education program.

ED 690 - MASTER'S ACTION RESEARCH PROJ  
Semester Hours: 3  
The capstone course will serve as a mechanism to support the research, methodology, development, and experimental stages of the required action research. The student's work will be approved and supervised by a selected faculty advisor with direct connections to the research area. A symposium in which students present their research report will be culminating activity.

ED 691 - PORTFOLIO SEMINAR & SYMPOSIUM  
Semester Hour: 1  
The seminar will provide a forum in which the student's culminating portfolio is refined and submitted for faculty review. The seminar will also serve as a mechanism to support the final writing stages of the required action research project or case study report. The student's work will be approved and supervised by the faculty advisor(s). A symposium in which students present their research will be the culminating activity.

ED 693 - ELEMENTARY INTERNSHIP  
Semester Hours: 6  
Observation, participation and teaching in elementary school (full time, 15 week semesters). Students will also attend campus-based seminars designed to meet specific needs of the interns.
ED 696 - P-12 INTERNSHIP  
Semester Hours: 3-6

ED 698 - HIGH SCHOOL INTERNSHIP  
Semester Hours: 3-6

Observation, participation, and teaching in middle/high school (full-time, 15 week semester). Students will also attend campus based seminars designed to meet specific needs of interns.

EDC 511 - INSTRUCTIONAL STRATEGIES  
Semester Hours: 3

This course provides foundational, in-depth pedagogical strategies for assisting learners in constructing their own understanding of information. This course focuses on multiple instructional options that all learners need in order to be successful. It takes a broad approach to the multiple teaching models that are necessary for working with diverse populations.

EDC 551 - FND OF VISUAL IMPAIRMENTS  
Semester Hours: 3

Introduction to academic language found within the profession of special education of students with visual impairments. Examines standards, organizations, programs, and services for students with visual impairments. Studies the basic anatomy, diseases, and disorders of the visual system and explores how to conduct a Functional Vision Assessment.

EDC 625 - ASSISTIVE TECH EDUC INDV W/ASD  
Semester Hours: 3

This course provides an overview of assistive technology devices and services that are used in the instruction of students with autism spectrum disorders (ASD) and other communication disabilities.

EDC 636 - INTRO STUD AUTISM SPECTR DISOR  
Semester Hours: 3

This course will provide advanced teacher candidates with an introduction to working with students diagnosed with autism spectrum disorders. Candidates will develop an understanding of the range of characteristics and behaviors associated with ASD, the effectiveness of early intervention on behaviors, and the theories regarding the etiology of the disorder.

EDC 645 - ASMT & BEHAVIOR APPLC ASD  
Semester Hours: 3

This course focuses on assessment and intervention planning for children with ASD. Candidates will enhance their knowledge of various assessments appropriate to the ASD population and develop skills to administer and interpret assessments. The course will provide candidates with an overview of the Applied Behavioral Analysis approach to assessing and teaching students with ASD.

EDC 652 - INTRO TO O&M  
Semester Hours: 3

Examines the psychosocial implications of blindness, with a particular focus on independence. Exploration of basic orientation mobility concepts including human guide and basic independent travel through the use of verbal description and tactile graphics.

EDC 653 - STRATEGIES FOR VI  
Semester Hours: 3

Examines the strategies used to make education accessible to students with visual impairments through the creation of high-quality accommodations and/or modifications. Topics include organization, assessment, early intervention, and the expanded core curriculum. This course is a practicum for visual impairments.

EDC 654 - INTRO TO BRAILLE  
Semester Hours: 3

Focused exploration of braille, braille literacy, and braille assessment.

EDC 655 - COLLAB & TRANSITION PLANNG  
Semester Hours: 3

Using case-based instructional strategies, this course is designed to assist advanced teacher candidates in learning to build supportive relationships with families, paraprofessionals, and related service providers, including community agencies, as a foundation for designing differentiated learning experiences for students with disabilities.
EDC 656 - PROGRAMS FOR MIVI/DB
Semester Hours: 3

Intensive examination of curricular adaptations, assessment, and intervention for students with multiple disabilities and visual impairments or deafblindness.

EDC 657 - ADVANCED BRAILLE AND AT
Semester Hours: 3

Focused exploration of the braille for use in various contexts (STEM, music, foreign language), assistive technology and STEM education for students with visual impairments.

EDC 660 - PRCTL APPLC VIS INSTR STRATEGY
Semester Hours: 3

Advanced candidates will participate in an extensive summer clinic for children with ASD. Candidates learn how to create an appropriate learning environment, organize schedules for individual students, develop materials, engage in instruction, respond to behavioral issues, and document student progress.

College of Engineering

102 Engineering Building
Telephone: 256.824.6474
Email: eng_grad@uah.edu (eng_grad@uah.edu)

Mission

The mission of the College of Engineering is to advance knowledge through research and education of students in core engineering disciplines. The college promotes ethical, innovative, and multidisciplinary approaches in an environment of collaboration with local and global partners to address society's technological problems.

Dean: Shankar Mahalingam, B.Tech., M.S., Ph.D., Professor of Mechanical Engineering
Associate Dean for Graduate Education and Research: Michael D. Anderson, Ph.D., Professor of Civil Engineering

Departments and Degree Programs

The College of Engineering has five academic departments: Chemical and Materials Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering, Industrial and Systems Engineering and Engineering Management, and Mechanical and Aerospace Engineering. The academic departments offer several graduate degree programs including:

- Master of Science in Engineering (Options in Civil, Chemical, Computer, Electrical, Industrial, and Mechanical)
- Master of Science in Aerospace Systems Engineering
- Master of Science in Operations Research
- Master of Science in Software Engineering
- Doctor of Philosophy (Aerospace Systems, Civil, Computer, Electrical, Industrial, and Mechanical)

The College of Engineering also supports several interdisciplinary graduate degree programs including:

- Master of Science in Cybersecurity
- Master of Science in Material Science
- Doctor of Philosophy in Biotechnology Science and Engineering
- Doctor of Philosophy in Material Science
- Doctor of Philosophy in Optical Science and Engineering

Engineering Graduate Study

The College of Engineering comprises five academic departments of instruction and research. These units offer programs of study and research leading to master's and doctoral degrees. Some departments also offer programs in one or more subdisciplines as well as joint programs with other UAH colleges/departments or other universities in the University of Alabama system.

The College of Engineering graduate programs are designed to provide a balance of strong academics and graduate level research. Engineering faculty members provide broad and vigorous research programs with excellent opportunities for thesis and dissertation work.
Admissions

Applicants for graduate study in the College of Engineering must apply for admission to the UAH Graduate Studies. Applicants may initiate the admissions process at http://register.uah.edu. More information about the admissions process may be found here (http://www.uah.edu/admissions/graduate/admission-process).

Unconditional admission to an Engineering Master’s degree program may be granted to applicants who have

1. earned a baccalaureate degree in engineering from institutions with ABET-accredited programs (not required for MS in Operations Research),
2. earned a minimum 3.0/4.0 grade point average for their baccalaureate work
3. earned minimum GRE scores of 145 (Verbal) and 155 (Quantitative) and
4. have met specific program requirements. An engineering department may choose to waive one or more of these requirements with appropriate and documented justification.

International students may be granted unconditional admission if they meet the requirements for unconditional admission described above AND have earned a minimum of 18 on each TOEFL subscore.

For admission to an Engineering Doctoral degree program, additional admissions criteria is specified by each department or program. Students should consult their major engineering department for the additional requirements.

Graduate Assistantships

Financial aid, in the form of teaching and research assistantships, is available for qualified students. Admission to an Engineering graduate degree program does not guarantee financial aid. Students should consult their major department for information on applying for assistantships.

Initial Advisement

Applicants who are granted admission to graduate study in the College of Engineering will be referred to the major department for the assignment of a temporary advisor.

Master’s Degree General Requirements

The College of Engineering master’s degree programs include a Plan I, thesis option, or a Plan II, non-thesis option. Students who choose the Plan I option must complete and defend a thesis based on research performed under a faculty advisor. Students who choose the Plan II option must complete a capstone experience or a comprehensive exam. Each engineering master’s degree program requires a minimum of 30 semester hours. Students should consult with their major department for additional requirements.

A minimum overall grade point average of 3.0/4.0 is required for all graduate courses at UAH, whether or not the course is required to satisfy the master’s degree requirements. Further, a minimum overall grade point average of 3.0/4.0 is required for all courses taken at the 600-level or above. With permission of the major department, students may transfer up to 12 semester hours of acceptable graduate credit earned at an approved institution to satisfy master’s degree requirements. Transfer coursework may not be older than 10 years at the time of graduation. All requirements for the master’s degree must be completed in six years.

Doctoral Degree General Requirements

The College of Engineering doctoral degree programs require a minimum of 48 hours of graduate level coursework and a minimum of 18 hours of dissertation. All programs require a qualifying examination, which is administered by the supervisory committee within a year after the student has completed their graduate coursework. All programs also require the completion and defense of a dissertation based on research performed under a faculty advisor. Some programs may also require a preliminary examination or other subject examination as well as a research proposal presentation. For those students who have already earned a Master’s degree, a minimum of 18 semester hours of approved coursework beyond the Master’s degree, with an average grade no lower than a B.

A minimum overall grade point average of 3.0/4.0 is required for all graduate courses at UAH, whether or not the course is required to satisfy the master’s degree requirements. Further, a minimum overall grade point average of 3.0/4.0 is required for all courses taken at the 600-level or above. With permission of the major department, students may transfer acceptable graduate credit earned at an approved institution to satisfy Ph.D. degree requirements. Transfer coursework may not be older than 10 years at the time of graduation. All requirements for the Ph.D. degree must be completed within 5 years after the student has passed the qualifying exam.

Programs leading to the degree of Doctor of Philosophy are offered in the College of Engineering and are granted on the basis of general demonstrated ability to do independent, original investigation. These attributes are tested in a comprehensive examination and in a dissertation that must clearly and effectively present the substantial results of research. These accomplishments, rather than mere accumulation of residence and course credits, are essential considerations in awarding the Ph.D. degree.

Residency Requirements

A majority of semester hours (including thesis/dissertation hours) must be earned at UAH or in the case of joint/shared program, at the participating institution. Residence may be established through either (1) being enrolled as a full-time student (at least 9 graduate semester hours) either for one
continuous academic year, or for Spring and Fall semesters in the same calendar year, or (2) being enrolled in at least 6 hours of graduate course work in at least three of the four consecutive semesters.

All research effort presented for residence credit toward the Ph.D. degree must be performed under the direction of a member of the graduate faculty who holds full membership status.

**Master's Programs in Engineering**

- Aerospace Systems Engineering, MSASE (p. 101)
- Chemical Engineering, MSE (p. 53)
- Civil Engineering, MSE (p. 61)
- Computer Engineering, MSE (p. 77)
- Cybersecurity, MS - Computer Engineering Track (p. 78)
- Cybersecurity, MS Interdisciplinary - Computer Engineering Track (p. 106)
- Cybersecurity, MS Interdisciplinary - Computer Science Track (p. 108)
- Cybersecurity, MS Interdisciplinary - Management Track (p. 35)
- Electrical Engineering, MSE (p. 79)
- Industrial and Systems Engineering, MSE (p. 88)
- Industrial and Systems Engineering, MSOR (p. 90)
- Material Science, MS (p. 112)
- Mechanical Engineering, MSE (p. 103)
- Software Engineering, MSSE (p. 80)

**Doctoral Programs in Engineering**

- Aerospace Systems Engineering, PhD (p. 101)
- Biotechnology Science and Engineering, PhD (p. 104)
- Civil Engineering, PhD (Joint with UAB) (p. 62)
- Computer Engineering, PhD (Shared with UAB) (p. 76)
- Electrical Engineering, PhD (p. 77)
- Industrial and Systems Engineering, PhD (p. 86)
- Material Science, PhD (p. 114)
- Mechanical Engineering, PhD (p. 102)
- Optical Science and Engineering, PhD (p. 116)

**Chemical and Materials Engineering**

117 Engineering Building
Telephone: 256.824.6810
Email: chegrad@uah.edu

**Interim Chair:** Shankar Mahalingam, Dean and Professor

**Mission**

The Department of Chemical and Materials Engineering is dedicated to developing and maintaining undergraduate and graduate programs that educate students in the safe control and manipulation of matter in industrially important chemical and materials systems. The faculty will continue to educate students and maintain its programs by providing intellectual leadership, innovative teaching, university and community service, while conducting internationally recognized research. Undergraduate and graduate programs within the department are continuously refined based on national standards and are designed to encourage interdisciplinary education. Research objectives focus on technology important to the further development of the university, the community, the state of Alabama, and the nation.

**Degree Programs**

The Department of Chemical and Materials Engineering offers coursework and research leading to the Master of Science degree in Engineering. The Doctor of Philosophy degree is available through the Materials Science PhD program, the Biotechnology Science and Engineering Program, or the Chemical Engineering Option of the Mechanical Engineering PhD program.

The range of research interests in the chemical engineering faculty is broad. It affords graduate students opportunities for advanced work in processes, reaction engineering, electrochemical systems, material processing and biotechnology and energy. The MSE degree granted in these areas of
concentration is equivalent to those available in a traditional chemical engineering program. Please contact the Department of Chemical and Materials Engineering (256.824.6810) or visit the CHE homepage at http://www.uah.edu/eng/departments/cme for further details.

**Chemical Engineering, MSE**

The MSE in CHE requires a total of 30 semester hours. There are two options: Plan One includes 24 semester hours of coursework and 6 semester hour of thesis work and Plan Two The basic program of study contains a minimum of 18 semester hours of graduate-level course work that must include 12 semester hours in graduate chemical engineering courses and 6 semester hours of courses in Graduate Engineering Analysis.

**Chemical Engineering, PhD options**

The College of Engineering does not offer a PhD in Chemical Engineering. However, students with a background in chemical engineering may pursue one the following interdisciplinary options:

- PhD in Materials Science. This program is innovative joint-program involving all three campuses of the University of Alabama System (UAB, UAH, and UA) and multiple departments from the UAH College of Science and College of Engineering. The requirements include a three-part program examination, 48 credit hours of graduate coursework, 18 credit hours of dissertation (MTS 799) and successful defense of a doctoral dissertation.
- PhD in Biotechnology Science and Engineering. This is a joint program between the UAH College of Science and College of Engineering. The requirements include 48 credit hours of graduate coursework, 18 credit hours of dissertation (BSE 799) and successful completion of a preliminary examination and a doctoral dissertation.
- PhD in Mechanical Engineering with a Chemical Engineering option. The Chemical Engineering Option of the Mechanical Engineering PhD program requires 48 credit hours of graduate coursework. Students should consult the requirements for the Mechanical Engineering PhD.

Students who wish to pursue one of these options should consult the catalog entries for these programs for more information or visit the CME Department office.

**Graduate Programs in Chemical & Materials Engineering**

- Chemical Engineering, MSE (p. 53)

**CHE 540 - PHYSICAL PROP OF FLUIDS**

*Semester Hours: 3*

Theoretical, experimental, and correlation methods for determining and predicting the thermodynamic and transport properties of various fluids. Critical properties, equations of state, vapor pressure and latent heat, heat capacity. Viscosity, thermal conductivity, diffusion coefficient, phase equilibrium, heat and free energy for formation.

**CHE 541 - CHEMICAL KINETICS & REACTOR DE**

*Semester Hours: 3*

Fundamental principles of chemical kinetics and chemical reactor engineering along with the design of both thermal and catalytic reactors.

**CHE 549 - INTRO ENVIRONMENTAL ENGR**

*Semester Hours: 3*

Engineering aspects of air, water, and thermal pollution. Hydrologic cycle, water sources and uses; industrial and other sources of primary and secondary pollutants. Transport process in environmental problems and in their control.

**CHE 552 - EXPER TECH IN FLUID MECH**

*Semester Hours: 3*

**CHE 559 - SELECTED TOPICS/CHE**

*Semester Hours: 1-6*

Discussion of biocompatible polymers and their application in drug delivery systems. Polymers of natural and synthetic origin will be studied, special emphasis will be placed upon the synthesis of biocompatible polymers. The formation of polymeric micelles, hydrogels and liposomes will be studied. The process of extravasation as uptake mechanism for polymeric delivery systems will be discussed. Reading material will be based on the latest publications in the field.

**CHE 560 - INTRO TO BIOPROCESS ENGR**

*Semester Hours: 3*

Application of engineering principles to the analysis of and the development and design of processes using biological catalysts including enzymes, plant and animal cells, and genetically engineered cells. Other topics include fermentation and biological mass transport processes.
CHE 561 - BIOSEPARATIONS RECOMBI TECH/PR  
Semester Hours: 3  
General characteristics of separation processes used in the biotechnology industry, including removal of insolubles, isolation and purification of thermally sensitive products for final use by the customer. Application of unit operation principles for biological separations, recombinant DNA techniques, protein engineering. Prerequisite: CHE 560.

CHE 594 - APPLIED MATERIALS PROCESSING  
Semester Hours: 3  
Synthesis and processing methods of materials for engineering applications. Selection and use of materials performance factors for design of structural and functional components. Use of computational methods in solving open-ended design problems that depend on an understanding of the nature and properties of materials will be emphasized. All classes of materials are covered.

CHE 595 - POLYMER ENGINEERING  
Semester Hours: 3  

CHE 641 - ADV THERMODYNAMICS  
Semester Hours: 3  
Application of classical thermodynamics. Treatment of problems involving nonideal gases and liquids, phase equilibrium, and chemical equilibrium.

CHE 642 - PHYSICOCHEMICAL HYDRODYNAMICS  
Semester Hours: 3  
Treatment of electrokinetic phenomena, axial dispersion, convective diffusion in liquids, Brownian motion, flows driven by surface tensions, capillary motion.

CHE 644 - INTRO ELECTROCHEM SYSTEM  
Semester Hours: 3  
Thermodynamics, transport, and kinetics of electrodes and cells. Systems analysis of batteries, fuel cells, porous electrodes, electroplating, electrowinning, and corrosion processes. Convective diffusion at high Schmidt numbers.

CHE 646 - THERMODYNAMICS OF MATRLS  
Semester Hours: 3  
Fundamental thermodynamic review, phase equilibrium, chemical reaction equilibrium, free energy, binary and ternary phase transformations, solution models and selected topics.

CHE 648 - TRANSPORT PHENOMENA I  
Semester Hours: 3  
Introduction to transport phenomena, fluid and continuum mechanics. Exact solutions of the Navier-Stokes equation. Introduction to boundary-layer, multiphase flows. Capillary flows.

CHE 649 - TRANSPORT PHENOMENA II  
Semester Hours: 3  

CHE 650 - PRINC LIQUID/SOLID INTER  
Semester Hours: 3  
Applies basic principles in thermodynamics and kinetics to characterize surfaces and surface phenomena. Fundamental properties of gas-liquid, liquid-liquid, solid-liquid, and solid-gas interfaces and phenomena occurring at these interfaces.

CHE 652 - INTRO TO AIR POLLU CONTROL  
Semester Hours: 3  
Technology of air pollution dealing with air pollutants, effects, sources, combustion processes, and abatement and control technology. Engineering contributions to both the problems and their solutions. Nature of air pollution problem and fundamental technological approaches to its solution.

CHE 657 - ADVANCED PROCESS CONTROL  
Semester Hours: 3  
Application of modern control theory to chemical processes; multivariable control; estimation and adaptive control, optimal control.
CHE 658 - CATALYSIS/REACTOR DESIGN  
Semester Hours: 3  
Treatment of homogeneous and heterogeneous reaction kinetics, transport in fluid-solid reactions, catalyst deactivation and their effects on the analysis and design of chemical reactors. Prerequisite: CHE 541.

CHE 659 - SELECTED TOPICS/CHE  
Semester Hours: 1-6  
CHE 696 - GRAD INTERNSHIP CHE ENGR  
Semester Hours: 1-9  
Active involvement in an engineering project in an engineering enterprise, professional organization or government agency that has particular interest and relevance to the graduate student. Permission of CHE faculty member required.

CHE 699 - MASTER'S THESIS  
Semester Hours: 1-9  
CHE 724 - INSTR METH/BIO-MTLS CHARACTERI  
Semester Hours: 3  
CHE 725 - INSTR METH/BIO-MTLS CHARACTERI  
Semester Hours: 4  
CHE 747 - ADV TOP/BIOENGINEERING  
Semester Hours: 3  
Engineering aspects of microbial processes and the processing of biological materials. Integrating knowledge of governing biological properties and principles with chemical engineering methodology. Emphasis on current literature in the areas of purification and separation technology, bioprocess development and biomaterials.

CHE 749 - MASS TRANSPORT  
Semester Hours: 3  
Mass transfer in solid and fluid systems under steady and transient conditions. Integration of momentum, heat and mass transfer equations with application to reactive, rheological and multicomponent systems.

CHE 757 - OPT TECH/FLUID MECHANICS  
Semester Hours: 3  
Laser courses, molecular interactions with light and diatomic spectroscopy needed fluorescence, Brillouin scattering, four wave mixing, CARS and other applications in optical fluid diagnostics.

CHE 759 - ADV SELECTED TOPICS IN CHE  
Semester Hours: 1-3  
CHE 799 - DOCTORAL DISSERTATION  
Semester Hours: 1-9  
Required each semester student is enrolled and receiving direction on doctoral dissertation.

Chemical Engineering, MSE

The CME Department offers two plans leading to the MSE degree for the Chemical Engineering option. These are designated:

- Plan I (Thesis)
- Plan II (Non-thesis)

The following sections describe the requirements for each of these options. Additional requirements, policies, and required forms may be found in the CME Department office.

Basic Program of Study

The Basic Program of Study, common to both the Plan I and Plan II (Non-thesis) MSE options, contains a minimum of 24 semester hours of graduate-level course work that must include:
Civil and Environmental Engineering

Plan I, Thesis Option

Students selecting this option must:

<table>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Complete Basic Program of Study as described above</td>
<td>24</td>
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<tr>
<td></td>
<td>Master's Thesis</td>
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</tr>
<tr>
<td></td>
<td>CHE 699 MASTER'S THESIS</td>
<td>6</td>
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<tr>
<td></td>
<td>Complete an acceptable thesis including a public defense</td>
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<td>Total Semester Hours</td>
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Plan II, Non-Thesis Option

Students selecting this option must:

<table>
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<th>Title</th>
<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Complete Basic Program of Study as described above</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Select 6 semester hours of graduate courses to complete an approved extended program of study</td>
<td>6</td>
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<tr>
<td>Total Semester Hours</td>
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<td>30</td>
</tr>
</tbody>
</table>

Civil and Environmental Engineering

S201 Technology Hall
Telephone: 256.824.6854
Email: ceegrad@uah.edu

Chair: Sherif Ishak, PhD, Professor

Mission

The mission of the Civil Engineering program is to educate students with the fundamental knowledge, and analytical skills necessary for successful careers in civil and environmental engineering. Through rigorous scholarship, innovative instruction, and service, we advance knowledge to improve our global community.

Degrees

- Master of Science in Engineering (Civil Engineering) (p. 61)
- Doctor of Philosophy in Civil Engineering (p. 62)

The Civil and Environmental Engineering (CEE) Department offers coursework and research leading to the MSE and PhD degrees. The PhD program is offered jointly with the Department of Civil and Environmental Engineering at the University of Alabama at Birmingham (UAB).

Research performed by the civil engineering faculty emphasizes state-of-the-art technology and is geared largely toward space-based applications. The philosophy and unique qualifications of the faculty afford graduate students opportunities for advanced work in structural engineering and structural...
materials, geotechnical engineering, engineering mechanics, environmental engineering, hydraulics and hydrologic processes, transportation planning, intelligent transportation systems, experimental mechanics/applied optics and natural hazard mitigation.

Under a cooperative agreement, several courses are co-listed and jointly taught by civil and mechanical engineering faculty so that a variety of courses can be offered on a regular basis. Courses are also available by the Intercampus Interactive Telecommunications System (IITS) from faculty at UAB, USA, and UA. Financial support is available at attractive levels for qualified students in the form of assistantships. Graduate Co-op positions are also available with many local research and industrial organizations. UAH has the intellectual and social environment to provide a well-rounded, high technology oriented degree. The MSE degree granted by the department is equivalent to those available in traditional civil and environmental engineering programs.

Civil Engineering, MSE
Students wishing to pursue the MSE in Civil Engineering must meet the admission requirements of the UAH Graduate Studies as well as the College of Engineering. A beginning student files a Program of Study in consultation with the faculty advisor. The MSE in Civil Engineering requires a minimum of 30 semester hours and consists of two options. The thesis option requires 24 hours of graduate coursework and 6 hours of thesis. Under this options, students must complete a written thesis and an oral defense. The non-thesis option requires 30 hours of graduate coursework.

Civil Engineering, PhD
The CEE Department offers a program (jointly with UAB) leading to the Doctor of Philosophy (PhD) in Civil Engineering. Courses are offered jointly by CEE faculty from both universities and are available in real time via IITS. The doctoral work is supervised by an experienced researcher and recognized authority in the field and the supervisory Committee is made up of faculty from both UAH and UAB and a minimum number of course semester hours must be taken from each campus. Coursework, written and oral examinations, and the dissertation are all essential components of the doctorate. The doctoral program requires 48 semester hours of coursework beyond the BS degree, plus 24 semester hours of dissertation. However, for students entering with an MSE degree with thesis, the dissertation requirement is 18 semester hours. PhD students must meet the minimum requirements set by the School of Graduate Studies, the College of Engineering, and the department.

In addition to the graduate coursework, students must pass a preliminary exam which ascertains their academic, technical and intellectual preparedness to pursue doctoral level work. For doctoral students with a master's degree, the preliminary exam must be administered within the first two semesters of study, and for doctoral students with a baccalaureate degree after completion of 24 semester hours of graduate coursework. More information about this exam is available in the CEE Department office.

Students must also pass a qualifying exam, which is administered after all course work is completed by the student's supervisory committee. The qualifying exam is given in conjunction with the presentation of the dissertation proposal to the supervisory Committee and is designed to determine the student's research competence. This exam process includes both written questions related to the coursework and an oral presentation of the proposal to the committee. The exam should be completed at least two semesters (one academic year) before the PhD is awarded. Students are allowed two attempts at the qualifying exam.

Finally, students must write a dissertation on their research work. When the dissertation has been completed, the supervisory committee will give the candidate a final oral examination as a part of a public dissertation defense. More information about the dissertation process is available in the CEE department office.

Master's Program in Civil and Environmental Engineering
- Civil Engineering, MSE (p. 61)

Doctoral Program in Civil and Environmental Engineering
- Civil Engineering, PhD (Joint with UAB) (p. 62)

CE 511 - INTRO GEOGRAPHICAL INFO SYS
Semester Hours: 3
Introduces vector, raster and tabular concepts, emphasizing the vector approach. Topics include: spatial relationships, map features, attributes, relational database, layers of data, data ingesting, digitizing from maps, projections, output, applications, and availability of public data sets.

CE 520 - URBAN TRANSPORTATION PLANNING
Semester Hours: 3
Planning of highway systems and terminals as part of a complete planning approach; public transportation system planning; transportation planning studies, projection analysis, plan formulation, and programming.

CE 541 - OPEN CHANNEL HYDRAULICS
Semester Hours: 3
Design and analysis of erodible and non-erodible channels. Uniform flow, channel roughness, gradually and spatially varied flow, rapidly varied flow, hydraulic jumps, gradually varied unsteady flow, flood routing, flow measurements, channel models, channel and culvert design.
CE 549 - INTRO ENVIRONMENTAL ENGR
Semester Hours: 3

Engineering aspects of air, water, and thermal pollution. Hydrologic cycle, water sources and uses; industrial and other sources of primary and secondary pollutants. Transport process in environmental problems and in their control.

CE 550 - ENVIRONMENTAL CONTROL
Semester Hours: 3

Engineering design and synthesis of environmental control systems. Control of multiphase systems with application to air and water pollution control.

CE 552 - INDUSTRIAL WASTE TREATMENT
Semester Hours: 3

Advanced topics in the area of hazardous waste management and water quality control. Emphasis on industrial waste, including hazardous waste management. Topics include: generation, storage, collection, transfer, disposal, recycling, economic, environmental, and regulatory considerations.

CE 554 - SOLID & HAZARDOUS WASTE MGMT
Semester Hours: 3

Waste characterization, minimization, collection, treatment, transport, and disposal. Landfill design and incineration options. Leachate characteristics and potential groundwater contamination. Prerequisite: CE 549.

CE 555 - WATER QUALITY LABORATORY
Semester Hours: 3

Properties of natural water sources and laboratory methods associated with water and wastewater treatment systems. Students design and demonstrate a water treatment system to bring a water sample into compliance with drinking water standards.

CE 556 - WATER QUALITY CONTROL PROC
Semester Hours: 3

Principles of public water supply design. Source selection, collection, purification, and distribution for municipal use. Collection of waste waters, their treatment, and disposal. Prerequisite: CE 549.

CE 557 - HYDROLOGY
Semester Hours: 3

Occurrence and movement of water over the earth's surface for engineering planning and design. Relationship of precipitation to streamflow with frequency analysis, flood routing, and unit hydrograph theory.

CE 558 - ENVIRONMENTAL ENGR DSGN
Semester Hours: 3

Engineering design and project management of environmental quality/restoration systems. Students will complete a design project focusing on one of the following systems: sanitary landfill, municipal incinerator, or groundwater/site remediation. Lectures will address skills for technical presentations and proposal writing, as well as process design and decision making.

CE 559 - SEL TOPICS CIVIL ENGINEERING
Semester Hours: 1-6

CE 561 - VIBRATIONS ELASTIC SYS
Semester Hours: 3

Formulation of the equations of motion of discrete and continuous systems, analytical and numerical methods of solution, eigenvalue problems, and dynamic response.

CE 571 - ADVANCED SOIL MECHANICS
Semester Hours: 3

Continuum mechanics applied to soil behavior. Theoretical approaches to consolidation, shear strength, slope stability and soil stabilization.

CE 572 - SOIL DYNAMICS
Semester Hours: 3

Behavior of soils under dynamic, earthquake and blast loading. Analysis of foundation vibration and isolation.

CE 573 - EARTH STRUCTURES ENGINEERING
Semester Hours: 3

Principles of earth structure design. Theories of earth pressures and the design of retaining wall systems including gravity, cantilever, mechanically stabilized earth, flexible sheet pile, and anchored wall systems. Methods of stability analyses for retaining walls, earth slopes, and embankment design.
CE 574 - APP MECHANICS OF SOLIDS  
Semester Hours: 3  
Stresses and strains at a point, theories of failures, stress concentration factors, thick-walled cylinders, torsion of noncircular members, curved beams, unsymmetrical bending, and shear center.

CE 577 - EXP TECH SOLID MECHANICS  
Semester Hours: 3  
Experimental methods to determine stress, strain, displacement, velocity, and acceleration in various media. Theory and laboratory applications of electrical resistance strain gages, brittle coatings, and photoelasticity. Application of transducers and experimental analysis of engineering systems.

CE 578 - MATRIX METH STRUCT MECH  
Semester Hours: 3  
Matrix application to formulation and solution of linear problems in structural mechanics. Stresses, vibrations, and stability of engineering structures.

CE 581 - STRUCTURAL ANALYSIS II  
Semester Hours: 3  
Reactions, shears, moments and deformations in complex structural systems. Statically indeterminate systems, advanced geometric and energy methods.

CE 583 - REINFORCED CONCRETE DESIGN  
Semester Hours: 3  
Theory and practice of reinforced concrete design. Theory and design of high strength concrete mixtures. Design of reinforced concrete beams, slabs and columns using the ultimate strength design code of the American Concrete Institute.

CE 584 - STEEL DESIGN  
Semester Hours: 3  
Principles of the design of steel structures using ASD methods. Analysis and design of structural elements including beams, columns, connection details.

CE 585 - FOUNDATION ENGINEERING  
Semester Hours: 3  
Design of foundations with emphasis on reinforced concrete, footings, caissons, piles, retaining walls, and mat foundations. Effect of bearing pressure on foundations. Prerequisite: CE 583.

CE 586 - ADV CEMENTITIOUS & COMPOSITE  
Semester Hours: 3  
Concrete structures, rheology, mechanical properties, environmental durability, dimensional stability, advanced concrete technologies (such as high strength, fiber reinforced, and fracture mechanics), advanced fiber polymer composites, and repair/rehabilitation of concrete structures.

CE 587 - BRIDGE DESIGN  
Semester Hours: 3  
Bridge loads, load distribution, composite beam bridges, bridge bearings, reinforced and prestressed concrete slab and T-beam bridges, bridge evaluations and ratings, and upgrade methodology.

CE 603 - ADVANCED CONCRETE DESIGN  
Semester Hours: 3  
Design of concrete columns; bond, anchorage and reinforcing details; design of two-way slabs; design and analysis of multistory building frames; introduction to prestressed concrete; design of prestressed cross-sections for moment.

CE 611 - GIS IN CIVIL ENGINEERING  
Semester Hours: 3  
Advanced topics in geographical information systems (GIS) with civil engineering applications. Emphasis will be placed on spatial/temporal data analyses using digitized maps and database information in an area of CE specialization. Research project will be required.

CE 622 - ADVANCED TRAFFIC ENGRG DESIGN  
Semester Hours: 3  
In depth analysis of traffic engineering concepts related to intersection analysis (signalized and un-signalized) as well as arterial systems.
CE 646 - EROSION & SEDIMENTATION
Semester Hours: 3

River morphology and river response, incipient erosion and its prediction, bed form and roughness, degradation, aggradation, and local scour in alluvial rivers. Design of stable channels, computation of bed load.

CE 650 - ENVIRONMENTAL IMPACT ANAL
Semester Hours: 3


CE 651 - ENVIRONMENTAL REGULATIONS
Semester Hours: 3

Basic understanding of environmental law with an appreciation for the practical implementation of regulations for environmental engineers. Includes an overview of the major American environmental laws for protection of water and air resources, as well as permitting requirements and health/safety responsibilities. Prerequisite: CE 549.

CE 652 - INTRO TO AIR POLLUTION CONTROL
Semester Hours: 3

Technology of air pollution dealing with air pollutants, effects, sources, combustion processes, and abatement and control technology. Engineering contributions to both the problems and their solutions. Nature of air pollution problem and fundamental technological approaches to its solution.

CE 653 - GROUNDWATER ENGINEERING
Semester Hours: 3

Application of engineering principles to the movement of groundwater. Influence of physical and geological environment on groundwater hydraulics. Water well hydraulics and aquifer evaluation. Emphasis on practical groundwater engineering problems. Prerequisites: MA 526 or MAE 693.

CE 654 - ENVIRONMENTAL TRANSPORT
Semester Hours: 3

Fundamental principles of mass transport, chemical partitioning/transformations in environmental systems. Practical transport examples for surface water, ground water, and atmospheric systems will be presented and mathematical modeling will be utilized for solutions.

CE 655 - HAZARDOUS WASTE MGMT
Semester Hours: 3

Topics include definition of hazardous waste, regulatory considerations, risk assessments, and categories of waste. Current and emerging treatment and disposal technologies will be explored.

CE 656 - ENV SYSTEMS SAMPLING & ANAL
Semester Hours: 3

CE 657 - ADVANCED HYDROLOGY
Semester Hours: 3

Hydrologic cycle, including interrelationships between classical and statistical methods of hydrology. Evaluation of governing equations, linearizations, analytical approximations and numerical solution techniques for various boundary conditions. Stochastic hydrologic modeling in both temporal and spatial domains. Prerequisites: ISE 690, MAE 586, MAE 693, and CE 557.

CE 658 - SUSTAINABLE DESIGN
Semester Hours: 3

The built environment has a substantial impact on energy and material resources as well as being a critical determinant of health and productivity. This course covers topics such as site planning and construction variables, energy and water alternatives, and current rating systems. Case studies and field trips of historic and contemporary projects exemplifying various sustainability features will be included.

CE 659 - SEL TOPICS CIVIL ENGINEERING
Semester Hours: 1-6

CE 660 - STRUCTURAL DYNAMICS
Semester Hours: 3

CE 662 - GEOTECHNICAL ENGINEERING
Semester Hours: 3
Shallow foundation’s immediate and consolidated settlement, advanced deep foundations under lateral and axial loads, design of single and pile groups, soil-pile interaction, introduction to seismology, earthquake characteristics, dynamic soil properties and response, soil profile response spectra, soil liquefaction. Prerequisite: CE 585.

CE 666 - EARTHQUAKE ENGR & STRUCT DYNAM
Semester Hours: 3
This allows structural engineers to consolidate their knowledge on the effect of earthquake ground motions on civil engineering structures. The course will cover the analysis and the theories of structures made of various materials that are located in active seismic zones. Finally, the course will allow structural engineers to acquire new basic knowledge in earthquake engineering that will allow them to communicate better with scientists and engineers of other disciplines in earthquake engineering (e.g. seismologist, geotechnical engineers, etc.).

CE 671 - CONTINUUM MECHANICS
Semester Hours: 3
Kinematics and kinetics, various coordinate systems, constitutive equations for continuous media; governing partial differential equations from first and second laws of thermodynamics; applications to solids, liquids, and gases.

CE 672 - THEORY OF ELASTICITY
Semester Hours: 3
Formulation of boundary-value problems of classical elasticity. Application to plane problems, prismatic members, and axisymmetric problems. Introduction to three-dimensional problems.

CE 673 - PLASTICITY
Semester Hours: 3

CE 674 - FINITE ELEMENT ANALYS I
Semester Hours: 3
Finite element theory, variational methods, weighted residuals. Applications to linear partial differential equations in continuous media. Solution of boundary value and initial value problems.

CE 675 - ROCK MECHANICS
Semester Hours: 4
Principles of continuum mechanics applied to the design of structures in rock; tunnels, underground structures and foundations. Joint behavior; stresses; analysis of rock slopes; instrumentation.

CE 676 - VISCOELASTICITY
Semester Hours: 3

CE 677 - OPTICAL TECH IN SOLID MECH
Semester Hours: 3
Overview of conventional methods for experimental stress analysis. Introduction to applied optics with emphasis on non-destructive, laser-based testing methods, fiber optic recording systems, photoelectronic-numerical data acquisition, and computer aided analysis.

CE 678 - MECHANICS OF COMPOSITE MATRLS
Semester Hours: 3
Introduction to composite materials, micro- and macro-mechanical behavior of laminae; bending, buckling and vibration of laminated plates.

CE 679 - HYPERVELOCITY IMPACT PHENOMENA
Semester Hours: 3
Fundamental principles of penetration mechanics. Analytical and numerical approaches to perforation and penetration problems. Shock jump conditions, hugonioti, and equations of state; low, high, and hypervelocity impacts of finite and thin targets.
CE 681 - ADVANCED STRUCTURAL ANALYSIS
Semester Hours: 3

Explores modern methods of structural analysis, matrix formulation of flexibility and stiffness methods, and analysis of structures with material and geometric nonlinearities. Also introduces energy methods for indeterminate structures. Prerequisite: CE 581.

CE 683 - GRADUATE SEMINAR
Semester Hour: 1

Professional activities designed to promote the skills required to organize and deliver oral technical presentations and to broaden the individual's awareness of technical issues. Required for all students pursuing a graduate degree. Students will be graded "S" (Satisfactory) or "U" (Unsatisfactory) based upon their performance and attendance. Students who do not receive an "S" grade must register for the course until an "S" is obtained.

CE 696 - GRAD INTERNSHIP CE ENGR
Semester Hours: 1-9

Active involvement in an engineering project in an engineering enterprise, professional organization or government agency that has particular interest and relevance to the graduate student. Permission of CEE faculty member required.

CE 697 - MASTER'S PLAN II PROJECT
Semester Hours: 3

Application-oriented student project designed to show competence in an area of civil engineering.

CE 699 - MASTER'S THESIS
Semester Hours: 1-9

Required each semester in which a student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of nine hours of credit is awarded upon successful completion of master's thesis. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.

CE 722 - SLIDING MODE CONTROL
Semester Hours: 3

CE 756 - HAZARDOUS WASTE REMEDIATION
Semester Hours: 3

Engineering design skills applied to the solution of real world hazardous waste remediation problems. Remedy screening and selection; treatment train development for a Superfund facility.

CE 762 - WAVE MOTION CONTINUOUS ELASTIC BODIES
Semester Hours: 3

Elements of stress wave propagation in bounded elastic media. Propagation of elastic waves in infinite and semi-infinite bodies, cylinders, rods and beams.

CE 765 - RAND VIBRATIONS ELASTIC SYSTEMS
Semester Hours: 3


CE 772 - THEORY STRUCTURAL STABILITY
Semester Hours: 3


CE 773 - THEORY OF SHELLS
Semester Hours: 3

Analysis of thin plates and shells, including higher approximations theories and transverse-shear deformations; illustration of theories by selected problems.

CE 774 - FINITE ELEMENT ANALYSIS II
Semester Hours: 3

Advanced topics in finite element analysis: application to nonlinear partial differential equations in continuum mechanics: theoretical studies of convergence and stability of solutions.
CE 778 - FRACTURE MECHANICS  
Semester Hours: 3

CE 779 - ADV PENETRATION MECHANIC  
Semester Hours: 3

Advanced analytical modeling of penetration and perforation phenomena, hydrocode development and applications, and similitude analysis.

CE 799 - DOCTORAL DISSERTATION  
Semester Hours: 3-9

Civil Engineering, MSE

Civil Engineering, MSE

The CEE Department offers two plans leading to the MSE degree for the Civil Engineering option. These are designated:

- Plan I (Thesis),
- Plan II (Non-thesis)

The following sections describe the requirements for each of these options. For both options, 50% of the graduate coursework must be at the 600-level or above and students must earn a grade of B or better in all 600-level or above coursework. Students should consult their faculty advisor when selecting courses for their Program of Study.

Basic Program of Study

The Basic Program of Study, common to both Plan I and Plan II MSE options, contains a minimum of 24 semester hours of graduate-level course work that must include:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Engineering Major</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select 12 semester hours of graduate courses in an engineering major including supporting engineering courses</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td><strong>First Minor</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select a first minor of 6 semester hours in an approved engineering area of specialization</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td><strong>Second Minor</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select a second minor of 6 semester hours in Mathematics or Graduate Engineering Analysis</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td><strong>Total Semester Hours</strong></td>
<td>24</td>
</tr>
</tbody>
</table>

Plan I, Thesis Option

Students selecting this option must:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete Basic Program of Study as described above</td>
<td>24</td>
</tr>
<tr>
<td>CE 699</td>
<td>MASTER'S THESIS</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Complete an acceptable thesis including a public defense</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Semester Hours</strong></td>
<td>30</td>
</tr>
</tbody>
</table>

Plan II, Non-Thesis Option

Student selecting this option must:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete Basic Program of Study</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Select 3 semester hours of graduate coursework to complete an approved extended program of study</td>
<td>3</td>
</tr>
<tr>
<td>CE 697</td>
<td>MASTER'S PLAN II PROJECT</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Pass comprehensive final examination</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Semester Hours</strong></td>
<td>30</td>
</tr>
</tbody>
</table>
Civil Engineering, PhD (Joint with UAB)

The CEE Department offers a PhD program (jointly with UAB) in Civil Engineering.

The following table is an outline of the program of study requirements. Students should consult their dissertation advisor and supervisory committee to develop their program of study.

Program of Study

Students entering the joint PhD degree program with a baccalaureate degree and without a master's degree must complete the following graduate coursework:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Engineering Major</strong> ^1</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Select a minimum of 27 semester hours of graduate coursework in a major area</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>First Minor</strong> ^1</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Select 9 semester hours of graduate coursework in an approved engineering area of specialization</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Second Minor</strong> ^1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Select 6 semester hours of graduate coursework in mathematics and/or Graduate Engineering Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Additional Courses</strong></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Select 6 additional semester hours of graduate coursework in the major, first or second minors</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Doctoral Dissertation</strong> ^2</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>24 hours of CE 799 - Doctoral Dissertation</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Semester Hours</strong></td>
<td>72</td>
</tr>
</tbody>
</table>

^1 Students entering the joint PhD program after completing their master's degree must complete 24 semester hours of coursework beyond the coursework required for their master's degree. The combined coursework completed in the master's and doctoral programs of study must satisfy the semester hour requirements for the major and minor areas specified above.

^2 24 semester hours of CE 799 must be completed for those who entered the program with a master's degree without a thesis. 18 semester hours of CE 799 must be completed for those who entered the program with a thesis.

Electrical and Computer Engineering

272 Engineering Building
Telephone: 256.824.6316
Email: ecegrad@uah.edu

Chair: Ravi Gorur, Professor

Mission

The mission of the Electrical and Computer Engineering Department is to develop and maintain high quality undergraduate and graduate programs in electrical, computer, and optical engineering to meet the needs of its constituents, and to participate in scholarly and productive research that contributes to the economic well-being and quality of life for the residents of Huntsville, the State of Alabama, and the citizens of the United States of America.

Degree Programs

The ECE Department supports several degree programs that provide a unique academic and research experience for students including:

- Master of Science in Engineering (Computer Engineering)
- Master of Science in Engineering (Electrical Engineering)
- Master of Science in Software Engineering
- Master of Science in Cybersecurity
- Doctor of Philosophy in Computer Engineering
- Doctor of Philosophy in Electrical Engineering
The Department of Electrical and Computer Engineering (ECE) offers opportunities for advanced work in a variety of fields including radar and radar systems, digital signal processing, digital communications, digital and analog electronics, computer architecture, parallel processing, software engineering, software safety, optics, and photonics.

Co-located in one of the nation's largest research parks, UAH has the intellectual and social environment to provide a well-rounded, technologically-oriented degree. ECE graduate students have outstanding opportunities for research, collaboration, cooperative employment, and future employment with government research centers and high-tech businesses. In addition, a number of UAH research centers collaborate with the ECE Department, including the Center for Rotorcraft Systems Engineering and Simulation, the Center for Modeling, Simulation & Analysis, the Center for Applied Optics, and the Nano and Micro Devices Center.

Prospective and current students are encouraged to visit the ECE Department web site at www.uah.edu/eng/departments/ece for information about faculty research interests, ongoing research projects, funding opportunities and course availability. Other information about the ECE graduate programs are available in the department office.

**MSE in Computer or Electrical Engineering**

The MSE in Computer or Electrical Engineering each require 31 semester hours and consist of two options. The thesis option requires 24 semester hours of graduate coursework and a minimum of 6 semester hours of thesis. Students under this option, must complete a written thesis and an oral defense. The non-thesis option requires 30 hours of graduate coursework and 1 hour of Practicum.

Students wishing to pursue a MSE degree in Computer or Electrical Engineering must meet the admission requirements of UAH Graduate Studies as well as the College of Engineering. Students who are admitted to these programs must file a program of study made in consultation with their faculty advisor.

**MS in Software Engineering (MSSE)**

The MSSE degree program has two options: Plan I and Plan II. Plan I requires 24 semester hours of graduate coursework and a minimum of 6 semester hours of thesis. Plan I students must also write and defend a thesis as a final examination. Plan II requires 36 semester hours of coursework including 6 semester hours of Software Studio. Students who are admitted to these programs must file a program of study made in consultation with their faculty advisor. Students wishing to pursue a MSSE degree must meet the admission requirements of UAH Graduate Studies, as well as the College of Engineering.

**MS in Cybersecurity (MSCBS)**

The MSCBS degree program is an interdisciplinary program with the Colleges of Science and Business with a distinct computer engineering track. The MSCBS has one option: 30 semester hours of graduate coursework with no thesis. Students who are admitted to these programs must file a program of study made in consultation with their faculty advisor. Students wishing to pursue a MSCBS degree must meet the admission requirements of UAH Graduate Studies, as well as the College of Engineering.

**PhD in Computer or Electrical Engineering**

The ECE Department offers a program leading to the degree of Doctor of Philosophy (PhD) in Computer or Electrical Engineering. The PhD is a research-oriented degree awarded upon completion of a defined program of study, demonstration of scholarly competence, distinctive achievement in a special field, and demonstrated ability to do an independent, original investigation. Demonstration of substantial scholarly research accomplishments, rather than mere accumulation of residence and course credits, is an essential consideration in awarding the PhD degree.

The ECE Department doctoral programs require 48 semester hours of approved coursework. Students must register for a minimum of 18 semester hours of dissertation research. Students must meet with their doctoral advisors to develop a program of study, which lists the approved coursework required for the PhD. In addition, students must register for dissertation research every semester after the completion of the program of study until the dissertation defense. At the end of the coursework, a student must pass a Qualifying Examination. Finally, a student must write an acceptable dissertation which must be defended in front of the supervisory committee. More details about these examinations are available in the department office. In order for a student's doctoral dissertation to be approved, at least one refereed journal or refereed national conference article must be published or accepted for publication.

Students wishing to pursue a PhD must meet the admission requirements of UAH Graduate Studies as well as the College of Engineering. Students who do not have the appropriate bachelor's or master's degree from an ABET-accredited Computer or Electrical Engineering program must complete the foundation courses described below or demonstrate proficiency by completing similar courses or providing evidence based on employment experience.

**Foundation Courses**

The Computer and Electrical Engineering degree programs described above assume that students have a bachelor's degree and/or master's degree in Computer or Electrical Engineering, respectively.

To pursue the MSE or PhD in Computer Engineering, students who do not have a bachelor's degree in Computer Engineering should complete coursework or demonstrate knowledge in the following CPE foundation areas:
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPE 211</td>
<td>INTRO COMPUTER PROG FOR ENGR</td>
<td>3</td>
</tr>
<tr>
<td>CPE 212</td>
<td>FUNDAMENTALS SOFTWARE ENGRG</td>
<td>3</td>
</tr>
<tr>
<td>CS 317</td>
<td>INTRO DESIGN/ANALYSIS OF ALG</td>
<td>3</td>
</tr>
</tbody>
</table>

**Programming Languages/Software Engineering**

- EE 202  | INTRO DIGITAL LOGIC DSGN                  | 3              |
- EE 315  | INTRO ELECTRONIC ANAL & DESIGN            | 3              |

**Digital Logic Design/Electronics**

- CPE 221 | COMPUTER ORGANIZATION                     | 3              |
- CPE 323 | INTRO TO EMBEDDED COMPUTER SYS            | 3              |
- CPE 531 | INTRO COMPUTER ARCHITECTURE              | 3              |

**Computer Organization/Microprocessors**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE 202</td>
<td>INTRO DIGITAL LOGIC DSGN</td>
<td>3</td>
</tr>
<tr>
<td>EE 213</td>
<td>ELECTRICAL CIRCUIT ANALYSIS I</td>
<td>3</td>
</tr>
<tr>
<td>EE 307</td>
<td>ELECTRICITY &amp; MAGNETISM</td>
<td>3</td>
</tr>
<tr>
<td>EE 315</td>
<td>INTRO ELECTRONIC ANAL &amp; DESIGN</td>
<td>3</td>
</tr>
<tr>
<td>EE 382</td>
<td>ANALY METH CONTINUOUS TIME SYS</td>
<td>3</td>
</tr>
<tr>
<td>EE 383</td>
<td>ANALY METH MULTIVARIABLE</td>
<td>3</td>
</tr>
<tr>
<td>EE 385</td>
<td>RANDOM SIGNALS &amp; NOISE</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Semester Hours**: 24

An entering student can demonstrate knowledge of the material in one of the following ways: completing the courses at UAH, completing similar courses at another institution, or by providing evidence based on employment experience. A student may be required to successfully pass a placement exam to demonstrate their knowledge of the material. Up to 3 credit hours from CPE 531 may be applied towards a student’s graduate program if: (1) The student has completed the foundation courses at UAH as a part of their graduate program, and (2) the student is enrolled in Plan II (non-thesis) MSE in the CPE program.

To pursue the MSE or PhD in Electrical Engineering, students who do not have a bachelor’s degree in Electrical Engineering should complete coursework or demonstrate knowledge in the following subjects:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE 202</td>
<td>INTRO DIGITAL LOGIC DSGN</td>
<td>3</td>
</tr>
<tr>
<td>EE 213</td>
<td>ELECTRICAL CIRCUIT ANALYSIS I</td>
<td>3</td>
</tr>
<tr>
<td>EE 307</td>
<td>ELECTRICITY &amp; MAGNETISM</td>
<td>3</td>
</tr>
<tr>
<td>EE 315</td>
<td>INTRO ELECTRONIC ANAL &amp; DESIGN</td>
<td>3</td>
</tr>
<tr>
<td>EE 382</td>
<td>ANALY METH CONTINUOUS TIME SYS</td>
<td>3</td>
</tr>
<tr>
<td>EE 383</td>
<td>ANALY METH MULTIVARIABLE</td>
<td>3</td>
</tr>
<tr>
<td>EE 385</td>
<td>RANDOM SIGNALS &amp; NOISE</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Semester Hours**: 21

An entering student can demonstrate knowledge of the material in one of the following ways: completing the courses at UAH, completing similar courses at another institution, or by providing evidence based on employment experience. A student may be required to successfully pass a placement exam to demonstrate their knowledge of the material.

To pursue either the MSSE or the MSCBS degrees, students who do not have a Computer Science or Computer Engineering bachelor's degree from an ABET-accredited program must complete the following courses or demonstrate knowledge in those subject areas. Experience in the development of a large scale, industrial strength software system is highly desirable.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPE 211</td>
<td>INTRO COMPUTER PROG FOR ENGR (or programming in C, C++ or Java)</td>
<td>3</td>
</tr>
<tr>
<td>CPE 212</td>
<td>FUNDAMENTALS SOFTWARE ENGRG (Data Structures)</td>
<td>3</td>
</tr>
<tr>
<td>CS 214</td>
<td>INTRO DISCRETE STRUCTURE</td>
<td>3</td>
</tr>
<tr>
<td>CS 317</td>
<td>INTRO DESIGN/ANALYSIS OF ALG</td>
<td>3</td>
</tr>
<tr>
<td>CPE 431</td>
<td>INTRO COMPUTER ARCHITECTURE</td>
<td>3</td>
</tr>
<tr>
<td>CPE 434</td>
<td>OPERATING SYSTEMS</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Semester Hours**: 18

An entering student can demonstrate knowledge of the material in one of the following ways: completing the courses at UAH, completing similar courses at another institution, or by providing evidence based on employment experience. A student may be required to successfully pass a placement exam to demonstrate their knowledge of the material.
Master’s Programs in Electrical & Computer Engineering

- Computer Engineering, MSE (p. 77)
- Electrical Engineering, MSE (p. 79)
- Master of Science in Cyber Security (p. 78)
- Master of Science in Software Engineering, MSSE (p. 80)

Doctoral Programs in Electrical & Computer Engineering

- Computer Engineering, PhD (p. 76)
- Electrical Engineering, PhD (p. 77)

CPE 512 - INTRO PARALLEL PROGRAMMING
Semester Hours: 3


CPE 523 - HARDWARE/SOFTWARE CO-DESIGN
Semester Hours: 3

Study and design of Systems On a Chip (SOC). Emphasis on Field Programmable realizations of SOC systems. Prerequisite: CPE 522 or CPE 526.

CPE 526 - VLSI HARDWARE DESC LANG/MODL/S
Semester Hours: 3

Modern VLSI design techniques and tools, such as silicon compilers, (V)HDL modeling languages, placement and routing tools, synthesis tools, and simulators. Students will design, simulate, and layout using both programmable logic families and ASIC libraries.

CPE 527 - VLSI DESIGN I
Semester Hours: 3

Introduction to VLSI design using CAD tools, CMOS logic, switch level modeling, circuit characterization, logic design in CMOS, systems design methods, test subsystem design, design examples, student design project. Design project to be fabricated and tested in CPE 528. Students enrolling in CPE 527 must enroll concurrently in CPE 527L.

CPE 527L - LABORATORY
Semester Hours: 0

Students enrolling in CPE 527L must enroll concurrently in CPE 527.

CPE 528 - VLSI DESIGN II
Semester Hours: 3

Advanced experience with CAD tools for VLSI design, IC testing. Design project from CPE 527 will be fabricated and tested. Implementation and verification of test programs, IC testing and troubleshooting, legal, economic, and ethical design issues. Oral presentations and written reports are required. Students enrolling in CPE 528 must enroll concurrently in CPE 528L.

CPE 528L - LABORATORY
Semester Hours: 0

Students enrolling in CPE 528L must enroll concurrently in CPE 528.

CPE 531 - INTRO COMPUTER ARCHITECTURE
Semester Hours: 3

Existing computer structures. Computer organization with emphasis on busing systems, storage systems, and instruction sets. Special purpose architecture, performance models and measures, VLSI influence on architecture.

CPE 534 - OPERATING SYSTEMS
Semester Hours: 3

Study of the fundamentals of operating systems. Emphasis on processes, file management, interprocess communication, input-output, virtual memory, networking and security.
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>CPE 536</td>
<td>INTernals OF MODERN OPER SYS</td>
<td>3</td>
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<td>In depth study of the design of modern operating systems such as Unix, NT, and Linux. Emphasis on the internals and implementation details of interrupt processing, real-time clocks, device independent I/O, process management, memory management, file management.</td>
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<td>CPE 538</td>
<td>REAL TIME &amp; EMBEDDED SYSTEMS</td>
<td>3</td>
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<td>Study of design methodologies for reliable real time systems.</td>
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<td>CPE 549</td>
<td>INTRO TO CYBERSECURITY ENGINRG</td>
<td>3</td>
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<td>Introduction to cryptography and computer security through hardware and physical security to a knowledge of audit methods, security management, and public law. The course will introduce security engineering skills such as business process analysis, software security, IAE evaluation, and IAE testing. Prerequisite: CPE 548.</td>
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<tr>
<td>CPE 549L</td>
<td>INTRO CYBERSECURITY ENG LAB</td>
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<td>Students enrolling in CPE 549 must enroll concurrently in CPE 549L.</td>
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<tr>
<td>CPE 561</td>
<td>TRANSLATION SYSTEMS</td>
<td>3</td>
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<td>Grammars, parsers, and lexical analyzers; implementation of translators via top-down and bottom up techniques; grammar analysis to identify ambiguities. Practical applications of translators including conversion of file formats and compilation of traditional computer languages.</td>
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<tr>
<td>CPE 590</td>
<td>SPECIAL TOPICS IN COMP ENGR</td>
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<tr>
<td>CPE 590L</td>
<td>SELECTED TOPICS LABORATORY</td>
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<td>CPE 601</td>
<td>SURVEY INFORMATION ASSURANCE</td>
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<td>CPE 610</td>
<td>SELECTED TOPICS IN COMPUTER EN</td>
<td>1-6</td>
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<tr>
<td>CPE 612</td>
<td>PARALLEL ALGORITHMS</td>
<td>3</td>
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<td>Introduction to metrics describing the performance and scalability of parallel algorithms. Performance analysis of parallel algorithms for performing sorting, matrix multiplication, solving linear equations, and FFT.</td>
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<td>CPE 613</td>
<td>GEN PURPOSE GPU COMPUTING</td>
<td>3</td>
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<td>The focus of this course is to introduce emerging techniques and programming paradigms that can be used to accelerate the processing speed of scientific and other high performance applications using Graphics Processing Units, GPUs. GPUs represent low-cost highly parallel video processing hardware that can be programmed for general purpose applications using UDA/OpenCL software architecture. The course will survey the current state of research and industrial activity and will give student's hands-on experience implementing design applications on real-world GPU facilities for a wide range of scientific applications. Prerequisite: CPE 512.</td>
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<tr>
<td>CPE 619</td>
<td>MODELING &amp; ANAL COMPU/COMMUN S</td>
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<td>CPE 621</td>
<td>ADVANCED EMBEDDED SYSTEMS</td>
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<td>Deeply embedded low-power wireless sensors. Low-power microcontroller architectures, sensor platform architecture, wireless intelligent sensors, low power wireless communication standards, battery powered systems, resource constrained operating systems, data aggregation/sensor synergy, and collaborative signal processing.</td>
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</tbody>
</table>
CPE 625 - CMOS ANALOG CIRCUIT DESIGN
Semester Hours: 3

CPE 626 - ADVANCED VLSI DESIGN
Semester Hours: 3
Advanced VLSI Design. Case study of the VLSI design of a modern RISC processor using a Hardware Description Language. Prerequisite: CPE 526.

CPE 628 - TESTING OF HARDWARE SYSTEMS
Semester Hours: 3
Introduction to testing of digital electronic circuits and systems. Topics include: fault modeling, testing problems, testing schemes, test generation for combinational and sequential circuits, the complexity of testing, design for testability, built-in self-testing and boundary scan.

CPE 631 - ADV COMP SYSTEMS ARCHITECTURE
Semester Hours: 3
Study of architectural features of modern processors, including cache memories and memory systems, pipeline designs, branch prediction techniques. Design of superscalar, multithreaded VLIW processors, code optimization for such systems will be studied. Quantitative evaluation of architectural features are emphasized throughout the course. Prerequisite: CPE 512 and CPE 531.

CPE 633 - FULT-TOLERANT COMPUTING SYSTEM
Semester Hours: 3
Analysis and design of very high reliability and availability systems. Fault types, reliability techniques, and maintenance techniques. Case studies of high-availability long-life, life-critical systems. Both hardware and software techniques for achieving fault-tolerance will be studied.

CPE 635 - SYSTOLIC ARRAY PROCESSING
Semester Hours: 3
Systolic structure of fast algorithms and switchable array realizations.

CPE 641 - DATA & DIGITAL COMMUNICATIONS
Semester Hours: 3
Introduction to digital and data communications; transmission channels; modulation and coding; telephone networks; data communication standards; noise and distortion; computer interfacing; protocols.

CPE 643 - OPTICAL COMMUNICATIONS
Semester Hours: 3

CPE 645 - COMPUTER NETWORK SECURITY
Semester Hours: 3
Principles and concepts of computer network security. Introduction to cryptography, confidentiality, authentication, digital signatures, E-mail security, IP security, web security, intruders, malicious software, firewall, and other network security-related issues. Prerequisite: CPE 548.

CPE 646 - MOBILE & WIRELESS NETWORKS
Semester Hours: 3
High-level issues in mobile and wireless networks. The main topics are mobile IP, mobile Ad hoc NETworks (MANETS) wireless sensor networks, wireless LAN, Bluetooth, cellular networks, satellite systems and security issues in mobiles and wireless networks. Prerequisite: CPE 548.

CPE 647 - UBIQUITOUS COMPUTING
Semester Hours: 3
The course is based on the new "anytime, anywhere" computing paradigm, also known as ubiquitous computing. This course is project oriented, and explores issues of mobile, wireless, and distributed computing in Internet environment, advanced human-computer interfaces, and power efficient computing.

CPE 648 - ADVANCED COMPUTER NETWORKS
Semester Hours: 3
Advanced principles and concepts of general-purpose computer networks, with a special emphasis to internetworking and Internet. Transport and higher level protocols emphasis. Programming issues. High-speed networking, congestion control, data compression, security and distributed processing will be covered. Prerequisite: CPE 548.
CPE 649 - ADV CYBERSECURITY ENGINEERING
Semester Hours: 3

Introduction to topics ranging from how to attack computer systems and networks to how to protect and recover from attacks on computer systems and networks. Basic process utilized by computer attackers in order to develop a complete understanding and appreciation of the threat to information assurance. Process of detecting, preventing, and recovering from information assurance attacks. Intrusion Detection and Prevention Systems, Auditing, Security Vulnerability Assessments, and the Incident Response process. Prerequisite: CPE 549.

CPE 649L - ADV CYBERSECURITY ENG LAB
Semester Hours: 0

Students enrolling CPE 649 must enroll concurrently in CPE 649L.

CPE 656 - SOFTWARE ENGRG STUDIO I
Semester Hours: 3

This is the first course in a two course studio series required for the MSSE degree in the College of Engineering. Students will work in small design teams on medium sized software projects. Activities include developing requirements, designing and constructing system prototypes, developing and implementing test and verification plans, and presenting the project for evaluation. The practice of software design and evaluation will be conducted in an iterative cycle using best software engineering practices, so that design and execution can be refined over the lifecycle of the project. Prerequisite: CS 650.

CPE 658 - SOFTWARE ENGRG STUDIO II
Semester Hours: 3

This is the second course in a two course studio series required for the MSSE degree in the College of Engineering. Students will work in small design teams on medium sized software projects. Activities include developing requirements, designing and constructing system prototypes, developing and implementing test and verification plans, and presenting the project for evaluation. The practice of software design and evaluation will be conducted in an iterative cycle using best software engineering practices, so that design and execution can be refined over the lifecycle of the project. Prerequisite: CPE 656.

CPE 690 - SELECTED TOPICS COMPUTER ENGRG
Semester Hours: 1-6

CPE 692 - CYBERSECURITY CAPSTONE
Semester Hours: 3

A capstone course emphasizing the intergration of various principles, theories, and techniques for developing, implementing and using cybersecurity strategies and applications in organizations. Includes readings, lectures, tours, situation analysis, cases, and the completion of a major practical project. Normally taken in the last semester of a student's program. Minimum grade B required. Prerequisites: CS, 585, CPE 549, IS 660, IS 663.

CPE 695 - PROJECTS IN COMPUTER ENGRG
Semester Hours: 3

CPE 699 - MASTER'S THESIS
Semester Hours: 1-9

Required each semester student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of 9 hours credit is awarded upon successful completion of master's thesis. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.

CPE 710 - SEL TOPICS IN PARALLEL PROC
Semester Hours: 3

CPE 715 - SELECTED TOPICS IN COMPUTAT TH
Semester Hours: 3

CPE 720 - SELECTED TOPICS IN VLSI DESIGN
Semester Hours: 3

Prerequisite: CPE 626.

CPE 726 - ALGORITHMS FOR VLSI DESIGN TOO
Semester Hours: 3

Tools for VLSI Design. This course is concerned with the algorithms found in VLSI design tools.
CPE 730 - SELECTED TOPICS IN COMPUTER SY
Semester Hours: 3
Prerequisite: CPE 631.

CPE 731 - DISTRIBUTED SHARED MEMORY SYS
Semester Hours: 3
Study issues related to performance, granularity of sharing, multithreading, cache coherence, memory consistency models, pull vs push caching, false sharing, thread migration. Case studies systems, including DASH, FLASH ThreadMarks, SHRIMP, Calypso, Alewife to understand these issues.

CPE 735 - SELECTED TOPICS IN OPERATING S
Semester Hours: 3

CPE 740 - SPEC TOPICS COMPUTER NETWORKS
Semester Hours: 3
Prerequisite: CPE 648.

CPE 742 - PARALLEL PROCESS DESIGN
Semester Hours: 3

CPE 748 - MOBILE & WIRELESS NETWORKS
Semester Hours: 3
High-level issues in mobile and wireless networks. The main topics are mobile IP, Mobile Ad hoc NETworks (MANETs), wireless sensor networks, wireless LAN, Bluetooth, cellular networks, satellite systems, and security issues in mobiles and wireless networks. Prerequisite: CPE 648 or CS 670.

CPE 760 - SEL TOPICS COMPILER/TRANSLAT S
Semester Hours: 3

CPE 790 - SEL TOPICS COMPUTER ENGRG
Semester Hours: 1-6

CPE 795 - RESEARCH IN COMPUTER ENGRG
Semester Hours: 1-6

CPE 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9
Required each semester student is enrolled and receiving direction on doctoral dissertation.

EE 500 - RANDOM SIGNALS & NOISE
Semester Hours: 3

EE 501 - DIGITAL SIGNAL PROC ARCHITECTU
Semester Hours: 3
Introduction to digital signal processor architecture, applications, assembly language programming, and development tools for designing and implementing DSP systems.

EE 503 - COMMUNICA SYS & SIMULAT W/LAB
Semester Hours: 3
Modern test equipment and computer-based simulation methods are used to conduct experiments in the area of communication systems. Hands-on experiments are conducted using digital oscilloscopes, arbitrary waveform generators, vector impedance meters and other relevant test and measurement equipment. Methods are investigated for signal modulation and demodulation; studies are conducted on AM, FM, PSK, PCM and delta modulation circuits and systems. Several types of filters are investigated, both analytically and experimentally. Properties and behavior of phase-locked loop are studied by using both hardware and numerical simulations.

EE 504 - INTRO DATA COMMUNICA NETWORKS
Semester Hours: 3
Overview of historic development of modern telephone and data communication system, system architecture, standards, broadband switching systems, modems, protocols, personal and mobile communications, digital modulation techniques.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>EE 505</td>
<td>INTRO CONTROL/ROBOTIC SY</td>
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<tr>
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<td>The basic theories and analytical techniques for</td>
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<td>modeling, analysis and control of dynamical</td>
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<td>systems. Transfer functions, block-diagrams,</td>
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<td>frequency response, stability criteria, series</td>
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<td>and feedback controller design, digital control.</td>
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<td>Introduction to the dynamic analysis and control</td>
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<tr>
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<td>of robotic systems.</td>
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<tr>
<td>EE 506</td>
<td>COMMUNICATION THEORY</td>
<td>3</td>
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<tr>
<td></td>
<td>Review of elementary signals and systems</td>
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<td>including the Hilbert transform, cross and auto</td>
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<td>correlation, power density spectrum, and the</td>
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<td>Wiener-Khintchine theorem. Butterworth and</td>
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<td>Chebyshev lowpass filters. Bandpass signals and</td>
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<td>systems. The lowpass equivalent of a bandpass</td>
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<td>signal/system. Commonly used forms of linear</td>
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<td>and nonlinear modulation. Demodulation methods</td>
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<td>and circuits. Phase lock and frequency feedback</td>
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<td>techniques.</td>
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<td>EE 510</td>
<td>SELECTED TOPICS/ECE</td>
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<tr>
<td>EE 510L</td>
<td>SELECTED TOPICS LABORATORY</td>
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<td>EE 514</td>
<td>ANALOG AND DIGITAL</td>
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<tr>
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<td>Analog filter design via Butterworth, Chebyshev,</td>
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<td>and elliptical approximation. Active filter</td>
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<td>design using operational amplifiers. Digital</td>
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<td>filter design methods.</td>
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<td>EE 516</td>
<td>DIGITAL ELECTRONICS</td>
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<td></td>
<td>Introduction to digital electronics. The Metal-</td>
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<td>Oxide-Semiconductor (MOS) transistor. MOS</td>
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<td>inverters and gate circuits. Bipolar junction</td>
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<td></td>
<td>transistors, ECL inverters, and bipolar digital</td>
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<td>gates. Semiconductor memories. Circuit design</td>
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<td>for VLSI.</td>
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<td>EE 519</td>
<td>DIGITAL ELECTRONICS LAB</td>
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<td>EE 527</td>
<td>ELECTROMAGNETIC ENGINEERING</td>
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<tr>
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<td>Review of Maxwell's equations, uniform plane</td>
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<td>waves in different types of media, reflection</td>
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<td>and transmission of uniform plane waves,</td>
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<td>transmission lines, microwave and fiber optic</td>
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<td>waveguides, antennas, wireless applications.</td>
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<td>EE 532</td>
<td>OPTICAL SYSTEMS DESIGN</td>
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<tr>
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<td>Introduction to the geometrical design and</td>
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<td>analysis of optical systems, and to the design</td>
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<td>principles of lens systems.</td>
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<td>EE 534</td>
<td>OPTICAL FIBER COMMUNICATIONS</td>
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<td>Introduction to optical fibers and their</td>
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<td>transmission characteristics, optical fiber</td>
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<td>measurements, sources and detectors, noise</td>
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<td>considerations for digital and analog</td>
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<td>communications, optical fiber systems.</td>
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<td>Prerequisite: EE 527.</td>
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<td>EE 541</td>
<td>OPTICS I</td>
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<td></td>
<td>Foundations and physics of geometrical optics.</td>
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<td></td>
<td>Fermat's principles and Huygen wavelets,</td>
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<td>refraction and reflection. The many forms of</td>
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<td>Snell's Law. Optical path lengths, geometrical</td>
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<td>wavefronts and rays. Ray tracing, ynu-chart and</td>
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<td>matrix methods. Gaussian imagery and paraxial</td>
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<td>optics, conjugate elements, cardinal points,</td>
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<td>and image-object relations. Stops and pupils,</td>
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<td>chief and marginal rays, vignetting, and the</td>
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<td>optical or Lagrange invariant. The y-ybar</td>
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<td>diagram, design of common systems: objectives,</td>
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<td>magnifiers, microscopes, collimators and</td>
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<td>detectors. Optical glasses and chromatic</td>
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<td>aberrations, wavefront and transverse</td>
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<td>aberrations, spot diagrams and ray fan plots.</td>
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<td>EE 542</td>
<td>PHYSICAL OPTICS</td>
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<tr>
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<td>Scalar and electromagnetic waves, polarization,</td>
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<td>coherence, reflection and refraction; two beam</td>
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<td>and multiple beam interference, interferometers,</td>
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<td>Fabry-Perots, thin films, diffraction, and</td>
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<td>absorption and dispersion.</td>
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<td>EE 543</td>
<td>OPTICAL COMM SYS &amp; NETWORKS</td>
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<td>Semester Hours: 3</td>
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</table>
EE 553 - LASER SYSTEMS  
Semester Hours: 3  
Spontaneous and stimulated emission, population inversion, optical resonators, three- and four-level systems, Q-switching and modelocking, semiconductor lasers, integrated optic waveguides and couplers, scanning systems, high power industrial applications. Includes a research project and oral presentation.

EE 570 - OPT & PHOTONIC SYSTEMS DESIGN  
Semester Hours: 3

EE 586 - INTRO MODERN CONTROL SYSTEMS  
Semester Hours: 3  

EE 601 - LINEAR SYSTEMS  
Semester Hours: 3  
Formulation and solution by transform methods of differential equations of linear electrical and electromechanical systems, state equations, signal-flow graphs, and discrete-time systems.

EE 603 - RANDOM SIGNALS IN COMMUNICATION  
Semester Hours: 3  
Random processes applied to communication and control. Concepts covered include stationarity, correlation, power spectrum, Brownian motion, thermal noise, Markov processes, and queuing theory. Emphasis on systems with noisy excitation.

EE 604 - DIGITAL IMAGE PROCESSING  
Semester Hours: 3  

EE 605 - CLASSICAL CONTROL DESIGN  
Semester Hours: 3  
Design of feedback, feedforward, and minor-loop controllers/compensators using classical control engineering techniques and classical performance criteria. Frequency domain synthesis of lead, lag, lead-lag, etc. compensators; tuning of PD and PID controllers; error budgets; use of commercial CAD software for classical control design and performance evaluation; digital simulation techniques. CAD laboratory sessions.

EE 606 - STATISTICAL COMM THEORY  
Semester Hours: 3  

EE 607 - ROBOTIC SYSTEMS CONTROL  
Semester Hours: 3  
In-depth study of information, decision and control problems associated with robotic system design. Sensor systems, recognition and decision algorithms, kinematics and dynamics, trajectory planning, analog and digital controllers, adaptive and optimal control.

EE 609 - ELECTROMAGNETIC FIELD THEORY  
Semester Hours: 3  

EE 610 - SELECTED TOPICS/ECE  
Semester Hours: 1-6

EE 612 - GRADUATE DESIGN PROJECT  
Semester Hours: 3  
Graduate design project in support of an M.S.E. program.
EE 613 - LASER ELECTRONICS
Semester Hours: 3

EE 614 - DATA COMPRESSION
Semester Hours: 3
Introduction to the fundamental theories and techniques of lossless and lossy data compression. Topics include Huffman codes, arithmetic codes, Golomb-Rice code, dictionary techniques, context-based compression, scalar quantization, vector quantization, transform coding, subband coding, wavelets, compression standards, and selected advanced topics of data compression.

EE 615 - ANALOG CIRCUIT DESIGN
Semester Hours: 3
Use of operational amplifiers to synthesize special-purpose filters and circuits for analog signal processing and conditioning; linear and switching power supplies; high-frequency effects; circuits for transmitters and receivers; digital circuits from an analog viewpoint; A/D and D/A converters; selected topics.

EE 616 - MICROELECT DEV/INTE CIRC
Semester Hours: 3

EE 617 - VLSI INTEGRATION DEVICES
Semester Hours: 3
Operation and modeling of the MOS transistor. Second-order considerations for a MOSFET. VLSI device fundamentals and scaling laws. Micron-length and submicron-length semiconductor devices. Basic technology and applications of VLSI. Impact of VLSI on computer architecture. VLSI computer aided design.

EE 618 - VLSI CIRCUITS
Semester Hours: 3

EE 619 - INTRO RADAR SYSTEMS
Semester Hours: 3
Topics include radar equation, CW radar, MTI and pulse Doppler radar, tracking radar, major systems components, detection in the presence of noise and clutter, ambiguity, and resolution.

EE 620 - CMOS ANALOG CIRCUIT DESIGN
Semester Hours: 3

EE 629 - ANAL & COMP METH IN ELEC ENG I
Semester Hours: 3
Analytic and numerical solution techniques applicable to problems arising in engineering, utilizing complex variable theory, linear algebra, matrix theory, and transform methods.

EE 630 - ANAL & COMP METHODS ELEC EG II
Semester Hours: 3
Analytical and numerical solution techniques applicable to problems arising in electrical engineering. Partial differential equations, vector differential and integral calculus, special functions, Fourier analysis with applications and integral equations.

EE 632 - FOURIER OPTICS
Semester Hours: 3
Introducing the optical system as an invariant linear system, convolution, Sommerfield's diffraction integral, Fourier Transform, angular spectrum, coherent and incoherent imaging, optical transfer function.
EE 633 - ELECTRO-OPTICAL ENGINEERING  
Semester Hours: 3  
Propagation of optical beams in homogeneous and guiding media, optical resonators, and spectrum analyzers, theory of laser oscillation, some specific laser systems, parametric oscillators, electro-optical and acousto-optical modulators.

EE 634 - OPTICAL COMMUNICATIONS  
Semester Hours: 3  
Optical communication systems; counting statistics; the optical detector response process; direct detection; heterodyne detection parameter estimation in optical communications; pointing, spatial acquisition and tracking.

EE 642 - DATA & DIGITAL COMMUNICATION  
Semester Hours: 3  
Introduction to digital and data communications; transmission channels; modulation and coding; telephone networks; data communication standards; noise and distortion; computer interfacing; protocols. Prerequisite: EE 603.

EE 648 - DIGITAL SIGNAL PROCESSING  
Semester Hours: 3  
Theory and applications of signal processing by digital techniques. Difference equations, Z-transform theory, digital-filter design, fast Fourier transform, quantization effects, and discrete estimation. Applications in digital filtering, signal processing, data analysis and smoothing, and image processing. Prerequisite: EE 528.

EE 654 - OPTICAL TESTING  
Semester Hours: 3

EE 670 - OPTOMECHANICAL DESIGN & MANUF  
Semester Hours: 3

EE 672 - DIGITAL PROC RANDOM SIGNALS I  
Semester Hours: 3  
Discrete signals, linear systems, spectral analysis and probability; and random discrete-time signals. Introduction to statistical interference, time-series analysis and spectral estimation of random discrete-time signals. Cross correlation and cross spectra, multitaper spectrum estimation and multivariable spectral analysis.

EE 673 - DIGITAL PROC RANDOM SIGNALS II  
Semester Hours: 3  
Parametric models for random signal processing; AR (autoregressive), MA (moving average), ARMA (autoregressive moving average), and Prony method. Two-dimensional spectral estimation; higher-order spectral analysis and multiresolution signal analysis.

EE 690 - UNIFORM GEOM THY DIFFRAC  
Semester Hours: 3  
Geometrical optics fields, geometrical optics reflected fields, two-dimensional wedge diffraction (GTD and UTD), three-dimensional wedge diffraction and corner diffraction, equivalent currents, diffraction at a smooth convex conducting surface, radar cross section.

EE 693 - ECE CAPSTONE  
Semester Hours: 1-3  
The purpose of this course is for students to perform research in a subject gained from courses taken at the graduate level. Students will be introduced to rhetorical theory, training in oral and written communication skills. They are required to organize and deliver oral and written technical presentations on individual research, journal articles, or design projects.

EE 696 - GRAD INTERN EE ENGR  
Semester Hours: 1-9  
Active involvement in an engineering project in an engineering enterprise, professional organization or government agency that has particular interest and relevance to the graduate student. Permission of EE faculty member is required.

EE 699 - MASTER'S THESIS  
Semester Hours: 1-9  
Required each semester student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of nine hours of credit is awarded upon successful completion of master's thesis. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.
EE 700 - SAMPLED DATA CONT SYS
Semester Hours: 3

Classical and modern methods for analysis and design of sampled data-control systems; Ztransforms, transport lags, z and w plane analysis, state variables, and the transition matrix.

EE 701 - ADV LINEAR CONTROL THRY
Semester Hours: 3

Modern techniques for analysis and design of linear control systems. Matrix formulation, multivariable control systems, state variable concepts. Linear transformation, controllability, observability, discrete-time systems. Prerequisite: EE 505.

EE 703 - MODERN CONTROL DESIGN
Semester Hours: 3

Use of modern (state-variable) control concepts and theories to design high-performance controllers for multi-input/multi-output set-point regulation and servo-tracking/pointing problems. Modeling of uncertain disturbances; design of disturbance-accommodating controllers; introduction to adaptive and stochastic control. Use of commercial CAD software for modern control design and performance evaluation. CAD laboratory sessions. Prerequisite: EE 701.

EE 704 - NONLINEAR CONTROL SYSTEM
Semester Hours: 3

Classical and modern methods for analysis and design of nonlinear automatic control systems. State variables, phase plane, limit cycles, stability, describing functions, relay control, stabilization theory. Prerequisite: EE 701.

EE 705 - THEORY OPTIMAL CONTROL
Semester Hours: 3


EE 706 - KALMAN FILT TECH CON & SIG PRO
Semester Hours: 3

Basic concepts of Kalman Filtering Theory with applications to: 1) analysis and design of control systems for dynamic processes with noisy sensors and random-type disturbance inputs, and 2) estimation, smoothing and prediction of information in noisy signals; Optimum Stochastic Control and the Separation Principle. Matrix Riccati Equation, Covariance Matrix, Orthogonal Projection Theorem. Prerequisite: EE 701.

EE 707 - INFORMATION THEORY
Semester Hours: 3

Self-information, entropy, mutual information, and channel capacity, encoding, error detecting and correcting codes. Sampling theorem. Discrete and continuous channels.

EE 709 - DISCR RANDOM SIG/SPEC ES
Semester Hours: 3

Review of linear systems theory, random discrete processes, classical spectral estimation, parametric models of discrete random processes, autoregressive (AR), moving average (MA), autoregressive moving average (ARMA) models.

EE 710 - SELECTED TOPICS/ECE
Semester Hours: 1-6

EE 711 - ANTENNA THEORY
Semester Hours: 3

Antennas and antenna arrays. Radiation patterns and impedance characteristics. Spheres, cylinders, horns, slots, microwave lenses, traveling-wave, and frequency independent antennas.

EE 716 - DEVICE MOD INTEG CIR DSG
Semester Hours: 3

EE 717 - SPACE APPLI/ELECTROMAGNE
Semester Hours: 3
Plasma as a dielectric; dielectric functions for cold, warm, isotropic and anisotropic plasmas, body-plasma interaction; space craft electrodynamics, antennas in plasmas; mode of radiation, input impedance and radiation pattern, scattering problems involving plasmas.

EE 718 - MICROWAVE TECHNIQUES
Semester Hours: 3

EE 721 - ROBUST AND ADAPTIVE CONTROL
Semester Hours: 3
Introduction to fundamental ideas of robust and adaptive control. Effects of parameter and disturbance uncertainties, H-infinity and mu-synthesis ideas; parameter estimation techniques; adaptive control algorithms; stability considerations; model-reference and linear adaptive control techniques.

EE 722 - SLIDING MODE CONTROL
Semester Hours: 3
The basic and advanced theories and analytical techniques for modeling and analysis of systems dynamics in sliding manifolds. Traditional and High Order Sliding mode controller design. Discontinuous and equivalent control, robustness. Applications to control of electro-mechanical systems, reusable launch vehicle, air craft, spacecraft, and DC-to-DC power converters. Prerequisite: EE 701.

EE 724 - RADAR WAVEFORMS & SIGNAL PROCE
Semester Hours: 3
Stretch Processing, Synthetic Aperture Radar and SAR signal processing, Space-time adaptive processing (STAP). Phase coded waveforms and processing. Frequency hop waveforms Prerequisite: EE 619.

EE 725 - ADVANCED RADAR TECHNIQUE
Semester Hours: 3
Modern radar systems for search and tracking are analyzed with emphasis on signal processing. Modeling and simulation of system and environment. Advanced techniques include CFAR, binary modulation, frequency agility, polarization agility, and synthetic aperture. Prerequisite: EE 603 and EE 619.

EE 726 - DECIS/ESTIMATION THEORY
Semester Hours: 3
Classical detection theory, including maximum likelihood, Neyman-Pearson, Bayes and minimax criteria. Estimation theory concepts and criteria, linear estimators, Kalman filters, maximum likelihood and least-squares estimator, matched filters, Cramer-Rao lower bound. Introduction to pattern recognition.

EE 727 - NUMER METH ELECTROMAGNET
Semester Hours: 3

EE 733 - NONLINEAR OPTICS APPLICATIONS
Semester Hours: 3
Modeling of optical nonlinearities; Kerr, thermal and photorefractive effects; nonlinearity-induced beam distortion; applications of nonlinearities in crystals and fibers; quantum well and SEED devices; soliton-based communication system; nonlinear optical switches, deflectors and limiters; measurements of nonlinearities.

EE 734 - FIBER OPTICS
Semester Hours: 3
Propagation in dielectric slab and fibers with step and graded index of refraction; electromagnetic and ray optical methods; eikonal equations; ray trajectory; WKB method; paraxial approximation; weakly guiding structures.

EE 735 - STATISTICAL OPTICS
Semester Hours: 3
Introduction to random variables and random processes; first-order properties of light waves; coherence of optical waves, partial coherence and imaging systems, imaging in randomly inhomogeneous media, fundamental limits in photoelectric detection of light.
EE 737 - CHAN CHAR COMM RAND MEDI
Semester Hours: 3
Modeling stationary and not strictly stationary random media; scatter communications channels; line of sight communication channels and weak scattering and strong scattering.

EE 738 - OPT TRANSF/PATTN RECOGNI
Semester Hours: 3
Systems and transforms in diffraction theory; two-dimensional Fourier transform; Hankel transforms; generalized Hankel transforms; optical signals, correlation coherence; filtering; apodization; applications to optical pattern recognition.

EE 742 - WIRELESS COMMUNICATIONS
Semester Hours: 3
Design and analysis of wireless transmission systems. Prerequisite: EE 642.

EE 744 - CODING THRY & SPREAD SPECTRUM
Semester Hours: 3
Linear block coding techniques, convolutional codes and the Viterbi decoding algorithm, probability of error bounds, channels with intersymbol interference and additive Gaussian noise. Introduction to spread spectrum direct sequence and frequency hopping methods.

EE 745 - MOD/PHASE LOCK TECH COMM
Semester Hours: 3

EE 747 - PATTERN RECOGNITION ALGORITHMS
Semester Hours: 3

EE 748 - DIGITAL SIG PROC ALG/APP
Semester Hours: 3
Introduction to digital signal processors hardware architecture. Applications of digital signal processing in telecommunications, speech and image processing, radar and sonar. Development and implementation of DSP algorithms; DSP laboratory session.

EE 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9
Required each semester student is enrolled and receiving direction on doctoral dissertation.

Computer Engineering, PhD (Shared with UAB)

The ECE Department offers, jointly with UAB, a PhD program in Computer Engineering.

The following table is an outline of the program of study requirements. Students should consult their dissertation advisor and supervisory committee to develop their program of study.

**Program of Study**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPE Major</td>
<td>Select a major consisting of a minimum of 18 semester hours of approved related coursework in Computer Engineering</td>
<td>18</td>
</tr>
<tr>
<td>Math Minor</td>
<td>Select one of the following options:</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Option 1: Select 12 semester hours in approved graduate level mathematics courses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Option 2: Select 6 semester hours in approved graduate level mathematics courses and select one of the following approved two-course sequences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MA 585 &amp; CPE 619 PROBABILITY and MODELING &amp; ANAL COMPU/COMMUN S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MA 540 &amp; MA 640 COMBINATORIAL ENUMERATION and GRAPH THEORY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MA 640 &amp; MA 740 GRAPH THEORY and COMBINATORIAL ALGORITHMS</td>
<td></td>
</tr>
</tbody>
</table>
The University of Alabama in Huntsville - DRAFT COPY

EE 629 & EE 630 ANAL & COMP METH IN ELEC ENG I and ANAL & COMP METHODS ELEC EG II
MA 542 CPE 645 ALGEBRA and COMPUTER NETWORK SECURITY

Engineering or Computer Science Area of Specialization Minor
Select a minor consisting of 12 semester hours of approved coursework in engineering or computer science 12

Supporting Coursework and Dissertation Hours
Select 6 semester hours of approved ECE graduate coursework 6
Complete a dissertation 18
Total Semester Hours 66

Electrical Engineering, PhD
The ECE Department offers a PhD in Electrical Engineering.

The following table is an outline of the program of study requirements. Students should consult their dissertation advisor and supervisory committee to develop their program of study.

Program of Study

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE Major</td>
<td>Select a minimum of 18 semester hours of approved related coursework in Electrical Engineering</td>
<td>18</td>
</tr>
<tr>
<td>Math Minor</td>
<td>Select one of the following options:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Option 1: Select 12 semester hours in approved graduate level mathematics courses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Option 2: Select 6 or 9 semester hours in approved graduate level mathematics courses and one of the following approved two-course sequences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select one of the following approved two course sequences:</td>
<td></td>
</tr>
<tr>
<td>EE 629 &amp; EE 630</td>
<td>ANAL &amp; COMP METH IN ELEC ENG I and ANAL &amp; COMP METHODS ELEC EG II</td>
<td></td>
</tr>
<tr>
<td>PH 607 &amp; PH 609</td>
<td>MATHEMATICAL METHODS I and MATHEMATICAL METHODS II</td>
<td></td>
</tr>
<tr>
<td>Engineering or Computer Science Area of Specialization Minor</td>
<td>Select a minor consisting of 12 semester hours of approved coursework in engineering or computer science</td>
<td>12</td>
</tr>
<tr>
<td>Supporting Coursework and Dissertation Semester Hours</td>
<td>Select 6 additional semester hours of approved graduate level ECE coursework</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Complete a dissertation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dissertation research</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Semester Hours</td>
<td>66</td>
</tr>
</tbody>
</table>

Computer Engineering, MSE
The CPE program offers two plans leading to the MSE with a Computer Engineering option. These are designated:

- Plan I (Thesis)
- Plan II (Non-thesis)

The following sections describe the requirements for each of these options. With prior approval, up to 12 semester hours of 500-level courses may be taken in fulfillment of the MSE requirements.

Basic Program of Study
The Basic Program of Study, common to both the Plan I and Plan II MSE options, contains a minimum of 24 semester hours of graduate-level coursework that must include:
Cybersecurity, MS - Computer Engineering Track

The CPE program offers a Master of Science degree in Cybersecurity as part of an interdisciplinary program with the College of Science and the College of Business. The program requires 30 semester hours of graduate course work. There is no thesis option.

For this degree program, at least 50% of the coursework must be at the 600-level or above and a grade of B or better is required for all courses. All coursework must be approved by a faculty advisor.

Program of Study

The program of study for the MS in Cybersecurity must include:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBS Core</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 660</td>
<td>CYBERSECURITY MANAGEMENT</td>
<td>3</td>
</tr>
<tr>
<td>IS 663</td>
<td>COMPUTER FORENSICS</td>
<td>3</td>
</tr>
<tr>
<td>CPE 549</td>
<td>INTRO TO CYBERSECURITY ENGINRG</td>
<td>3</td>
</tr>
</tbody>
</table>

1. At least 3 semester hours must be at the 600-level or above
Electrical Engineering, MSE

The EE program offers two plans leading to the MSE with a Electrical Engineering option. These are designated:

- Plan I (Thesis)
- Plan II (Non-thesis)

The following sections describe the requirements for each of these options. With prior approval, up to 6 semester hours of 500-level courses may be taken in fulfillment of the MSE requirements. All courses in the program of study must be approved by a faculty advisor.

Basic Program of Study

The Basic Program of Study, common to both the Plan I and Plan II MSE options, contains a minimum of 24 semester hours of graduate-level course work that must include:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE Major</td>
<td>Select 12 semester hours of related graduate-level courses in an EE subject area</td>
<td>12</td>
</tr>
<tr>
<td>Math Minor</td>
<td>6 hours of coursework with mathematical or theoretical foundation.</td>
<td>6</td>
</tr>
<tr>
<td>Engineering Area of Specialization Minor</td>
<td>Select a 2-course sequence from engineering, or computer science</td>
<td>6</td>
</tr>
<tr>
<td>Total Semester Hours</td>
<td></td>
<td>24</td>
</tr>
</tbody>
</table>

1. Typically, students take EE 629 and EE 630 or an approved sequence of courses in mathematics.
2. At least one of those courses should be at the 600 level.

Plan I, Thesis Option

Students selecting this option must:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete the Basic Program of Study as described above</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>EE 699</td>
<td>MASTER'S THESIS</td>
<td>6</td>
</tr>
<tr>
<td>Complete an acceptable thesis including a public defense</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

Plan II, Non-Thesis Option

Students selecting this option must:
Software Engineering, MSSE

The CPE program offers two plans leading to the MSSE. These are designated:

• Plan I (Thesis)
• Plan II (Non-thesis)

The following sections describe the requirements for each of these options. Students must consult their faculty advisor when constructing their program of study.

Basic Program of Study

The Basic Program of Study, common to both Plan I and Plan II MSSE options, contains a minimum of 24 semester hours of graduate-level coursework that must include:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 650</td>
<td>SOFT’W ENGINEERING PROC</td>
<td>3</td>
</tr>
<tr>
<td>Select 6 semester hours from any two of three CS areas</td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

CPE Courses

Select 9 semester hours of CPE electives

Studio Courses

CPE 656 SOFTWARE ENGRG STUDIO I
CPE 658 SOFTWARE ENGRG STUDIO II

Total Semester Hours

Plan I, Thesis Option

Students selecting this option must:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete the Basic Program of Study as described above</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>CPE 699 MASTER’S THESIS</td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

Total Semester Hours

Plan II, Non-thesis Option

Students selecting this option must:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete the Basic Program of Study described above</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>CPE Courses</td>
<td>Select 6 semester hours from the list of approved CPE electives</td>
<td></td>
</tr>
</tbody>
</table>

Total Semester Hours
Industrial and Systems Engineering and Engineering Management

N143 Technology Hall
Telephone: 256.824.6256
Email: isegrad@uah.edu
Chair: Paul D. Collopy, Professor

Mission
To provide integrated, applications-oriented education and research programs in the areas of Industrial Engineering, Systems Engineering, and Engineering Management to support the needs of students and organizations in the Huntsville area and beyond.

Degrees
Master of Science in Engineering (Engineering Management, Industrial Engineering, Systems Engineering concentrations)
Master of Science in Operations Research

The Department of Industrial and Systems Engineering and Engineering Management offers major options and associated minors in the subject areas of Operations Research, Industrial Engineering, Systems Engineering, and Engineering Management. All students are encouraged to tailor their graduate programs with a blend of theory and applications. ISEEM faculty are actively involved in research programs, which affords graduate students opportunities for coursework and research inquiry in the areas described above. Please contact the ISEEM Department (256.824.6256) or visit the ISEEM homepage at http://www.uah.edu/iseem for further details.

Industrial and Systems Engineering, MSE & MSOR

Additional Admission Requirements

The requirements for admission for graduate study in an ISEEM program conform to the policies of the School of Graduate Studies and the College of Engineering. In addition, the MSE Engineering Management and Systems Engineering Options require two years of engineering work experience.

General Requirements

Students pursuing an MSE option or the MSOR under ISEEM must follow the requirements for either Plan I (Thesis Option) or Plan II (Non-Thesis Option). Both plans require 24 semester hours of approved graduate coursework. Plan I requires a minimum of 6 semester hours of thesis work and the successful completion of the thesis as approved by the supervisory committee. Plan II requires an additional 6 semester hours of approved graduate coursework.

MSE Concentrations

The MSE-Engineering Management Concentration was developed to meet the needs of practicing engineers who find themselves performing engineering management functions without the benefit of formal management education. The Engineering Management Concentration is designed to build upon the mathematical and analytical expertise gained from both a formal engineering education and professional experience. The Engineering Management curriculum emphasizes the application of the management function in the technological setting, while recognizing the basic and applied sciences in engineering systems.

The MSE-Industrial Engineering Concentration is offered for engineers who possess a bachelor’s degree in a traditional engineering discipline and who have the desire to broaden their engineering problem solving skills. This is accomplished by providing them with a better understanding of traditional and contemporary problem solving skills in the areas of operation research, quality control, computer integrated manufacturing, and simulation. The program is applications-oriented and can be tailored to fit the individual needs of the student.

The MSE-Systems Engineering Concentration is offered for engineers with a bachelor’s degree in a traditional engineering area who desire to broaden their background into systems oriented aspects of engineering. Methods of systems design, cost-benefit analysis, decision making and trade studies, and systems modeling provide students with knowledge and skills to supplement their baccalaureate engineering program.

MS Operations Research

The MS in Operations Research Option is for individuals who desire to broaden their background into operations research. Courses in the curriculum include linear programming, optimization, queueing, Markov processes, and systems modeling.
Industrial and Systems Engineering, PhD.

The PhD in Industrial Engineering offers majors in Engineering Management, Industrial Engineering, Operations Research, or Systems Engineering. The content of these programs can vary to suit the needs and goals of the student.

Additional Admission Requirements

The requirements for admission for graduate study in an ISEEM program conform to the policies of the School of Graduate Studies and the College of Engineering. In addition, the PhD in Industrial Engineering majors of Engineering Management and Systems Engineering Options require five years of engineering work experience.

General Requirements and Exams

Students pursuing a PhD option under ISEEM must complete 48 semester hours of approved graduate coursework beyond the bachelor’s degree. A maximum of six hours of Master’s Thesis credit may be included in the 48 semester hour requirement. A Program of Study must be submitted to the student’s supervisory committee for review and approval.

The PhD program in the ISEEM Department has a Preliminary Examination requirement under which students must achieve a 4.0 GPA in their four principal core courses. If courses fail to meet the GPA requirement, they may be retaken until the requirement is met.

After completing the coursework on the Program of Study, students will complete a Comprehensive Exam that either contains both written and oral portions, or, at the option of the student’s committee, is based on writing a journal article.

After passing the Comprehensive exam, students will prepare a dissertation proposal to satisfy the Qualifying Examination requirement. Upon completion of the Qualifying Examination, students have five years to complete and defend a research dissertation, which is then approved by the supervisory committee, College Dean, and Graduate Dean.

Foundation Courses

Outstanding students (3.5 GPA) from other technical fields may gain admittance to the College of Engineering MSE and PhD graduate programs by completing the following courses, or equivalents as approved by the ISEEM Faculty. Applicants who have passed the Fundamental of Engineering Exam (FE) may substitute the exam for the courses.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA 171</td>
<td>CALCULUS A</td>
<td>4</td>
</tr>
<tr>
<td>MA 172</td>
<td>CALCULUS B</td>
<td>4</td>
</tr>
<tr>
<td>MA 201</td>
<td>CALCULUS C</td>
<td>4</td>
</tr>
<tr>
<td>MA 238</td>
<td>APPL DIFFERENTIAL EQUATIONS</td>
<td>3</td>
</tr>
<tr>
<td>MA 244</td>
<td>INTRO TO LINEAR ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>PH 111</td>
<td>GEN PHYSICS W/CALCULUS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 112</td>
<td>GEN PHYSICS W/CALC II</td>
<td>3</td>
</tr>
<tr>
<td>CH 121</td>
<td>GENERAL CHEMISTRY I</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE 213</td>
<td>ELECTRICAL CIRCUIT ANALYSIS I</td>
<td>3</td>
</tr>
<tr>
<td>MAE 271</td>
<td>STATICS</td>
<td>3</td>
</tr>
<tr>
<td>MAE 310</td>
<td>FLUID MECHANICS I</td>
<td>3</td>
</tr>
<tr>
<td>ISE 321</td>
<td>ENGINEERING ECONOMY</td>
<td>3</td>
</tr>
<tr>
<td>MAE 341</td>
<td>THERMODYNAMICS I</td>
<td>3</td>
</tr>
<tr>
<td>ISE 390</td>
<td>PROB &amp; ENGR STATISTICS I</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Semester Hours

Online Learning

Several engineering graduate programs are available to qualified graduate students through the College of Engineering Online Learning program. The Industrial and Systems Engineering and Engineering Management (ISEEM) department has options of the MSE degree available to students who cannot attend on-campus classes. The ISEEM Department also has options of the departmental PhD program available by online learning. For information about the availability of other Online Learning programs, contact the Online Learning Office at 256.824.7391.
Master’s Programs in Industrial and Systems Engineering and Engineering Management

- Industrial and Systems Engineering, MSE (p. 88)
- Industrial and Systems Engineering, MSOR (p. 90)
- Engineering Management (http://catalog.uah.edu/grad/colleges-departments/engineering/industrial-systems-engineering-and-engineering-management/engineering-management)

Doctoral Program in Industrial Engineering

- Industrial and Systems Engineering, PhD (p. 86)

ISE 502 - INDUSTRIAL & ORGANIZATIONAL PSY
Semester Hours: 3
Application of basic principles of learning, motivation, and perception to typical industrial and organizational problems.

ISE 503 - HUMAN FACTORS PSYCHOLOGY
Semester Hours: 3

ISE 523 - INTR STATISTICAL QUALITY CONTR
Semester Hours: 3
This course introduces statistical theory and techniques to control quality of manufacturing products. This course will provide a solid foundation in Statistical Quality Control (SQC). The Six Sigma methodology is also introduced in this course. Students can take the certification exam to earn a Green Belt in Six Sigma.

ISE 526 - DESIGN/ANALYZE OF EXPERIMENT
Semester Hours: 3
Advanced topics in statistical experiments with emphasis on design aspect. Confounding, fractional replication, factorial and nested design.

ISE 530 - MANUFACTURING SYSTEM & FACILITIES DESIGN
Semester Hours: 3
Overview of modern manufacturing systems design with emphasis on facility location and plant layout. Includes classical systems, just-in-time systems, basic principles of integrated manufacturing systems design, as well as analysis of process flow, process productivity, and available space to determine plant layout. Includes laboratory exercises.

ISE 533 - PRODUCTION/INVENTORY CONTROL SYSTEMS
Semester Hours: 3
Inventory models including classical optimal economic order quantity models, manufacturing resource planning (MRP) systems, master production scheduling, material requirements planning, and purchase order control. Emphasis on manufacturing system revision, continuous process improvement, and the implementation of lean principles.

ISE 537 - ELECTRONICS MANUFACTURING PROCESSES
Semester Hours: 3
Current concepts, facilities, and technology utilized in the manufacture of electronic components and products. Includes printed wiring board fabrication and component mounting methods, automation, quality and reliability, product testing, and economic issues.

ISE 539 - SELECTED TOPICS/ISE
Semester Hours: 1-3

ISE 547 - INTRODUCTION TO SYSTEMS SIMULATION
Semester Hours: 3
Philosophy and elements of digital discrete-event simulation. Emphasis on modeling and analysis of stochastic systems, including probabilistic models, output analysis, and use of simulation software.

ISE 623 - ENGR ECON ANALYSIS
Semester Hours: 3
This course is designed for graduate students in industrial engineering, systems engineering and engineering management. This course involves mathematical models for expenditure analysis under uncertainty; investment decision criteria; capital planning and budgeting; and decisions involving expansion, acquisitions, replacement, and disinvestment.
ISE 624 - HUMAN FACTORS IN SYS DESIGN
Semester Hours: 3

Psychological, physiological, and anthropometric requirements for human beings and the integration of these requirements into the design of tools, machines, and systems.

ISE 626 - INTRO OPERATIONS RESEARCH
Semester Hours: 3

Philosophy and methodology of operations research. Includes linear programming, game theory, sequencing, and networks.

ISE 627 - ENGINEERING SYSTEMS
Semester Hours: 3

Development of a systems-scientific framework for the integration of systems theory, systems thinking, systems engineering, and systems management. Emphasis is on the conception, design, and management of systems to accommodate complex environments.

ISE 630 - COMPUTER INTEGRATED MANUFACT
Semester Hours: 3

In-depth analysis of integrated manufacturing/computer integrated manufacturing. Reviews the tools, concepts, and enabling technologies necessary to integrate the physical, information, and managerial aspects of a manufacturing enterprise.

ISE 635 - LINEAR PROGRAMMING
Semester Hours: 3

Application of linear programming to complex allocation problems. Methods for determining maximum or minimum of objective functions whose variables are subject to constraints. Simplex methods, degeneracy, modified simplex, transportation problems, flows, goal programming, and sensitivity analysis.

ISE 637 - SYSTEMS MODELING & ANALYSIS
Semester Hours: 3

System analysis and modeling of large complex systems using systems engineering fundamentals. Life cycle simulations developed as a focus for the multidisciplinary analysis integration using computational systems engineering techniques including probability, statistics, design of experiments, response surfaces, and optimization. State of the art software tools will be used for simulation development.

ISE 638 - ENGINEERING RELIABILITY
Semester Hours: 3

Methodology of reliability prediction including application of discrete and continuous distribution models. Reliability estimation, reliability logic diagrams, life testing, and reliability demonstrations.

ISE 639 - SELECTED TOPICS/ISE
Semester Hours: 1-6

ISE 641 - ADVANCED QUALITY CONTROL
Semester Hours: 3

This capstone course uses advanced statistical quality tools such as autocorrelated data, multi-variate quality controls charts, response surface methodology, ridge analysis, and evolutionary operations (EVOP). Advanced Six Sigma concepts will be taught and students will have the opportunity to earn a Black Belt in Six Sigma upon successful completion of the certification exam and an acceptable project.

ISE 647 - ADVANCED SYSTEM SIMULATION
Semester Hours: 3

Methods and procedures for simulation of large and complex systems. Discrete increment, continuous time and combined models. Comparison of discrete-event simulation languages. Model verification and validation. Statistical inference. Input data collection and analysis, output analysis, and comparison of alternatives.

ISE 670 - INTEGRATED PRODUCT & PROC DES
Semester Hours: 3

This capstone course incorporates curriculum materials to support an integrated products and process design process. Particular attention is devoted to multifunctional teams and their value in promoting the concept of life-cycle engineering. Provides experience with tools and technologies that support the IPPD philosophy.

ISE 690 - STATISTICAL METHODS FOR ENGR
Semester Hours: 3

Application of statistics for estimation and inference using parametric and nonparametric methods. Descriptive statistics, sampling distributions, point and interval estimates, tests of hypotheses, ANOVA, and linear regression.
ISE 696 - GRAD INTERN ISE ENGR
Semester Hours: 1-9
Active involvement in an engineering project in an engineering enterprise, professional organization, or government agency that has particular interest and relevance to the graduate student. Permission of ISE faculty member required.

ISE 697 - INDUS & SYSTEMS ENGR PROJECT I
Semester Hours: 3-9
Application oriented student project designed to show competence in Industrial and Systems Engineering.

ISE 698 - INDUS & SYSTEMS ENGR PROJECT II
Semester Hours: 3-9
Required each semester student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of 9 hours of credit is awarded upon successful completion of master's thesis.

ISE 699 - MASTER'S THESIS
Semester Hours: 1-9
Required each semester student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of 9 hours of credit is awarded upon successful completion of master's thesis. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.

ISE 726 - SYSTEMS MODELING
Semester Hours: 3
The capstone course for the operations research option studies the philosophy and methodology for modeling probabilistic systems. Includes Markov processes, queueing theory, and inventory theory. Team project required.

ISE 728 - OPTIMIZATION OPER RES
Semester Hours: 3
Classical optimization theory with introduction to search techniques, the Jacobian, and Lagrangian methods. Kuhn-Tucker conditions, quadratic programming, geometric and dynamic programming, and several search procedures.

ISE 729 - ADV NONLINEAR PROGRAM
Semester Hours: 3
Continuation of ISE 728 with emphasis on development and application of nonlinear programming algorithms. SUMT algorithm, Zoutendijk's method of feasible directions, Rosen's gradient method, and selected algorithms from current literature.

ISE 730 - MULTI-CRITERIA DEC ANALYSIS
Semester Hours: 3
Methods for analysis of management-decision problems involving multiple goals and constraints. Linear and nonlinear goal programming; risk programming and decision making in fuzzy environments.

ISE 732 - INDUST FORECASTING/ANALYSIS
Semester Hours: 3
Industrial forecasting methods. Simple forecasting models, multivariate regression, correlation, and spectral analysis, exponential smoothing, and Box-Jenkins forecasting.

ISE 734 - DECISION ANALYSIS
Semester Hours: 3
Decision making for systems engineering and engineering management, with an emphasis on applications to complex systems. Builds a rigorous foundation in decision making under uncertainty using expected utility theory. Topics include decision trees, value models, predictive models, preferences and bias.

ISE 735 - DISCRETE OPTIMIZATION
Semester Hours: 3
Integer programming and network analysis. Zero-one problem formulation and Balas method, cutting plane techniques, branch and bound, out-of-kilter algorithm, and special applications of integer programming.
ISE 738 - RELIAB/AVAILAB/MAINTAINA
Semester Hours: 3

In-depth application of decision theory and MIL-HDBK-217, and maintenance engineering techniques in order to achieve targeted reliability, availability and maintainability design goals.

ISE 739 - SELECTED TOPICS/ISE
Semester Hours: 1-6

ISE 741 - QUALITY ENGINEERING
Semester Hours: 3

Application of quality engineering techniques to the design and improvement of products and processes. Topics include: multivariate analysis, Taguchi methods, mixture experiments, and response surface analysis.

ISE 761 - EVOL THRY ENG MGMT/IND SYS ENG
Semester Hours: 3

Development of applicable engineering management or industrial and systems engineering theory using classical concepts, contemporary studies and practices at successful technology-based organizations.

ISE 767 - CONTEMPORARY APPL EM/ISE
Semester Hours: 3

Application of key qualitative and quantitative principles of engineering management or industrial and systems engineering to real-world case problems. Students work both in teams and as individuals to solve multidimensional problems which require an integrative point of view.

ISE 790 - ADV STATISTICAL APPLICATIONS
Semester Hours: 3

Continuation of ISE 690 with extension to regression models and nonparametric methods.

ISE 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9

Required each semester student is enrolled and receiving direction on doctoral dissertation.

Industrial and Systems Engineering, PhD

The ISEEM Department offers a PhD in Industrial Engineering with the following concentrations: Engineering Management, Industrial Engineering, or Systems Engineering. The following tables provide an outline of the program of study for these concentrations. Students must consult with their faculty advisor and supervisory committee when developing their program of study.

Program of Study: Engineering Management

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td>EM 660</td>
<td>ENGR MGMT THEORY</td>
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<tr>
<td>EM 666</td>
<td>ENGR PROJECT MANAGEMENT</td>
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<td>EM 711</td>
<td>RES METHODS IN SURVEY DEVELOPM</td>
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<td>EM 760</td>
<td>ENGR MGMT STRUCTURES &amp; SYSTEMS</td>
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<td>EM 761</td>
<td>EVOL THRY ENG MGMT/IND SYS ENG</td>
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<td>EM 766</td>
<td>MANAGING CHG IN HIGH TECH ORG</td>
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</table>

Supporting Courses

Select 15 semester hours of graduate coursework to add the necessary breadth and depth. 15

Strongly suggested: EM 661 and ISE 734

First Minor

Select 15 semester hours in graduate coursework from the following areas: Industrial Eng, Quality Eng, Reliability Eng, Systems Simulation, Operations Research, Human Factors, or other approved areas 15

Second Minor: Mathematics/Statistics

<table>
<thead>
<tr>
<th>Code</th>
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<tbody>
<tr>
<td>ISE 526</td>
<td>DESIGN/ANALY OF EXPERIMENT</td>
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<td>ISE 690</td>
<td>STATISTICAL METHODS FOR ENGR</td>
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<td>ISE 790</td>
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Program of Study: Industrial Engineering

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<td>ISE 626</td>
<td>INTRO OPERATIONS RESEARCH</td>
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<td>ISE 627</td>
<td>ENGINEERING SYSTEMS</td>
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<td>ISE 630</td>
<td>COMPUTER INTEGRATED MANUFACT</td>
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<tr>
<td>ISE 726</td>
<td>SYSTEMS MODELING</td>
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Supporting Courses

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<td>ISE 530</td>
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<td>ISE 547</td>
<td>INTRO TO SYSTEMS SIMULATION</td>
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<td>ISE 623</td>
<td>ENGR ECON ANALYSIS</td>
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<tr>
<td>ISE 761</td>
<td>EVOL THRY ENG MGMT/IND SYS ENG</td>
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First Minor

Select 15 semester hours in graduate coursework from the following areas: Industrial Eng, Quality Eng, Reliability Eng, Systems Simulation, Operations Research, Human Factors, or other approved areas

Second Minor: Mathematics/Statistics

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Math/Statistics Elective

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Dissertation

Minimum of 18 hours of ISE 799

Total Semester Hours

78

Program of Study: Systems Engineering

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<td>ENGINEERING SYSTEMS</td>
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</tr>
<tr>
<td>ISE 637</td>
<td>SYSTEMS MODELING &amp; ANALYSIS</td>
<td>3</td>
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<td>ISE 638</td>
<td>ENGINEERING RELIABILITY</td>
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<tr>
<td>ISE 670</td>
<td>INTEGRATED PRODUCT &amp; PROC DES</td>
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</tr>
<tr>
<td>ISE 734</td>
<td>DECISION ANALYSIS</td>
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</tbody>
</table>

Supporting Courses

Select 15 semester hours of graduate coursework to support student's professional and academic goals including ISE 761

First Minor

Select 15 semester hours in graduate coursework from the following areas: Industrial Eng, Quality Eng, Reliability Eng, Systems Simulation, Operations Research, Human Factors, or other approved areas

Second Minor: Mathematics/Statistics

ISE 526 | DESIGN/ANALY OF EXPERIMENT          | 3              |

1 Students not minoring in ISE may be required to take 9-12 semester hours of graduate ISE coursework to provide a basic knowledge of the discipline. This is at the discretion of the student's supervisory committee.
The ISEEM Department offers three plans leading to the Master of Science in Engineering degree. Each plan is designated as:

- **Plan I (Thesis),**
- **Plan II (Non-thesis, coursework only)**

For each plan, students may choose concentrations in Engineering Management, Industrial Engineering, or Systems Engineering. The following sections describe the requirements for each of these concentrations. Additional requirements, policies, and required forms may be found in the ISEEM Department office.

### Program of Study: Engineering Management

The Basic Program of Study, common to the Plan I and Plan II MSE options, contains a minimum of 24 semester hours of graduate-level course work that must include:

<table>
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<tr>
<td>EM 766</td>
<td>MANAGING CHG IN HIGH TECH ORG</td>
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**First Minor**

Select two of the following:

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>EM 661</td>
<td>STRATEGIC ENGR MGMT</td>
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</tr>
<tr>
<td>EM 662</td>
<td>FOUND QUALITY SYSTEMS MGMT</td>
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<td>EM 664</td>
<td>TEAMS IN ACTION</td>
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<tr>
<td>EM 679</td>
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**Second Minor**

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<tr>
<th>Code</th>
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<th>Semester Hours</th>
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<tbody>
<tr>
<td>ISE 690</td>
<td>STATISTICAL METHODS FOR ENGR</td>
<td>3</td>
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<tr>
<td>ISE 526</td>
<td>DESIGN/ANALY OF EXPERIMENT</td>
<td>3</td>
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</table>

Total Semester Hours: 24

### Plan I, Thesis Option

Students selecting this option must:

<table>
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<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td></td>
<td>Complete Basic Program of Study as described above</td>
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**Master’s Thesis**

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<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>ISE 699</td>
<td>MASTER'S THESIS</td>
<td>6</td>
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</tbody>
</table>

Complete an acceptable thesis including a public defense

Total Semester Hours: 30

### Plan II, Non-Thesis Option (Coursework Only)

Students selecting this option must:
Program of Study: Industrial Engineering

The Basic Program of Study, common to the Plan I and Plan II MSE options, contains a minimum of 24 semester hours of graduate-level course work that must include:

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<th>Code</th>
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</thead>
<tbody>
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</tr>
<tr>
<td>ISE 726</td>
<td>SYSTEMS MODELING</td>
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First Minor

Select six hours in approved Engineering Management or Systems Engineering

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<th>Semester Hours</th>
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<tbody>
<tr>
<td>ISE 526</td>
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<tr>
<td>ISE 690</td>
<td>STATISTICAL METHODS FOR ENGR</td>
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Total Semester Hours

24

Plan I, Thesis Option

Students selecting this option must:

<table>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>ISE 699</td>
<td>MASTER'S THESIS</td>
<td>6</td>
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</table>

Complete an acceptable thesis including a public defense

Total Semester Hours

30

Plan II, Non-Thesis Option (Coursework Only)

Students selecting this option must:

<table>
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<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>ISE 699</td>
<td>MASTER'S THESIS</td>
<td>6</td>
</tr>
</tbody>
</table>

Complete an acceptable thesis including a public defense

Total Semester Hours

30

Program of Study: Systems Engineering

The Basic Program of Study, common to the Plan I and Plan II MSE options, contains a minimum of 24 semester hours of graduate-level course work that must include:

<table>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>ISE 623</td>
<td>ENGR ECON ANALYSIS</td>
<td>3</td>
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</tbody>
</table>
ISE 627  ENGINEERING SYSTEMS  3
ISE 670  INTEGRATED PRODUCT & PROC DES  3
ISE 734  DECISION ANALYSIS  3

First Minor
Select six hours in approved Engineering Management, Quality Engineering, Systems Engineering, Industrial Engineering, Operations Research, Engineering Reliability or Human Factors courses  6

Second Minor
ISE 526  DESIGN/ANALY OF EXPERIMENT  3
ISE 690  STATISTICAL METHODS FOR ENGR  3

Total Semester Hours  24

Plan I, Thesis Option
Students selecting this option must:

Code  Title  Semester Hours
Complete Basic Program of Study as described above  24

Master's Thesis
ISE 699  MASTER'S THESIS  6
Complete an acceptable thesis including a public defense

Total Semester Hours  30

Plan II, Non-Thesis Option (Coursework Only)
Students selecting this option must:

Code  Title  Semester Hours
Complete Basic Program of Study as described above  24
Select 6 semester hours of graduate courses to complete an approved extended program of study  6

Total Semester Hours  30

Industrial and Systems Engineering, MSOR

The ISEEM Department offers three plans leading to the MSOR degree. These are designated:

• Plan I (Thesis),
• Plan II (Non-thesis with final project paper; exit exam is an oral examination)
• Plan II (Non-thesis, coursework only; exit exam is over coursework)

The following sections describe the requirements for each of these options. Additional requirements, policies and required forms may be found in the ISEEM Department office.

Basic Program of Study
The Basic Program of Study, common to the Plan I and Plan II (Non-thesis) MSE options, contains a minimum of 24 semester hours of graduate-level course work that must include:

Code  Title  Semester Hours
Engineering Major
ISE 626  INTRO OPERATIONS RESEARCH  3
ISE 726  SYSTEMS MODELING  3
Select two of the following  6
ISE 547  INTRO TO SYSTEMS SIMULATION
ISE 638  ENGINEERING RELIABILITY
ISE 647  ADVANCED SYSTEM SIMULATION
ISE 734  DECISION ANALYSIS
ISE 738    RELIAB/AVALAB/MAINTAINA

**First Minor**
Select a first minor of 6 semester hours of graduate courses in an approved engineering area of specialization 6

Choose from the following areas (courses are approved by advisor):

**Second Minor**
ISE 526   DESIGN/ANALY OF EXPERIMENT 3
ISE 690   STATISTICAL METHODS FOR ENGR 3

**Total Semester Hours** 24

**Plan I, Thesis Option**
Students selecting this option must:

<table>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
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<td>Complete Basic Program of Study as described above</td>
<td>24</td>
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</table>

**Master's Thesis**
ISE 699   MASTER'S THESIS 6
Complete an acceptable thesis including a public defense

**Total Semester Hours** 30

**Plan II, Non-Thesis Option (Final Project)**
Students selecting this option must:

<table>
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<th>Semester Hours</th>
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<tr>
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<tr>
<td>ISE 697</td>
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**Total Semester Hours** 30

**Plan II, Non-Thesis Option (Coursework Only)**
Students selecting this option must:

<table>
<thead>
<tr>
<th>Code</th>
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<tr>
<td></td>
<td>Select 6 semester hours of graduate courses to complete an approved extended program of study</td>
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</tbody>
</table>

**Total Semester Hours** 30

**Mechanical and Aerospace Engineering**

N274 Technology Hall  
Telephone: 256.824.6154  
Email: maegrad@uah.edu  

**Chair**: D. Keith Hollingsworth, Professor

**Mission**
The mission of the Department of Mechanical and Aerospace Engineering is to provide undergraduate and graduate education, research, and public service in the Mechanical and Aerospace Engineering disciplines and to support the Mechanical and Aerospace Engineering needs of Huntsville, the State of Alabama, the region, our nation, and the international community.
Degree Programs

- Master of Science in Engineering (Mechanical Engineering)
- Master of Science in Aerospace Systems Engineering
- Doctor of Philosophy in Mechanical Engineering
- Doctor of Philosophy in Aerospace Systems Engineering

The broad range of faculty research interests in the Department of Mechanical and Aerospace Engineering offers opportunities for advanced work in rocket propulsion, combustion, applications of plasma science, fluid and solid mechanics, heat transfer, acoustics, aerodynamics, transport phenomena in energy systems, computational mechanics, experimental mechanics, dynamics and controls, and autonomous vehicles.

Located in one of the nation’s leading centers for aviation and space research, UAH has the intellectual and social environment to provide a well-rounded, technologically-oriented degree. MAE graduate students have outstanding opportunities for research, collaboration, cooperative employment, and future employment with government research centers and high-tech businesses. In addition, a number of UAH research centers collaborate with the MAE Department, including the Propulsion Research Center, the Center for Rotorcraft Systems Engineering and Simulation, the Center for Modeling, Simulation & Analysis, the Center for Space Plasma and Aeronomic Research, the Center for Applied Optics, and the Nano and Micro Devices Center.

Prospective and current students are encouraged to visit the MAE Department web site at www.uah.edu/eng/departments/mae for information about faculty research interests, ongoing research projects, funding opportunities and course availability. Other information about the MAE graduate programs are available in the department office.

MS in Aerospace Systems Engineering or MSE in Mechanical Engineering

Students wishing to pursue an MAE master’s degree must meet the admission requirements of the UAH Graduate School as well as the College of Engineering. Students who are admitted to the MAE department master’s program have the option to enroll in the MS in Aerospace Systems Engineering or the MSE in Mechanical Engineering. All courses in the department are open to students in either option. A beginning student files a Program of Study in one of the specialized areas of concentration (e.g. aerodynamics, materials, solid mechanics, etc.). These selections are made in consultation with the faculty advisor (for students in the thesis program) or with the Graduate Director (for students in the non-thesis program). Each area of concentration may have other requirements.

The MS in Aerospace Systems Engineering and the MSE in Mechanical Engineering each require 30 semester hours and consist of two options. The thesis option requires 24 hours of graduate coursework and 6 hours of thesis. Students under this option must complete a written thesis and an oral defense. The non-thesis option requires 30 hours of graduate coursework.

PhD in Aerospace Systems Engineering or in Mechanical Engineering

The MAE Department offers a program leading to the degree of Doctor of Philosophy (PhD) in Aerospace Systems Engineering or in Mechanical Engineering. The PhD is a research-oriented degree awarded upon completion of a defined Program of Study, demonstration of scholarly competence, distinctive achievement in a special field, and demonstrated ability to do an independent, original investigation. Demonstration of substantial scholarly research accomplishments, rather than mere accumulation of residence and course credits, is an essential consideration in awarding the PhD degree. A Program of Study leading to a PhD degree in Chemical Engineering is also administered by the MAE Department. In addition to the admission requirements of the School of Graduate Studies and the College of Engineering for the MSE, students must also have a minimum graduate grade point average of 3.25 for an application to be processed. Specific admission requirements for students with an MSE degree from UAH or from another graduate institution are available by contacting the MAE department office.

The PhD Program of Study should exhibit both a breadth of understanding of engineering with a demonstrated depth in a focused area of Aerospace or Mechanical Engineering. The MAE PhD Program of Study consists of a minimum of 66 course and research semester hours beyond the BS degree. The course semester hour requirement for students with a MSE degree is a minimum of 18 semester hours beyond the MSE degree. The specific PhD Program of Study is designed by the student, his/her advisor, and the Supervisory Committee. In addition to the coursework required, a PhD student must pass three examinations before being awarded the degree; the Preliminary Examination, the Qualifying Examination, and the Final Comprehensive Examination. Specific details on each examination are provided in the MAE Department Office.

Details about these degree options can be found at http://catalog.uah.edu/grad/colleges-departments/engineering/mechanical-aerospace-engineering/#text .

Timing Requirements (Effective Fall Semester 2016)

Students who are pursuing a Ph.D. degree are subject to the following four timing requirements:

1. Part I of the Qualifying Examination (i.e., MAE Ph.D. Prelim Exam) must be completed successfully either within one year from the start of the Ph.D. degree program or prior to the completion of 12 credit hours of graduate coursework (whichever comes later).
2. A Ph.D. Dissertation Advisor and Ph.D. Supervisory Committee must be arranged and approved within one year of the successful completion of Part I of the Qualifying Examination.
3. Part II of the Qualifying Examination must be completed successfully within two years of the successful completion of Part I of the Qualifying Examination but no less than six months prior to the Dissertation Defense.
4. All Ph.D. degree requirements must be completed successfully within five years of the successful completion of Part II of the Qualifying Examination.

Exceptions to any of these requirements may be requested only one time (per each requirement) by petition from the student and the associated Ph.D. Dissertation Advisor. Approval of these petitions (including modifications or alterations) are made both by the MAE Department Graduate Committee and by the MAE Department Chair.

**Master's Programs in Mechanical and Aerospace Engineering**

- Aerospace Systems Engineering, MSASE (p. 101)
- Mechanical Engineering, MSE (p. 103)

**Doctoral Programs in Mechanical and Aerospace Engineering**

- Aerospace Systems Engineering, PhD (p. 101)
- Mechanical Engineering, PhD (p. 102)

**MAE 520 - COMPRESSIBLE AERODYNAMICS**

Semester Hours: 3

Principles of compressible flow including area change, friction, and heat transfer. Fundamentals of acoustic waves, one and two-dimensional shock and expansion waves, shock-expansion theory, and linearized flow with applications to inlets, nozzles, wind tunnels, and supersonic flow over aerodynamic bodies and wings. (Same as MAE 420.)

**MAE 530 - FUNDAMENTALS OF AERODYNAMICS**

Semester Hours: 3

Application of the principles of fluid mechanics and thermodynamics to the prediction of aerodynamic performance of aircraft, missiles and other flight vehicles. Topics include lift and drag, thrust and power, and the influence of wing loading, power loading, zero-lift drag, wing geometry, high lift devices Mach number, etc., on the performance and design trades of flight vehicles. (Same as MAE 430.)

**MAE 531 - INTRO TO PLASMA DYNAMICS**

Semester Hours: 3

**MAE 540 - ROCKET PROPULSION I**

Semester Hours: 3

Introduction to the operation, analysis and design of liquid and solid rockets. The course incorporates an experience in design and realization of a thermal system in which students work in teams to design a rocket motor or component.

**MAE 541 - AIRBREATHING PROPULSION**

Semester Hours: 3

Survey of airbreathing propulsion systems with special emphasis on gas turbine engines for aircraft and rotorcraft. Thermodynamic power cycles, design of components, and overall engine performance analysis. Discussion of practical design and operations considerations including engine controls, reliability, and durability. The course incorporates an experience in design and realization of a thermal system in which students work in teams to design a turbine engine. Students majoring in Aerospace Engineering must take either MAE 440 or MAE 441 to satisfy the Aerospace propulsion elective. Prerequisite: MAE 520.

**MAE 544 - INTRO TO ELECTRIC PROPULSION**

Semester Hours: 3

Elements of electrically-driven rocket propulsion for applications from low earth orbit to the outer planets. The physics of ionizing and heating gases and plasmas for electrothermal, electrostatic and electromagnetic acceleration. Characteristics of Resistojet, Arcjet, Magnetoplasmadynamic thrusters, Electrothermal, Pulsed plasma, Electrostatic, and Hall thrusters. Review thruster system performance, power requirements, and selection for space missions. Overview of current research efforts, including thruster systems, physics, and performance. Prerequisite: MAE 520.

**MAE 545 - HEAT DISTRIB SYS DESIGN**

Semester Hours: 3

Design of hydronic and air distribution systems used in heating and air conditioning. Piping design, pump selection, heat coils, room air distribution, ducting design, fan selection, controls, and complete systems.

**MAE 548 - ENERGY CONVERSION & POWER GEN**

Semester Hours: 3

Application of principles of thermodynamics, heat transfer, and fluid mechanics to combustion engines and turbines. Basic engine types, engine components, idealized cycles, combustion, fuels, engine variables, testing, exhaust gas analysis, and air pollution as related to spark-ignition, compression-ignition, and turbine engines.
MAE 552 - COMPRESSIBLE AERODYNAMICS
Semester Hours: 3

Principles of compressible flow including area change, friction, and heat transfer. Fundamentals of acoustic waves, one and two-dimensional shock and expansion waves, shock-expansion theory, and linearized flow with applications to inlets, nozzles, wind tunnels, and supersonic flow over aerodynamic bodies and wings.

MAE 561 - VIBRATIONS ELASTIC SYS
Semester Hours: 3

Formulation of the equations of motion of discrete and continuous systems, analytical and numerical methods of solution, eigenvalue problems, and dynamic response. (Same as MAE 461 and CE 461/561.).

MAE 563 - INTERMEDIATE DYNAMICS
Semester Hours: 3

Kinematics and dynamics of particles, system of particles, and rigid-bodies. Variational principles and Lagrangian mechanics.

MAE 568 - ELEMENTS OF SPACECRAFT DESIGN
Semester Hours: 3

Fundamentals of spacecraft engineering and design. Topics include: orbital mechanics, space environment, attitude determination and control, communications, space structures, thermal control, propulsion and power, and systems and mission design. (Same as MAE 468.) Prerequisite: MAE 520.

MAE 574 - APP MECHANICS OF SOLIDS
Semester Hours: 3

Stresses and strains at a point, theories of failures, stress concentration factors, thick-walled cylinders, torsion of noncircular members, curved beams, unsymmetrical bending, and shear center. (Same as MAE 474 and CE 474/574.).

MAE 576 - COMP MATLS: FABRIC/DES/ANALY
Semester Hours: 3

Introduction to the mechanics of advanced composite materials. Design and analysis of composite structures. Analysis of orthotropic and transversely isotropic materials and systems. Hands on fabrication of a composite structure. (Same as MAE 476.).

MAE 577 - EXP TECH SOLID MECHANICS
Semester Hours: 3

Experimental methods to determine stress, strain, displacement, velocity, and acceleration in various media. Theory and laboratory applications of electrical resistance strain gages, brittle coatings, and photoelasticity. Application of transducers and experimental analysis of engineering systems. (Same as MAE 477 and CE 477/577.).

MAE 580 - AIRCRAFT STABILITY & CONTROL
Semester Hours: 3

Stability and control of aerodynamic vehicles. Design of aircraft to obtain good flying characteristics. Complete governing equations and analog solutions of linearized equations. (Same as MAE 480.) Prerequisite: MAE 530.

MAE 585 - NUM METH & ENGR COMPUTAT III
Semester Hours: 3

Advanced topics in numerical methods and engineering computation including: finite elements and finite differences in solving various engineering problems; Gaussian quadrature; interpolation, integration, and differentiation; and stability and convergence analysis of iterative methods. Numerical applications to fluid mechanics, heat transfer, structural mechanics, and machine design.

MAE 589 - COMPUTER AIDED ENGR
Semester Hours: 3

Application of computer methods in the analysis and design of structural, thermal, and dynamical systems. Use of state-of-the-art finite element and finite difference computer programs. Practical guidelines for discrete modeling; analysis of modeling errors. Comparison of exact and approximate solutions to boundary value problems. Use of microcomputers in engineering design and analysis. (Same as MAE 489.).

MAE 593 - ROCKET DESIGN
Semester Hours: 3

Design, build, test and fly a high-powered rocket with a payload to a specified altitude. Students work on multi-disciplinary teams to design payloads, avionics, recovery systems, structures and other sub-systems and then integrate them into the final vehicle. Course may be used for senior design credit.
MAE 594 - AIRCRAFT DESIGN
Semester Hours: 3

Design and build an unmanned aircraft to meet specified requirements, and then verify design through ground and flight tests. Students work on multi-disciplinary teams to address configuration aerodynamics, avionics, structures, propulsion/power and payloads. Systems engineering aspects including simulation, fabrication, integration, scheduling and cost estimation are also emphasized. Course may be used for senior design credit.

MAE 595 - SELECTED TOPICS MECH & AERO EG
Semester Hours: 1-6

MAE 610 - AERODYNAMICS
Semester Hours: 3

Fundamental concepts in aerodynamics including conservation laws, complex potential theory, thin airfoil theories, finite-wing lifting-line theory, boundary layers and Von Karman momentum integral equations.

MAE 620 - COMPRESSIBLE FLOW
Semester Hours: 3

Study of compressible subsonic, transonic and supersonic flows as described by the Euler equations. Linear and nonlinear theories of shockwaves, expansion waves, and their interactions. Applications to wind tunnels, nozzles, diffusers and aerodynamic bodies.

MAE 623 - COMPUTATIONAL FLUID DYNAMICS I
Semester Hours: 3

Formulations by finite difference, finite element, finite volume, and spectral element methods for incompressible and compressible flows. Explicit and implicit methods, Von Neumann error analysis, consistency, convergence, and accuracy.

MAE 631 - ROTORCRAFT DESIGN I
Semester Hours: 3

Conceptual design of rotorcraft systems with an emphasis on multidisciplinary design. Comprehensive methodologies for vehicle synthesis and sizing including consideration of aerodynamics, propulsion, materials and structures, flight performance and control, and operations. Integration of advanced technologies. Rotorcraft Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Rotorcraft Systems Engineering. Corequisite: MAE 657.

MAE 632 - ROTORCRAFT DESIGN II
Semester Hours: 3

Continuation of Rotorcraft Design I including higher fidelity simulations and trade studies. Consideration of maneuverability, structural dynamics, drive train and hub design, advanced flight control system design, sensors, weapons, component integration, packaging, and life-cycle cost. Rotorcraft Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Rotorcraft Systems Engineering.

MAE 633 - TACTICAL MISSILE DESIGN I
Semester Hours: 3

Conceptual design of missile systems with an emphasis on multi-disciplinary design. Comprehensive methodologies for vehicle synthesis and sizing including consideration of aerodynamics, propulsion, materials and structures, flight performance and control, and operations. Integration of advanced technologies. Tactical Missile Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Missile Systems Engineering. Prerequisite with concurrency: MAE 755.

MAE 634 - TACTICAL MISSILE DESIGN II
Semester Hours: 3

Continuation of Tactical Missile Design I including higher fidelity simulations and trade studies. Consideration of trajectory modeling and simulation, open-loop flight control system design, sensors, component integration and packaging, and life-cycle cost. Tactical Missile Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Missile Systems Engineering. Prerequisite: MAE 633.

MAE 635 - AEROSPACE SYSTEMS ENGINEERING
Semester Hours: 3

Introduction to Integrated Product and Process Development (IPPD) and life cycle analysis with application to Aerospace Systems. Systems engineering and quality engineering methods and tools. Top-down design decision support process. Computer integrated environment and robust design simulation will be addressed. Prerequisite: ISE 601 or ISE 690.
MAE 639 - SYSTEM SAFETY  
Semester Hours: 3  

The process of system safety—from the creation and management of a safety program on a system under development to the analysis that must be performed as this system is designed and produced to assure acceptable risk in its operation. Full discussion of the management and analysis processes and procedures. Incorporates the safety procedures used by the Department of Defense and NASA. Basic statistical methods and network analysis methods which provide an understanding of the engineering analysis methods that follow are covered.

MAE 640 - ROCKET PROPULSION II  
Semester Hours: 3  

MAE 641 - ADV THERMODYNAMICS  
Semester Hours: 3  

Application of classical thermodynamics. Treatment of problems involving nonideal gases and liquids, phase equilibrium, and chemical equilibrium. (Same as CHE 641.)

MAE 643 - ADVANCED HEAT & MASS TRANSFER  
Semester Hours: 3  

Continuation of MAE 450 in the study of conductive, convective, and radiative heat transfer and mass transfer. Emphasis is placed on heat transfer in turbulent flows and high speed flows, combined mode heat transfer, and mass transfer in reacting flows.

MAE 644 - ADVCD SOLID ROCKET PROPUL  
Semester Hours: 3  

Overview of the design, manufacture and testing of solid rocket propulsion systems. Specific topics include propellant ballistics and combustion, grain design, motor case and nozzle design, thermal protection, motor performance, and reliability and failure. Prerequisite: MAE 540.

MAE 645 - COMBUSTION I  
Semester Hours: 3  

Combustion chemistry, introduction to mass transfer, chemical kinetics, reactors, simplified governing equations for chemically reacting flow, laminar diffusion and premixed flames.

MAE 646 - COMBUSTION I  
Semester Hours: 3  

Combustion chemistry, introduction to mass transfer, chemical kinetics, reactors, simplified governing equations for chemically reacting flow, laminar diffusion and premixed flames.

MAE 647 - UNCERTAINTY ANAL IN EXPER  
Semester Hours: 3  

Uncertainty analysis concepts and techniques; application in planning, design, construction, debugging, execution, data analysis and reporting phases of experimental programs. Discussion of national and international standards and current engineering uncertainty analysis literature.

MAE 649 - TRANSPORT PHENOMENA  
Semester Hours: 3  

Mass, energy, and momentum transport in steady and transient motions in real and rheological substances. (Same as CHE 649.)

MAE 651 - VISCOS FLUID MECHANICS  
Semester Hours: 3  

Fundamentals of incompressible viscous fluid motion, including development of Navier Stokes equation. Exact and approximate solutions for both large and small Reynolds number. Laminar and turbulent boundary layers.

MAE 657 - HELICOPTER THEORY  
Semester Hours: 3  

Vertical flight, forward flight, performance, design, mathematics of rotating systems, rotary wing dynamics, rotary wing aerodynamics, helicopter aeroelasticity, stability and control, stall, and noise. Prerequisite: MAE 530.

MAE 658 - ROTORDYNAMICS  
Semester Hours: 3  

Torsional and transverse rotor vibration, critical speed and stability analysis, response to unbalance, rotor balancing. Rotodynamic phenomena including: gyroscopic effects, fluid film bearings, annular seals, stiffness asymmetry.
MAE 660 - STRUCTURAL DYNAMICS
Semester Hours: 3
Application of the theory of vibrations to discrete and continuous models of structures. Numerical methods of analysis for both spatial and temporal variables. Modal synthesis and step-by-step time integration methods. Finite element applications; substructuring techniques. (Same as CE 660.)

MAE 661 - ADVANCED DYNAMICS
Semester Hours: 3
Variational methods, optimization, and dynamic stability. Lagrangian and Hamiltonian formulation for dynamical systems and Hamilton-Jacobi methods to orbital mechanics.

MAE 662 - NONLINEAR DYNAM & CHAOS
Semester Hours: 3
Nonlinear and chaotic dynamical systems, phase plane, periodic and strange attractors, stability analysis, critical points, Piapunov exponents, bifurcation points, solitons, logistic maps, Poincare and Henon iterative maps, factals, Mandelbrot and Julia sets, chaos in complex dynamical systems.

MAE 663 - ASTRODYNAMICS
Semester Hours: 3
Astronomical coordinates and time systems; the many-body problems and disturbing functions. General perturbation methods, and application of classical mechanics and Hamilton-Jacobi methods to orbital mechanics.

MAE 671 - CONTINUUM MECHANICS
Semester Hours: 3
Kinematics and kinetics, various coordinate systems, constitutive equations for continuous media; governing partial differential equations from first and second laws of thermodynamics; applications to solids, liquids, and gases. (Same as CE 671.)

MAE 672 - ELASTICITY
Semester Hours: 3
Formulation of boundary-value problems of classical elasticity. Application to plane problems, prismatic members, and axisymmetric problems. Introduction to three-dimensional problems. (Same as CE 672.)

MAE 673 - PLASTICITY
Semester Hours: 3
Fundamentals of mechanical behavior of metals and nonmetals for stress states greater than the yield stress state. Deformation and flow theories. Stress-strain relations and yield criteria. Solution of boundary value problems with plastic bodies. Limit analysis of structures. (Same as CE 673.)

MAE 674 - FINITE ELEMENT ANALYS I
Semester Hours: 3
Finite element theory, variational methods, weighted residuals; applications to linear partial differential equations in continuous media; solution of boundary-value and initial-value problems. (Same as CE 674.)

MAE 676 - VISCOELASTICITY
Semester Hours: 3

MAE 677 - OPTICAL TECH IN SOLID MECH
Semester Hours: 3
Overview of conventional methods for experimental stress analysis. Introduction to applied optics with emphasis on non-destructive, laser-based testing methods, fiber optic recording systems, photoelectronic-numerical data acquisition, and computer aided analysis. (Same as CE 677.)

MAE 678 - MECH COMPOSITE MATERIALS
Semester Hours: 3
Introduction to composite materials, micro- and macro-mechanical behavior of laminae; bending, buckling and vibration of laminated plates. (Same as CE 678.) Prerequisites: MAE 671 and MAE 672.

MAE 680 - PERFORMANCE FLIGHT TESTING
Semester Hours: 3
Fundamentals of rotorcraft test and evaluation. Topics include: test planning, requirements analysis, helicopter performance evaluation, fundamentals of propulsion testing, aviation safety, use of modeling and simulation in flight testing, Department of Defense and Federal Aviation Administration requirements and procedures.
MAE 681 - MISSILE TRAJECTORY ANALYSIS
Semester Hours: 3

Methods for generating trajectories of missiles and projectiles are studied as well as control mechanisms. Point mass approximations are developed using approximations and exact representations of drag and atmospheric conditions. Full six degree-of-freedom models are developed and solved numerically. Aerodynamic models are developed for both slowly spinning missiles and spin stabilized projectiles. Projectile linear theory is developed and used to discuss gyroscopic and dynamic stability and introduce rapid trajectory generation. Prerequisite: MAE 580.

MAE 683 - GRAD SEMINAR MECH ENGR
Semester Hour: 1

Professional activities designed to promote the skills required to organize and deliver oral technical presentations and to broaden the individual's awareness of technical issues. Required for all students pursuing a graduate degree. Students will be graded 'S' (satisfactory) or 'U' (unsatisfactory) based upon their performance and attendance. Students who do not receive an 'S' grade must register for the course until an 'S' is obtained.

MAE 684 - AEROSPACE SYSTEMS SEMINAR
Semester Hour: 1

Seminar course for students in the MSE (Aerospace) Rotorcraft Systems Engineering and Missile Systems Engineering programs of study. Students participate in seminars on specific aspects of rotorcraft and missile systems engineering including system integration, modeling and simulation, operations, and advanced technologies.

MAE 692 - GRAD ENGR ANALYSIS I
Semester Hours: 3

Ordinary differential equations (ODEs), Bessel functions, Legendre polynomials, Laplace transformations, simultaneous differential equations, application of ODEs to mechanical systems, partial differential equations (PDEs) and boundary-value problems, application of PDEs to mechanical systems.

MAE 693 - GRAD ENGR ANALYSIS II
Semester Hours: 3

Green's functions, Fourier series and integrals, linear algebra, vectors, vector analysis and integral theorems, introduction to tensor analysis, analytical functions of a complex variable, Taylor and Laurent expansions, the residue theorem, stability criteria, and Calculus of Variations. Prerequisite: MAE 692.

MAE 695 - SELECTED TOPICS MECH & AERO EG
Semester Hours: 1-9

MAE 696 - GRAD INTERN MECH & AERO ENGR
Semester Hours: 1-9

Active involvement in an engineering project in an engineering enterprise, professional organization, or government agency that has particular interest and relevance to the graduate student. Permission of MAE faculty member required.

MAE 698 - PLAN II MASTER'S PAPER
Semester Hours: 3

Required Plan II paper for a Plan II Masters degree. Completion of 18 semester hours of graduate course work required.

MAE 699 - MASTER'S THESIS
Semester Hours: 1-9

Required each semester in which a student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of 9 hours of credit is awarded upon successful completion of master's thesis. Requires thesis advisor permission. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.

MAE 723 - COMPUTATIONAL FLUID DYN II
Semester Hours: 3

Continuation of Computational Fluid Dynamics I, advanced topics in finite difference, finite element, finite volume, and spectral element methods. Prerequisite: MAE 623.

MAE 724 - COMPUTATIONAL FLUID DYNAM III
Semester Hours: 3

Grid generation techniques with structured and unstructured meshes, adaptive meshes, domain decompositions, and parallel processing. Applications of generated meshes to any one of the following problems: turbulence, combustion, acoustics, radiation, multiphase flows, or magnetohydrodynamics. Prerequisite: MAE 723.
MAE 726 - ROTORCRAFT COMPUT FLUID DYN
Semester Hours: 3

Full potential, Euler, Navier-Stokes approaches, structural and unstructured grids, wake capturing, turbulence, and acoustics.

MAE 740 - AEROTHERMODYNAMICS
Semester Hours: 3

Description of the dynamic and thermal fluid flow environments associated with hypervelocity vehicles and propulsion systems with emphasis on thermochemical nonequilibrium behavior. Topics include thermostatical basis for internal energies, specific heats and shock strengths in dissociated and ionized gases; formulation of reacting flow conservation equations; and recent experimental advances in aerothermodynamics.

MAE 741 - STATIS THERMODYNAMICS
Semester Hours: 3


MAE 745 - COMBUSTION II
Semester Hours: 3

Droplet evaporation and burning, introduction to turbulent flow, turbulent diffusion and premixed flames, burning of solids, pollutant emissions, and detonation. Prerequisite: MAE 645.

MAE 746 - CONVECTIVE HEAT TRANSFER
Semester Hours: 3

Advanced theory of convective transport processes in fluids, including transport of momentum and energy in laminar flow, boundary layers and turbulent transport in shear flow. Engineering applications include boiling and two phase processes.

MAE 748 - RADIATIVE TRANSFER
Semester Hours: 3

Physics and modeling of radiative transfer. Scattering, remote sensing, and absorption in participating media. Infrared through optical wave lengths. Computational methods in radiative transfer.

MAE 749 - MASS TRANSPORT
Semester Hours: 3

Mass transfer in solid and fluid systems under steady and transient conditions. Integration of momentum, heat and mass transfer equations with application to reactive, rheological and multicomponent systems.

MAE 751 - BOUNDARY LAYER THEORY
Semester Hours: 3

Development of boundary layers using singular perturbation theory. Curvature and compressible effects and the order of their importance. Modern applications and computational approaches.

MAE 752 - MECH OF RARIFIED GASES
Semester Hours: 3

Application of kinetic theory to rarefied gas-flow problems. Boltzmann statistical distribution; gas-surface interaction, transport properties, free molecule flow; heat-free molecule flow; procedures for non-equilibrium flows. Offered upon demand.

MAE 753 - MAGNETO-GAS DYNAMICS
Semester Hours: 3

Equations of motion for ionized gases with critical analysis of transport properties in steady and varying electric and magnetic fields. MHD shock waves and radiation effects.

MAE 754 - HYPERSONIC FLOW
Semester Hours: 3

Theories for treating the laminar and turbulent boundary layers of reacting fluids, mixtures, related chemical, thermodynamic, and physical phenomena in hypersonic flows. Leading edge bluntness, shock wave interactions, and vorticity effects.

MAE 755 - ADVANCED AERODYNAMICS
Semester Hours: 3

Transonic, supersonic, and hypersonic flows. Application of compressible potential theory, similarity rules, slender body theory and Newtonian flow theory to the analysis of aerodynamics of aircraft, missiles, re-entry vehicles, and other flight vehicles.
MAE 756 - NUM SIM OF MAGNETOHYDRODYNAMIC
Semester Hours: 3

Finite difference methods for simulation of MHD flows. Methods include explicit scheme, FICE methods, LBL, ADI, artificial damping and projected characteristics for multidimensional timedependent flow.

MAE 757 - OPT TECH/FLUID MECHANICS
Semester Hours: 3

Laser sources, molecular interactions with light and diatomic spectroscopy needed fluorescence, Brillouin scattering, four wave mixing, CARS and other applications in optical fluid diagnostics. (Same as CHE 757.).

MAE 758 - TURBULENCE
Semester Hours: 3

Turbulence in gases and liquids; boundary layers, atmospheric phenomena. Prerequisites: MAE 651 and MAE 671.

MAE 760 - ANALY METH NONLIN DYNAM
Semester Hours: 3

Application of averaging methods and perturbation methods to vibrations of nonlinear systems. Analysis of linear systems with periodic coefficients (Floquet theory). Elements of stability theory, Liapunov functions, and Liapunov's direct method. Prerequisites: MAE 660 and MAE 661.

MAE 762 - WAVE MOT/CONT ELAS BODIES
Semester Hours: 3

Elements of stress wave propagation in bounded elastic media. Propagation of elastic waves in infinite and semi-infinite bodies, cylinders, rods and beams. (Same as CE 762.).

MAE 765 - RANDOM VIBR/ELASTIC SYSTEMS
Semester Hours: 3


MAE 768 - DYN AEROSPACE VEHICLES
Semester Hours: 3

Elements of advanced rotational kinematics of rigid bodies. Attitude motion of space vehicles in circular and elliptic orbits. Methods of gravitation and spin stabilization of gyrostat.

MAE 772 - THEORY STRUCT STABILITY
Semester Hours: 3


MAE 773 - THEORY OF SHELLS
Semester Hours: 3

Analysis of thin plates and shells including higher order approximation theories and transverseshear deformations. Illustration of theories by selected problems. (Same as CE 773.).

MAE 774 - FINITE ELEM ANALY II
Semester Hours: 3

Advanced topics in finite element analysis; application to nonlinear partial differential equations in continuum mechanics; theoretical studies of convergence and stability of solutions. (Same as CE 774.) Prerequisite: MAE 674.

MAE 776 - TH FIN ELAST FIN VISCOEL
Semester Hours: 3

Theory of finite deformation analysis for elastic and viscoelastic materials. Constitute models are developed for a functional analysis approach leading to models based on the Cauchy-Green Deformation Tensor and the Strain Energy Density Function. Models discussed include: Mooney-Rivlin and Bernstein-Kearsley-Zappas.

MAE 778 - FRACTURE MECHANICS
Semester Hours: 3

Theory of crack propagation, stress intensity factors, mapping techniques, series expansion, asymptotic approximations, field singularities, integral transforms, numerical solutions. (Same as CE 778.) Prerequisite: MAE 672.
MAE 780 - THEORY OF ACOUSTICS  
Semester Hours: 3  
Simple harmonic oscillators, damped and forced oscillators, 1-D wave equation, vibration of a string, 2-D wave equation, vibration of membranes, the acoustic wave equation, plane waves, cylindrical and spherical waves, reflection and transmission, radiation and reception of acoustic waves, absorption and attenuation of sound, cavities and wave guides, and architectural acoustics. Prerequisite: MAE 692.

MAE 781 - NONLINEAR EFFECTS/PLASMA  
Semester Hours: 3  
Fundamental physical concepts and methods of estimating various nonlinear interactions in plasmas. Analytical and numerical methods to deal with these problems.

MAE 782 - PLASMA TURBULENCE  
Semester Hours: 3  
Methodology that deals with plasma turbulence together with current numerical techniques to solve these problems approximately, via super-computing.

MAE 795 - SELECTED TOPICS MECH & AERO EG  
Semester Hours: 1-9

MAE 799 - DOCTORAL DISSERTATION  
Semester Hours: 3-9  
Required each semester student is enrolled and receiving direction on doctoral dissertation.

**Aerospace Systems Engineering, PhD**

The MAE Department offers a PhD program in Mechanical Engineering.

The following table is an outline of the program of study requirements. Students should consult their dissertation advisor and supervisory committee to develop their program of study.

**Program of Study**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tr>
<td></td>
<td><strong>Engineering Major</strong></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>27 semester hours of graduate coursework from MAE or related departments</td>
<td>27</td>
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<tr>
<td>With approval, a Master’s Thesis may be counted 6 semester hours towards this total.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>First Minor</strong></td>
<td></td>
</tr>
<tr>
<td>ISE 627</td>
<td>ENGINEERING SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td>9 semester hours of graduate courses in an approved engineering area of specialization</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Second Minor</strong></td>
<td></td>
</tr>
<tr>
<td>MAE 692</td>
<td>GRAD ENGR ANALYSIS I</td>
<td>3</td>
</tr>
<tr>
<td>6 semester hours of graduate coursework in mathematics (Typically MAE 693 and ISE 690)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Doctoral Dissertation</strong></td>
<td></td>
</tr>
<tr>
<td>18 hours (minimum) of MAE 799 - Doctoral Dissertation</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Semester Hours</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>66</td>
</tr>
</tbody>
</table>

*With prior approval, up to 9 semester hours of 500 level courses may be taken in fulfillment of the Basic and specific program requirements.*

**Aerospace Systems Engineering, MSASE**

The MAE Department offers two options leading to the Master of Science degree in Aerospace Systems Engineering (MSASE). These are designated:

- Plan I (Thesis),
- Plan II (Non-thesis)

The following sections describe the requirements for each of these options. For both options, the majority of coursework, not including MAE 699, must be from MAE. With prior approval, up to 9 semester hours of 500 level courses may be taken in fulfillment of the Basic and specific program requirements.
Basic MSASE Program of Study

The Basic Program of Study, common to both the Plan I and Plan II (Non-thesis) MSASE options, contains a minimum of 24 semester hours of graduate-level course work that must include:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Engineering Major</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select an engineering major consisting of 12 semester hours of graduate courses including supporting engineering courses</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>First Minor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ISE 627 ENGINEERING SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3 semester hour graduate course in an approved engineering area of specialization</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Second Minor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MAE 692 GRAD ENGR ANALYSIS I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3 semester hour approved graduate mathematics or engineering mathematics course</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total Semester Hours</td>
<td>24</td>
</tr>
</tbody>
</table>

Plan I, Thesis Option

Students selecting this option must:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete Basic Program of Study as described above</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>MAE 699 MASTER'S THESIS</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Complete an acceptable thesis including a public defense and submit a journal manuscript to the research advisor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Semester Hours</td>
<td>30</td>
</tr>
</tbody>
</table>

Plan II, Non-Thesis Option

Students selecting this option must:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete Basic Program of Study as described above</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Select 6 semester hours of graduate courses to complete an approved extended program of study</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Total Semester Hours</td>
<td>30</td>
</tr>
</tbody>
</table>

Mechanical Engineering, PhD

The MAE Department offers a PhD program in Mechanical Engineering.

The following table is an outline of the program of study requirements. Students should consult their dissertation advisor and supervisory committee to develop their program of study.

Program of Study

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Engineering Major</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimum of 27 semester hours of graduate coursework from MAE or related departments</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>With approval, a Master's Thesis may be counted 6 semester hours towards this total.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Minor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 semester hours of graduate courses in an approved engineering area of specialization</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Second Minor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MAE 692 GRAD ENGR ANALYSIS I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>MAE 671 CONTINUUM MECHANICS</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3 semester hours of graduate coursework in mathematics (Typically MAE 693)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Doctoral Dissertation</td>
<td></td>
</tr>
</tbody>
</table>
18 hours (minimum) of MAE 799 - Doctoral Dissertation  

Total Semester Hours  

66 

With prior approval, up to 9 semester hours of 500 level courses may be taken in fulfillment of the Basic and specific program requirements. 

Mechanical Engineering, MSE 

The MAE Department offers two plans leading to the MSE degree for the Mechanical Engineering option. These are designated: 

- Plan I (Thesis) 
- Plan II (Non-thesis) 

The following sections describe the requirements for each of these options. For both options, the majority of coursework, not including MAE 699, must be from MAE. With prior approval, up to 9 semester hours of 500 level courses may be taken in fulfillment of the Basic and specific program requirements. 

Basic Program of Study 

The Basic Program of Study, common to both the Plan I and Plan II (non-thesis) MSE options, contains a minimum of 24 semester hours of graduate-level course work that must include: 

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Engineering Major</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select an engineering major consisting of 12 semester hours of graduate courses including supporting engineering courses</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>First Minor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select a first minor of 6 semester hours of graduate courses in an approved engineering area of specialization</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Second Minor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MAE 692 GRAD ENGR ANALYSIS I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Select 3 additional semester hours of graduate courses in Mathematics or Graduate Engineering Analysis</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total Semester Hours</td>
<td>24</td>
</tr>
</tbody>
</table>

6 semester hours of graduate coursework in mathematics (MAE 693 and MAE 671 are typical selections) 

Plan I, Thesis Option 

Students selecting this option must: 

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete Basic Program of Study including MAE 671 as described above</td>
<td>24</td>
</tr>
<tr>
<td>MAE 699</td>
<td>MASTER'S THESIS</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Complete an acceptable thesis including a public defense</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Semester Hours</td>
<td>30</td>
</tr>
</tbody>
</table>

Plan II, Non-Thesis Option 

Students selecting this option must: 

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete Basic Program of Study including MAE 671 as described above</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Select 6 semester hours of graduate courses to complete an approved extended program of study</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Total Semester Hours</td>
<td>30</td>
</tr>
</tbody>
</table>

Interdisciplinary Programs 

Interdisciplinary Master's Programs 

- Cybersecurity, MS Interdisciplinary - Management Track (p. 35) 
- Cybersecurity, MS Interdisciplinary - Computer Engineering Track (p. 106)
• Cybersecurity, MS Interdisciplinary - Computer Science Track (p. 108)
• Materials Science, MS (p. 112)

**Interdisciplinary Doctoral Programs**

• Biotechnology Science and Engineering, PhD (p. 104)
• Materials Science, PhD (p. 114)
• Optical Science and Engineering, PhD (p. 116)

**Biotechnology Science and Engineering, PhD**

**Biotechnology Science & Engineering**

**Degree**

Doctor of Philosophy

**Program Coordinator**

Joseph D. Ng, Biological Sciences
Materials Science Building, Rm. 221
256.824.3715
Email: ngj@uah.edu (ngj@email.uah.edu)

**Program Office**

Materials Science Building, Room 206A
256.824.3192

**Adjunct Faculty**

More than 10 scientists from NASA's Marshall Space Flight Center (Space Science Laboratory) and local biotechnology companies in Huntsville serve as adjunct faculty to the program and have expertise in at least one of the thrust areas of Biotechnology Science and Engineering.

**Mission**

The Biotechnology Science and Engineering Graduate Program (B.S.E.) is an interdisciplinary program of the University of Alabama in Huntsville concerned with research and scholarly activity in the diverse areas of biotechnology. The program's mission is to provide Ph.D. level graduates who are broadly trained in the areas of science and engineering pertinent to biotechnology and who will benefit the economic, educational, and cultural development of Alabama. Graduates of the program are expected to be able to make significant contributions to biotechnology in academic, governmental, and business settings.

Biotechnology is not a single area of study itself, but is a multidisciplinary field concerned with the practical application of biological organisms and their subcellular components to industrial or service manufacturing, to environmental management and health and medicine. It is, in essence, a series of enabling technologies drawn from the fields of microbiology, cellular biology, molecular biology, genetics, biochemistry, immunology, fermentation technology, environmental science and engineering which allow one to synthesize, breakdown or transform materials to suit human needs. Biotechnology ("Current Trends in Chemical Technology, Business, and Employment," American Chemical Society, Washington, DC. 1998) can therefore be defined as the safe study and manipulation of biological molecules for development of products or techniques for medical and industrial application. Although biotechnology in the broadest sense is not new, the current ability and demand for manipulating living organisms or their subcellular components to provide useful products, processes or services has reached new heights. Modern biotechnology has resulted from scientific scrutiny of old and familiar processes and from new advances in molecular biology, genetic engineering and fermentation technologies.

The future industrial landscape will continue to include research, development and the manufacturing of products such as proteins and nucleic acids that will be based wholly or in large part on biological processes. The interdisciplinary program in Biotechnology Science and Engineering will provide broad training in sciences and engineering dealing with the handling and the processing of macromolecules and living systems. Students will receive advanced training in one of three specializations:

1. Structural Biology,
2. Biomolecular Sciences or

The principal core of instructors and research advisors are drawn from the Departments of Biological Sciences, Chemistry, and Chemical and Materials Engineering. The program includes significant involvement from local biotechnology companies as well as NASA's Marshall Space Flight Center.

In addition to a set of core courses, the Ph.D. program requires the successful completion of a comprehensive exam, seminar attendance, the preparation of a U.S. National Institutes of Health (NIH) or National Science Foundation style research proposal, oral presentations and defense of
a dissertation describing original research. It is the intent of the program to produce internationally competitive graduates who will make significant contributions to the field of biotechnology.

**Admission Requirements**

Applicants may be unconditionally admitted to the program if they have:

1. A bachelor’s degree in science or engineering from an approved college or university;
2. A minimum grade point average (GPA) of 3.0 overall;
3. A combined score of 300 on the verbal, quantitative and analytical sections and at least 3.0 in the writing section of the Graduate Record Examination (GRE).
4. A TOEFL (iBT) score of: all sub-scores equal to or greater than 18 OR IELTS score of: all sub-scores equal to or greater than 6.0 for international students.

Applicants may be admitted conditionally if they do not meet these requirements but indicate the potential for success in the Biotechnology Science and Engineering program. Applicants must have knowledge from coursework in the areas of general biology, cell biology, genetics and molecular biology, general and organic chemistry, physics and calculus to satisfy the prerequisites of calculus-based physical or biophysical chemistry. Students with deficiencies in any of these areas may be admitted only conditionally pending remedy of the deficiencies.

To obtain a Ph.D. in Biotechnology Science and Engineering, the student must satisfy all requirements of the School of Graduate Studies as well as those of the Biotechnology Science and Engineering Program.

The requirements are as follows:

1. **Successfully complete the core courses:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 561</td>
<td>BIOSEPARATIONS RECOMBI TECH/PR</td>
<td>3</td>
</tr>
<tr>
<td>CH 561</td>
<td>BIOCHEMISTRY I</td>
<td>3</td>
</tr>
<tr>
<td>CH 562</td>
<td>BIOCHEMISTRY II</td>
<td>3</td>
</tr>
<tr>
<td>BYS 519</td>
<td>GENE STRUCTURE &amp; FUNCTION</td>
<td>3</td>
</tr>
<tr>
<td>BYS 543</td>
<td>MOLECULAR BIOLOGY OF THE CELL</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Total Semester Hours</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

2. **Pass the Preliminary Examination**

Each student must pass the preliminary examination which has to be taken at the end of the first summer of residence, and will cover materials from the core courses in the areas of Biochemistry, Cellular and Molecular Genetics and Bioprocessing/Bioseparations. Students will take examinations in all three areas during the first attempt. Students are required to repeat only the part of the exams that they did not pass. Students will have a maximum of two attempts to pass the preliminary examination. Appeals to this policy must be filed with the Director of the Biotechnology Program who will consult with the Graduate Dean and the Deans of the Colleges of Engineering and Science.

3. **Choose a dissertation advisor and committee**

Students who qualify for the Ph.D. program by passing the preliminary examination will choose a dissertation advisor and a Supervisory Committee during the fall semester of their second year. The committee will meet for the first time with the student to review the initial research goals (Research Start Meeting).

4. **Write and defend a research proposal**

In consultation with the dissertation advisor and committee, the student will begin working on a research project which will subsequently lead to an NIH or NSF style proposal. This written proposal will be submitted to the committee by the middle of the second summer. By the first semester of the third year, the student will defend this proposal in a seminar, followed by questions from committee members (Annual Research Appraisal I) (ARA-I). Successful completion of the written and oral presentation of the dissertation proposal constitutes the School of Graduate Studies Qualifying Examination.

5. **Complete an acceptable program of study**

The program of study will consist of at least 48 semester hours of coursework at the graduate level including the core courses required to prepare for the preliminary examinations and courses required to prepare the student to conduct original research in their area of study. Students must register for a total of three semester hours of seminar. A maximum of three seminar semester hours may be considered towards fulfillment of the graduate course requirements. A minimum of 18 semester hours of BSE 799 must be included in the program of study.
6. Complete and defend a research dissertation

During the fall semesters of the next two years, students will meet with their advisors and committee for research appraisals (ARA). Following these annual evaluations, the student will begin writing the dissertation and plan to defend it before the fifth year after passing the preliminary examination. The primary dissertation advisor and the committee have the discretion to allow students to defend the dissertation earlier if the work is of high quality and sufficient progress has been made toward the goals stated in the research proposal.

All requirements for the Ph.D. must be completed in no more than five years after the approval of the Research Proposal (ARA-I).

Cybersecurity, MS Interdisciplinary - Computer Engineering Track

Purpose

The MS degree is a unique program in that it is an interdisciplinary program of study among three colleges, Business, Engineering, and Science. Due to this collaboration among the colleges, students will be exposed to a diversified core curriculum with a choice of 3 different elective tracks; having in-depth curriculum in their track while gaining familiarity in the other two. Upon graduation students will be able to perform: Cybersecurity Analysis of vulnerabilities and threats to network environments, Network Penetration Testing, Auditing for Certification & Accreditation, and Technical Project Management in Information Technology. Students will also be able to integrate the business and scientific underpinnings of information technology trends related to the System Development Life Cycle and understand the federal, state & local statutory requirements associated with Information and cybersecurity through the Information Assurance Technical Framework (IATF).

Program prerequisites are kept to a minimum and the program is designed to meet the needs of students with a wide variety of educational backgrounds. The admission and program requirements for those pursuing the Management track are described below.

Admission Requirements

Individuals who are interested in obtaining application forms and information concerning admission procedures should contact the College’s Director of Graduate Programs, Room 102, Business Administration Building. The telephone number is 256.824.6681. The email address is gradbiz@uah.edu. The College’s home page can be accessed at http://uah.edu/cba.

Admission is granted to students who show high promise for success in graduate study and who hold baccalaureate degrees from approved institutions. Individuals with baccalaureate degrees in any field of study are eligible to apply. Students may have backgrounds in such diverse fields as engineering, science, business, liberal arts, education, and healthcare. Admission to the computer engineering or computer science tracks may require that a student hold a degree in one of the following disciplines:

- Management Information Systems
- Computer Science
- Electrical Engineering, Computer Engineering
- Information Systems Security Engineering

Admission to the program is competitive. It is based on an applicant’s undergraduate academic performance and scores on the Graduate Management Admission Test (GMAT) or the Graduate Records Examination (GRE). Scores on the Test of English as a Foreign Language (TOEFL) are required for the applicant whose native language is not English.

The GMAT measures general verbal, mathematical and analytical writing skills that are developed over a long period of time and are associated with success in the first year of study at graduate schools of management. The GMAT does not presuppose any specific knowledge of business areas. The GMAT is a Computer Adaptive Test (CAT) given throughout North America and at many international sites. The test is administered through individually scheduled appointments. Applicants may arrange to take the GMAT by applying on the web at http://www.mba.com.

The information on the GRE can be found at http://www.ets.org.

In order for applicants to receive full consideration from the admissions committee, all applications materials (graduate application, official copies of all transcripts, and official GMAT or GRE score report) should be received in a timely manner. Use the following dates as a guideline: The deadline for international students is earlier.

<table>
<thead>
<tr>
<th>For admission in</th>
<th>Preferred date for all materials</th>
<th>The latest date for all materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall semester</td>
<td>June 1</td>
<td>July 15</td>
</tr>
<tr>
<td>Spring Semester</td>
<td>October 1</td>
<td>November 30</td>
</tr>
<tr>
<td>Summer term</td>
<td>March 1</td>
<td>April 30</td>
</tr>
</tbody>
</table>

There is no guarantee that materials received after the latest guideline dates will be processed in time for enrollment in the next semester. Incomplete applications that cannot be processed will be considered for the following semester. Applicants should allow about three weeks from the date the GMAT
is administered for official scores to reach Graduate Admissions. Adequate lead time should also be allowed for the receipt of official transcripts from
other universities.

International Students

International applicants who are not native speakers of English are required to submit TOEFL scores or IELTS scores. Students who have received a
score of: TOEFL (iBT): all sub-scores equal or greater than 18 OR IELTS score of: all sub-scores equal or greater than 6.0 are eligible for full admission
with no language testing and/or Intensive Language/Culture coursework required. Any English language deficiencies must be remedied through required
English as a Second Language (ESL) courses which must be taken beginning in the first semester. For exceptions to this requirement, see the section
on Graduate Admissions Information.

International students must submit all application materials to the graduate admissions office by the following deadlines:

<table>
<thead>
<tr>
<th></th>
<th>Students currently outside of the United States</th>
<th>Students currently inside the United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall semester</td>
<td>April 1</td>
<td>June 1</td>
</tr>
<tr>
<td>Spring semester</td>
<td>September 1</td>
<td>October 1</td>
</tr>
<tr>
<td>Summer term</td>
<td>February 1</td>
<td>March 15</td>
</tr>
</tbody>
</table>

Tracks

The program is offered in three different disciplines (tracks). Additional requirements for each track are as follows:

Business

Bachelor's degree in a business or related field; students with a bachelor's in an unrelated field will be required to take the following prerequisites -
Computer Applications, Computer Programming, and Computer Science and Networks.

Computer Science

Bachelor's degree in computer science or a related field; student's with a bachelor's in an unrelated field will be required to take the following

Engineering

Bachelor's degree in engineering from an ABET accredited program; students with a bachelor's in an unrelated field will be required to take the following

MSCBS is a 33 semester hour graduate level credit program. 18 semester hours of the credits are part of the core classes while the other 15 are
focused on the specific track.

The MS-CBS program consists of 30 semester hours of graduate coursework. The coursework includes a five-course core that is required of all
students, 9 credit hours of management track required courses, and 6 credit hours of electives. The directed elective choices are designed to provide
students a broader understanding of multiple cybersecurity functions normally expected in an organization.

CS 692/IS 692 is the capstone course and should be taken toward the end of the student’s program. The grade in CS 692/IS 692 can be no lower than B.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 660</td>
<td>CYBERSECURITY MANAGEMENT</td>
<td>3</td>
</tr>
<tr>
<td>IS 663</td>
<td>COMPUTER FORENSICS</td>
<td>3</td>
</tr>
<tr>
<td>CPE 549</td>
<td>INTRO TO CYBERSECURITY ENGINRG</td>
<td>3</td>
</tr>
<tr>
<td>CS 585</td>
<td>INTRO TO COMPUTER SECURITY</td>
<td>3</td>
</tr>
<tr>
<td>CS 692</td>
<td>COMPUTER SECURITY</td>
<td>3</td>
</tr>
<tr>
<td>or IS 692</td>
<td>CYBERSECURITY PRACTICUM</td>
<td></td>
</tr>
</tbody>
</table>

Cybersecurity: Computer Engineering Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPE 645</td>
<td>COMPUTER NETWORK SECURITY</td>
</tr>
<tr>
<td>CPE 649</td>
<td>ADV CYBERSECURITY ENGINEERING</td>
</tr>
<tr>
<td>CPE 646</td>
<td>MOBILE &amp; WIRELESS NETWORKS</td>
</tr>
</tbody>
</table>

Electives

Select two of the following: 6
Restrictions on Elective Courses
1. Computer Science track students should take two elective courses from CS courses.
2. Computer Engineering track students should take at least one elective course from CPE courses.

1. Students can take only one course between these courses.
   a. CS 570 and IS 560
   b. CS 685 and CPE 645
   c. CS 670 and CPE 646
   d. CS 687 and IS 640

2. At least half of the hours must be completed in courses numbered 600.

Cybersecurity, MS Interdisciplinary - Computer Science Track

Purpose
The MS degree is a unique program in that it is an interdisciplinary program of study among three colleges, Business, Engineering, and Science. Due to this collaboration between the colleges, students will be exposed to a diversified core curriculum with a choice of 3 different elective tracks; having in-depth curriculum in their track while gaining familiarity in the other two. Upon graduation students will be able to perform: Cybersecurity Analysis of vulnerabilities and threats to network environments, Network Penetration Testing, Auditing for Certification & Accreditation, and Technical Project Management in Information Technology. Students will also be able to integrate the business and scientific underpinnings of information technology trends related to the System Development Life Cycle and understand the federal, state & local statutory requirements associated with Information and cybersecurity through the Information Assurance Technical Framework (IATF).

Program prerequisites are kept to a minimum and the program is designed to meet the needs of students with a wide variety of educational backgrounds. The admission and program requirements for those pursuing the Management track are described below.

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science, business, liberal arts, education, and healthcare. Admission to the computer engineering or computer science tracks may require that a student hold a degree in one of the following disciplines:

- Management Information Systems
- Computer Science
- Electrical Engineering, Computer Engineering
- Information Systems Security Engineering

Admission to the program is competitive. It is based on an applicant’s undergraduate academic performance and scores on the Graduate Management Admission Test (GMAT) or the Graduate Records Examination (GRE). Scores on the Test of English as a Foreign Language (TOEFL) are required for the applicant whose native language is not English.

The GMAT measures general verbal, mathematical and analytical writing skills that are developed over a long period of time and are associated with success in the first year of study at graduate schools of management. The GMAT does not presuppose any specific knowledge of business areas. The GMAT is a Computer Adaptive Test (CAT) given throughout North America and at many international sites. The test is administered through individually scheduled appointments. Applicants may arrange to take the GMAT by applying on the web at http://www.mba.com.

The information on the GRE can be found at http://www.ets.org.

In order for applicants to receive full consideration from the admissions committee, all applications materials (graduate application, official copies of all transcripts, and official GMAT or GRE score report) should be received in a timely manner. Use the following dates as a guideline: The deadline for international students is earlier.

### For admission in

<table>
<thead>
<tr>
<th></th>
<th>Preferred date for all materials</th>
<th>The latest date for all materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall semester</td>
<td>June 1</td>
<td>July 15</td>
</tr>
<tr>
<td>Spring Semester</td>
<td>October 1</td>
<td>November 30</td>
</tr>
<tr>
<td>Summer term</td>
<td>March 1</td>
<td>April 30</td>
</tr>
</tbody>
</table>

There is no guarantee that materials received after the latest guideline dates will be processed in time for enrollment in the next semester. Incomplete applications that cannot be processed will be considered for the following semester. Applicants should allow about three weeks from the date the GMAT is administered for official scores to reach Graduate Admissions. Adequate lead time should also be allowed for the receipt of official transcripts from other universities.

### International Students

International applicants who are not native speakers of English are required to submit TOEFL scores or IELTS scores. Students who have received a score of: TOEFL (iBT): all sub-scores equal or greater than 18 OR IELTS score of: all sub-scores equal or greater than 6.0 are eligible for full admission with no language testing and/or Intensive Language/Culture coursework required. Any English language deficiencies must be remedied through required English as a Second Language (ESL) courses which must be taken beginning in the first semester. For exceptions to this requirement, see the section on Graduate Admissions Information.

International students must submit all application materials to the graduate admissions office by the following deadlines:

<table>
<thead>
<tr>
<th></th>
<th>Students currently outside of the United States</th>
<th>Students currently inside the United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall semester</td>
<td>April 1</td>
<td>June 1</td>
</tr>
<tr>
<td>Spring semester</td>
<td>September 1</td>
<td>October 15</td>
</tr>
<tr>
<td>Summer term</td>
<td>February 1</td>
<td>March 15</td>
</tr>
</tbody>
</table>

### Tracks

The program is offered in three different disciplines (tracks). Additional requirements for each track are as follows:

#### Business

Bachelor’s degree in a business or related field; students with a bachelor’s in an unrelated field will be required to take the following prerequisites - Computer Applications, Computer Programming, and Computer Science and Networks.

#### Computer Science

Bachelor’s degree in computer science or a related field; student’s with a bachelor’s in an unrelated field will be required to take the following prerequisites: Data Structure, Operating Systems, Algorithm Design and Analysis, Computer Architecture and Probability and Statistics.
Engineering

Bachelor's degree in engineering from an ABET accredited program; students with a bachelor's in an unrelated field will be required to take the following prerequisites: Data Structure, Operating Systems, Algorithm Design and Analysis, Computer Architecture, Probability and Statistics.

MSCBS is a 33 semester hour graduate level credit program. 18 semester hours of the credits are part of the core classes while the other 15 are focused on the specific track.

The MS-CBS program consists of 30 semester hours of graduate coursework. The coursework includes a five-course core that is required of all students, 9 credit hours of management track required courses, and 6 credit hours of electives. The directed elective choices are designed to provide students a broader understanding of multiple cybersecurity functions normally expected in an organization.

CS 692/IS 692 is the capstone course and should be taken toward the end of the student's program. The grade in CS 692/IS 692 can be no lower than B.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 660</td>
<td>CYBERSECURITY MANAGEMENT</td>
<td>3</td>
</tr>
<tr>
<td>IS 663</td>
<td>COMPUTER FORENSICS</td>
<td>3</td>
</tr>
<tr>
<td>CPE 549</td>
<td>INTRO TO CYBERSECURITY ENGINRG</td>
<td>3</td>
</tr>
<tr>
<td>CS 585</td>
<td>INTRO TO COMPUTER SECURITY</td>
<td>3</td>
</tr>
<tr>
<td>CS 692</td>
<td>COMPUTER SECURITY</td>
<td>3</td>
</tr>
<tr>
<td>or IS 692</td>
<td>CYBERSECURITY PRACTICUM</td>
<td></td>
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</tbody>
</table>

### Cybersecurity: Computer Science Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 565</td>
<td>NETWORK SECURITY</td>
</tr>
<tr>
<td>CS 570</td>
<td>INTRO TO COMPUTER NETWORKS</td>
</tr>
<tr>
<td>CS 685</td>
<td>COMPUTER SECURITY</td>
</tr>
</tbody>
</table>

### Electives

Select two of the following: 6

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 571</td>
<td>BUSINESS INTELLIGENCE &amp; ANALYT</td>
</tr>
<tr>
<td>IS 640</td>
<td>DATA MGT AND DATA MINING</td>
</tr>
<tr>
<td>IS 691</td>
<td>INFORMATION SYS STRATEGY &amp; APP</td>
</tr>
<tr>
<td>CPE 534</td>
<td>OPERATING SYSTEMS</td>
</tr>
<tr>
<td>CPE 647</td>
<td>UBIQUITOUS COMPUTING</td>
</tr>
<tr>
<td>CPE 648</td>
<td>ADVANCED COMPUTER NETWORKS</td>
</tr>
<tr>
<td>CS 687</td>
<td>DATA BASE SYSTEMS</td>
</tr>
<tr>
<td>CS 553</td>
<td>CLIENT/SERVER ARCHITECTURES</td>
</tr>
<tr>
<td>CS 617</td>
<td>DES &amp; ANALY OF ALGORITHM</td>
</tr>
<tr>
<td>CS 650</td>
<td>SOFTW ENGINEERING PROC</td>
</tr>
<tr>
<td>CS 670</td>
<td>COMPUTER NETWORKS</td>
</tr>
<tr>
<td>CS 690</td>
<td>ADVANCED OPERATING SYSTEMS</td>
</tr>
<tr>
<td>IS 560</td>
<td>TELECOMMUNICATIONS &amp; NETRK’G</td>
</tr>
<tr>
<td>IS 577</td>
<td>NETWORK DEFENSE &amp; OPERATING SY</td>
</tr>
<tr>
<td>IS 670</td>
<td>BUSINESS CONTINGENCY PLANNING</td>
</tr>
<tr>
<td>CPE 649</td>
<td>ADV CYBERSECURITY ENGINEERING</td>
</tr>
<tr>
<td>CPE 645</td>
<td>COMPUTER NETWORK SECURITY</td>
</tr>
<tr>
<td>CPE 646</td>
<td>MOBILE &amp; WIRELESS NETWORKS</td>
</tr>
<tr>
<td>CS 565</td>
<td>NETWORK SECURITY</td>
</tr>
<tr>
<td>CS 570</td>
<td>INTRO TO COMPUTER NETWORKS</td>
</tr>
<tr>
<td>CS 685</td>
<td>COMPUTER SECURITY</td>
</tr>
</tbody>
</table>
Restrictions on Elective Courses

1. Computer Science track students should take two elective courses from CS courses.
2. Computer Engineering track students should take at least one elective course from CPE courses.

1. Students can take only one course between these courses.
   - a. CS 570 and IS 560
   - b. CS 685 and CPE 645
   - c. CS 670 and CPE 646
   - d. CS 687 and IS 640

2. At least half of the hours must be completed in courses numbered 600.

Cybersecurity, MS Interdisciplinary - Management Track

Purpose

The MS-CBS degree is a unique program in that it is an interdisciplinary program of study among three colleges: Business, Engineering, and Science. Due to this collaboration between the colleges, students will be exposed to a diversified core curriculum with a choice of 3 different elective tracks; having in-depth curriculum in their track while gaining familiarity in the other two. Upon graduation students will be able to perform Cybersecurity Analysis of vulnerabilities and threats to network environments, Network Penetration Testing, Auditing for Certification & Accreditation, and Technical Project Management in Information Technology. Students will also be able to integrate the business and scientific underpinnings of information technology trends related to the System Development Life Cycle and understand the federal, state & local statutory requirements associated with Information and cybersecurity through the Information Assurance Technical Framework (IATF).

Program prerequisites are kept to a minimum and the program is designed to meet the needs of students with a wide variety of educational backgrounds. The admission and program requirements for those pursuing the Management track are described below.

Degree Requirements

Prerequisites

Program prerequisites include a bachelor’s degree in any field and demonstration of competency in each of the following three areas:

1. Computer Applications Competency. Students must demonstrate this competency by passing an on-line computer applications competency exam or by successful completion of the IS 146 or its equivalent. IS 146 or its equivalent will not count towards the requirements of the MS-CBS degree.

2. Computer Programming Competency. Students must demonstrate this competency by passing an on-line computer programming competency exam or by successful completion of the IS 210 or its equivalent. IS 210 or its equivalent will not count towards the requirements of the MS-CBS degree.

3. Computer Science and Networks competencies. Students must be competent to be enrolled in graduate level core courses including those in computer science and networks. If a student does not have these competencies, s/he may be required to either self-prepare by reviewing online tutorials and passing a competency exam or to register for additional courses which will not count towards the 30 credit hours required for this degree.

The MS-CBS program consists of 30 semester hours of graduate coursework. The coursework includes a five-course core that is required of all students, 9 credit hours of management track required courses, and 6 credit hours of electives. The directed elective choices are designed to provide students a broader understanding of multiple cybersecurity functions normally expected in an organization.

IS 692/CPE 692/CS 692 is the capstone course and should be taken toward the end of the student’s program. Students must earn a grade of B or better in the capstone course.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 660</td>
<td>CYBERSECURITY MANAGEMENT</td>
<td>15</td>
</tr>
<tr>
<td>IS 663</td>
<td>COMPUTER FORENSICS</td>
<td></td>
</tr>
<tr>
<td>CPE 549</td>
<td>INTRO TO CYBERSECURITY ENGINRG</td>
<td></td>
</tr>
<tr>
<td>CS 585</td>
<td>INTRO TO COMPUTER SECURITY</td>
<td></td>
</tr>
<tr>
<td>IS 692</td>
<td>CYBERSECURITY PRACTICUM</td>
<td></td>
</tr>
<tr>
<td>or CPE 692</td>
<td>CYBERSECURITY CAPSTONE</td>
<td></td>
</tr>
<tr>
<td>or CS 692</td>
<td>COMPUTER SECURITY</td>
<td></td>
</tr>
</tbody>
</table>

Management Track-required Courses 1 9
Elective, select two courses from the following:  

IS 571  BUSINESS INTELLIGENCE & ANALYT
IS 640  DATA MGT AND DATA MINING
IS 691  INFORMATION SYS STRATEGY & APP
CPE 534  OPERATING SYSTEMS
CPE 647  UBIQUITOUS COMPUTING
CPE 648  ADVANCED COMPUTER NETWORKS
CS 687  DATA BASE SYSTEMS
CS 553  CLIENT/SERVER ARCHITECTURES
CS 617  DES & ANALY OF ALGORITHM
CS 650  SOFTW ENGINEERING PROC
CS 670  COMPUTER NETWORKS
CS 690  ADVANCED OPERATING SYSTEMS
CPE 649  ADV CYBERSECURITY ENGINEERING
CPE 645  COMPUTER NETWORK SECURITY
CPE 646  MOBILE & WIRELESS NETWORKS
CS 565  NETWORK SECURITY
CS 570  INTRO TO COMPUTER NETWORKS
CS 685  COMPUTER SECURITY

Total Semester Hours 30

1 MS-CBS students whose previous studies include the undergraduate equivalents of IS 560 and IS 577 must substitute a 3-credit-hour graduate-level IS course for each of the latter.

2 Students are required to satisfy the prerequisites for any elective they choose. Students who wish to substitute some other courses as directed electives may seek prior approval for such a substitution by contacting the Director of Graduate Programs in UAH College of Business.

Additional Information

Thesis Option

A thesis option is available. Students interested in this option should contact the both the faculty member who the student wants to serve as the thesis advisor and the Director of Graduate Programs in the College of Business before completing 12 hours of graduate study. If selected, the student will register for the IS 699 Master's Thesis course for 6 credit hours in lieu of 6 credit hours of electives.

Transfer Credit

Up to 12 semester hours of graduate credit taken at other universities may be transferred to meet MS-CBS degree requirement. Inquiries about the transferability of specific courses should be directed to the College of Business Director of Graduate Programs, who will consult with the IS faculty to determine whether the content of the class will be accepted for transfer credit.

Materials Science, MS

Degree: Master of Science
Telephone: 256.824.2596
Email: materials.science@uah.edu
Interim Program Coordinator: Emanuel A. Waddell

Admission Requirements

General requirements of the Graduate School (see Admissions Information section of this catalog) must be satisfied. In addition, students admitted to the graduate Materials Science Program are assumed to have background training in chemistry, mathematics, physics, and possibly biology and engineering, depending upon the student's research interests. Students should realize that if deficiencies exist, some additional undergraduate courses may be required. The time required to complete the degree may then be proportionately increased.
Program Objective

The program objective of the Materials Science program is to educate students in the classroom and laboratory so that their technical skill set and knowledge is enhanced through laboratory research and didactic courses such that graduates have the ability to contribute to organizations that perform research or contribute to the research enterprise through education, policy or manufacturing.

The Materials Science MS Program at the The University of Alabama in Huntsville is an interdisciplinary masters program that “focuses on the general application of mathematical and scientific principles to the analysis and evaluation of the characteristics and behavior of solids, including internal structure, chemical properties, transport and energy flow properties, thermodynamics of solids, stress and failure factors, chemical transformation states and processes, compound materials, and research on industrial applications of specific materials.” The University of Alabama in Huntsville MS in Materials Science is not part of the tri-campus program. Students receiving a masters in materials science may be based in one of several departments including chemistry, physics, chemical engineering and mechanical engineering. In the majority of cases, students receive their masters in materials science as part of their doctoral program. Students are encourage to pursue the thesis option as it enhances the student's technical skill set, exposes them to new research opportunities and makes them more attractive to employers.

Learning Outcomes

Materials Science students will

- Acquire a comprehensive knowledge of materials science at an introductory graduate level
- Perform semi-independent research (M.S. Plan I students)
- Develop project management skills

Research

Research in Materials Science focuses on the fundamental relations that exist between the structure of materials on the one hand, and properties and the methods for synthesizing and processing these materials on the other; otherwise known as the materials triangle. The material may be a metal, a ceramic, or a polymer, and it may be dispersed in the solid, liquid or gaseous state. Depending upon the desired application, the structure of the material may have to be investigated at the nuclear, atomic, molecular, granular, or larger length scales. The property that is determined by the structure may be mechanical, electrical, magnetic, optical, thermal, chemical, or biological. Synthesizing may be done by thermal, mechanical, photochemical, electrochemical, or biological processes. Many basic academic disciplines can be fruitfully applied to the solution of materials science problems. Among them, we note particularly chemistry, physics, biology, and engineering. Faculty members guiding students in the Materials Science Program represent all four of these areas.

Master of Science Degree Requirements

General requirements of the Graduate School under Plan I or Plan II must be satisfied. The M.S. degree is a general degree in materials science. As such, it is based upon a core sequence of courses emphasizing areas of materials science.

Plan I

This plan requires 24 semester hours of graduate coursework, which must include a core consisting of:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTS 660</td>
<td>INTRO SOLID ST PHY I</td>
<td>3</td>
</tr>
<tr>
<td>MTS 602</td>
<td>PROPERTIES OF MATERIALS</td>
<td>3</td>
</tr>
<tr>
<td>CH 640</td>
<td>ADV CHEMICAL THERMODYNAMICS</td>
<td>3</td>
</tr>
<tr>
<td>CH 642</td>
<td>ADV CHEMICAL DYNAMICS</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Select one of the following:</td>
<td></td>
</tr>
<tr>
<td>CH 521</td>
<td>CHEMICAL INSTRUMENTATION</td>
<td>3</td>
</tr>
<tr>
<td>MTS 601</td>
<td>NATURE OF MATERIALS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select a minimum of 6 additional semester hours of graduate coursework in Materials Science</td>
<td>6</td>
</tr>
<tr>
<td>MTS 699</td>
<td>MASTER'S THESIS</td>
<td>6</td>
</tr>
<tr>
<td>MTS 780</td>
<td>MATERIALS SCIENCE SEMINAR</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Semester Hours 28

1 Students should also register for MTS 780 during every semester they are in residence at UAH.
Additional Information

At least 50% of the coursework must be at the 600-level or above. A program of study must be planned in consultation with a member of the materials science faculty serving as a temporary advisor assigned by the program director. After a student following Plan I selects a thesis topic and thesis supervisor, a supervisory committee will be appointed. This committee should consist of three members of the materials science faculty including the thesis supervisor as chair. A student must complete a written thesis and successfully defend it by an oral presentation before the supervisory committee.

Plan II

This plan requires 33 or more semester hours of graduate coursework in Materials Science or a related discipline to include the 15 semester hour Materials Science core:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTS 601</td>
<td>NATURE OF MATERIALS</td>
<td>3</td>
</tr>
<tr>
<td>MTS 602</td>
<td>PROPERTIES OF MATERIALS</td>
<td>3</td>
</tr>
<tr>
<td>MTS 660</td>
<td>INTRO SOLID ST PHY I</td>
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</tr>
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<td>CH 640</td>
<td>ADV CHEMICAL THERMODYNAMICS</td>
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<tr>
<td>CH 642</td>
<td>ADV CHEMICAL DYNAMICS</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total Semester Hours</td>
<td>15</td>
</tr>
</tbody>
</table>

Students must also register for MTS 780 during every semester in which they are in residence at UAH. Half of any graduate coursework taken must be at the 600-level or above. A program of study must be planned in consultation with a member of the materials science faculty serving as an advisor assigned by the program director. To fulfill the requirement of a final comprehensive exam, the student must pass one of the three sections of the Materials Science Ph.D. Program Exam I. This plan is typically followed, but not unique to, by students who are in the Ph.D. program.

Materials Science, PhD

The Materials Science Ph.D. program is novel in that the three University of Alabama System (UAS) campuses offer a joint doctoral degree without the existence of a separate Materials Science Department on any campus of the system. Under this program, faculty members from the various departments on each campus constitute the Materials Science faculty. Participating faculty come from the Departments of Chemical & Materials Engineering, Chemistry, Engineering Mechanics, Metallurgical Engineering, Mineral Engineering, and Physics at UA; from the Departments of Biochemistry, Biomedical Engineering, Biomaterials, Chemistry, Materials Engineering, Optometry, Physics, and the School of Medicine at UAB; and from the Departments of Chemical Engineering, Chemistry, Mechanical and Aerospace Engineering, and Physics at UAH. The program is governed by a Tricampus Coordinating Committee consisting of faculty members representing each of the three campuses. The UAH faculty contingent is led by the UAH Materials Science Coordinator. Students successfully completing the program will receive a Ph.D. diploma issued jointly by all three universities. Although both science and engineering faculty participate, the curriculum stresses the science of materials, placing special emphasis on materials processing, the production of new materials, and on the application of materials to the needs of technology.

Owing to the differences in undergraduate concentration, students will have differing background knowledge in the field of materials science. The multidisciplinary curriculum has been structured to correct for these differences and to provide depth in a specialty area. In providing options for students to pursue, the faculties of each campus build on their individual research strengths. These strengths currently fall into the following general curricular areas which we designate as options for specialization:

1. Materials structure and properties
2. Macromolecular materials
3. Electronic, optical, and magnetic materials
4. Materials processing
5. Biomaterials
6. Mechanical behavior of materials

Admission Requirements

General requirements of the School of Graduate Studies (see Admissions Information section of this catalog) must be satisfied. Students entering the program are expected to have strong, but diverse, undergraduate training. They will typically have bachelor's degrees in chemistry, chemical engineering, materials science, materials engineering, mechanical engineering, or physics. In order to be successful in this program it is recommended that a student have:
1. A bachelor's degree or its equivalent from an approved college or university in engineering or one of the physical sciences;
2. A minimum B level scholarship overall or over the last 60 semester hours of undergraduate credit;
3. A minimum score of 300 on the Graduate Record Examination.

An applicant whose scholastic record reveals a deficiency may be admitted on a conditional basis as provided in the Graduate School regulations. The student must then follow the Graduate School's policies in achieving unconditional admission status before completing Program Examination I.

**Program Objective**

Materials Science objective is to have our Graduate students attain successful careers and recognition as leaders in industry, government, or academia and in the community within a few years of graduation. Our graduates will demonstrate the ability to create innovative solutions through application of their knowledge base and capacity form critical thinking.

**Learning Outcomes**

Materials Science students will:

- Acquire comprehensive knowledge, skills, and vision for successful careers in materials science and related fields
- Demonstrate the ability to carry out original scholarly research and to defend the scientific concepts in their research specialty
- Lecture their findings of their work

**Program Examination Requirements**

Program Examination I is a three-part written examination covering the program's core material and qualifies the student to begin research. The three parts are:

1. Structure and Properties of Materials
2. Characterization and Testing
3. Thermodynamics and Processing

The examination is administered by the Tri Campus Coordinating Committee and is offered simultaneously on all three campuses on pre-announced dates. Students must pass all parts of the examination according to a schedule which is available from the Materials Science Coordinator.

After Program Examination I has been successfully completed, the student ordinarily chooses a faculty member to supervise the research for the dissertation. The supervisor chairs a dissertation supervisory committee consisting of no fewer than four additional members. The committee members will be selected based on the student's academic interest and area of research. At least one of the committee members will be from the student's research area at one of the other cooperating universities and another will be a UAH materials science faculty member from a department other than that of the dissertation supervisor. The dissertation committee is charged with supervision and approval of the student's research and progress toward the completion of all requirements leading to the awarding of the degree.

Program Examination II is a comprehensive examination covering the subject of the student's proposed dissertation and consists of two parts. In part one, the student answers written questions submitted by the members of the supervisory committee. In part two, the student describes the plan of his dissertation in an oral presentation before the members of the committee.

Program Examination III is administered by the supervisory committee and consists of an oral presentation and defense of the results of the dissertation. Grading of student performance in Program Examinations II and III is the responsibility of dissertation supervisory committee.

**Coursework Requirements**

A minimum of 48 semester hours of graduate-level coursework plus at least 18 semester hours of MTS 799 are required. A student may transfer up to 24 semester hours of approved graduate coursework toward the 48 semester hour requirement. The student and the dissertation supervisor select courses appropriate to the student's dissertation area and complete a Program of Study. Frequently included in the Program of Study are the five core courses listed under the requirements for the Materials Science M.S. degree that is described above. The Materials Science Ph.D. Program otherwise has no further specific course requirements. Students take courses to prepare for the Program Examination I or to complete their Program of Study as approved by their dissertation advisor.

**Candidacy and Dissertation Requirements**

Admission to candidacy for the doctoral degree will be contingent upon the successful completion of the qualifying exam, called Program Examination II. Normally, a student will be considered eligible to take Program Examination II when all of the required coursework has been completed. After being
admitted to candidacy, the student must then complete the remaining requirements for the degree, with the principal remaining requirement involving the doctoral research and dissertation.

Residence Requirement

The minimum period in which the doctoral degree can be earned is three full academic years of graduate study. The student must spend the last or penultimate academic year in continuous residence as a full-time graduate student at one of the campuses.

Time Limits

The Program Examination I is to be taken at the first September offering immediately after the student enters the program. The Program Examination I is generally to be completed by all full-time students within two years after first entering the program, with exceptions being made for part-time students.

The Program Examination II is to be attempted within a reasonable time after the Program Examination I. In general, it is to be taken no later than one year prior to submitting an application for graduation.

All requirements for the doctoral degree must be completed within a period of five years after the completion of Program Exam II. Credits earned towards an M.S. or Ed.S. degree may be applied to the doctoral degree provided that they are applicable to the area of specialization or to the core. Dated credits may be accepted if recommended by a student's supervisory committee, the UAH Materials Science Coordinator, and approved by the Graduate School. For application toward this degree, the student may be required to demonstrate competence in the dated coursework.

Advisement

Students admitted into the program without having already communicated with a dissertation supervisor will initially be assisted in program planning and other academic matters by a temporary faculty advisor appointed by the Materials Science Coordinator. Also, upon being accepted into the program, students will be assigned to one of the participating departments as their temporary "home" department. They may apply for an assistantship and, if awarded, the teaching or research duties associated with the assistantship will normally be assigned in that department by the department chair. A student may select a dissertation research project in a participating department other than the temporary home department. If the research project is acceptable to the UAH Materials Science Program Committee, a permanent advisor (normally the research supervisor selected by the student) will be assigned.

Optical Science and Engineering, PhD

Optical Science and Engineering, PhD Degree

400-A Optics Building
Telephone: 256.824.2525
Program Coordinator: Robert Lindquist (robert.lindquist@uah.edu), Electrical and Computer Engineering

Mission

The mission of the Optical Science and Engineering Program is to develop and maintain a world class graduate education and research program in the rapidly advancing and expanding fields of optical science and engineering, to provide our students with exciting opportunities to learn and to do forefront research, and to prepare these students for productive and fulfilling careers.

OSE Program

Optics is an area of major scientific and technological importance. With cooperation of the College of Engineering and the College of Science, the Optical Science and Engineering (OSE) doctoral program was formally approved at UAH in 1992. This unique program is highly multi-disciplinary and is followed by a wide variety of advanced coursework and research in both fundamental and applied subjects. This diversity is reflected by the OSE faculty, which is drawn from the expertise of optical scientists and engineers from the departments of Physics, Electrical and Computer Engineering, and Mechanical and Aerospace Engineering, and from the Center for Applied Optics.

Degree Requirements

Because students will come into this program with strong, but diverse undergraduate and graduate training, the multidisciplinary curriculum has been structured on a common basis for all entering students, but will compensate for individual differences and provide depth in specific areas. A total of 48 semester hours of graduate coursework are required, of which 28 semester hours are in designated optics courses. An additional 18 semester hours must be in dissertation research. Students are also required to satisfy the Seminar requirements of their home departments, as required. In addition, all requirements of the School of Graduate Studies must be met in order to remain in good standing.
Admissions Requirement

Applicants may be unconditionally admitted to the program if they have:

1. A bachelor’s degree in science or engineering from an approved college or university;
2. A minimum grade point average (GPA) of 3.0 overall;
3. A combined score of 300 on the verbal, quantitative and analytical sections and at least 3.0 in the writing section of the Graduate Record Examination (GRE).
4. A TOEFL (iBT) score of: all sub-scores equal to or greater than 18 OR IELTS score of: all sub-scores equal to or greater than 6.0 for international students and
5. Three letters of reference.

All entering students will be administered a background evaluation at admission conducted by the Optics Coordinating Committee. An applicant whose scholastic record reveals a deficiency in one or more of the first two categories above, may, upon recommendation of the Program Coordinator and the approval of the Graduate Dean, be admitted on a conditional basis, as provided by Graduate School regulations. However, that student must follow the Graduate School's policies in achieving unconditional admission status prior to taking the Preliminary Examination.

The student will complete three study phases, punctuated by three program examinations.

Phase I

(The core phase) will consist of 19 semester hours of coursework. To complete this phase and become eligible for continuation in a focus area, the student must pass the Preliminary Examination (only two attempts will be permitted). After successful completion of this phase, the student should have acquired the common optics background that the program faculty believes is necessary for the doctoral program. Full-time students will normally select a dissertation advisor during their first year. Once an advisor has been chosen and the Preliminary Examination passed, a graduate committee will be appointed and a Program of Study completed.

Phase II

Consists of coursework in the Program of Study (which includes a Focus Area). Much of this coursework will support the dissertation research to be conducted in Phase III. This phase will be completed when the student has completed most of the formal course work as prescribed in the Program of Study and has passed the Qualifying Examination which is prepared and administered by the student’s graduate committee. It will contain both written and oral parts. Questions can be drawn from part of the Program of Study (with special emphasis on the student’s Focus Area). This exam will also include a proposal for dissertation research prepared by the student and distributed to the graduate committee. The proposal will demonstrate that the student is intimately familiar with the proposed research, that published research related to the proposal has been reviewed, and that the student has a clear understanding of how to proceed and can set realistic goals. If the student fails the Qualifying Examination, a second attempt will be scheduled. Students who fail in two attempts will be dropped from the program.

Phase III

Consists of all experimental and/or theoretical work needed to complete the student’s dissertation. These activities will be directly supervised by the student’s advisor. Since the Ph.D. is a research degree, recipients must demonstrate both the ability to perform independent and original research, and to clearly communicate this work both in written and oral formats. The Final Examination will consist of a public, oral presentation and defense of the dissertation.

Advisement

A student admitted to the program will have a member of the OSE Program Committee as an advisor. The student will be encouraged to consult with all faculty members in the intended area of specialization in order to develop an appropriate program of study and topic for dissertation research.

A graduate committee will be appointed for the student as soon as the student passes the Preliminary Examination and selects a research project. The committee will include an advisor and at least four other members. At least one of the committee members will be from a department other than the student’s “home department.” Otherwise, the composition of the committee will follow the rules governing such committees set forth by the School of Graduate Studies. The graduate committee is charged with supervision and approval of the student’s research and course of study toward the completion of all requirements for the degree.

The following optics courses are also available to students in the OSE program. See listings under indicated departments.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>EE 532</td>
<td>OPTICAL SYSTEMS DESIGN</td>
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<td>EE 633</td>
<td>ELECTRO-OPTICAL ENGINEER</td>
<td>3</td>
</tr>
<tr>
<td>EE 634</td>
<td>OPTICAL COMMUNICATIONS</td>
<td>3</td>
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</tbody>
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College of Nursing

1610 Ben Graves Drive
Telephone: 256.824.6345
Email: nursing@uah.edu

Dean:
Marsha Howell Adams, PhD, RN, CNE, ANEF, FAAN, Professor

Mission
Educate and inspire individuals to become nurse leaders who act with integrity, discover through scientific methods, and advocate for the best health care experiences of people and communities in a complex and evolving health care environment. In collaboration with our university colleagues and community partners, we are committed to excellence through our teaching, scholarship, practice, and service.

Vision
To have a global reputation for transforming health care through innovative nursing practice, education, and research.

Core Values
- Integrity - Resolutely adhering to moral, ethical, and professional standards.
- Inspiration - Encouraging, role-modeling, and mentoring others to pursue their professional dreams.
- Caring - Acting with compassion and respecting all persons by embracing cultural humility, diversity, and person-centered care.
- Excellence - Pursuing and achieving goals of the highest caliber.
- Wellness - Maximizing well-being in different states of health.

Accreditation
The UAH College of Nursing BSN, MSN, and Joint DNP programs are accredited by the Commission on Collegiate Nursing Education (CCNE). The independent DNP program is presently being reviewed for accreditation by CCNE. The College of Nursing maintains approval status by the Alabama Board of Nursing.

Degrees and Certificates Offered
The College of Nursing offers Doctor of Nursing Practice, Master of Science in Nursing, Post-Master's Family Nurse Practitioner Certificate Program, and a Graduate Certificate in Nursing Education.

Doctor of Nursing Practice (DNP)
The purpose of the DNP program is:
• To prepare graduates at the highest level of nursing practice to provide complex hospital and community-based care for patients and families.
• To redesign and evaluate nursing and health care systems.
• To address dire shortages of clinical nursing faculty to mentor and educate new nurses.

The University of Alabama in Huntsville, College of Nursing offers both the Post-Master’s to DNP and the Post-Baccalaureate to DNP pathways. The post-baccalaureate to DNP pathway allows a seamless progression from the completion of a baccalaureate degree to advanced practice. Advanced practice specialty training at the doctoral level is needed to address the growing complexity of patient care and health care systems. In addition, expanding accountability of clinical expert nurses in advanced practice roles requires competencies in population-based care, leadership, health policy, health system improvement, research and evidence-based practice.

**DNP Program Objectives**

Upon successful completion of the DNP program, the graduate will be able to:

1. Synthesize scientific evidence for the development of clinical interventions for practice.
2. Evaluate policy, care delivery, and organizational systems for current and future health care needs.
3. Demonstrate intra- and inter-professional collaboration to address health disparities and to improve health care quality across diverse populations and cultures.
4. Incorporate knowledge of current and emerging health technologies to improve care delivery and organizational systems.
5. Translate scientific, theoretical, and ethical principles into health care for individuals, families and populations.
6. Assume complex leadership roles to advance clinical practice and the health care delivery at the organizational and systems level and to improve health outcomes of individuals and populations.
7. Advocate for social justice, equity, and ethical policies in health care.
8. Deliver evidence-based care using clinical reasoning and analysis of complex healthcare issues to improve patient outcomes.

**DNP Admission Requirements**

1. Graduation from a Commission for Collegiate Nursing Education (CCNE), Accreditation Commission of Nursing Education (ACEN) or Commission on Nursing Education Accreditation (CNEA) accredited baccalaureate program with a major in nursing (for BSN to DNP).
2. Hold a master's degree in advanced practice nursing from an accredited institution (for MSN to DNP).
3. Submit a UAH Application for Graduate Admission.
4. Submit official transcripts from all higher education programs attempted.
5. Submit proof of current/active unencumbered licensure and advanced specialty certification.
7. Submit Professional Statement describing career goals and identified area of clinical practice interest.
8. Apply to the MSN program first (for BSN to DNP applicants).
9. Meet health and background clearance requirements.

**DNP Progression Requirements**

1. Students who receive a "C" in any DNP course and the student's graduate GPA falls below a 3.0, will be placed on academic probation by the University. The student has an additional 12 semester hours to bring the GPA up to 3.0 in accordance with the UAH School of Graduate Studies policy.
2. Students who receive a "C" in a DNP course (regardless of graduate GPA) will be reviewed for progression by the DNP Coordinator and faculty of record. These individuals will make a recommendation to the Associate Dean of Graduate Programs for either continuation in the program with repeat of the course or dismissal from the nursing program. The Associate Dean of Graduate Programs will review the recommendation and deliver a final decision.
3. If the recommendation is for the student to continue in the program and repeat the course, he/she may retake the course the next time the course is offered.
4. If the student obtains a "C" in a nursing course and is allowed to continue, receives a "C" in the retake of the original course, or makes a "C" in a second nursing course, this student will not be allowed to progress regardless of graduate GPA, and the student will be dismissed from the DNP program in the College of Nursing. No student will be able to record a grade "C," "D," or "F" on their program of study for the DNP program.
5. Courses taken at other universities will be considered for transfer credit only if a grade of "B" or higher is obtained in the course. The maximum transferable credit hours is 12 for graduate and doctoral programs. Students are responsible for requesting a transfer of credit review from the College of Nursing Director of Graduate Admissions and Advisement and provide documentation.
Master of Science in Nursing (MSN)

Graduate tracks offered through the College of Nursing are focused on preparing advanced practice nurses in direct care provider roles as a family nurse practitioner, adult-gerontology acute care nurse practitioner, or in an indirect care provider role in nursing administration. The Master of Science degree is awarded upon successful completion of one of the three tracks.

Advanced practice nursing is distinguished by autonomy of practice and characterized by both increased complexity in clinical decision making and skills in managing organizations and health care environments.

Comprehensive health assessment skills provide a foundation for the critical thinking used in diagnostic decision making and treatments of complex human responses of diverse individuals, families, and communities to health problems. Advanced practice nursing students are guided in classroom and clinical experiences to formulate clinical decisions to manage common health problems, acute and chronic illness, and promotion of wellness.

Theory and research form a central core of knowledge for all tracks in the master’s program. Building on content in these areas, all students integrate education, management, leadership, and consultation into their clinical experiences as they practice in a variety of settings. Practice sites for clinical courses are individually arranged with the student. Classes are usually offered one day per week and may be offered on campus, or through web-based courses.

Students who successfully complete their program of study are eligible to sit for the national certification examination in their area of expertise in the nurse practitioner program and after work requirements are met in the nursing administration program.

MSN Program Objectives

Upon successful completion of the MSN program, the graduate will be able to:

1. Implement clinical decision-making skills in the delivery and management of diverse populations in a variety of settings.
2. Synthesize theoretical foundations, knowledge of science and humanities, and scholarly inquiry to provide clinical prevention, patient therapy, and system improvement to improve patient outcomes in diverse populations.
3. Analyze healthcare policies and information management systems to affect patient outcomes in diverse populations through organization and systems leadership and inter-professional collaboration.
4. Incorporate human, fiscal, and technological resources in providing and managing advanced care for improvement of patient and population outcomes.
5. Demonstrate an understanding of ethical principles, quality, safety, and equality in healthcare.

MSN Admission Requirements

1. Graduation from a Commission for Collegiate Nursing Education (CCNE), Accreditation Commission of Nursing Education (ACEN) or Commission on Nursing Education Accreditation (CNEA) accredited baccalaureate program with a major in nursing.
2. Overall grade-point average of 3.0 on a 4.0 scale in all baccalaureate coursework or on the last 60 semester hours of baccalaureate coursework completed.
3. Acceptable score on either the Graduate Record Examination (GRE) or the Miller Analogies Test (MAT) taken within the last five years. The minimum score on the MAT is 410. The minimum scores for the GRE are 150 Verbal, 150 Quantitative, and 3.0 Analytical Writing. (Students with an overall GPA of 3.0 may waive #3).
4. Submit a UAH Application for Graduate Admission.
5. Submit official transcripts from all higher education programs attempted.
7. Three completed College of Nursing Graduate Recommendation Forms from individuals familiar with applicant's academic and clinical abilities. Forms are available in the College of Nursing Office of Graduate Programs.
8. Current unencumbered registered nurse license. If a student is permitted to meet course clinical requirements in a state other than Alabama, the student must be licensed in that state. Students will not be allowed to continue in the track if any license is placed on probation, suspended, or revoked. Licensure must be maintained throughout the program.

MSN Degree Requirements

In addition to the graduate degree requirements of the UAH Graduate Program, a student is required to complete a minimum of 30-42 semester hours of graduate coursework in one of the following tracks:

- Adult-Gerontology Acute Care Nurse Practitioner
- Family Nurse Practitioner
- Nursing Administration
Please note that curricular changes may be made in the coming year. Please contact the College of Nursing Office of Graduate Programs for the most current information.

**MSN Synthesis Requirement**

The MSN student is expected to complete a synthesis requirement as part of the graduate program in nursing. The purpose of this synthesis requirement is to demonstrate development of the knowledge base, values, and skills related to the particular program of study as a prerequisite for graduation. There are two options in which the MSN student may meet the synthesis requirement:

1. Completion of a traditional research thesis under the guidance of a committee of graduate nursing faculty within the College of Nursing. This option requires that the students enroll in a minimum of 6 semester hours of thesis credit (not necessarily in the same semester). Oral defense serves as the final comprehensive examination for students completing the thesis or scholarly project option. This oral examination must follow policies outlined in the UAH Graduate Catalog.
2. Completion of two graduate level electives. Graduate level electives are designed to offer in depth study of areas on interest to graduate level nursing students. Examples include:
   - Diabetes and Dyslipidemia
   - Business Development in Advanced Practice
   - Abuse Throughout the Lifespan

**MSN Progression Requirements**

1. Any student who receives a “C” in any MSN clinical nursing courses will be reviewed for progression by the NP Coordinator and faculty of record. These individuals will make a recommendation to the Associate Dean of Graduate Programs for either continuation in the program with repeat of the course or dismissal from the nursing program. The Associate Dean of Graduate Programs will review the recommendation and deliver a final decision. **Courses Requiring a Grade of "B" or Higher:**
   - ACNP I, II, III, IV
   - FNP I, II, III, IV and Post FNP I, II, III, IV
   - Nursing Administration, NUR 634
   - Advanced Health Assessment, Pathophysiology, Pharmacology

2. If a recommendation is made for the student to continue in the program and repeat the course, he/she may retake the course at the next time the course is offered.

3. If the student obtains a “C” in a nursing course and is allowed to continue, makes a “C” in a second clinical nursing course, or if the student receives a “C” in the retake of the original course, this student may not be allowed to progress independent of GPA, and will be dismissed from the College of Nursing. The student may petition for readmission to the Associate Dean for Graduate Programs.

4. If the student makes a “C” in any graduate course and the student's GPA falls below a 3.0, the student will be placed on academic probation by the University. The student has an additional twelve semester hours to bring the GPA up to 3.0 in accordance with the UAH School of Graduate Studies policy.

5. No student will be able to record a grade less than a “C” on their program of study for the preferred graduate track.

6. Courses taken at other universities will be considered for transfer credit only if a grade of “B” or higher is obtained in the course.

**Nurse Practitioner**

The nurse practitioner is a skilled health care provider who uses expert clinical judgment and decision making in conducting comprehensive health assessments, making differential diagnoses, and prescribing of pharmacologic and non-pharmacologic interventions in the direct treatment of health problems. Nurse practitioners function as care providers, case managers, researchers, consultants, and educators. Two nurse practitioner tracks are offered at the college:

- Family Nurse Practitioner
- Adult-Gerontology Acute Care Nurse Practitioner

Although both are advanced practice nurses, family nurse practitioners function as primary care providers focusing on common health care problems. Family nurse practitioners establish collaborative practices with primary care physicians to deliver culturally sensitive care to clients. Adult-gerontology acute care nurse practitioners focus on the acute care of adults with acute illnesses and may practice in the hospital, home, or clinic setting. Adult gerontology acute care nurse practitioners provide expert interventions focused on health promotion, illness prevention, and health care management.

**Nursing Administration**

This track prepares nurses who will influence the future of health care through visionary nursing leadership. Competencies include communication, financial skills, information technology, leading and managing change, policy analysis, and empowerment for professional practice. Graduates are prepared to assume positions in education, administration, management, or specialty area roles in a variety of care delivery sites.
Post-Master’s Family Nurse Practitioner Certificate

Students already possessing a master's degree in nursing have the opportunity to pursue a family nurse practitioner certificate. Students are admitted to the family nurse practitioner certificate program on a full-time basis to complete the requirements in four semesters.

Graduate Certificate Program in Nursing Education

Students who are currently enrolled in graduate education or those possessing a master's degree have the opportunity to continue their education and obtain a certificate in nursing education. Classes for this program are arranged in a manner to allow for full time employment or continued study in the master's program. The program is composed of six courses and requirements for the certificate program may be completed in one calendar year.

More detailed information about opportunities for students seeking graduate degrees and certification may be obtained from the College of Nursing Office of Graduate Programs 256.824.6669.

Online Learning

Online courses are offered by the College of Nursing to improve access to higher education. The College of Nursing offers the DNP program and the MSN in Nursing Administration program completely online. The nurse practitioner programs include hybrid courses allowing the student maximum flexibility. All courses contain web-based enhancement.

Courses offered completely online or those with a hybrid of on-campus/online are delivered in Canvas, the official course management system for UAH. Faculty in the College of Nursing use a common template to organize courses for student ease of navigation. Other educational technologies such as Panopto, Turnitin, wiki pages, chats, etc. are used to enhance student interaction, learning, and enjoyment.

Facilities

The College of Nursing utilizes the facilities and resources of the entire university, the community, and affiliated health care agencies. The college is housed in a four-story building centrally located on the UAH campus. Classrooms equipped with current educational technology as well as the Learning and Technology Resource Center (LTRC) with a state-of-the-art simulation lab known as Charger Hospital assist students to learn in multiple ways.

The College of Nursing maintains contracts with over 1000 health related agencies to offer a wide range of clinical sites for student educational experiences. Agencies in the local area include the Huntsville Hospital Health System, Crestwood Medical Center, local Public Health Departments, skilled nursing homes, home health agencies, and the University of Alabama at Birmingham Medical Clinics-Huntsville Campus also partner with the College to provide clinical sites. Other hospitals, clinics, physicians’ offices, and rural health clinics across Alabama and southern Tennessee are also used for student experiences.

Transportation

Clinical learning experiences are varied in settings and are located within Huntsville and surrounding communities. Students are expected to travel to and from all clinical experiences. Students are responsible for providing their own transportation and carrying appropriate insurance. The College of Nursing is not liable for any traffic violations or auto mishaps during student commutes.

Advising and Assistance

The focus of advising in the College of Nursing is to assist students to successfully progress toward their educational objectives. Advising is designed to provide assistance where desired and appropriate. All pre-admission graduate students are advised in the College of Nursing Office of Graduate Programs located on the second floor of the Nursing Building.

Students admitted to the graduate program work with the academic advisor who assists them throughout the remainder of the academic program. Program coordinators assist students in completing a program of study for the track to which they have been admitted as well as providing guidance for future employment or educational endeavors.

Requirements for Enrollment and Admitted Students

1. Documentation of professional liability insurance must be provided to the College of Nursing Office of Graduate Programs or third party designee prior to enrollment in a nursing class. Professional liability insurance must be maintained throughout the program.

2. Documentation of cardiopulmonary resuscitation (CPR) training must be provided to the College of Nursing Office of Graduate Programs prior to enrolling in a nursing class. CPR certification must be maintained throughout the program. Students entering the adult gerontology acute care nurse practitioner tracks must obtain and maintain Advanced Cardiac Life Support certification (ACLS) prior to enrolling in a clinical nursing class.

3. Students are required to undergo drug testing and a criminal background check prior to enrollment in nursing courses and for cause at other points. Information and procedures are provided upon admission. If the College deems the drug testing and/or background check information to be unsatisfactory, acceptance or enrollment into the College may be denied or an offer of acceptance rescinded. If a student's acceptance or enrollment is denied or rescinded based on the information obtained from a criminal background check report, the student will be advised of the name and address of the consumer reporting agency that furnished the report, and of the right to dispute the accuracy and completeness of any information contained in the report by contacting the consumer reporting agency directly. If the College decides, based upon the individual's written description,
The clinical experiences of graduate nursing students require a health screening program. The following steps are required as part of admission to and nursing students to meet program objectives and requirements. The College or its affiliated agencies may identify additional critical behaviors or abilities. These essential functions are not intended to be a complete listing of all nursing behaviors, but they are a sampling of the types of abilities needed by students.

Students may also be required to have additional drug screens and/or criminal background checks prior to attending selected clinical agencies.

Each student must be immunized for Hepatitis B. For initial enrollment, certification that the series of injections has begun or results of a recent titer of Hepatitis B is required. Documentation of current license to practice as a registered nurse must be provided to the College of Nursing Office of Graduate Programs prior to enrollment in a nursing class. Registered nurse students must submit proof of an unencumbered current license. If a student is permitted to meet course clinical requirements in a state other than Alabama, the student must be licensed in that state. Registered nurse students will not be allowed to continue in the program if any nursing license is placed on probation, suspended, or revoked. Licensure must be maintained throughout the program.

Essential functions define selected attributes and behaviors necessary for students to demonstrate in order to successfully complete their education and subsequently enter nursing practice. These essential functions are determined to be required for initial and continued enrollment in the College of Nursing. Students must be able to perform each of the following essential functions with or without reasonable accommodations:

1. Communication abilities sufficient for verbal and written interaction with others. Examples (not all inclusive) include explaining treatment procedures, initiating health teaching, and documenting and interpreting nursing actions and patient/client responses.
2. Auditory ability sufficient to monitor and assess health needs. Examples (not all inclusive) include hearing basic conversation; monitoring alarms, emergency signals and auscultatory sounds; and hearing cries for help.
3. Gross and fine motor abilities sufficient for providing safe, effective nursing care. Examples (not all inclusive) include completing examinations/evaluations by writing, typing or demonstration; calibrating and using equipment; and positioning clients.
4. Auditory ability sufficient to monitor and assess health needs. Examples (not all inclusive) include hearing basic conversation; monitoring alarms, emergency signals and auscultatory sounds; and hearing cries for help.
5. Visual abilities sufficient for observation and assessment necessary in nursing care. Examples (not all inclusive) include reading documents such as patient charts and laboratory reports; reading calibrations on syringes, sphygmomanometers, and thermometers, and equipment outputs such as waves, printouts, and digital readings; and accurately observing client behaviors such as color changes and nonverbal communication.
6. Behavioral/Social abilities sufficient to demonstrate emotional stability, maintenance of composure under stress, development of mature, empathetic and effective nurse-patient relationships and use of sound and unimpaired judgment in classroom and clinical activities.

These essential functions are not intended to be a complete listing of all nursing behaviors, but they are a sampling of the types of abilities needed by nursing students to meet program objectives and requirements. The College or its affiliated agencies may identify additional critical behaviors or abilities. The identified essential functions are adapted from the Americans with Disabilities Act: Implications for Nursing Education by the Southern Regional Education Board and the Council on Collegiate Education.

**Health Requirements**

The clinical experiences of graduate nursing students require a health screening program. The following steps are required as part of admission to and enrollment in the graduate program:

1. Each student is required to have a health examination by a physician or a certified nurse practitioner. Reports of the results of this examination must be submitted on forms provided by the College of Nursing and must be received by the College of Nursing Office of Graduate Programs by published deadlines. Individual clinical agencies may require additional documentation for specific health requirements which must be met by students;
2. Each student must be immunized for Hepatitis B. For initial enrollment, certification that the series of injections has begun or results of a recent titer is required. Documentation of current license to practice as a registered nurse must be received by the College of Nursing Office of Graduate Programs by published deadlines. Immunizations and titer results are at the expense of the student;
3. Each student must be immunized against measles, mumps, rubella, rubeola, and varicella. Annual influenza vaccinations are required. Documentation of current immunization, healthcare provider's statement, or copy of recent titer results must be received by the College of Nursing Office of Graduate Programs by the published deadlines. Immunizations and titer results are at the expense of the student;
4. The CDC does require a 2 step initial testing, however, if you have had initial testing and annual screening through your employer, documentation of a single step will be sufficient. Annual single PPD skin test update required OR T-Spot OR QuantIFERON TB Gold Blood draw annual update
is required. *If a TB skin test is positive, a chest x-ray must have been completed within the last 5 years (annual symptom evaluation must be completed and uploaded).

5. Documentation of current health insurance must be received by the College of Nursing Office of Graduate Programs by published deadlines. Hospitals and health agencies provide emergency treatment to students for injury or illness occurring in the course of program requirements in their agencies. Such treatment will be at the expense of the student. Students are required to maintain health insurance throughout the program.

6. Each student must complete a certified background check and a drug screen before starting the program. All health requirements must be completed prior to the first day of class in the semester. Students who fail to meet this requirement will not be allowed to start classes until all health requirements are met.

**Student Financial Services**

Student Financial Services, located in the Student Services Building, provides financial aid information and assists students in meeting individual needs. Financial aid for graduate students in the College of Nursing comes primarily from the following sources:

1. Alabama Board of Nursing Scholarships. Fifteen scholarships are granted each year to graduate students attending schools in Alabama. Funding is $3,800 for full-time study for one year. Students must make application directly to the Alabama Board of Nursing. Contact the Alabama Board of Nursing for further information.
2. Alabama Board of Nursing Loan Repayment plan.
3. Elizabeth M. Fisher Memorial Scholarship.
4. Joan Williamson NANPA Scholarship.
5. Graduate Teaching Assistantships.
7. Graduate Tuition Scholarships.
8. Nurse Faculty Loan Program

**Course Load**

The usual course load for a full-time graduate student in nursing is from 9 to 12 semester hours. Students may choose to complete a degree in full-time or part-time study with the exception of the post-master's students. Students admitted to the postmaster's program are required to complete the program in full-time study.

**Master's Program in Nursing**

- Nursing, MSN - Adult-Gerontology Acute Care Nursing Practitioner (p. 133)
- Nursing, MSN - Family Nurse Practitioner (p. 133)
- Nursing, MSN - Nursing Administration (p. 134)

**Doctoral Program in Nursing**

- Nursing, MSN to DNP (p. 132)
- Nursing, BSN to DNP

**Certificates in Nursing**

- Nursing Education (http://catalog.uah.edu/grad,colleges-departments/nursing/nursing-education-graduate-certificate)
- Post-Master's Family Nurse Practitioner Program (p. 134)

**NUR 500 - SPECIAL TOPICS**

Semester Hours: 2-4

Advanced study of selected area of interest in nursing.

**NUR 518 - GLOBAL HEALTH: INTERN'L STUDY**

Semester Hours: 3

This course will focus on a selected international health care system. The international system will be compared with the US Health Care System in relation to economic, social, cultural, policy, and environmental influences. Culmination of the course will center on international experiences with health care facilities, policy making bodies, historical, and cultural introductions in another country.

**NUR 524 - HEALTH CARE AND THE LAW**

Semester Hours: 3

Introduction to basic health law in the context of application to nursing practice. Content relates to involvement with legal principles in nursing and healthcare. Federal, state and local aspects of law are included. (Cross listed with NUR 424).
NUR 525 - HUMAN SEXUALITY
Semester Hours: 3

Theory and issues related to human sexuality in health and illness. Emphasis on theory and values, clarification of human sexuality needs. Elective, open to all university students. (Cross listed with NUR 425).

NUR 526 - CONS:WKG W/IND & GRP COMM APPR
Semester Hours: 3

This course presents consultation as a process of interacting with individuals and groups to resolve issues related to clients and/or the delivery of health care. Students explore the consultation process, group dynamics, application-oriented approaches and strategies, and professional issues. The focus is on communication as the key to developing successful relationships.

NUR 527 - INTRO TO FORENSICS IN NURSING
Semester Hours: 3

This course is designed to provide basic theoretical knowledge related to nursing care of the donor/transplantation client and their families. Course content focuses on historical and current issues in donor/transplantation nursing including the impact of legal, ethical, political, economic, and socio-cultural issues. Students will examine the roles of the professional nurse and the interdisciplinary team in the management of care for the donor/transplant client and their families. Topics of future research and critical thinking will be discussed.

NUR 528 - GERONTOLOGICAL NURSING
Semester Hours: 3

Nursing care of older adults in multiple settings. Issues and trends are incorporated.

NUR 530 - HLTH CARE WKF:ISS/LDERSH STRAT
Semester Hours: 3

Description and analysis of contemporary issues regarding the health care workforce. Particular focus will be placed on the multifaceted nature of health care workforce shortages. Various models for analysis of workforce issues will be used and strategies being used will be examined. An evaluation of the nurse leader role in creating positive work environments and implementing solutions conclude the student experience.

NUR 534 - PALLIATIVE CARE
Semester Hours: 3

Palliative care is when there is no longer a medical treatment or cure for a physical problem. This palliative care course includes meeting the physical, emotional, social, cultural, and spiritual needs of individual and their families. A course focus will be on coping, grief, bereavement, pain relief and managing living implications for individuals with life-threatening illnesses. There will be recognition of the importance of individuality, vulnerability, and resilience in the quality of living during the dying process.

NUR 537 - NURSING AS A POLITICAL FORCE
Semester Hours: 3

The course explores the historical, current, and future impact of nursing on the political process. Local, state, national, and international aspects of nursing as a political force are analyzed. Emphasis is on political systems, regulatory processes, and organizational issues influencing health care delivery. Elective, open to all university students.

NUR 539 - NURSING MEDICAL MISSIONS
Semester Hours: 3

This course will focus on global health and humanitarian concepts and issues, and the nursing care needed to impact those issues. These issues will be examined and analyzed in relation to the mission country's economic, social, cultural, policy, and environmental influences. Culmination of the course will center on international experiences with supervised nursing care for a medical mission in another country. This course is an accepted elective in the Nursing Program. Additional work is required for graduate credit.

NUR 540 - ONCOLOGY NURSING
Semester Hours: 3

This course provides a holistic approach to the nursing care of people with cancer. The nursing process is used as the basis for promoting health and facilitating adaptation in the person with cancer. The course includes clinical experiences in selected agencies.

NUR 550 - ISSUES IN TRANSPLANTATION
Semester Hours: 3

This course is designed to provide basic theoretical knowledge related to nursing care of the donor/transplantation client and their families. Course content focuses on historical and current issues in donor/transplantation nursing including the impact of legal, ethical, political, economic, and socio-cultural issues. Students will examine the roles of the professional nurse and the interdisciplinary team in the management of care for the donor/transplant client and their families. Topics of future research and critical thinking will be discussed.
NUR 601 - THEORETICAL PERS ADV NUR PRAC  
Semester Hours: 3  

NUR 602 - SCHOLARLY INQ ADV NUR PRAC  
Semester Hours: 3  
Includes discussion of philosophical and theoretical bases of nursing research and the application of research findings to practice. Development of a research problem, including problem identification, evaluation of current knowledge, and the selection of an appropriate research approach. Focuses on research methodologies, both quantitative and qualitative, as they relate to data collection, data analysis including both interpretive and statistical strategies, and discussion of findings. Proposal generation and research funding mechanisms are included.

NUR 604 - HEALTH POLICY  
Semester Hours: 3  
Local, state, and national health care policies, with emphasis on political systems, regulatory processes, and organizational issues influencing health care delivery. Elective; open to university students.

NUR 605 - ADVANCED HLTH ASSESSMENT  
Semester Hours: 3  
This course provides an opportunity for the advanced practice nurse to utilize theoretical and evidence-based clinical practice guidelines to conduct a comprehensive and systematic assessment as a foundation for decision making in caring for clients across the lifespan.

NUR 605L - CLINICAL  
Semester Hours: 0  

NUR 606 - PATHOPHYSIOLOGY  
Semester Hours: 3  
Expands upon previous knowledge of anatomy, physiology, and developmental disease processes. Anticipated physiological alterations are discussed as they affect individuals throughout the lifespan.

NUR 607 - PHARMACOLOGY IN ADV PRAC  
Semester Hours: 3  
This course is designed to provide the advanced practice nursing student with clinical reasoning skills necessary to analyze data obtained from findings of the patient health history, advanced physical and pharmacological assessment of patients across the lifespan. The student will utilize the findings to determine the appropriate treatment regimen based on the individual needs of the patient.

NUR 610 - FAMILY NURSE PRACTITIONER I  
Semester Hours: 6  
This clinical course introduces the roles of the advanced practice nurse in direct and indirect health services for assessment, health promotion, illness prevention, and health management of patients across the lifespan. Prerequisite: NUR 605 and NUR 606 (concurrently).

NUR 610L - CLINICAL EXPERIENCE  
Semester Hours: 0  

NUR 611 - FAM NURS PRACTITIONER II  
Semester Hours: 6  
This course encourages the advanced practice nurse to integrate principles of advanced practice nursing into broad organized, culturally appropriate planning, delivery, management, and evaluation in prevention and services of health through the lifespan/identified populations.

NUR 611L - CLINICAL  
Semester Hours: 0  

NUR 612 - FAMILY NUR PRACTITIONER III  
Semester Hours: 6  
This course encourages the advanced practice nurse to define principles of advanced practice nursing including interventions that influence favorable health outcomes for common conditions through the lifespan/identified populations in collaboration with other health professionals. Prerequisites with concurrency: NUR 606 and NUR 607.

NUR 612L - CLINICAL EXPERIENCE  
Semester Hours: 0
NUR 613 - FAMILY NURSE PRACTITIONER IV
Semester Hours: 6

This is the culminating primary care clinical course in which the advanced practice student initiates and maintains effective working relationships, appraise policy development and systems organization, establishes respectful communication within inter-professional groups with skills and care coordination, delegation and initiation of conflict resolution strategies. Prerequisites: NUR 610, 611, & 612.

NUR 613L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 614 - FAMILY NURSE PRACTITIONER V
Semester Hours: 3

First of two culminating courses/seminar/clinical practicum in the family nurse practitioner certificate program. The clinical practicum will be completed in a primary care setting. Classroom seminar focuses on the role, trends, and health policy issues facing the family nurse practitioner. Prerequisite: NUR 610.

NUR 614L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 615 - FAMILY NURSE PRACTITIONER VI
Semester Hours: 3

The culminating course/seminar/clinical practicum in the family nurse practitioner certificate. The clinical practicum will be completed in a primary care setting. Classroom seminar focuses on the role, trends, and issues facing the family nurse practitioner.

NUR 615L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 620 - ADULT GER Oncology Acute Care Nurse Practitioner I
Semester Hours: 6

This is the culminating adult gerontology acute care clinical course in which the advanced practice student initiates and maintains effective working relationships, establishes respectful communication within inter-professional groups with skills and care coordination, delegation, and initiation of conflict resolution strategies. Prerequisites with concurrency: NUR 602, NUR 605, NUR 606, NUR 607 Prerequisites: NUR 621, NUR 622, NUR 623.

NUR 620L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 621 - ADULT GER Oncology Acute Care Nurse Practitioner II
Semester Hours: 6

This course allows the advanced practice nurse to refine principles of advanced practice nursing into the delivery of broad, organized, culturally appropriate planning, delivery, management, and evaluation of evidence based care of complex, acute critically and chronically ill diverse patients across the entire spectrum of adulthood. Prerequisites w/ concurrency: NUR 606 or NUR 607 or NUR 620.

NUR 621L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 622 - ADULT GER Oncology Acute Care Nurse Practitioner III
Semester Hours: 6

Clinical course in care of adult patients with acute alterations in health in the hospital, home, or clinic setting focusing on the concept of managed care. Within a selected product line, the practitioner will develop protocols, care for and evaluate care for patients and practice consulting with client groups.

NUR 622L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 623 - ADULT GER Oncology Acute Care Nurse Practitioner IV
Semester Hours: 6

Culminating course in the acute care nurse practitioner track. Student will complete a clinical residency in a selected acute care area/specialty. Classroom theory will focus on the role and legal trends and issues facing the acute care nurse practitioner. Prerequisites: NUR 620, NUR 621, NUR 622.

NUR 623L - CLINICAL EXPERIENCE
Semester Hours: 0
NUR 629 - US HEALTHCARE SYSTEM
Semester Hours: 3

The focus of this course is to explore the structure and complexity of the US health care system. Content will include underlying values, major historical developments, reimbursement methods, stakeholders, and issues driving reform. Prerequisite w/ concurrency: NUR 630.

NUR 630 - FND CONCEPTS NURSING ADMINATOR
Semester Hours: 3

This course focuses on the Nurse Administrator's relationships and roles in a variety of health care systems. Theories of management and organization are analyzed from the perspective of structure, communication, dynamics, trends, and key management, responsibilities, and functions in health care delivery systems.

NUR 631 - LEADERSHIP HUMAN RESRC MGMT
Semester Hours: 3

This course focuses on the role of the nurse leader in resource allocation and management in health care systems and related organizations. Content related to human resource management includes workforce development, the healthcare workforce, recruitment, selection, retention, development, and labor relations.

NUR 632 - ECONOMIC AND POLICY IMPLICATIONS FOR LEADERS IN HEALTH CARE SYSTEMS
Semester Hours: 3

This course focuses on economic and financial implications for nurse administrators with emphasis on executive level budget management and business planning skills. The course is designed to assist nurse administrators in gaining conceptual knowledge regarding budgeting in health systems and policy factors impacting cost, quality and access to healthcare.

NUR 634 - INTERNSHIP IN NURS LEADERSHIP
Semester Hours: 3

This is the culminating course that provides opportunities to synthesize leadership learning, administrative theory, and operational skills in budgeting and finance, and resource management. This knowledge is applied through the identified nurse executive competencies in selected health care related organizations. Course objectives reflect the AONE competencies and QSEN standards. Clinical hours 3, Contact hours 135 Prerequisite: NUR 633.

NUR 634L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 636 - BUDGETING IN HEALTH CARE SYS
Semester Hours: 3

This course is designed to assist nurse leaders in gaining conceptual knowledge regarding budgeting in health systems. The focus is on planning and controlling budgets. Topics include knowledge related to executive level budget management and business planning. Prerequisite: NUR 632.

NUR 637 - CASE MGMT IN HEALTH CARE SYS
Semester Hours: 2

This course is designed as an introduction to health care delivery through case management model. The course focuses upon basic foundational information targeting the professional nurse?s role in case management. Various types of case management are discussed and analyzed. The impact of managed care to case management and other care delivery methods is explored for a changing health care delivery system. Fiscal, ethical/legal and clinical implications of case management are considered.

NUR 638 - INFORMATICS NRSE ADMINISTRATOR
Semester Hours: 1-6

The focus of this course is on the structuring and processing of health information for making decisions in health care.

NUR 640 - CURRICULUM DEV IN NURSING
Semester Hours: 3

Principles and concepts of curriculum development are examined with respect to their application to development of both the theoretical and clinical components of nursing programs. Includes principle regarding theories of learning, the changing nature of knowledge and societal needs as basic considerations directing curricular planning and revision.

NUR 641 - TEACHING/LEARNING IN NURSING
Semester Hours: 3

Emphasis is on the development of classroom and clinical laboratory teaching skills and includes a critical appraisal of specific teaching strategies. The student is provided the opportunity to acquire knowledge in the use and design of common and innovative teaching methods including web-based and interactive delivery systems.
NUR 642 - TESTING & EVALUATION IN NURS
Semester Hours: 3

Major emphasis on the development of classroom and clinical skills in appraisal and evaluation methods of student performance. The student is provided with the opportunity to acquire skills in constructing various types of testing and evaluation (formative and summative) procedures as they relate to nursing education.

NUR 643 - FACULTY ROLE DEV IN NURSING
Semester Hours: 3

Role theory serves as the basis for the discussion and practice in developing teaching, service and research role of a faculty member in a nursing program. Discussion on legislative and professional agencies issues and policies impinging on the teaching role.

NUR 644 - PRACTICUM IN TEACHING
Semester Hours: 3

Opportunities to do practice teaching with nursing students in various phases of their basic educational programs. Learning activities will be planned on an individual basis and based on the specific teaching responsibilities of their primary course assignment. Selected baccalaureate degree and/or associate degree programs will be used as practice sites. Prerequisites with concurrency: NUR 640, NUR 641, NUR 642.

NUR 645 - CAPSTONE NURS EDUC CERTIF CRS
Semester Hours: 3

The major emphasis of this capstone education course is the development of the professional teaching role within an institutional setting. The focus is on the student's ability to function as a professional leader utilizing knowledge gained to promote change, engage in professional actives; promote continuous improvement; and serve as a mentor in an educational environment. Prerequisites: NUR 640, NUR 641, NUR 642, NUR 643, NUR 644.

NUR 647 - STRATEGIC PLANNING
Semester Hours: 3

The focus of this course is to prepare Nursing Administration graduate students to comprehend and actively engage in organizational strategic planning. Emphasis is on the development of organizational blueprints, tracking current trends, forecasting, and innovative strategies in healthcare to achieve an organization's mission and vision, thus remaining competitive in the healthcare industry. Prerequisite w/ concurrency: NUR 630.

NUR 648 - CONCEPTS OF HLTH ASSMNT & PROM
Semester Hours: 3

This course focuses on concepts in health assessment and health promotion for individuals and populations. This course is designed for nurses preparing for leadership roles in health care organizations. Prerequisite w/ concurrency: NUR 630.

NUR 649 - QUALITY, SAFETY, & RISK MGMT
Semester Hours: 3

This course focuses on the quality, safety, and risk management concepts for nurse leaders. Content includes the use of quality tools and use of data to evaluate and promote quality outcomes. Prerequisite w/ concurrency: NUR 630.

NUR 650 - INDEPENDENT STUDY
Semester Hours: 2-4

Planning, implementation, and evaluation of related phenomena of special interest observed in nursing practice.

NUR 660 - ADLT GERONT CNS I
Semester Hours: 6

Primary focus is on nursing care of adults and families with long-term alterations in health. Subroles of the advanced practice nurse are introduced and reinforced. Theory concerning adult development, health promotion, and disease prevention practices, identifying populations at risk, cultural and environmental diversity issues, provides the background knowledge used by the student in giving care to patients/families in a variety of settings. Patient and caregiver needs and care interventions are central as the student practices the role of clinician caring for adults with chronic problems. Prerequisites: NUR 605, NUR 606.

NUR 660L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 661 - ADLT GERONT CNS II
Semester Hours: 6

Care management of the adult patient in the hospital or community setting. Rural and other vulnerable populations are of major concern. Health policy, fiscal regulations, and differing health delivery systems serve as points of discussion. Clinical experiences with vulnerable and underserved populations primarily in rural settings. Prerequisites: NUR 660 and either NUR 606 or NUR 607.
NUR 661L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 662 - ADLT GERONT CNS 111
Semester Hours: 6

Advanced nursing care of adults of diverse populations in secondary or tertiary settings. Emphasis on special needs and advanced nursing care of adults with acute health alterations. Student clinical experiences are therapeutic nursing interventions with acutely ill patients with complex health problems.

NUR 662L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 663 - ADLT GERONT CNS IV
Semester Hours: 6

Culminating residency course where the student uses the sub-roles of the advanced practice nurse?clinician, teacher, manager, researcher, consultant, in providing direct and indirect care to the adult patient. Legal, ethical, and licensing issues affecting the role of the advanced practice nurse are points of classroom discussion, along with current issues and trends. Theories concerning ethical decision making, consultation, leadership, and methods of research utilization enhance the student?s practice. The clinical placement should strengthen the student?s area of concentration developed with the faculty advisor. Prerequisites: NUR 660, NUR 661, NUR 662.

NUR 663L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 670 - HUMAN FACTORS HEALTHCARE COMPU
Semester Hours: 3

Overview of epidemiologic methods with discussion of application to diagnosis and choice of therapy. Concepts and mechanisms related to transmission, acquisition of disease, trends and distribution of patterns of disease discussed. The application of epidemiology to human health problems and rural settings is emphasized. Prerequisite: NUR 638.

NUR 671 - USABILITY EVAL HEALTHCARE I.T.
Semester Hours: 3

This course examines usability methods for the design and testing of healthcare information technology including health information websites, electronic health records, clinical decision support systems, and medical equipment with an emphasis on the user experience. The iterative nature of user-centered design and usability testing of health IT will be emphasized. Prerequisite: NUR 679.

NUR 672 - EBP ADVANCED NURSING PRACTICE
Semester Hours: 3

This course focuses on developing the advanced practice nurse to critique and synthesize evidence for nursing for the purpose of improving healthcare outcomes. Emphasis is on the critical analysis of evidence to be used in formulating of information technology, data from practice, databases and research methods to appropriately generate evidence for advanced nursing practice. Prerequisite: NUR 602.

NUR 680 - CLINICAL NURSE LEADER I
Semester Hours: 6

This course will introduce key concepts that impact today?s healthcare environment and patient population as well as relevant quality management tools that improve patient care delivery and outcomes. In addition, the role of the clinical nurse leader will be explored.

NUR 680L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 681 - CLINICAL NURSE LEADER II
Semester Hours: 6

NUR 681L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 682 - CLINICAL NURSE LEADER III
Semester Hours: 6

Advancing nursing care of adults of diverse populations in secondary or tertiary settings. Emphasis on special needs and advanced nursing care of adults with acute health alterations. Student clinical experiences are therapeutic nursing interventions with acutely ill patients with complex health problems.
NUR 682L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 683 - CLINICAL NURSE LEADER IV
Semester Hours: 6

NUR 683L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 698 - PLAN II: OTHER RES ACTIVITIES
Semester Hours: 1-4

Application of activities appropriate to student program of study. Intended to expand student knowledge and enhance track specific content.

NUR 699 - PLAN I: THESIS
Semester Hours: 1-4

Independent research investigation related to practice of nursing under faculty guidance. Minimum of six hours required. Prerequisite: NUR 602.

NUR 700 - CLINICAL DATA MGT & ANALYSIS
Semester Hours: 3

This required course provides students with the knowledge base to understand, collect, manage, and measure clinical data. Students will explore data collection and management processes, levels of measurement, basic statistics, and measurement for improvement in order to effectively use clinical data. Data entry exercises employed through analytical tools and statistical software packages will allow the students practice and apply the basic data management and analysis skills needed for the evaluation of clinical data and evidence-based practice.

NUR 701 - WRITING FOR PUBLICATION
Semester Hours: 3

This course concerns the development of skills in writing, editing, and preparing manuscripts for publication from initial idea to submission of a publishable manuscript. The course emphasizes a writing process that encourages productivity and collegial peer review. Legal and ethical aspects of authorship prepare students for responsible practices expected of scholars. Students should have mastered basic writing skills, e.g., grammar, syntax, and computer skills, prior to enrolling in this course.

NUR 729 - EVID BASED PRACT DESGN & TRANS
Semester Hours: 3

The purpose of this course is to provide students with models for evidence-based practice (EBP) design and improvement translation. Students learn to formulate clinical questions in answerable format, and search for and identify best research evidence. The focus of the course is to evaluate and critically appraise evidence for rigor and applicability to the clinical problem and is designed to improve clinical outcomes. Students will translate evidence into practice environments for safe, quality care. Students will gain access to information that will support optimal clinical decision-making. Improvement translation sciences will also be introduced.

NUR 731 - PHIL/THEOR/CONC FOUN FOR APN
Semester Hours: 3

This required core course in the Doctor of Nursing Practice program provides an understanding of the use of theory and conceptual foundation to guide the complexity of specialty nursing practice at the doctoral level. The content is derived from the philosophical and scientific underpinnings of nursing, natural, and psycho-social sciences.

NUR 733 - INFORMATICS FOR APN
Semester Hours: 3

This required core course in the Doctor of Nursing Practice program focuses on the collection, organization, analysis, and dissemination of information in nursing and health care. Students are introduced to the specialty of nursing informatics, the information system life-cycle telemedicine, and the use of technology to enhance nursing care delivery and patient safety. Also, students learn how to design, use, and manipulate large and small patient databases for the analysis of patient outcomes.

NUR 734 - ADVANCED EXPERIENTIAL CLINICAL
Semester Hours: 1-7

This course is designed to validate Master's level competencies in clinical and organizational leadership. The course is required for post-master's DNP students who are graduates of programs in nursing with less than 500 clinical hours. The course is a pre-requisite to NUR 739 Scholarly Project.
NUR 735 - POPULATION HEALTH IN APN
Semester Hours: 3

This required core course in the Doctor of Nursing Practice program prepares the student to implement specialty population-based disease prevention and health promotion activities to achieve national and international goals of improving worldwide health status. The course focuses on a spectrum of issues affecting health which includes emerging infectious diseases, emergency preparedness, disparities in health and healthcare services, and the impact of behavior and lifestyle choices.

NUR 737 - INTDIS LDRSHIP/ROLE DEV PRA EXC
Semester Hours: 3

This course is a required core course in the Doctor of Nursing Practice program that focuses on organizational and systems leadership and knowledge and skills critical to role development in independent and inter and intra-disciplinary practice. Content includes communication, conflict resolution, collaboration and negotiation, leadership, and team-functioning to maximize success in the establishment of safe, effective patient-centered care in complex environments.

NUR 738 - DNP PROJECT DEVELOPMENT
Semester Hours: 3

This course is a 2-hour seminar designed to assist the student in selecting an area of interest within a practice specialization and in demonstrating professional competencies related to that area of interest. The student will document previously acquired abilities and competencies in a professional portfolio. Students will participate in the seminar to obtain guidance and receive peer suggestions about the portfolio and project plans. Prerequisites: NUR 742 and NUR 743.

NUR 739 - DNP PROJECT
Semester Hours: 1-7

This is the capstone clinical course in all advanced practice tracks. The student presents evidence of achievements and competencies in a professional portfolio. The practice residency is completed in a specialty area of the student's choice. This course focuses on aspects of the final practice project and interventions that promote health, prevent illness and disability, and alleviate health disparities. The final project selected and planned by the student and advisor is implemented during this course. The student completes the project, evaluates the outcomes, disseminates findings, and makes a formal, scholarly presentation to peers and faculty. Prerequisite: NUR 738.

NUR 740 - HLH POLIC/POLIT:IMPLICATION HC
Semester Hours: 3

This course prepares students to assume complex leadership roles in order to advance specialty practice and health. This course focuses on the unique challenges of engaging and influencing health care policy in the U.S. and internationally. It is designed to develop skills, techniques, and approaches to the critical analysis of health policy proposals, health policies and related stakeholder in policy and public forums. The health policy framework is analyzed from a governmental, institutional and organizational perspective.

NUR 742 - PROGRAM EVAL & METHODS
Semester Hours: 3

The purpose of this course is to synthesize knowledge related to translation/implementation science models and strategies to improve health outcomes. The emphasis in the course is the use of program evaluation as a strategic planning tool to achieve positive changes in health status, to initiate quality improvement, to engage in risk anticipation, management and to facilitate organizational and system level changes. Prerequisite: NUR 738.

NUR 743 - EVID BASED PRACT STATEGIES
Semester Hours: 3

This is a required course in the Doctor of Nursing Practice program, which expands on evidence-based practice concepts to refine a problem statement and derive a searchable and answerable clinical question. Content includes conducting a systematic review of the literature to guide the selection of methods, strategies, tools and metrics needed to complete a successful scholarly project. The course also addresses targeted strategies for disseminating evidence associated with scholarly projects. Prerequisites: NUR 729, NUR 738.

**Nursing, DNP**

In addition to the graduate degree requirements of the School of Graduate Studies, a student is required to complete a minimum of 40 semester hours of coursework in the Doctor of Nursing Practice (DNP) program. The DNP degree is distinguished by the completion of a DNP Project that demonstrates synthesis of the student's coursework and lays the groundwork for future scholarship. Because the DNP is focused on mastery of advanced practice in a specialty area, the DNP Project should demonstrate the achievement of that mastery. The practice doctorate focuses heavily on practice that is innovative and evidence-based, reflecting the application of credible research findings, through an integrative practice experience. The DNP Project is evidence that the student can independently identify a problem of contemporary significance through familiarity with the current literature in the major field, organize, design, implement, and evaluate a project that addresses the problem and present the project in cogent, well written exposition. The DNP Project documents the outcomes of the student's doctoral education experience, providing a measurable medium for evaluating the mastery of and growth in knowledge and clinical expertise.
The project will be completed under the direction of a chair and supervising committee. The project has several approval points including a proposal review, Institutional Review Board (IRB) review, and final evaluation. The final evaluation of the DNP Project must be scheduled through the College of Nursing at least two weeks in advance of the proposed evaluation date taking into account the expected date of graduation and the deadlines set by the School of Graduate Studies. Results of the DNP Project are expected to be manuscript ready in preparation for submission as a refereed scholarly publication.

**DNP Courses**

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<td>CLINICAL DATA MGT &amp; ANALYSIS</td>
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<td>NUR 734</td>
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Total Semester Hours: **40-47**

**Nursing, MSN - Adult Gerontology Acute Care Nursing Practitioner Track**

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<td>NUR 699</td>
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**Core Requirements**

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<td>NUR 623</td>
<td>ADLT GER ACUTE CR NUR PRACT IV</td>
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Total Semester Hours: **42**

**Nursing, MSN - Family Nurse Practitioner Track**

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Nursing, MSN - Nursing Administration Track

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<td>PLAN I: THESIS</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>or two NUR Electives 500 level and above</td>
<td></td>
</tr>
<tr>
<td>NUR 630</td>
<td>FND CONCEPTS NURSING ADMINATOR</td>
<td>3</td>
</tr>
<tr>
<td>NUR 631</td>
<td>LEADERSHIP HUMAN RESRC MGMT</td>
<td>3</td>
</tr>
<tr>
<td>NUR 632</td>
<td>ECONOMIC AND POLICY IMPLICATIONS FOR LEADERS IN HEALTH CARE SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td>NUR 633</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>NUR 634</td>
<td>INTERNSHIP IN NURS LEADERSHIP</td>
<td>5</td>
</tr>
<tr>
<td>NUR 635</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>NUR 636</td>
<td>BUDGETING IN HEALTH CARE SYS</td>
<td>3</td>
</tr>
<tr>
<td>NUR 637</td>
<td>CASE MGMT IN HEALTH CARE SYS</td>
<td>2</td>
</tr>
<tr>
<td>NUR 638</td>
<td>INFORMATICS NRSE ADMINISTRATOR</td>
<td>3</td>
</tr>
<tr>
<td>NUR 639</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Total Semester Hours 39

Post-Master’s Family Nurse Practitioner Program

The Post-Master’s Family Nurse Practitioner (FNP) Program is designed for individuals who have already earned a master’s degree in Nursing, but who desire additional preparation for FNP Certification. Students must be formally admitted to the program to enroll and must meet identical academic standards as students enrolled in the master’s program. Students admitted to this program must attend full-time. In order to facilitate this certificate of study, an "en block" format may be offered, meeting three times a semester for two-three days. Graduates from this program are eligible to sit for the FNP national certification examination. There are two required prerequisite or co-requisite courses for the Post-Master’s FNP Program. Students must have completed advanced health assessment and pathophysiology at UAH or another institution prior to enrolling in any course. Students enrolling in this program will complete the requirements for the FNP in four semesters of study.

Program prerequisites or co-requisites:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUR 605</td>
<td>ADVANCED HLTH ASSESSMENT</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>or transfer equivalent</td>
<td></td>
</tr>
<tr>
<td>NUR 606</td>
<td>PATHOPHYSIOLOGY</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>or transfer equivalent</td>
<td></td>
</tr>
<tr>
<td>NUR 607</td>
<td>PHARMACOLOGY IN ADV PRAC</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(or transfer equivalent taken in the last 5 years)</td>
<td></td>
</tr>
</tbody>
</table>

The program of study is as follows:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUR 610</td>
<td>FAMILY NURSE PRACTITIONER I (Post Master's)</td>
<td>6</td>
</tr>
<tr>
<td>NUR 611</td>
<td>FAM NURS PRACTITIONER II (Post Master's)</td>
<td>6</td>
</tr>
<tr>
<td>NUR 612</td>
<td>FAMILY NUR PRACTITIONER III (Post Master's)</td>
<td>6</td>
</tr>
</tbody>
</table>
College of Science

C207 and C206 Materials Science Building
Telephone: 256.824.6605

Mission

The College of Science provides quality education with leading-edge research opportunities through interdisciplinary programs administered by seven departments and vibrant collaborations across campus and community. Faculty bring their innovative research into the classroom, equipping students with advanced knowledge, skills and abilities, and preparing leaders for this generation and beyond.

Departments

The College of Science consists of seven academic departments:

- Atmospheric Science (Earth System Science)
- Biological Sciences
- Chemistry
- Computer Science
- Mathematical Sciences
- Physics
- Space Science

Faculty in the College collaborate with several UAH research centers including the Center for Applied Optics, Earth System Science Center, Information Technology and Systems Center, Center for Microgravity and Materials Research, and the Center for Space Plasma and Aeronomic Research. The College benefits from its strategic location in the midst of high technology-oriented companies and federal organizations such as NASA and NOAA. Unique opportunities are available for original research at the forefront of science and technology, including projects that are of direct interest to industry and academia.

Degrees and Programs

The College of Science offers the following graduate degree programs:

<table>
<thead>
<tr>
<th>Program</th>
<th>Degree(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Mathematics</td>
<td>Ph.D.</td>
</tr>
<tr>
<td>Atmospheric Science</td>
<td>M.S., Ph.D.</td>
</tr>
<tr>
<td>Biology</td>
<td>M.S.</td>
</tr>
<tr>
<td>Chemistry</td>
<td>M.S.</td>
</tr>
<tr>
<td>Computer Science</td>
<td>M.S., M.S.S.E., Ph.D.</td>
</tr>
<tr>
<td>Earth System Science</td>
<td>M.S.</td>
</tr>
<tr>
<td>Mathematics</td>
<td>M.A., M.S.</td>
</tr>
<tr>
<td>Physics</td>
<td>M.S., Ph.D.</td>
</tr>
<tr>
<td>Space Science</td>
<td>M.S., Ph.D.</td>
</tr>
<tr>
<td>Software Engineering</td>
<td>M.S.</td>
</tr>
<tr>
<td>Biotechnology Science and Engineering</td>
<td>Ph.D.</td>
</tr>
<tr>
<td>Cybersecurity</td>
<td>M.S.</td>
</tr>
<tr>
<td>Materials Science</td>
<td>M.S., Ph.D.</td>
</tr>
<tr>
<td>Optical Science and Engineering</td>
<td>Ph.D.</td>
</tr>
</tbody>
</table>

*Interdisciplinary programs include:

These programs are described in the Interdisciplinary Programs (p. 103).

In addition, certificate programs are available in Software Engineering and Information Assurance.

All first time graduate students should consult with a departmental advisor before registration.
Master's Degrees in Science

- Atmospheric Science, MS (p. 145)
- Biological Sciences, MS (p. 150)
- Chemistry, MS (p. 157)
- Computer Science, MS (p. 171)
- Computer Science, MSSE (p. 174)
- Earth System Science, MS (p. 182)
- Mathematical Sciences, MA (p. 192)
- Mathematical Sciences, MS (p. 193)
- Physics, MS (p. 204)
- Space Science, MS (p. 214)

Doctoral Degrees in Science

- Applied Mathematics, PhD (p. 192)
- Atmospheric Science, PhD (p. 144)
- Computer Science, PhD (p. 170)
- Physics, PhD (p. 203)
- Space Science, PhD (p. 218)

Certificates in Science

- Information Assurance (http://catalog.uah.edu/grad/colleges-departments/science/computer-science/information-assurance-certificate)
- Software Engineering (http://catalog.uah.edu/grad/colleges-departments/science/computer-science/software-engineering-certificate)

Atmospheric Science

National Space Science and Technology Center
Room 4044
Telephone: 256.961.7877
Email: ats@uah.edu

Department Chair: Larry Carey, Associate Professor

The Atmospheric Science department offers the following graduate degree programs:

- Master of Science - Atmospheric Science
- Master of Science - Earth Systems Science
- Doctor of Philosophy - Atmospheric Science

Admission Requirements

Refer to the appropriate section of the Graduate Catalog for general admission and degree requirements. The applicant should have training through a calculus sequence (including the calculus of vector-valued functions), a course in linear algebra, and courses in ordinary and partial differential equations. He or she should also have completed at least two semesters of chemistry, two semesters of calculus-based physics, and have demonstrable computer proficiency in at least one high-level programming language.

Program Objective

The Atmospheric Science Department's first objective is to produce graduates who are successful in writing scientific research papers in peer-reviewed scientific journals and in making presentations at national or international scientific conferences and workshops. Our second objective is to produce graduates who successfully obtain employment as research scientists in a research center, government lab, or corporation, or in academic positions at a university.

Learning Outcomes

Students will demonstrate:
• Knowledge of the reviewed literature in the atmospheric science that is relevant to their specific research
• Proficiency in scientific methodology, while successfully carrying out a research project from concept to completion
• Effective oral communication skills in reporting the results of their scientific research

Master's Program in Atmospheric Science

http://nsstc.uah.edu/ats/ats_ms.html

• To obtain the M.S. degree in Atmospheric Science, each student must satisfy all requirements of the School of Graduate Studies, as well as those of the Atmospheric Science Program.
• Students must formulate an appropriate Program of Study (POS), in consultation with a faculty advisor and chair, before the end of the second semester.
• Students must maintain a cumulative GPA of at least 3.0.

Option 1 - Thesis

Minimum degree requirements under this plan include completion of at least 24 credit hours of graduate course work and at least 6 credit hours of thesis research. At least 50% of the required 24 semester hours must be from 600 level (or higher) courses. Students are also required to take 6 credit hours of supporting courses. The supporting courses do not count toward the minimum degree requirements.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATS 541</td>
<td>ATM THERMODYN &amp; CLOUD PHYSICS</td>
<td>3</td>
</tr>
<tr>
<td>ATS 551</td>
<td>ATMOS FLUID DYNAMICS I</td>
<td>3</td>
</tr>
<tr>
<td>ATS 561</td>
<td>ATMOSPHERIC RADIATION I</td>
<td>3</td>
</tr>
<tr>
<td>Elective Courses</td>
<td>Select 12 semester hours from 600 level (or higher) courses</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Select 3 semester hours from 500 or 600 level courses and may be outside of ATS only with advisor’s approval</td>
<td>3</td>
</tr>
<tr>
<td>Required Supporting Courses</td>
<td>ATS 509 APPL COMPUTERS IN METEOROLOGY</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>ATS 780 ATMOSPHERIC SCIENCE SEMINAR</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>ATS 781 STUDENT SEMINAR</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>ATS 782 PROFESSIONAL DEVELOPMENT</td>
<td>1</td>
</tr>
<tr>
<td>Thesis Credits</td>
<td>ATS 699 MASTER'S THESIS</td>
<td>6</td>
</tr>
<tr>
<td>Total Semester Hours</td>
<td></td>
<td>36</td>
</tr>
</tbody>
</table>

1 Students must earn a B or above in core courses.
2 Students who have earned a B or better in the undergraduate equivalent ATS 541, ATS 551, ATS 561 at UAH do not have to re-take the course at the graduate level. However, their Program of Study must include alternative semester hours at the appropriate level approved by their advisor and chair of the department.
3 Students who have earned a B or better in the undergraduate equivalent of ATS 509 at UAH have fulfilled the requirement.

Additional Information

In Option 1, the student must write and defend a thesis. The thesis must show evidence of the student’s capability for research, independent thought, and analysis in Atmospheric Science and must be written in fluent, acceptable english. During the second semester, the student, with the guidance of their advisor, should form a supervisory committee. Students must submit a 5 page thesis proposal to be approved by the advisor and committee by the end of the third full semester.

Option 2 - Non-Thesis

Minimum degree requirements under this plan include completion of at least 33 credit hours of graduate course work. At least 50% of the required 33 semester hours must be from 600 level (or higher) courses. In addition, all M.S. students are required to take 6 credit hours of supporting courses. The supporting courses do not count toward the minimum degree requirements.
### Required Core Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATS 541</td>
<td>ATM THERMODYN &amp; CLOUD PHYSICS</td>
<td>3</td>
</tr>
<tr>
<td>ATS 551</td>
<td>ATMOS FLUID DYNAMICS I</td>
<td>3</td>
</tr>
<tr>
<td>ATS 561</td>
<td>ATMOSPHERIC RADIATION I</td>
<td>3</td>
</tr>
</tbody>
</table>

### Elective Courses

Select 18 semester hours from 600 level (or higher) courses

Select 6 semester hours from 500 or 600 level courses and may be outside of ATS only with advisor's approval

### Required Supporting Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATS 509</td>
<td>APPL COMPUTERS IN METEOROLOGY</td>
<td>3</td>
</tr>
<tr>
<td>ATS 780</td>
<td>ATMOSPHERIC SCIENCE SEMINAR</td>
<td>1</td>
</tr>
<tr>
<td>ATS 781</td>
<td>STUDENT SEMINAR</td>
<td>1</td>
</tr>
<tr>
<td>ATS 782</td>
<td>PROFESSIONAL DEVELOPMENT</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Semester Hours: 39

1. Students must earn a B or above in core courses.
2. Students who have earned a B or better in the undergraduate equivalent ATS 541, ATS 551, ATS 561 at UAH do not have to re-take the course at the graduate level. However, their Program of Study must include alternative semester hours at the appropriate level approved by their advisor and chair of the department.
3. Students who have earned a B or better in the undergraduate equivalent of ATS 509 at UAH have fulfilled the requirement.

### Comprehensive Examination/Thesis Defense

A final comprehensive examination is required of all candidates for a master’s degree; this examination may be written or oral, or both. In accordance with the Graduate Studies Dates & Deadlines, a written notice of the time and place of the examination/defense must be sent to the Graduate Dean. After approval by the Graduate Dean, the Department Chair sends a copy of the written Notification of Oral Examination/Defense to the candidate and each member of the committee. A student may take the Comprehensive Examination only twice.

- **Thesis** candidates will be examined primarily on the thesis by a committee of at least three faculty members appointed by the Department Chair and approved by the Graduate Dean.

- **Non-Thesis** candidates will be examined on course work. Three weeks before the exam, the advisor/chair will email two “lead-in” questions about the student’s course work from each committee member. This will be the starting point for the oral exam. The committee members may also question further during the exam. Students who pass all sections of the Ph.D. Preliminary Exam are not required to take the M.S. Comprehensive Exam.

### M.S. Supervisory Committee

The committee must consist of a minimum of three members and be approved by the Department Chair. Two of the three members, including the Committee Chair, must be full-time, tenured, or tenure-earning faculty members in the department. The other member may be nominated to the Affiliate Graduate Faculty or be a current faculty member from another UAH department.

### Paperwork

- Students must formulate an appropriate Program of Study (POS), in consultation with a faculty advisor and chair, before the end of the second semester.
- Application for graduate degree according to the Graduate Studies Dates & Deadlines.
- Notification of Oral Examination/Defense according to the Graduate Studies Dates & Deadlines.

### Doctoral Program in Atmospheric Sciences

http://nsstc.uah.edu/ats/ats_phd.html

The doctor of philosophy degree is a research-oriented degree awarded upon the demonstration of scholarly competence. To obtain the Ph.D. degree in Atmospheric Science, each student must satisfy all requirements of the School of Graduate Studies, as well as those of the Atmospheric Science Program. Admission to the Ph.D. program in Atmospheric Science is dependent upon satisfactory performance on the Preliminary Examination, which is administered twice a year. Students entering UAH with an M.S. degree or previous graduate training in Atmospheric Science must pass the Preliminary Examination at an early opportunity. Students are permitted two attempts to pass the Preliminary Examination.
In summary, the five major requirements for the Ph.D. degree in Atmospheric Science are the following:

1. **Take the core courses and pass the preliminary examination**

Each student must pass the Preliminary Examination covering material in the three core courses plus three other ATS courses as outlined in the Ph.D. Preliminary Exam policies. The core courses are:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATS 541</td>
<td>ATM THERMODYN &amp; CLOUD PHYSICS</td>
<td>3</td>
</tr>
<tr>
<td>ATS 551</td>
<td>ATMOS FLUID DYNAMICS I</td>
<td>3</td>
</tr>
<tr>
<td>ATS 561</td>
<td>ATMOSPHERIC RADIATION I</td>
<td>3</td>
</tr>
</tbody>
</table>

It is anticipated that a student will take the exam during the second year of graduate study, but those with a strong background in Atmospheric Science may take the exam within the first year. The Preliminary Examination may be taken only twice. The student must pass all six sections in order to continue toward Ph.D. candidacy.

**Supervisory Committee**

After a student has passed the Preliminary Examination, a Supervisory Committee will be formed. The committee will consist of the student’s academic advisor plus at least four other members. Three of the Committee Members, including the Committee Chair, must be tenured or tenure-track members of the ATS faculty. The committee must be approved by the Graduate Dean. The committee will later administer the Qualifying Examination, and with consent of the Graduate Dean, give approval to all aspects of requirements 2-5.

2. **Satisfy the residence requirement**

According to graduate school policy, residence may be established through either:

1. being enrolled as a full-time student (at least 9 graduate semester hours) either for one continuous academic year, or for Spring and Fall semesters in the same calendar year, or
2. being enrolled in at least 6 semester hours of graduate course work in at least three of four consecutive semesters.

3. **Complete an acceptable Program of Study (POS).**

Students must formulate an appropriate Program of Study, in consultation with a faculty advisor and chair, before the end of the second semester. Each Program of Study, individualized to meet the student’s needs and requirements of the program, will stress breadth, depth, and research competence, and relate the major area to its applications. Any prerequisites for courses on the POS must be fulfilled before attempting the courses.

- Minimum degree requirements of this Program of Study will include at least 48 semester hours of graduate level course work. These include the core courses needed to prepare for the Preliminary Examination and courses required in a major area of concentration that will prepare the student to conduct original research. While required, supporting courses, ATS 509, ATS 780, ATS 781, ATS 782, are not included in the minimum degree requirements of 48 semester hours.
- Students can transfer up to 24 semester hours of course work from their M.S. program.
- Students can transfer an additional 6 semester hours of course work, including, with approval, special topics courses, but not including thesis semester hours.
- 50% of the minimum degree requirements (48 semester hours) must be from 600 level or higher courses.
- A minimum of 18 semester hours of doctoral dissertation (ATS 799) is required.
- Students must register for a total of 3 semester hours of Seminar and Professional Development. (ATS 780, ATS 781, ATS 782)
- Students must maintain a cumulative GPA of at least 3.0.

4. **Pass the Qualifying Examination**

Once the Program of Study has been submitted and the Ph.D. Student Advisory Committee (SAC) has been formed, the next steps are to submit a written dissertation proposal to the SAC and then make an oral presentation (usually 2-3 weeks later). This will be followed by the Qualifying Examination, which will cover the major areas of study and the student’s proposal for the dissertation topic. It will have both written and oral components and will be prepared and graded by the SAC. This examination may be taken at most twice.

5. **Complete and defend a research dissertation**

Each student must complete and successfully defend a research dissertation, the results of which are publishable in a nationally recognized journal. The dissertation, which must comply with the regulations set forth in the School of Graduate Studies’ Thesis and Dissertation Manual, must be approved by
the student’s supervisory committee, the chair of the Atmospheric Science Department, the Dean of the College of Science, and the Dean of the School of Graduate Studies. A significant portion of the dissertation must be submitted for publication in an approved journal.

**Additional Information**

All requirements for the Ph.D. must be completed in no more than five years after the student has passed the qualifying examination.

The atmospheric science program does not require knowledge of a foreign language, but it does require proficiency in both spoken and written English.

**ATS 501 - SURVEY OF ATMOSPHERIC SCIENCE**
Semester Hours: 3

General survey of the field of atmospheric science includes thermodynamics, atmospheric dynamics, cloud physics, and atmospheric radiation. Quantitative examination of atmospheric properties including atmospheric composition, structure and dynamics.

**ATS 509 - APPL COMPUTERS IN METEOROLOGY**
Semester Hours: 3

Survey of scientific programming techniques used in atmospheric sciences. Various data types, control statements, and programming design using object oriented techniques are discussed, emphasizing efficient programming. Course prepares students for graduate work and research in atmospheric science.

**ATS 510 - OPERATIONAL WEATHER FORECASTING**
Semester Hours: 3

Subjective & objective methods of atmospheric prognosis. Forecasting critical weather elements. Interpretation, use & systematic errors of computer-generated products, human factors, & application of meteorological theory in an operational setting.

**ATS 513 - GIS & REMOTE SENSING**
Semester Hours: 3

Hands-on approach to GIS and satellite remote sensing. Popular satellite data sets such as LANDSAT and AVHRR are coupled with GIS data sets to increase understanding of the earth system. Topics include satellite sensors, basic radiative transfer, orbits, raster formats, atmospheric correction, distortion, image corrections, rotations and mapping, spatial resolution, image interpretation, radiometric and geometric enhancement, multispectral transformations, and classifications. (Same as ATS 413, ES 413, ES 513.) Spring. Prerequisite: ATS 511 or ESS 511.

**ATS 515 - ADVANCED TOPICS IN GIS**
Semester Hours: 3

Advanced special topics: visualization of GIS and remote sensing data, landscape characterization (pattern vs. process), multitemporal analysis, aggregation of data types, developing an integrated GIS environment for performing complex space-time modeling analyses, and land-atmosphere interactions. (Same as ATS 415, ES 415, ES 515.) Spring.

**ATS 520 - INTRO ATMOS CHEM & AIR POLLUTION**
Semester Hours: 3

An introduction designed to provide students with the basics of atmospheric chemistry and air pollution concepts. Topics include air pollutants, air-pollution meteorology, atmospheric gases and aerosols, and atmospheric processes.

**ATS 522 - AIR POLLUTION & ATMOSPHERIC PHYSICS**
Semester Hours: 3

Thermodynamic & cloud physical processes in the atmosphere. Atmospheric statics & stability. Role of aerosols in nucleation of cloud and ice particles. Physical processes that produce the growth of hydrometeors in cold and warm clouds. Applicable measurement techniques.

**ATS 551 - ATMOS FLUID DYNAMICS I**
Semester Hours: 3

Fluid dynamics in the atmosphere. Coriolis acceleration, scale analysis and appropriate approximations of the complete governing equations. Numerical analysis and interpretation of weather phenomena.
ATS 554 - FORECASTING MESOSCALE PROC
Semester Hours: 3

Detection and forecasting of atmospheric mesoscale phenomena including the structure and evolution of clouds, precipitation (including floods) thunderstorms and severe weather. Includes basics of instruments used to detect mesoscale phenomena, most notably satellite and radar. Prerequisites: ATS 551.

ATS 561 - ATMOSPHERIC RADIATION I
Semester Hours: 3

Fundamentals of terrestrial atmospheric radiation. Topics include: basic concepts, radiative transfer equation, gaseous absorption, scattering by molecules and particles, band models, transmittance along an inhomogeneous path.

ATS 571 - INTRO TO RADAR METEOROLOGY
Semester Hours: 3

Introduction to principles of radar meteorology, including radar operations, hardware, interpretation and analysis. Doppler, dual-polarization and dual-wavelength radar theory, methods and applications are covered. Prerequisite: ATS 541.

ATS 581 - ATS THERMODYNAMICS & CHEM
Semester Hours: 3

ATS 590 - SPECIAL TOPICS
Semester Hours: 1-3

Selected topics of interest not included in other courses.

ATS 603 - CLIMATE DYNAMICS
Semester Hours: 3

Origin and evolution of the climate system including underlying causes for past climates such as occurred during the ice ages. Statistical processing of various time series to extract climactic signals in the data. Determination of global-scale forcing mechanisms, which impact climate. Prerequisites: ATS 541 and ATS 551.

ATS 606 - DATA ANALY ATMOSPHERIC SCNTS
Semester Hours: 3

A theoretical and practical introduction to various data analysis methods commonly used in atmospheric science. Topics include forecasting techniques to generate models to fit data, assess models using parametric tests, probability theory and Monte Carlo methods to solve a variety of problems. Prerequisites: ATS 509.

ATS 620 - ATMOSPHERIC CHEMISTRY & AEROSI
Semester Hours: 3

Primary processes, thermodynamics, photochemistry, kinetics, models, and measurements applied to troposphere and stratosphere; natural and anthropogenic; chlorine, nitrogen, hydrogen, and oxygen catalytic cycles; ground- and satellite-based observations of trace species. Prerequisites: ATS 520.

ATS 622 - AIR POLLUTION MODELING
Semester Hours: 3

Air pollution Langrangian and Eulerian modeling concepts and methods from micro to synoptic scales; plume, large eddy simulations and urban-regional models in research and regulatory applications; transport, dispersion, chemistry, clouds, aerosols, and wet/dry deposition. Prerequisites: ATS 520 and ATS 551.

ATS 630 - PHYSICAL CLIMATOLOGY
Semester Hours: 3

This course examines the physical aspects of the global climate system, including the global energy balance, surface energy balance, hydrologic cycle, climate classification, ocean change and other selected topics such as climate sensitivity. Prerequisites: ATS 501 or ATS 541.

ATS 635 - GENERAL CIRCULATION
Semester Hours: 3

Detailed examination of the observed dynamic, thermodynamic and chemical structure of the atmosphere, including mid-latitude baroclinic systems, tropical systems, global-scale energy, mass and momentum budgets and the fundamental climatology of the atmosphere. Prerequisites: ATS 541 and ATS 551.
ATS 642 - PRECIP PHYSICS FOR RADAR
Semester Hours: 3
Cloud microphysics theory, models, in-situ and radar observations of hydrometers will be utilized together to explore advanced concepts in precipitation physics and their connection to radar meteorology, including coalescence, break-up, freezing, size sorting, aggregation, riming and melting. Prerequisite: ATS 531 and ATS 571.

ATS 651 - ATMOS FLUID DYNAMICS II
Semester Hours: 3
Wave motions in the atmosphere with emphasis of Rossby, Kelvin and gravity waves. Systematic scaling of primitive equations to develop quasigeostrophic and Ekman-layer theory. Shallow water theory, stratified flows, and barotropic and baroclinic instability. Prerequisites: ATS 551.

ATS 652 - ADV SYNOP METEOROLOGY
Semester Hours: 3
Analysis, interpretation and forecasting synoptic-scale and mesoscale phenomena, including air masses, frontal systems, cyclones, anti-cyclones and waves toward understanding process dynamics. Emphasize the use of observational, satellite and numerical model data, including radars and profilers. Prerequisites: ATS 541 and ATS 551.

ATS 654 - FORECASTING MESOSCALE PROCESSE
Semester Hours: 3

ATS 655 - BOUNDARY LAYER METEOROLOGY
Semester Hours: 3
Survey of atmospheric boundary layer (ABL) properties. Review of turbulence, convective and stable boundary layers, surface forcing, boundary layer discontinuities, and singular phenomena within the ABL. Atmospheric field measurements are used to enhance understanding of ABL process. Prerequisites: ATS 541 and ATS 551.

ATS 656 - TROPICAL METEOROLOGY
Semester Hours: 3
Overview concepts of the dynamics and climatology of the tropics and of significant tropical precipitation systems. Topics also include Kelvin waves, equatorial flows, convective scale dynamics, island meteorology, tropical cyclones, ENSO, radiative-convective equilibrium, gregarious cloud systems. Prerequisites: ATS 541 and ATS 551.

ATS 657 - NOWCASTING THEORY METHODS
Semester Hours: 3
Theory, methods and applications of 0-6 hour weather and ecological prediction, which is a forecast time period when numerical prediction models have low skill. Topics include predictability, data assimilation, statistical methods, and algorithms using Earth and atmospheric science observations.

ATS 670 - SATELLITE REMOTE SENSING I
Semester Hours: 3
Using a hands-on approach, this course covers a broad range of topics concerning digital image processing applied to the remote sensing of atmospheric, cloud and surface properties using various satellite data sets. Prerequisites: ATS 509.

ATS 671 - GROUND BASED REMOTE SENSING
Semester Hours: 3
Principles and measurement capabilities of active and passive ground-based remote sensing systems: radar, wind profiler, lidar, sodar, and passive radiometer systems. Integration of remote sensing measurements to retrieve properties of atmospheric phenomena. Hands on usage and field measurements. Prerequisites: ATS 541.

ATS 672 - DUAL POLARIZATION RADAR MTRLGY
Semester Hours: 3
Theory, analysis and interpretation of dual polarization radar for meteorological applications. Course covers dual polarization radar system hardware; the basic theory underlying polarimetric radar data and methodology; analysis, interpretation and application of polarimetric radar variables; and dual meteorological and convective weather applications; specifically, precipitation measurement and hyrometeor identification. Example applications include rain rate estimation, drop size determination, hail identification, tornado detection, snow vs rain delineation, and cloud electrification studies. Prerequisites: ATS 571.
ATS 673 - LIGHTNING
Semester Hours: 3

An introduction to lightning. Topics include qualitative and quantitative description of lightning discharges; electrification of thunderstorms; temporal and spatial variation of lightning on multiple scales; various types of lightning; basic lightning models; current methods of measuring lightning. Prerequisites: ATS 509.

ATS 675 - ATMOSPHERIC DATA ASSIMILATION
Semester Hours: 3

Data assimilation methods and concepts including objective analysis and initialization as relevant to numerical weather prediction. Emphasis on variational methods, successive correction, optimal interpolation, adjoint and gradient concepts, singular vectors, Kalman filters and nudging. Prerequisites: ATS 541 and ATS 551.

ATS 681 - NUMERICAL ATMOS MODELING
Semester Hours: 3

Introduction to numerical methods applied to simulation of the atmosphere. Basic numerical solution techniques, along with filtering, radiative parameterizations, thermodynamics, turbulent parameterization, initialization and coordinate transformation. Prerequisites: ATS 551.

ATS 690 - SEL TOPICS IN ATMOS SCI
Semester Hours: 1-4

Selected topics of interest not included under other courses.

ATS 699 - MASTER'S THESIS
Semester Hours: 1-6

Required each semester a student is enrolled and receiving direction on a master's thesis.

ATS 740 - CLOUD PROCESSES
Semester Hours: 3

Theory and observations of the bulk microphysics and kinematic structures of clouds. Topics include: interactions among dynamical, microphysical and thermodynamic processes within cloud systems, the dynamics of organized convective systems, and remote sensing of clouds and precipitation features. Prerequisites: ATS 541 and ATS 551.

ATS 761 - ATMOSPHERIC RADIATION II
Semester Hours: 3

Advanced topics in atmospheric radiative transfer. Specific topics include Maxwell equations, Mie theory, polarization and radiative transfer in a scattering atmosphere. Prerequisites: ATS 561.

ATS 762 - MICROPARTICLE OPT & RADIOMETRY
Semester Hours: 3


ATS 770 - SATELLITE REMOTE SENSING
Semester Hours: 3

Using various satellite data sets and radiative transfer models, this course will train students to calculate and study cloud, aerosol, ocean and land surface properties to assess the radiative energy budget of the earth-atmosphere system. Prerequisites: ATS 670.

ATS 780 - ATMOSPHERIC SCIENCE SEMINAR
Semester Hour: 1

Speakers are invited to report on research relevant to the field of atmospheric science. Students are expected to attend at least twelve seminars and to write short descriptions of the presentations.

ATS 781 - STUDENT SEMINAR
Semester Hour: 1

Guest speakers report on research relevant to the fields of Atmospheric and Earth System Science. Students are expected to attend weekly seminars, submit a paper based on at least ten talks, and make a 15-minute conference type presentation on a research topic in atmospheric science selected in agreement with their advisor. Prerequisites: ATS/ESS 780.
ATS 782 - PROFESSIONAL DEVELOPMENT
Semester Hour: 1

Topics concerning professional ethics, writing scientific journal articles, proposals and resumes, preparing budgets, networking, time management, conference presentations, research administration, funding agencies, stress and burnout will be discussed. Selected topics of interest not included under other courses.

ATS 790 - SEL TOPICS IN ATMOS SCI
Semester Hours: 1-4

Selected topics of interest not included under other courses.

ATS 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9

Required each semester student is enrolled and receiving direction on a doctoral dissertation.

Atmospheric Science, PhD

The Doctor of Philosophy degree is a research-oriented degree awarded upon the demonstration of scholarly competence. To obtain the Ph.D. degree in Atmospheric Science, each student must satisfy all requirements of the School of Graduate Studies, as well as those of the Atmospheric Science Program. Admission to the Ph.D. program in Atmospheric Science is dependent upon satisfactory performance on the Preliminary Examination which is administered twice a year. Students entering UAH with an M.S. degree or previous graduate training in Atmospheric Science must pass the Preliminary Examination at an early opportunity. Students are permitted two attempts to pass the Preliminary Examination.

In summary, the five major requirements for the Ph.D. degree in Atmospheric Science are the following:

1. Take the core courses and pass the preliminary examination

Each student must pass the Preliminary Examination covering material in the three core courses plus three other ATS courses as outlined in the Ph.D. Preliminary Exam policies. The core courses are:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>ATS 541</td>
<td>ATM THERMODYN &amp; CLOUD PHYSICS</td>
<td>3</td>
</tr>
<tr>
<td>ATS 551</td>
<td>ATMOS FLUID DYNAMICS I</td>
<td>3</td>
</tr>
<tr>
<td>ATS 561</td>
<td>ATMOSPHERIC RADIATION I</td>
<td>3</td>
</tr>
</tbody>
</table>

It is anticipated that a student will take the exam during the second year of graduate study, but those with a strong background in Atmospheric Science may take the exam within the first year. The Preliminary Examination may be taken only twice. The student must pass all six sections in order to continue toward Ph.D. candidacy.

Supervisory Committee

After a student has passed the Preliminary Examination, a Supervisory Committee will be formed. The committee will consist of the student’s academic advisor plus at least four other members. Three of the Committee Members, including the Committee Chair, must be tenured or tenure-track members of the ATS faculty. The committee must be approved by the Graduate Dean. The committee will later administer the Qualifying Examination, and with consent of the Graduate Dean, give approval to all aspects of requirements 2-5.

2. Satisfy the residence requirement

According to graduate school policy, residence may be established through either:

1. being enrolled as a full-time student (at least 9 graduate semester hours) either for one continuous academic year, or for Spring and Fall semesters in the same calendar year, or
2. being enrolled in at least 6 semester hours of graduate course work in at least three of four consecutive semesters.

3. Complete an acceptable Program of Study (POS).

Students must formulate an appropriate Program of Study, in consultation with a faculty advisor and chair, before the end of the second semester. Each Program of Study, individualized to meet the student’s needs and requirements of the program, will stress breadth, depth, and research competence, and relate the major area to its applications. Any prerequisites for courses on the POS must be fulfilled before attempting the courses.

- Minimum degree requirements of this Program of Study will include at least 48 semester hours of graduate level course work. These include the core courses needed to prepare for the Preliminary Examination and courses required in a major area of concentration that will prepare the student
to conduct original research. While required, supporting courses, ATS 509, ATS 780, ATS 781, ATS 782, are not included in the minimum degree requirements of 48 semester hours.

- Students can transfer up to 24 semester hours of course work from their M.S. program.
- Students can transfer an additional 6 semester hours of course work, including, with approval, special topics courses but not including thesis semester hours.
- 50% of the minimum degree requirements (48 semester hours) must be from 600 level or higher courses.
- A minimum of 18 semester hours of doctoral dissertation (ATS 799) is required.
- Students must register for a total of 3 semester hours of Seminar and Professional Development. (ATS 780, ATS 781, ATS 782)
- Students must maintain a cumulative GPA of at least 3.0.

4. Pass the Qualifying Examination

Once the Program of Study has been submitted and the Ph.D. Student Advisory Committee (SAC) has been formed, the next steps are to submit a written dissertation proposal to the SAC and then make an oral presentation (usually 2-3 weeks later). This will be followed by the Qualifying Examination, which will cover the major areas of study and the student’s proposal for the dissertation topic. It will have both written and oral components and will be prepared and graded by the SAC. This examination may be taken at most twice.

5. Complete and defend a research dissertation

Each student must complete and successfully defend a research dissertation, the results of which are publishable in a nationally recognized journal. The dissertation, which must comply with the regulations set forth in the School of Graduate Studies' Thesis and Dissertation Manual, must be approved by the student’s supervisory committee, the chair of the Atmospheric Science Department, the Dean of the College of Science, and the Dean of the School of Graduate Studies. A significant portion of the dissertation must be submitted for publication in an approved journal.

Additional Information

All requirements for the Ph.D. must be completed in no more than five years after the student has passed the qualifying examination.

The atmospheric science program does not require knowledge of a foreign language, but it does require proficiency in both spoken and written English.

Atmospheric Science, MS

- To obtain the M.S. degree in Atmospheric Science, each student must satisfy all requirements of the School of Graduate Studies as well as those of the Atmospheric Science Program.
- Students must formulate an appropriate Program of Study (POS), in consultation with a faculty advisor and chair, before the end of the second semester.
- Students must maintain a cumulative GPA of at least 3.0.

Option 1 - Thesis

Minimum degree requirements under this plan include completion of at least 24 credit hours of graduate course work and at least 6 credit hours of thesis research. At least 50% of the required 24 semester hours must be from 600 level (or higher) courses. Students are also required to take 6 credit hours of supporting courses. The supporting courses do not count toward the minimum degree requirements.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>ATS 541</td>
<td>ATM THERMODYN &amp; CLOUD PHYSICS</td>
<td>3</td>
</tr>
<tr>
<td>ATS 551</td>
<td>ATOMS FLUID DYNAMICS I</td>
<td>3</td>
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<tr>
<td>ATS 561</td>
<td>ATMOSPHERIC RADIATION I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Elective Courses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select 12 semester hours from 600 level (or higher) courses</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Select 3 semester hours from 500 or 600 level courses and may be outside of ATS only with advisor's approval</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Required Supporting Courses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATS 509 APPL COMPUTERS IN METEOROLOGY</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>ATS 780 ATMOSPHERIC SCIENCE SEMINAR</td>
<td>1</td>
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<tr>
<td></td>
<td>ATS 781 STUDENT SEMINAR</td>
<td>1</td>
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<tr>
<td></td>
<td>ATS 782 PROFESSIONAL DEVELOPMENT</td>
<td>1</td>
</tr>
</tbody>
</table>

Thesis Credits
Additional Information

In Option 1, the student must write and defend a thesis. The thesis must show evidence of the student's capability for research, independent thought and analysis in atmospheric science and must be written in fluent, acceptable English. During the second semester, the student, with the guidance of their advisor, should form a supervisory committee. Student must submit a 5 page thesis proposal to be approved by the advisor and committee by the end of the third full semester.

Option 2 - Non-Thesis

Minimum degree requirements under this plan include completion of at least 33 credit hours of graduate course work. At least 50% of the required 33 semester hours must be from 600 level (or higher) courses. In addition, all M.S. students are required to take 6 credit hours of supporting courses. The supporting courses do not count toward the minimum degree requirements.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>ATS 541</td>
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<td></td>
<td>Elective Courses</td>
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<tr>
<td></td>
<td>Select 18 semester hours from 600 level (or higher) courses</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Select 6 semester hours from 500 or 600 level courses and may be outside of ATS only with advisor's approval</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Required Supporting Courses</td>
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<tr>
<td>ATS 509</td>
<td>APPL COMPUTERS IN METEOROLOGY</td>
<td>3</td>
</tr>
<tr>
<td>ATS 780</td>
<td>ATMOSPHERIC SCIENCE SEMINAR</td>
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</tr>
<tr>
<td>ATS 781</td>
<td>STUDENT SEMINAR</td>
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</tr>
<tr>
<td>ATS 782</td>
<td>PROFESSIONAL DEVELOPMENT</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total Semester Hours</td>
<td>39</td>
</tr>
</tbody>
</table>

1. Students must earn a B or above in core courses.
2. Students who have earned a B or better in the undergraduate equivalent ATS 541, ATS 551, ATS 561 at UAH do not have to re-take the course at the graduate level. However, their Program of Study must include alternative semester hours at the appropriate level approved by their advisor and chair of the department.
3. Students who have earned a B or better in the undergraduate equivalent of ATS 509 at UAH have fulfilled the requirement.

Comprehensive Examination/Thesis Defense

A final comprehensive examination is required of all candidates for a master's degree; this examination may be written or oral, or both. In accordance with the Graduate Studies Dates & Deadlines, a written notice of the time and place of the examination/defense must be sent to the Graduate Dean. After approval by the Graduate Dean, the Department Chair sends a copy of the written Notification of Oral Examination/Defense to the candidate and each member of the committee. A student may take the Comprehensive Examination only twice.

- **Thesis** candidates will be examined primarily on the thesis by a committee of at least three faculty members appointed by the Department Chair and approved by the Graduate Dean.

- **Non-Thesis** candidates will be examined on course work. Three weeks before the exam, the advisor/chair will email two "lead-in" questions about the student's course work from each committee member. This will be the starting point for the oral exam. The committee members may also question further during the exam. Students who pass all sections of the Ph.D. Preliminary Exam are not required to take the M.S. Comprehensive Exam.
M.S. Supervisory Committee

The committee must consist of a minimum of three members and be approved by the Department Chair. Two of the three members, including the Committee Chair, must be full-time, tenured or tenure-earning faculty members in the department. The other member may be nominated to the Affiliate Graduate Faculty or be a current faculty member from another UAH department.

Paperwork

• Students must formulate an appropriate Program of Study (POS), in consultation with a faculty advisor and chair, before the end of the second semester.
• Application for graduate degree according to the Graduate Studies Dates & Deadlines.
• Notification of Oral Examination/Defense according to the Graduate Studies Dates & Deadlines.

Biological Sciences

369A Shelby Center
Telephone: 256.824.6260
Email: biology@uah.edu (biology.grad@uah.edu)

Chair: Debra M. Moriarity, Professor

The Biological Sciences department offers the following graduate degree program:

Master of Science

Admission Requirements

In addition to fulfilling admission requirements set by the School of Graduate Studies, applicants must also:

1. Take the general GRE exam and TOEFL when applicable
2. Have a Biology degree or related course work
3. Show competence in an area of life science related to the proposed area of study
4. Complete one year of undergraduate chemistry, including at least one semester each of organic chemistry and biochemistry
5. Complete at least one advanced (upper division) class in any of the following: biochemistry, cell biology, ecology, evolution, genetics, molecular biology, or physiology course
6. Have a minimum cumulative GPA of 3.0 as well as in the major area of concentration
7. A course in statistics is also recommended

Applicants demonstrating potential for graduate study in the biological sciences, but having some deficiencies in their previous academic work, may be admitted on a conditional basis. See the Biological Sciences (http://www.uah.edu/science/departments/biology) webpage for application information.

Program Objective

The UAH Department of Biological Sciences aspires to provide one of the best programs in the Southeast through undergraduate and graduate education and research. Our objective is to educate and train students for the critical analysis, problem solving, and independent thinking skills required in scientific research. Through our M.S programs and the interdisciplinary Biotechnology Ph.D. degree, we aspire thorough training and mentoring, to cultivate future scientists who are trained to serve national needs in education, government, and industry.

Learning Outcomes

Students will demonstrate their ability to

• Utilize the scientific method to resolve biological problems
• Write a scholarly document
• Prepare and deliver an effective oral scientific presentation

Master's Program in Biological Sciences
Program Requirements

A minimum of 25 percent of biological sciences course requirements must be met at the cooperating institution. A minimum of 50 percent of the graduate program must be taken at the 600-level. The graduate program of study cannot include more than 6 semester hours each of BYS 691 (http://catalog.uah.edu/search/?P=BYS%20691) or BYS 692 (http://catalog.uah.edu/search/?P=BYS%20692). Three semester hours of graduate seminar can be counted toward fulfillment of the graduate program. Titled BYS 691 (http://catalog.uah.edu/search/?P=BYS%20691) courses offered on an ad hoc basis and instructed as part of the didactic curriculum are exempt from the 6 semester hour maximum.

Students may elect one of the following three plans for the Master’s degree:

Plan I – Master of Science with Thesis

Students will complete coursework (minimum of 24 semester hours) and perform original research that will be described in their thesis (minimum of 6 semester hours of BYS 699 (http://catalog.uah.edu/search/?P=BYS%20699)), for a total of 30 semester hours. Students will complete a comprehensive written examination, and final oral examination (seminar presentation of thesis work and master’s committee examination of thesis work).

Plan II – Master of Science without Thesis

Students will complete an approved program of study (minimum of 33 semester hours), complete a written comprehensive final examination, and write and present a master’s report for the supervisory committee. The report is usually in the form of a literature review, survey, and/or experimentation about some pertinent topic.

Plan III – Master of Science with Education

Alternative Class A

Students with an accredited baccalaureate degree other than teacher education, seeking initial certification (those that do not have a Class B – baccalaureate level teaching certification) will complete coursework in the Department of Education (21 semester hours, including an internship) and the Department of Biological Sciences (24 semester hours) as well as complete a written comprehensive final examination and write a master’s report. The master’s report is usually in the form of a literature review, survey, and/or experimentation about some pertinent topic.

BYS 505 - PSYCHOPHARMACOLOGY
Semester Hours: 3
Introduction to drug classification and action with emphasis on physiological and psychological interactions. Same as PY 505.

BYS 519 - GENE STRUCTURE & FUNCTION
Semester Hours: 3
Advanced studies of macromolecular structure and biological function of proteins and nucleic acids involved in the passage of genetic information and cellular response. Structural significance of viruses and molecular evolution included.

BYS 523 - PRINCIPLES OF VIROLOGY/A&M
Semester Hours: 3
Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Principles of viral infectivity, multiplication, and chemical constitution; laboratory techniques for their isolation, cultivation, identification, and enumeration.

BYS 524 - MYCOLOGY/A&M
Semester Hours: 3
Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Lines of phycymycetes using representative species; various series of actinomycetes; representative pathogenic (crop and vegetative pathogens) and nonpathogenic heterobasidiomycetidae organisms; order and families of homobasidiomycetidae. Ontogenetics, cellular, and structural study applied to all divisions, classes, series, orders and families.

BYS 526 - MICROBIAL ECOLOGY
Semester Hours: 4
Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Relationship of soil and aquatic microorganisms and their importance in ammonification, nitrification, and other biological processes.

BYS 529 - BIOSTATISTICS/AL A&M
Semester Hours: 4
BYS 532 - MEDICAL PHYSIOLOGY
Semester Hours: 4
Detailed study of physiology, covering membrane transport, muscle, nerve, heart, lung, gastrointestinal and renal function. Emphasis will be on homeostasis, genetic disease and pharmacological therapy.

BYS 532L - LABORATORY
Semester Hours: 0

BYS 534 - MEDICAL PHYSIOLOGY II
Semester Hours: 3
Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Continuation of mammalian physiology with consideration of kidney function, respiratory, digestive, reproductive, and endocrine systems.

BYS 535 - ADVANCED MICROBIOLOGY
Semester Hours: 3
Aspects of microbial behavior, development, morphogenesis or physiology.

BYS 537 - PSYCHOBIOLOGY STRESS & ILLNESS
Semester Hours: 3
Overview of physiological stress responses and their influence on health, behavior, and illness. Same as PY 536.

BYS 542 - NUTRITIONAL PHYSIOLOGY
Semester Hours: 3
Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Advanced laboratory dealing with modern techniques of molecular biology and biochemistry.

BYS 543 - MOLECULAR BIOLOGY OF THE CELL
Semester Hours: 3
Advanced study of cell structure and function of macromolecules (lipids, proteins, carbohydrates and nucleotides). In depth literature readings on subcellular organelles, metabolic pathways, cell cycle, cancer, and cell differentiation.

BYS 547 - BIOCHEMISTRY I
Semester Hours: 3
Structural chemistry and function of biomolecules, mechanisms of biochemical reactions, and enzyme kinetics. Same as: CH 561.

BYS 548 - BIOCHEMISTRY II
Semester Hours: 3
Energy transduction, metabolism, biosynthesis of macromolecular precursors, storage, transmission, and expression of genetic information. Same as CH 562. Prerequisites: BYS 547 or CH 561.

BYS 556 - ADV MOLECULAR TECHNIQUES
Semester Hours: 3
Laboratory techniques in molecular biology including current methodology in genomics, proteomics and RNA analysis. Prerequisites: BYS 519 with concurrency.

BYS 560 - ENVIRONMENTAL BIOLOGY/A&M
Semester Hours: 3
Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Principles of interaction between living systems and their resources. Current problems in management of natural resources including new approaches in management of pest populations.

BYS 562 - COMMUNITY ECOLOGY
Semester Hours: 4
Detailed consideration of ecological principles and concepts, as well as biotic and abiotic factors relevant to development of communities and ecosystems. Field trips required.

BYS 563 - POPULATION ECOLOGY
Semester Hours: 4
Distribution, population dynamics and behavior of populations in relation to environmental factors. Field trips required.
BYS 564 - LIMNOLOGY  
Semester Hours: 3  
Fresh-water environments and organisms exemplified by lakes, ponds, and streams in North Alabama.

BYS 600 - NEUROSCIENCE  
Semester Hours: 3  
An advanced survey of the field of neuroscience, from basic neuroanatomy and physiology, to current topics, such as neurodegenerative disease, learning and memory, consciousness, cognitive theory and neurocomputing.

BYS 601 - BIOINFORMATICS I  
Semester Hours: 3  
Practical use in Bioinformatics and X-ray crystallography.

BYS 602 - BIOINFORMATICS II  
Semester Hours: 3  
Practical use in Bioinformatics and applied Genomics.

BYS 619 - MICROBIAL GENETICS  
Semester Hours: 3  

BYS 630 - IMMUNOLOGY  
Semester Hours: 4  
Innate, humoral and cell-mediated immunity. Immune deficiencies and hyper sensitivities. Autoimmunity, transplantation and tumor immunology.

BYS 631 - MEDICAL PHARMACOLOGY/A&M  
Semester Hours: 3  
Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Drug-receptor interaction, kinetics of drug absorption, distribution and elimination, and discussion of drugs affecting different systems. Pharmacogenetics, toxicity, mutagenesis, teratogenesis, carcinogenesis, and drug interactions. Mechanism of action of drugs, in relation to their use as therapeutic agents in medicine.

BYS 690 - SEMINAR  
Semester Hour: 1  
Student reports on current journal articles, research, or assigned readings. Graduate students should attend whether enrolled for credit or not. May be taken up to three times for credit.

BYS 691 - SPECIAL TOPICS  
Semester Hours: 1-4  
Directed readings and/or written reports on topics of individual student interest carried out under the supervision of an instructor. Prerequisite: permission of instructor required before registration.

BYS 692 - RESEARCH  
Semester Hours: 2-4  
Individual investigations of biological problems under supervision of a graduate faculty member. Permission of instructor required before registration.

BYS 699 - MASTER'S THESIS  
Semester Hours: 1-6  
Required each semester student is working on and receiving direction on master's thesis. Minimum of six hours required for M.S. thesis students.

Biological Sciences, MS

Biological Sciences Department (http://www.uah.edu/science/departments/biology)

369A Shelby Center for Science and Technology  
256-824-6260  
biology@uah.edu (biology@uah.edu)  
Department Chair: Debra M. Moriarity, PhD
The graduate faculty, in cooperation with the graduate faculty of Alabama A&M University, offers an M.S. in Biological Sciences with emphasis in cell biology, environmental biology, genetics and molecular biology, biotechnology, bioinformatics, microbiology, or physiology.

Admissions Requirements
In addition to fulfilling admission requirements set by the School of Graduate Studies, applicants must also have:

- Taken the general GRE exam and TOEFL when applicable
- Biology degree or related course work
- At least one advanced (upper division) class in any of the following: biochemistry, cell biology, ecology, evolution, genetics, molecular biology, or physiology course
- A minimum cumulative GPA of 3.0 as well as in the major area of concentration

Applicants demonstrating potential for graduate study in the Biological Sciences, but having some deficiencies in their previous academic work may be admitted on a conditional basis. See the Biological Sciences (http://www.uah.edu/science/departments/biology) webpage for application information.

Program Requirements
A minimum of 25 percent of Biological Sciences course requirements must be met at the cooperating institution. A minimum of 50 percent of the graduate program must be taken at the 600-level. The graduate program of study cannot include more than 6 semester hours each of BYS 691 or BYS 692. Three semester hours of graduate seminar can be counted toward fulfillment of the graduate program. Titled BYS 691 courses offered on an ad hoc basis and instructed as part of the didactic curriculum are exempt from the 6 semester hour maximum.

Students may elect one of the following three plans for the Master’s degree:

**Plan I – Master of Science with Thesis**
Students will complete coursework (minimum of 24 semester hours) and perform original research that will be described in their thesis (minimum of 6 semester hours of BYS 699), for a total of 30 semester hours. Students will complete a comprehensive written examination, and final oral examination (seminar presentation of thesis work and master’s committee examination of thesis work).

**Plan II – Master of Science without Thesis**
Students will complete an approved program of study (minimum of 33 semester hours), complete a written comprehensive final examination, and write and present a master’s report for the supervisory committee. The report is usually in the form of a literature review, survey, and/or experimentation about some pertinent topic.

**Plan III – Master of Science with Education (Two Choices)**

**Traditional Program**
Students with Alabama Class B certification will complete coursework without specialization in the Department of Biological Sciences (24 semester hours), and in the Department of Education (12 semester hours), complete a written comprehensive final examination, and write and present a master’s report for the supervisory committee. The report is usually in the form of a literature review, survey, and/or experimentation about some pertinent topic. Graduates will be recommended for Alabama Class A teaching certification.

**Non-traditional Fifth Year Program**
Students with an accredited baccalaureate degree other than teacher education, seeking initial certification (those that do not have a Class B – baccalaureate level teaching certification) will complete coursework in the Department of Education (21 semester hours, including an internship) and the Department of Biological Sciences (24 semester hours) as well as complete a written comprehensive final examination and write a master’s report. The master’s report is usually in the form of a literature review, survey, and/or experimentation about some pertinent topic.

**Chemistry**

203-C Materials Science Building
Telephone: 256.824.6153
Email: chem.admin@uah.edu (jeffrey.champoux@uah.edu)

Chair: John Foster, Professor

The Chemistry department offers the following graduate degree program:

Masters of Science
Admission Requirements

General requirements of the School of Graduate Studies must be satisfied. In addition, students admitted to the graduate chemistry program are assumed to have training equivalent to the chemistry B.S. degree recommended by the American Chemical Society. The degree includes lecture and laboratory work in organic chemistry, physical chemistry, inorganic chemistry, analytical chemistry, biochemistry, polymer chemistry, and materials chemistry. Graduation from an undergraduate program not adhering to ACS standards does not preclude entrance into the UAH program. Students should realize, however, that if deficiencies exist, some additional undergraduate courses might be required. The time required to complete the M.S. degree may then be proportionately increased.

Program Objective

The Department of Chemistry is to provide high quality education in all aspects of chemistry. Graduates of the Master of Science program will present their work in well-respected journals with significant impact. Our second objective is to educate our students in chemistry to obtain either satisfactory employment or enrollment in a graduate or professional degree program.

Learning Outcomes

Students will demonstrate:

• Ability to effectively present chemical knowledge in writing
• Ability to deliver an effective oral presentation of their research
• An excellent understanding of the basic concepts, methods, terminology, and theories of modern chemistry related to their research interests

Master's Program in Chemistry

General requirements of the School of Graduate Studies under Plan I or Plan II must be satisfied.

Plan I – Master of Science with Thesis

Up to 12 semester hours of the course requirements may be accepted as transfer credits from graduate work done in other chemistry programs.

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Plan II – Master of Science without Thesis

Graduate students entering Plan II must qualify by meeting one of the following preliminary examination requirements:

1. Passing ACS exams in biochemistry, inorganic chemistry, organic chemistry, or physical chemistry.
2. Having previously passed at least two sections of the Materials Science Program Exam I.
3. Having previously passed the Biotechnology Science and Engineering Preliminary Exam.

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<td><strong>Select at least 18 semester hours in graduate coursework in chemistry or related fields:</strong></td>
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<td><strong>Total Semester Hours</strong></td>
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¹ CH 633 can only be applied to one area: Organic or Analytical Chemistry

At least 18 semester hours out of the 33 total semester hours must be in Chemistry.
Plan II requires a program of study drawn up by the student and the Chemistry M.S. degree program advisor. Students must also complete two credit hours of CH 780 (http://catalog.uah.edu/search/?P=CH%20780). Plan II is not recommended for students seeking employment as industrial laboratory chemists because it does not require any experimental work.

**Non-Traditional Fifth-Year Program Leading to the M.S. in Chemistry Plus a Class A Alabama High School Teacher’s Certificate**

Those who have a B.A. or B.S. degree with a major or its equivalent in chemistry as determined by the Department of Chemistry, who have not taken more than 12 semester hours in teacher education (graduate or undergraduate), and who are interested in obtaining Class A (master’s level) certification for secondary school teaching, should consider the Non-Traditional Fifth Year Program. Contact the College of Education for preliminary advisement on admission and general program requirements. See the description in the Education (http://catalog.uah.edu/search/?P=Education) section for more details.

**CH 500 - TOPICS IN CHEMISTRY**
Semester Hours: 1-3

Advanced laboratory research in one of the departmental research groups. The student works on an independent or group research project. Completion of the course requires an appropriate written and oral report. Prerequisites: Approval of instructor.

**CH 521 - CHEMICAL INSTRUMENTATION**
Semester Hours: 4

Use of basic instrumentation in NMR, mass spectrometric, chromatographic, and spectrophotometric analysis.

**CH 540 - POLYMER SYNTHESIS & CHARACTERI**
Semester Hours: 3

Same as MTS 649.

**CH 549 - SPECTROSCOPY & MOLEC STR**
Semester Hours: 3

Intermediate level treatment of principles of spectroscopy and their application to determination of molecular structure.

**CH 553 - INTRO QUANTUM MECH I**
Semester Hours: 3

Waves and particles; Bohr’s model; de Broglie waves, wave-packets, uncertainty principle; quantum mechanics postulates; Schroedinger equation; systems in 1, 2 & 3 dimensions; hydrogen atom. Same as PH 551, OSE 555, and MTS 651.

**CH 554 - INTRO QUANTUM MECH II**
Semester Hours: 3

Angular momentum and spin; atomic structure and spectrum; time-independent pertubation theory, variational methods; time-dependent pertubation theory and interactions of light with matter; scattering theory; electronic structure of solids; relativistic quantum mechanics. Same as: PH 552, MTS 652. Prerequisite: PH 551 or CH 553.

**CH 561 - BIOCHEMISTRY I**
Semester Hours: 3

Structural chemistry and function of biomolecules, mechanisms of biochemical reactions, enzyme kinetics, and energy transfer. Same as: BYS 547.

**CH 562 - BIOCHEMISTRY II**
Semester Hours: 3

Metabolism, biosynthesis of macromolecular precursors, storage, transmission, and expression of genetic information, and molecular physiology. Same as BYS 548. Prerequisites: CH 561 or BYS 547.

**CH 600 - ADV INORGANIC CHEMISTRY**
Semester Hours: 3

Survey with emphasis on structure and reactivity of inorganic compounds.

**CH 602 - CHEM COORD COMPOUNDS**
Semester Hours: 3

Modern bonding theory and stereo chemistry of coordination compounds.
CH 621 - METHODS OF CHEMICAL ANALYSIS  
Semester Hours: 3  
Literature, seminar course. Theory and methodology of various techniques of chemical analysis.

CH 631 - SYNTHETIC ORGANIC CHEMISTRY  
Semester Hours: 3  
Survey of certain reactions that enjoy widespread application to the synthesis of organic compounds.

CH 632 - PHYSICAL ORGANIC CHEMISTRY  
Semester Hours: 3  
Reactive intermediates, structure-activity relationships, reaction mechanisms and techniques used to determine them.

CH 633 - ORGANIC STRUCTURE DETERMINATION  
Semester Hours: 3  
Structure determination of organic molecules using spectroscopic methods, especially NMR, IR, and MS. Emphasis on the theory and interpretation of many NMR methods useful in chemistry research.

CH 634 - MOLECULAR MODELING  
Semester Hours: 4  
Molecular modeling methods, including molecular mechanics, molecular docking, molecular orbital theory, and density functional theory, will be used to investigate conformational properties of organic compounds, molecular interactions between biological macromolecules and organic ligands, electronic structure of organic and inorganic compounds, frontier molecular orbitals, pericyclic reactions, and reactive intermediates. Extensive computational laboratory work included.

CH 635 - CHEMICAL TOXICOLOGY  
Semester Hours: 3  
An introduction to the principles of chemical toxicology, including the effects of drugs, environmental pollutants, natural toxins and venoms and other potentially hazardous chemicals at the physiological, cellular, and molecular level.

CH 640 - ADVANCED CHEMICAL THERMODYNAMICS  
Semester Hours: 3  

CH 641 - STATISTICAL THERMODYNAMICS  
Semester Hours: 3  
Principles leading to the development of Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics. Thermodynamic properties calculated from partition functions.

CH 642 - ADVANCED CHEMICAL DYNAMICS  
Semester Hours: 3  
Non-equilibrium thermodynamics, macroscopic and microscopic theories of diffusion, chemical reaction rate laws and mechanisms, transition state theory, gas phase molecular dynamics, electrical conduction in electrolyte solutions, electrode kinetics. Prerequisite: CH 640.

CH 643 - QUANTUM CHEMISTRY  
Semester Hours: 3  
Application of quantum theory to the chemical bond.

CH 644 - CHEMICAL ELECTRODYNAMICS  
Semester Hours: 3  
Maxwell's equations applied to electrodynamic problems in chemistry. Theory of dielectrics, dipole moments, Beer's law, Landolt's rule, light scattering, magnetic properties, quantum theory of radiation.

CH 645 - POLYMER PHYSICAL CHEMISTRY  
Semester Hours: 3  
Introduction to structure, properties and processing of polymers. Physical behavior of polymers, structure-property relationships, polymer characterization, thermodynamics of polymer solutions and melts, mechanical evaluation of polymers. Same as MTS 747. Prerequisite: CH 540.
CH 646 - THERMODYNAMICS OF MATRLS
Semester Hours: 3
Fundamental thermodynamic review, phase equilibrium, chemical reaction equilibrium, free energy, binary and ternary phase transformations, solution models and selected topics. Same as CHE 646 and MTS 646.

CH 647 - ADV BIOPHYSICAL CHEMISTRY I
Semester Hours: 3
Topics include: computer data analysis & simulation, first & second laws of thermodynamics, free energy & equilibrium, calorimetry, protein stability, binding & interactions, solution thermodynamics, electrolytes. Students who have completed CH 347 cannot earn credit for CH 647.

CH 648 - ADV BIOPHYSICAL CHEMISTRY II
Semester Hours: 3
Advanced biophysical chemistry, including biochemical reaction kinetics, enzyme catalysis, quantum mechanics, statistical thermodynamics, spectroscopy, including UV-VIS, fluorescence, circular dichroism, NMR, and Structure determinations. An emphasis is placed on the current research literature. Prerequisite: CH 647 Students who have completed CH 348 cannot earn credit for CH 648.

CH 650 - PRINC LIQUID/SOLID INTER
Semester Hours: 3
Applies principles in thermodynamics & kinetics to characterize surfaces & surface phenomena. Fundamental properties of gas-liquid, liquid-liquid, solid-liquid and solid-gas interfaces and phenomena at these interfaces. Same as MTS 650 and CHE 650.

CH 699 - MASTER'S THESIS
Semester Hours: 3-6
Required each semester a student is enrolled and receiving direction on a masters thesis. Minimum of two terms is required. (A maximum of six hours may be applied towards the degree).

CH 700 - CURRENT TOPICS IN CHEMISTRY
Semester Hours: 1-3
Advanced laboratory research in one of the departmental research groups. The student works on an independent or group research project. Completion of the course requires a written and an oral report. Prerequisite: approval of instructor.

CH 705 - SEL TOP IN INORGANIC CHEM
Semester Hours: 3
Prerequisites: CH 600 and approval of instructor.

CH 721 - SP TOP IN ANALYTICAL CHEMISTRY
Semester Hours: 3
Prerequisites: CH 621 and approval of instructor.

CH 735 - SEL TOP IN ORGANIC CHEM
Semester Hours: 3
Prerequisites: CH 632 and approval of instructor.

CH 745 - SEL TOP IN PHYSICAL CHEM
Semester Hours: 3

CH 746 - SOLID STATE CHEMISTRY
Semester Hours: 3
Chemical properties of solids. Includes phase equilibria, chemical bonding in ionic and covalent crystals, thermodynamics of atomic defects, ionic conductivity in solids, corrosion, & introduction to surfaces and adsorption.

CH 765 - SEL TOPICS IN BIOCHEM
Semester Hours: 3
Prerequisites: CH 560 and approval of instructor.

CH 780 - CHEMISTRY SEMINAR
Semester Hour: 1
Required during each semester of residence.
CH 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9

Chemistry, MS

General requirements of the School of Graduate Studies under Plan I or Plan II must be satisfied.

Plan I – Master of Science with Thesis

Up to 12 semester hours of the course requirements may be accepted as transfer credits from graduate work done in other Chemistry programs.

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Plan II – Master of Science without Thesis

Graduate students entering Plan II must qualify by meeting one of the following preliminary examination requirements:

a. Passing ACS exams in biochemistry, inorganic chemistry, organic chemistry and physical chemistry.

b. Having previously passed at least two sections of the Materials Science Program Exam I.

c. Having previously passed the Biotechnology Science and Engineering Preliminary Exam.
Select one course from each of the following fields:

### Analytical:
- **CH 521** CHEMICAL INSTRUMENTATION
- **CH 549** SPECTROSCOPY & MOLEC STR
- **CH 621** METHODS OF CHEMICAL ANALYSIS

### Inorganic:
- **CH 600** ADV INORGANIC CHEMISTRY

### Organic:
- **CH 631** SYNTHETIC ORGANIC CHEMISTRY
- **CH 632** PHYSICAL ORGANIC CHEMISTRY
- **CH 633** ORGANIC STRUCTURE DETERMINAT'N
- **CH 634** MOLECULAR MODELING

### Physical Chemistry:
- **CH 640** ADV CHEMICAL THERMODYNAMICS
- **CH 641** STATIST THERMODYNAMICS
- **CH 642** ADV CHEMICAL DYNAMICS
- **CH 643** QUANTUM CHEMISTRY
- **CH 646** THERMODYNAMICS OF MATRLS
- **CH 647** ADV BIOPHYSICAL CHEMISTRY I
- **CH 648** ADV BIOPHYSICAL CHEMISTRY II

Select one course from one of the following fields:

### Biochemistry:
- **CH 561** BIOCHEMISTRY I
- **CH 562** BIOCHEMISTRY II

### Polymer:
- **CH 540** POLYMER SYNTHESIS & CHARACTERI
- **CH 645** POLYMER PHYSICAL CHEMISTRY

Select at least 18 semester hours in graduate coursework in chemistry or related fields

Total Semester Hours: 33

Of the total of 33 semester hours of course work required under Plan II, at least 18 semester hours must be in Chemistry.

Plan II requires a program of study drawn up by the student and the Chemistry M.S. degree program advisor. Students must also register for CH 780 (http://catalog.uah.edu/search/?P=CH%20780) during at least four semesters. Plan II is not recommended for students seeking employment as industrial laboratory chemists because it does not require any experimental work.

### Non-Traditional Fifth-Year Program Leading to the M.S. in Chemistry Plus a Class A Alabama High School Teacher’s Certificate

Those who have a B.A. or B.S. degree with a major or its equivalent in Chemistry as determined by the Department of Chemistry, who have not taken more than twelve semester hours in teacher education (graduate or undergraduate), and who are interested in obtaining Class A (master’s level) certification for secondary school teaching, should consider the Non-Traditional Fifth-Year Program. Contact the Education Department for preliminary advisement on admission and general program requirements. See the description in the Education (http://catalog.uah.edu/search/?P=Education) section for more details.

### Computer Science

Olin B. King Technology Hall

300 Technology Drive

Telephone: 256.824.6088

Email: info@cs.uah.edu
Chair: Heggere S. Ranganath, Professor

The Computer Science department offers the following graduate degree programs:

Master of Science in Computer Science
Interdisciplinary Master of Science in Software Engineering
Interdisciplinary Master of Science in Cybersecurity (http://catalog.uah.edu/grad/colleges-departments/interdisciplinary-programs/cybersecurity-ms-interdisciplinary-computer-science-track)
Doctor of Philosophy in Computer Science

The Computer Science department offers the following certificate programs:

Software Engineering

Admission Requirements

Requirements for admission to the computer science graduate degree program are in addition to those of the School of Graduate Studies. Scores from the GRE basic test are required for admission to the program. Transcripts will be reviewed and deficiencies in computer science background may result in the need to take one or more broadening courses. The MAT or GMAT is not an acceptable substitute for the GRE.

Requirements for admission to a graduate certificate program are the same as requirements for admission to the Computer Science M.S. program. Students must also satisfy the breadth requirements described below. Students in a certificate program are required to maintain a 3.0 GPA.

Students applying for the master’s program are expected to have an undergraduate background in Computer Science. Those students who do not have such a background must satisfy the breadth requirements described below. In particular, students who have not had an undergraduate course in programming language principles must take CS 424 (http://catalog.uah.edu/search/?P=CS%20424) or CS 524 (http://catalog.uah.edu/search/?P=CS%20524) as a prerequisite to the MSCS and MSSE programs.

The admission policies for the Ph.D. program in computer science follow the general policies of the School of Graduate Studies and Computer Science Department as described above. An applicant’s admission request will be reviewed in light of preparatory coursework, GRE scores, any supporting information, and general expectation of completing the degree. Students requiring a large amount of prerequisite coursework will not normally be admitted to the program until the courses have been completed. Graduate admission requests for the Ph.D. program will be reviewed once per semester by a departmental admissions committee. Applicants are required to submit supporting recommendation letters and an indication of research interests and study plans. Specific requirements are available from the Computer Science Department office. Requests for admission will be evaluated according to the following guidelines.

Unconditional Admission

Students applying to the M.S. program will be given unconditional admission if they meet all the requirements of the School of Graduate Studies and of the Computer Science Department including the breadth requirements listed below.

Unconditional admission to the Ph.D. program will be given to applicants who meet all of the requirements of the School of Graduate Studies and Computer Science Department. Students showing exceptional promise who desire to pursue the Ph.D. full-time may be admitted to the program after completing a bachelor’s degree in Computer Science.

Conditional Admission

Conditional admission will be recommended for applicants who do not meet all of the requirements of the School of Graduate Studies and the Computer Science Department, but show high potential for completing the degree requirements.

Breadth Requirements

Applicants to graduate programs in Computer Science must satisfy the following breadth requirements before admission to the program.

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<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td>MA 171</td>
<td>CALCULUS A</td>
<td>4</td>
</tr>
<tr>
<td>MA 172</td>
<td>CALCULUS B</td>
<td>4</td>
</tr>
<tr>
<td>MA 244</td>
<td>INTRO TO LINEAR ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>MA 385</td>
<td>INTRO TO PROBABILITY &amp; STATIST</td>
<td>3</td>
</tr>
<tr>
<td>CS 121</td>
<td>COMPUTER SCIENCE I</td>
<td>3</td>
</tr>
</tbody>
</table>
Program Objective
The objective of the Computer Science program is to prepare students to become contributors to the computer science profession, whether they find themselves in industrial, government, research, or university environments. Our second objective is to enable students to demonstrate leadership capabilities and work effectively with others of varying backgrounds in team environments.

Learning Outcomes
Students will demonstrate:

- Advanced knowledge of computer systems
- Proficient development and usage of software systems and development tools
- Ability to develop solutions based on advanced algorithmic principles

Master's Programs in Computer Science

Degree Requirements and Restrictions
The Master of Science degree or Master of Science in Software Engineering is conferred under Plan I or Plan II.

Transfer to Computer Science from Other UAH Graduate Programs
Students enrolled in other graduate programs at UAH who wish to obtain a degree in Computer Science should see a Computer Science advisor for evaluation. Such a student must fulfill the Computer Science breadth requirements. Taking CS graduate courses without first checking with a departmental advisor will not eliminate the need for completing the breadth requirements.

The Program of Study
A program of study should be completed as soon as the course content of the program has been selected. The plan must be made in consultation with an advisor from the Computer Science faculty. The student’s Faculty Advisor, Department Chair, and the Dean of the School of Graduate Studies approve the program of study. After approval, student requested changes must be agreed to by the student’s advisor and submitted for approval.

Cybersecurity
The MSCBS degree is a unique, interdisciplinary program involving three colleges: Business Administration, Engineering, and Science. The program prepares graduates with the skills to secure and defend networks, recover from security failures, use computer forensics, and manage data security -- leading to careers in the fast growing field of information security. The Computer Science track involves developing, documenting, and maintaining secure coding practices for scripts and applications. The design aspects of networks ensuring a risk mitigated network in relation to confidentiality, integrity, and the availability of data and devices are also included. A student must complete five core courses (IS 660, IS 663, CPE 549, CS 585 and CPE/CS/IS 692 (capstone course)), two courses from (CS 565, CS 570, and CS 685) and 9 hours of elective courses approved by the department to earn the MSCBS degree in the Computer Science track. The elective courses in this area include the following:
Plan I – Master of Science with Thesis

A minimum of 24 semester hours of coursework and the writing of an acceptable thesis is required. At least six semester hours of thesis credit (CS 699) must be earned. A student must present his/her thesis and pass an oral examination based on the thesis and related coursework. Plan I students must register for CS 699 each term they receive supervision from their advisor.

Plan II – Master of Science without Thesis

A minimum of 33 semester hours of coursework is required. A student must pass a written comprehensive examination over three core courses as described below. Plan II students must complete at least 18 semester hours of coursework before taking the written comprehensive examination. The examination may only be taken twice.

The following requirements and restriction apply to a student in either plan.

Course Requirements

All M.S. students must take three core courses from the options below:

Master of Science in Software Engineering

Plan I Thesis Option:

1. Complete 12 hours of core courses including one course in systems architecture
2. Complete 3 hours in cyber security (CS or CPE)
3. Complete 6 hours in one concentration
4. Complete 6 hours CS 699 or CPE 699
5. Complete 3 hours of electives (must include CS 524 if no prior course in program languages have been taken)
6. Total of 30 hours

Plan II Non-thesis Option:

1. Complete 12 hours of core courses including one course in systems architecture
2. Complete 3 hours in cyber security (CS or CPE)
3. Complete 6 hours in one concentration
4. Complete 3 hours capstone
5. Complete 6 hours of electives (must include CS 524 if no prior course in program languages have been taken)
6. Total of 30 hours

Other Elective Courses may be taken with Departmental Approval
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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td>CS 617</td>
<td>DES &amp; ANALY OF ALGORITHM</td>
<td>3</td>
</tr>
<tr>
<td>CS 650</td>
<td>SOFT'W ENGINEERING PROC</td>
<td>3</td>
</tr>
<tr>
<td>CS 652</td>
<td>OBJECT-ORIENTED DESIGN</td>
<td>3</td>
</tr>
<tr>
<td>CS 613</td>
<td>COMPUTER ARCHITECTURES</td>
<td>3</td>
</tr>
<tr>
<td>or CS 690</td>
<td>ADVANCED OPERATING SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>or CPE 536</td>
<td>INTERNALS OF MODERN OPER SYS</td>
<td></td>
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<tr>
<td>or CPE 631</td>
<td>ADV COMP SYSTEMS ARCHITECTURE</td>
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<tr>
<td>CPE 549</td>
<td>INTRO TO CYBERSECURITY ENGINRG</td>
<td>3</td>
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<tr>
<td>or CS 585</td>
<td>INTRO TO COMPUTER SECURITY</td>
<td></td>
</tr>
<tr>
<td>or CS 685</td>
<td>COMPUTER SECURITY</td>
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</tbody>
</table>

**Concentration Area - Pick two courses within any one concentration**

6

**Big Data and Data Mining**

- CS 554 INTRO TO CLOUD COMPUTING
- CS 696 SELECTED TOPICS IN CS (ST: BIG DATA ANALYTICS)
- CS 696 SELECTED TOPICS IN CS (ST: MACHINE LEARNING)
- CS 696 SELECTED TOPICS IN CS (ST: DATA VISUALIZATION)
- CS 641 DATA MINING

**Project Management (ISE 690 Required)**

- EM 660 ENGR MGMT THEORY
- MGT 601 TECH & INNOVATION MGMT
- MKT 604 NEW PRODUCT DEVELOPMENT
- ISE 690 STATISTICAL METHODS FOR ENGR

**Parallel Programming**

- CPE 512 INTRO PARALLEL PROGRAMMING
- CPE 612 PARALLEL ALGORITHMS
- CPE 613 GEN PURPOSE GPU COMPUTING

**Embedded Systems**

- CPE 538 REAL TIME & EMBEDDED SYSTEMS
- CPE 523 HARDWARE/SOFTWARE CO-DESIGN
- CPE 621 ADVANCED EMBEDDED SYSTEMS

**Advanced Cybersecurity**

- CPE 649 ADV CYBERSECURITY ENGINEERING
- CPE 645 COMPUTER NETWORK SECURITY
- IS 663 COMPUTER FORENSICS

**Non-Thesis and Thesis Options:**

9

**Non-Thesis Option**

**Capstone (3 hours)**

- CPE 656 SOFTWARE ENGRG STUDIO I

**Electives (6 hours)**

- CS 524 PROGRAMMING LANGUAGES (If no prior course in Programming Languages has been completed)

**Thesis Option**

- CS 699 MASTER'S THESIS (6 hours)
  or CPE 699 MASTER'S THESIS

**Elective (3 hours)**

- CS 524 PROGRAMMING LANGUAGES (If no prior course in Programming Languages has been completed)
Additional Information

If a student has not had an undergraduate course in programming languages, CS 524 (http://catalog.uah.edu/search/?P=CS%20524) must be included in the program of study. No more than 50% of the semester hours in the program of study may be 500-level courses. No more than three semester hours of selected topics or independent study courses may be included in a program of study. Exceptions must be recommended by the student’s advisor and approved by the department chair.

Grade Requirements

A grade of B or better must be earned in each of the core courses. No grade lower than C can be counted toward a graduate degree. A 3.0 average must be maintained in all graduate work at UAH and in all work to be counted toward the degree.

Time Limit

The degree must be completed within six years. Courses older than six years may be validated according to Graduate School policy. Courses older than ten years may not be applied to the degree.

Transfer Credit

Graduate work may be transferred from another institution according to Graduate School policy.

Doctoral Program in Computer Science

Degree Requirements

The general requirements for the Ph.D. degree comply with those of the School of Graduate Studies. The requirements include a preliminary examination, completion of coursework, a Qualifying Examination, completion of significant research documented in a dissertation, and the dissertation defense.

Major/Minor Subjects

A minimum of 54 semester hours of graduate course credit plus a minimum of 18 dissertation semester hours is required for the Ph.D. in Computer Science. The program of study will be approved by the student’s Supervisory Committee. Coursework grade requirements are the same as for the M.S. degree. Coursework taken as part of a graduate degree program at another institution may be applied to the degree with permission of the student’s Supervisory Committee. At least 9 semester hours of graduate level mathematics or statistics must also be included in the program.

The program must include:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td>CS 524</td>
<td>PROGRAMMING LANGUAGES</td>
<td>3</td>
</tr>
<tr>
<td>CS 603</td>
<td>FORMAL LANG/AUTOMAT THRY</td>
<td>3</td>
</tr>
<tr>
<td>CS 613</td>
<td>COMPUTER ARCHITECTURES</td>
<td>3</td>
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<tr>
<td>CS 617</td>
<td>DES &amp; ANALY OF ALGORITHM</td>
<td>3</td>
</tr>
<tr>
<td>CS 650</td>
<td>SOFT’W ENGINEERING PROC</td>
<td>3</td>
</tr>
<tr>
<td>CS 690</td>
<td>ADVANCED OPERATING SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total Semester Hours</td>
<td>18</td>
</tr>
</tbody>
</table>

It also must have a coherent area of emphasis, of which at least 6 semester hours must be at the 700 level.

Additional Information

Preliminary Examination

Ph.D. students will be required to take a preliminary examination, consisting of:

1. a written test covering fundamental concepts in Computer Science, and
2. an evaluation by the graduate faculty of the student’s overall academic potential.

The examination must be taken within a year after admission to the Ph.D. program, or at the earliest opportunity upon completion of the core coursework. Successful completion of the examination will provide evidence of the student’s ability to continue in pursuit of the Ph.D. degree. The examination can be taken no more than twice.
Admission to Candidacy

To be admitted to candidacy for the Ph.D. degree, students must first pass the Qualifying Examination. The Qualifying Examination can cover any aspect of the student’s program and is taken after completion of the student’s coursework and upon recommendation of the student’s Supervisory Committee. It is designed to test students’ fitness for pursuing research projects in their chosen areas and to test their general knowledge of Computer Science. As part of the Qualifying Examination, each student will present a research proposal to the Supervisory Committee.

Ph.D. Residency Requirements

According to graduate school policy, residence may be established through either:

1. being enrolled as a full-time student (at least 9 graduate semester hours) either for one continuous academic year, or for Spring and Fall semesters in the same calendar year, or
2. being enrolled in at least 6 semester hours of graduate coursework in at least three of four consecutive semesters.

Other Requirements for the Ph.D. Degree

- The program must be completed within five years after admission to candidacy.
- The Qualifying Examination may be taken no more than twice.
- CS 799 (http://catalog.uah.edu/search/?P=CS%20799) is required each semester a student is receiving direction on the doctoral dissertation.

For additional requirements, consult the Academic Information (p. 5) Section of this Graduate Catalog.

Dissertation

The research described in the dissertation must be accepted for publication in an approved journal or three conference proceedings prior to defense of the dissertation. A public defense of the dissertation is required.

Certificates in Computer Science

Software Engineering Certificate

The Software Engineering Program is designed for those students who want to broaden their knowledge in this area, but do not necessarily desire to pursue a graduate degree in Computer Science.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td>CS 650</td>
<td>SOFTW ENGINEERING PROC</td>
<td>3</td>
</tr>
<tr>
<td>CS 585</td>
<td>INTRO TO COMPUTER SECURITY</td>
<td>3</td>
</tr>
<tr>
<td>ISE 690</td>
<td>STATISTICAL METHODS FOR ENGR</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Select 2 courses from the following:</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>CS 553 CLIENT/SERVER ARCHITECTURES</td>
<td></td>
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<td>CS 652 OBJECT-ORIENTED DESIGN</td>
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<td>CS 655 FORMAL METHODS IN SOFTWARE ENG</td>
<td></td>
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<td>CS 656 SOFTWARE TESTING</td>
<td></td>
</tr>
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<td>Select 1 course from the following:</td>
<td>3</td>
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<tr>
<td></td>
<td>MGT 601 TECH &amp; INNOVATION MGMT</td>
<td></td>
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<tr>
<td></td>
<td>MGT 622 MGT TECHNI PROFESSIONALS</td>
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</table>

Total Semester Hours 18

Students desiring to complete the certificate program should have either industrial experience in software development or have undergraduate courses in software development. Students pursuing an MSSE degree are not eligible for the Software Engineering Certificate.

CS 513 - INTRO TO COMP ARCHITECT
Semester Hours: 3

Review of combinational and sequential logic design, register transfer concept, logic design of memory, arithmetic unit, control unit, and I/O system of simple computer. Review of Machine and Assembler language programming. Architectural trade-offs.
CS 517 - DATA ORG ANALYSIS OF ALGORITHMS
Semester Hours: 3

Review of basic data structures such as stacks, queues, lists, B-Trees, and binary trees. Overview of file structures and access methods. Introduction to complexity analysis of algorithms. Basic algorithm design techniques such as divide & conquer, dynamic programming, and backtracking. Introduction to the classification of problems by class; i.e., tractable, NP, intractable, and unsolvable.

CS 524 - PROGRAMMING LANGUAGES
Semester Hours: 3


CS 526 - PROG TRANS & COMPILER CONSTRUCTION
Semester Hours: 3

Language representation; grammar classification; lexical analysis technique and tools; parsing technique and tools; compile-time and run-time symbol table design; code generation and optimization; error diagnostics. Compiler writing tools.

CS 530 - EXP SYS/HEURISTIC PROGRAMMING
Semester Hours: 3

Expert systems concepts and architectures. Languages and tools for knowledge engineering. Heuristic versus algorithmic methods, heuristics as used in expert systems, and heuristic programming techniques. Class and individual projects. Background in algorithms and programming languages assumed.

CS 537 - INTRO TO NEURAL NETWORKS
Semester Hours: 3

Introduction to artificial neural networks, covering the most prominent models. Neural networks solutions to classification, clustering, data compression, and constrained optimization applications. Experience with neural networks through projects.

CS 543 - INTRO TO MULTIMEDIA SYSTEMS
Semester Hours: 3

Multimedia authoring, color models for image and video, introduction to image and video compression, digital audio, multimedia networks, multimedia synchronization, multimedia retrieval. Students may not receive credit for both CS 443 and CS 543. Courses numbered at the 500-level may be taken for undergraduate credit with prior approval, except as otherwise noted. Courses at 600-level or above are reserved for graduate students. They may be taken by other students only by approval. Consult Seniors Taking Graduate Courses in the Graduate Admissions section of this catalog for specific policies and approval procedures. Taught as CS 443/543. Course completion and/or grade requirements for graduate credit will differ from those for undergraduate credit. Prerequisite: CS 617.

CS 545 - INTRO COMPUTER GRAPHICS
Semester Hours: 3

Introduces underlying theory and mechanics of interactive computer graphics. Basic modeling, rasterization, 2D/3D transformations, and viewing. 3D graphics rudiments. Some hardware and historical perspectives. Many programs.

CS 546 - ADVANCED COMPUTER GRAPHICS
Semester Hours: 3

High resolution 3D graphics, including advanced topics in viewing, vertex processing, fragment processing, local and global illumination and shading, 3D modeling (including curve and surface representation), texture mapping, and some coverage of solid modeling and color theory. Game production pipeline. Hierarchical issues, visibility, and 3D processing algorithms may also be covered. A significant number of programming projects are involved, with some different program requirements and additional theoretical expectations for CS 546 students. (Same as CS 456; no credit for both). Prerequisite: CS 545.

CS 547 - GAME ENGINES & LEVEL DEVELOPMENT
Semester Hours: 3

(Same as CS 447) This course provides the opportunity for students to produce fully functional games from beginning to end with team members. Along the way, students work on homework/projects involving design document creation, prototyping and gameplay/implementation. Also, game software as artistic content has led to collaborations between engineers and artists. In this course, students focus on not only game engineering development but also art asset generation and management. Considers a 3D game design and development using game engines focusing on the fundamental components for developing cross-platform games. The course focus includes design, development, and distribution of computer games. Emphasis also is on user interface and menus, scripting for game programming, game physics, terrain generation, asset management, animation management, special effects, and cross platform game development. Students may not receive credit for both CS 447 and CS 547.
CS 548 - HUMAN-COMPUTER INTERACTION  
Semester Hours: 3  
Introduces underlying theory and mechanics of interactive computer graphics. Basic modeling, rasterization, 2D/3D transformations, and viewing. 3D graphics rudiments. Some hardware and historical perspectives. Many programs. Introduction to human-computer interaction and principles of graphical user interface design. Includes examination of interactive environments including windowing systems development tools, multimedia, and visual programming interfaces. Prerequisite: CS 545.

CS 553 - CLIENT/SERVER ARCHITECTURES  
Semester Hours: 3  
Aspects of client/server distributed computing, a paradigm that includes technologies addressing web services (such as AJAX using Javascript/PHP, ASP.NET) as well as distributed object (such as .NET remoting, CORBA). Students will apply the concepts in practical distributed programs.

CS 554 - INTRO TO CLOUD COMPUTING  
Semester Hours: 3  
Different cloud computing paradigms: IaaS, SaaS, PaaS. Open Source cloud software (for ex., OpenStack, CloudStack). RESTful interfaces, AWS interface. Cloud security. Students may not receive credit for both CS 454 and CS 554.

CS 565 - NETWORK SECURITY  
Semester Hours: 3  

CS 570 - INTRO TO COMPUTER NETWORKS  
Semester Hours: 3  
Organization and operation of computer networks. Physical, Data Link, Network, Transport, and Application-layer protocols and algorithms; LAN and WAN systems; TCP/IP; Wired and wireless organizations; security approaches. Prerequisite: CS 513.

CS 571 - MOBILE COMPUTING SFTWR ARC&DEV  
Semester Hours: 3  
Considers application design for the mobile space, focusing on the fundamental requirements for mobile applications that target mobile devices. The course focus includes development, testing, distribution of mobile applications in a cross-platform environment. Emphasis also is on multimedia and entertainment computing and games. This course will also cover various issues in mobile computing from the readings from research literature such as software engineering practices, analysis of social media and general mobile analytics.

CS 580 - MOBILE DIGITAL FORENSICS  
Semester Hours: 3  
This course examines digital forensics of mobile devices such as smart phones and tablets in a law enforcement context. Mobile device characteristics that make forensics examinations difficult are discussed. Various forensics tools are critically examined with an eye toward improved tool development.

CS 581 - MODELING & SIMULATION I  
Semester Hours: 3  
Discrete event simulation from a computer science perspective. Mathematics of probability distributions applied to simulation. Design, implementation, and application of discrete event simulation software. Application to computer and network system design.

CS 582 - MODELING & SIMULATION II  
Semester Hours: 3  
Advanced application of computer science methods to modeling and simulation software development. Design, development, and integration of software for real-time distributed simulations using standard network interoperability protocols. Team development of modeling and simulation software. Prerequisites: CS 581 or MOD 501.

CS 585 - INTRO TO COMPUTER SECURITY  
Semester Hours: 3  
This course examines the issues related to security policies, models and mechanisms applicable to providing security for computer-based systems including operating systems, database management systems, and networks.

CS 590 - PROGRAMMING ENVIRON W/UNIX  
Semester Hours: 3  
Strategies for design and development of systems and programs in the UNIX environment. Emphasis: automated tool and system development using UNIX tools. Advanced shell concepts including control flow and interrupt handling. Process and inter-process communication.
CS 595 - INDEPENDENT STUDY
Semester Hours: 3

Individual directed study under the supervision of an instructor. Must have approval of the instructor.

CS 596 - SPECIAL TOPICS
Semester Hours: 3

Individual directed study under the supervision of an instructor. Must have approval of the instructor.

CS 597 - SPECIAL TOPICS
Semester Hours: 3

Course offered by an instructor in a specialized area of computer science. Must have approval of instructor.

CS 598 - SPECIAL TOPICS
Semester Hours: 3

Course offered by an instructor in a specialized area of computer science. Must have approval of instructor.

CS 600 - INTERNSHIP IN COMPUTER SCIENCE
Semester Hour: 1

Work experience in Computer Science or a related field in a business or government agency; conducted under the direction of the agency supervisor and approved by a member of the CS faculty. A substantial report must be produced and approved by the supervisor and the faculty member.

CS 603 - FORMAL LANG/AUTOMAT THRY
Semester Hours: 3


CS 613 - COMPUTER ARCHITECTURES
Semester Hours: 3

Organization, operation, and analysis of advanced computer architectures. Topics include advanced pipelining approaches, multi-processor architectures, instruction set architectures, memory hierarchy design, hardware and software-based performance optimization, and system performance measurement. Prerequisite: CS 513.

CS 617 - DES & ANALY OF ALGORITHM
Semester Hours: 3

Strategies of algorithm synthesis and analysis. Classical algorithm categories such as: divide-and-conquer, greedy method, dynamic programming, search and traversal. Computational complexity; theoretical results from lower- and upper-bound studies, NP-hard, and NP-complete problems. Prerequisite: CS 517.

CS 630 - ARTIFICIAL INTELLIGENCE I
Semester Hours: 3

All concepts and methods for problem solving, heuristic search, planning, hypothesis formation, modeling and knowledge representation, knowledge acquisition and learning. Applications of AI in various areas. Background in algorithms and programming languages assumed. CS 530 recommended.

CS 635 - COMPUTAT MODEL COGNITION
Semester Hours: 3

Computational models of human information processing covering topics of current interest to both artificial intelligence and cognitive psychology. Use of computer simulations to test psychological theories. Application of psychological research to building AI systems. Prerequisite: CS 630.

CS 640 - MACHINE LEARNING
Semester Hours: 3

Discriminant analysis, maximum likelihood decisions, deterministic and nondeterministic approaches for trainable classifiers, preprocessing and feature extraction, clustering, syntactic pattern recognition. Pattern recognition in image analysis.

CS 641 - DATA MINING
Semester Hours: 3

Data preprocessing, distance measures, classification with decision trees, Bayesian classifiers, neural networks, support vector machines, frequent item set analysis, association rule generation, clustering methods.
CS 642 - COMP PROC/DIGITAL IMAGES
Semester Hours: 3

Introduction to image processing systems; sensing, sampling and quantization; image transforms; image enhancement and restoration; image segmentation, and description; image correlation; image sequence analysis; practical applications of image processing.

CS 643 - DATA COMPRESSION
Semester Hours: 3

Lossless and lossy compression algorithms, Huffman coding, Arithmetic coding, Dictionary-based compression, quantization techniques, differential encoding, transform coding, wavelet-based coding; image compression, video compression, audio compression, applications of compression algorithms to audio, image, and video compression standards. Prerequisite: CS 617.

CS 646 - COMPUTER GEOMETRY MODELING
Semester Hours: 3


CS 650 - SOFTWARE ENGINEERING PROC
Semester Hours: 3

The process of developing complex software products. Includes software life cycles, phases of development and disciplines such as CM, QA, V&V, and T&E. Issues of professionalism and the ethical use of computers. Background in algorithms and programming languages assumed.

CS 652 - OBJECT-ORIENTED DESIGN
Semester Hours: 3

A survey of formal and informal techniques and methodologies for software analysis, requirements, architecture and design. Emphasis is on effective development processes. Comparison of different approaches, considering their advantages and disadvantages. Prerequisite: CS 650.

CS 655 - FORMAL METHODS IN SOFTWARE ENG
Semester Hours: 3

Formal mechanisms to specify, validate, and verify software systems. Propositional and predicate calculi. Program verification through Djikstra's weakest preconditions and Hoare's method. Formal specification via algebraic specifications and abstract model specifications. Prerequisites: CS 617 and CS 650.

CS 656 - SOFTWARE TESTING
Semester Hours: 3

Advanced software testing techniques, including white box, black box, integration testing, and system testing. Other topics may include test data adequacy, test data selection, and output oracle, including functional, structural, and fault-based testing methods. Prerequisite: CS 650.

CS 658 - SOFTWARE PROC & PROD IMPROVEMENT
Semester Hours: 3

Software quality assurance as an umbrella activity. Use of process, project, quality and product metrics to gain insight into the software development activity. Use of metrics to drive incremental process improvement techniques. Examination of CASE tools and how they affect the software process. Prerequisite: CS 650.

CS 666 - SOFTWARE STUDIO I
Semester Hours: 3

Students work in teams on medium-sized software projects to analyze and document software requirements, produce a project plan, design and build a prototype, and present the project for evaluation. The design-evaluation phases are repeated twice to generate a more mature design. Prerequisites: CS 650 and either CS 652, 656, or 658.

CS 668 - SOFTWARE STUDIO II
Semester Hours: 3

A continuation of CS 666. Students work in teams to continue the software engineering cycle with emphasis on software management, evolution, maintence, quality analysis, testing, integration, validation, and security auditing. Prerequisite: CS 666.

CS 670 - COMPUTER NETWORKS
Semester Hours: 3

Detailed analysis of the organization and operation of computer networks, focusing on algorithms and organizations for the Transport Layer, Network Layer and Data Link Layer protocols of wired and wireless systems. Prerequisite: CS 570.
CS 685 - COMPUTER SECURITY
Semester Hours: 3

Advanced topics in security policies, models and mechanisms applicable to providing security for computer based systems, including operating systems, database management systems, and networks.

CS 686 - INFORMATION ASSURANCE
Semester Hours: 3

CS 687 - DATA BASE SYSTEMS
Semester Hours: 3

Basic concepts of database systems. Use of semantic models in database design. Data models with an major focus on the relational and object-oriented models. Relational query languages and normal forms. Database management system design issues. Security and integrity issues.

CS 690 - ADVANCED OPERATING SYSTEMS
Semester Hours: 3

Issues related to shared memory multiprocessors, multicore computers, clusters, grids and clouds. Concurrency and distributed process coordination. Introduction to network communication issues and systems such as client-server, peer-to-peer, transaction based. Prerequisite: CS 513.

CS 692 - COMPUTER SECURITY
Semester Hours: 3

CS 695 - INDEPENDENT STUDY
Semester Hours: 3

Individual directed study under the supervision of an instructor. Must have instructor approval.

CS 696 - SELECTED TOPICS IN CS
Semester Hours: 3

Course offered by an instructor in a specialized area of computer science. Must have instructor approval.

CS 699 - MASTER'S THESIS
Semester Hours: 3-6

Course offered by an instructor in a specialized area of computer science. Must have instructor approval. Required each semester a student is working and receiving direction on master's thesis. Prerequisite: instructor approval.

CS 703 - THEORY OF PROG LANGUAGES
Semester Hours: 3

Syntactic analysis and semantic interpretation of programming languages based on research and results in formal languages and associated compiler techniques. Identification of research directions and potential research projects in programming languages.

CS 717 - ADV ALGORITHM DES/ANALYSIS
Semester Hours: 3

Parallel algorithms, combinatorial algorithms, approximation algorithms for NP-complete problems, computational complexity. Distribution of algorithms across complex architectures. Prerequisite: CS 617.

CS 730 - ARTIFICIAL INTELLIGENCE II
Semester Hours: 3

Rigorous treatment of special topics in artificial intelligence. Topics may include knowledge representation, automated deduction, search control, machine learning, or meta-level architectures. Prerequisite: CS 630.

CS 742 - IMAGE PROC ALGO/ARCHITECT
Semester Hours: 3

Algorithms and data structures for image enhancement, segmentation, object recognition and image sequence analysis; real-time versus non real-time image processing; computer architectures for fast image processing; cellular logic array processors, distributed, systolic and binary array processors. Prerequisite: CS 613 and CS 642.

CS 790 - OPERATING SYSTEMS SEMINAR
Semester Hours: 3

Advanced research topics in operating system theory and practice. Students will read and discuss classic and current papers in the literature. Each student will present reports in class and prepare a substantial research paper. Prerequisite: CS 690.
CS 795 - ADVANCED SELECTED TOPICS
Semester Hours: 3

Individual directed study under the supervision of an instructor. Must have instructor approval.

CS 796 - ADVANCED SELECTED TOPICS
Semester Hours: 3

Course offered by an instructor in a specialized area of computer science. Must have instructor approval.

CS 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9

Required each semester student is enrolled and receiving direction on doctoral dissertation. Maximum of 18 hours credit toward degree.

**Computer Science, PhD**

**Admission Requirements**

The admission policies for the Ph.D. program in computer science follow the general policies of the School of Graduate Studies and Computer Science Department as described above. An applicant’s admission request will be reviewed in light of preparatory coursework, GRE scores, any supporting information, and general expectation of completing the degree. Students requiring a large amount of prerequisite coursework will not normally be admitted to the program until the courses have been completed. Graduate admission requests for the Ph.D. program will be reviewed once per semester by a departmental admissions committee. Applicants are required to submit supporting recommendation letters and an indication of research interests and study plans. Specific requirements are available from the Computer Science Department office. Requests for admission will be evaluated according to the following guidelines.

**Unconditional Admission**

Unconditional admission will be given to applicants who meet all of the requirements of the School of Graduate Studies and Computer Science Department. Students showing exceptional promise who desire to pursue the Ph.D. full-time may be admitted to the program after completing a bachelor’s degree in Computer Science.

**Conditional Admission**

Conditional admission will be recommended for applicants who do not meet all of the requirements of the School of Graduate Studies and the Computer Science Department, but show high potential for completing the degree requirements.

**Degree Requirements**

The general requirements for the Ph.D. degree comply with those of the School of Graduate Studies. The requirements include a preliminary examination, completion of coursework, a Qualifying Examination, completion of significant research documented in a dissertation, and the dissertation defense.

**Major/Minor Subjects**

A minimum of 54 semester hours of graduate course credit plus a minimum of 18 dissertation semester hours is required for the Ph.D. in Computer Science. The program of study will be approved by the student’s Supervisory Committee. Coursework grade requirements are the same as for the M.S. degree. Coursework taken as part of a graduate degree program at another institution may be applied to the degree with permission of the student’s Supervisory Committee. At least 9 semester hours of graduate level mathematics must also be included in the program.

The program must include:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 524</td>
<td>PROGRAMMING LANGUAGES</td>
<td>3</td>
</tr>
<tr>
<td>CS 603</td>
<td>FORMAL LANG/AUTOMAT THRY</td>
<td>3</td>
</tr>
<tr>
<td>CS 613</td>
<td>COMPUTER ARCHITECTURES</td>
<td>3</td>
</tr>
<tr>
<td>CS 617</td>
<td>DES &amp; ANALY OF ALGORITHM</td>
<td>3</td>
</tr>
<tr>
<td>CS 650</td>
<td>SOFTW ENGINEERING PROC</td>
<td>3</td>
</tr>
<tr>
<td>CS 690</td>
<td>ADVANCED OPERATING SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td>Total Semester Hours</td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

It also must have a coherent area of emphasis, of which at least 6 semester hours must be at the 700 level.
Additional Information

Preliminary Examination

Ph.D. students will be required to take a preliminary examination, consisting of:

1. a written test covering fundamental concepts in Computer Science, and
2. an evaluation by the graduate faculty of the student’s overall academic potential.

The examination must be taken within a year after admission to the Ph.D. program, or at the earliest opportunity upon completion of the core coursework. Successful completion of the examination will provide evidence of the student’s ability to continue in pursuit of the Ph.D. degree. The examination can be taken no more than twice.

Admission to Candidacy

To be admitted to candidacy for the Ph.D. degree, students must first pass the Qualifying Examination. The Qualifying Examination can cover any aspect of the student’s program and is taken after completion of the student’s coursework and upon recommendation of the student’s Supervisory Committee. It is designed to test students’ fitness for pursuing research projects in their chosen areas and to test their general knowledge of computer science. As part of the Qualifying Examination, each student will present a research proposal to the Supervisory Committee.

Ph.D. Residency Requirements

According to graduate school policy, residence may be established through either:

1. being enrolled as a full-time student (at least 9 graduate semester hours) either for one continuous academic year, or for Spring and Fall semesters in the same calendar year, or
2. being enrolled in at least 6 semester hours of graduate coursework in at least three of four consecutive semesters.

Other Requirements for the Ph.D. Degree

- The program must be completed within five years after admission to candidacy.
- The Qualifying Examination may be taken no more than twice.
- CS 799 is required each semester a student is receiving direction on the doctoral dissertation.

For additional requirements, consult the Academic Information (p. 5) Section of this Graduate Catalog.

Dissertation

The research described in the dissertation must be accepted for publication in an approved journal or three conference proceedings prior to defense of the dissertation. A public defense of the dissertation is required.

Computer Science, MS

Students applying for the master's program are expected to have an undergraduate background in CS. Those students who do not have such a background must satisfy the breadth requirements described below.

Unconditional Admission

Students applying to the M.S. program will be given unconditional admission if they meet all the requirements of the School of Graduate Studies and of the Computer Science Department including the breadth requirements listed below.

Conditional Admission

Conditional admission will be recommended for students who, in the judgment of the department, have the potential for successfully completing graduate work but who do not meet all of the requirements for admission.

Degree Requirements and Restrictions

The Master of Science degree is conferred under Plan I or Plan II.

Breadth Requirements

Applicants to graduate programs in Computer Science must satisfy the following breadth requirements before admission to the program.

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<tr>
<th>Code</th>
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<td>MA 171</td>
<td>CALCULUS A</td>
<td>4</td>
</tr>
</tbody>
</table>
MA 172  CALCULUS B  4
MA 244  INTRO TO LINEAR ALGEBRA  3
MA 385  INTRO TO PROBABILITY & STATIST  3

Computer Science
CS 121  COMPUTER SCIENCE I 1  3
CS 221  COMP SCI II: DATA STRUCTURES 1  3
CS 321  INTRO OBJECT-ORIENTED PROG JAV 1  3
CS 214  INTRO DISCRETE STRUCTURE  3
CS 317  INTRO DESIGN/ANALYSIS OF ALG  3
CS 490  INTRO TO OPERATING SYSTEMS  3
CS 309  COMPUTER ORG & SWITCHING THRY  3
CS 413  INTRO DIGITAL COMP ARCHITECTUR  3

Total Semester Hours  38

1  An Introductory sequence covering Object-Oriented Programming and Data Structures in C/C++/Java.

The breadth requirements can be satisfied in one of the following ways:

1. Completion of the course at UAH with a grade of B or better;
2. Completion of an equivalent course at another institution with a grade of B or better;
3. Testing out of the course, where permitted by departmental policy.

Consult a departmental advisor for additional information.

Transfer to Computer Science from Other UAH Graduate Programs

Students enrolled in other graduate programs at UAH who wish to obtain a degree in Computer Science should see a Computer Science advisor for evaluation. Such a student must fulfill the Computer Science breadth requirements. Taking CS graduate courses without first checking with a departmental advisor will not eliminate the need for completing the breadth requirements.

The Program of Study

A program of study should be completed as soon as the course content of the program has been selected. The plan must be made in consultation with an advisor from the Computer Science faculty. The student’s faculty advisor, Department Chair, and the Dean of the School of Graduate Studies approve the program of study. After approval, student requested changes must be agreed to by the student’s advisor and submitted for approval.

Teaching Areas

The Computer Science Department offers an exceptionally broad spectrum of courses. For convenience, they are listed below by category. The teaching areas include software engineering, computer graphics and image processing, data and information technology, computer architecture and networking, artificial intelligence, languages and systems, and theoretical computer science. There is no requirement to stay within a particular area, and students may freely select from any of the areas when preparing the program of study with an advisor.

Software Engineering

Software engineering is a study of the process of large-scale software development. It includes a study of the phases of software development with emphasis on tools and practices for good software development. Any student who completes CS 650 two courses from (CS 553, CS 652, CS 655, CS 656), one statistics course (ISE 690), one management course from (MGT 601, MGT 622), and CS 585 will receive the software engineering certificate. The courses in this area include:

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<tbody>
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<td>CS 553</td>
<td>CLIENT/SERVER ARCHITECTURES</td>
<td>3</td>
</tr>
<tr>
<td>CS 650</td>
<td>SOFT’W ENGINEERING PROC</td>
<td>3</td>
</tr>
<tr>
<td>CS 652</td>
<td>OBJECT-ORIENTED DESIGN</td>
<td>3</td>
</tr>
<tr>
<td>CS 655</td>
<td>FORMAL METHODS IN SOFTWARE ENG</td>
<td>3</td>
</tr>
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<td>CS 656</td>
<td>SOFTWARE TESTING</td>
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The creation of computer-generated graphic animations and photo-realistic images has a growing number of exciting and important applications. The inverse problem - the processing and extraction of information from visual and other patterns - also has many industrial, military, and space applications. Courses in this emphasis area include a sequence in computer graphics and a sequence in the theory, computational algorithms, and architecture for the design and development of pattern recognition and vision systems.

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<tr>
<td>CS 545</td>
<td>INTRO COMPUTER GRAPHICS</td>
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<td>CS 546</td>
<td>ADVANCED COMPUTER GRAPHICS</td>
<td>3</td>
</tr>
<tr>
<td>CS 548</td>
<td>HUMAN-COMPUTER INTERACTION</td>
<td>3</td>
</tr>
<tr>
<td>CS 640</td>
<td>MACHINE LEARNING</td>
<td>3</td>
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<td>CS 642</td>
<td>COMP PROC/DIGITAL IMAGES</td>
<td>3</td>
</tr>
<tr>
<td>CS 646</td>
<td>COMPUTER GEOMETRY MODELING</td>
<td>3</td>
</tr>
<tr>
<td>CS 742</td>
<td>IMAGE PROC ALGO/ARCHITEC</td>
<td>3</td>
</tr>
</tbody>
</table>

Data and Information Technology

As the amount of information and data used by organizations rapidly increases, the need for techniques to manage, retrieve, process, and protect this geographically distributed data becomes critical. For very large data collections, these techniques must include methods to help users discover and select relevant data from the mass of available data. The data and information technology area focuses on the technology required to utilize effectively this rapidly growing volume of data and information. The courses in this area include the following:

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<td>CS 581</td>
<td>MODELING &amp; SIMULATION I</td>
<td>3</td>
</tr>
<tr>
<td>CS 585</td>
<td>INTRO TO COMPUTER SECURITY</td>
<td>3</td>
</tr>
<tr>
<td>CS 543</td>
<td>INTRO TO MULTIMEDIA SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td>CS 685</td>
<td>COMPUTER SECURITY</td>
<td>3</td>
</tr>
<tr>
<td>CS 582</td>
<td>MODELING &amp; SIMULATION II</td>
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</tr>
<tr>
<td>CS 687</td>
<td>DATA BASE SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td>CS 643</td>
<td>DATA COMPRESSION</td>
<td>3</td>
</tr>
</tbody>
</table>

Cybersecurity

The MSCBS degree is a unique, interdisciplinary program involving three colleges: Business Administration, Engineering, and Science. The program prepares graduates with the skills to secure and defend networks, recover from security failures, use computer forensics, and manage data security -- leading to careers in the fast growing field of information security. The Computer Science track involves developing, documenting and maintaining secure coding practices for scripts and applications. Also the design aspects of networks ensuring a risk mitigated network in relation to confidentiality, integrity and the availability of data and devices are included. A student must complete five core courses (IS 660, IS 663, CPE 549, CS 585 and CPE/CS/IS 692 (capstone course)), two courses from (CS 565, CS 570, and CS 685) and 9 hours of elective courses approved by the department to earn the MSCBS degree in the computer science track. The courses in this area include the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 553</td>
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<td>CS 565</td>
<td>NETWORK SECURITY</td>
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<tr>
<td>CS 570</td>
<td>INTRO TO COMPUTER NETWORKS</td>
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</tr>
<tr>
<td>CS 585</td>
<td>INTRO TO COMPUTER SECURITY</td>
<td>3</td>
</tr>
<tr>
<td>CS 670</td>
<td>COMPUTER NETWORKS</td>
<td>3</td>
</tr>
<tr>
<td>CS 685</td>
<td>COMPUTER SECURITY</td>
<td>3</td>
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</tbody>
</table>

Computer Architecture and Networking

The courses offered in the area of computer architecture cover the organization, architecture and design of digital computer systems from high-level conceptual design to gate level implementation. The main concentration areas are: logic design and digital computer hardware design; parallel computer architectures; distributed processing; and networks. Courses in this area include:
Plan I – Master of Science with Thesis
A minimum of 24 semester hours of coursework and the writing of an acceptable thesis is required. At least six semester hours of thesis credit (CS 699) must be earned. A student must present his/her thesis and pass an oral examination based on the thesis and related coursework. Plan I students must register for CS 699 each term they receive supervision from their advisor.

Plan II – Master of Science without Thesis
A minimum of 33 semester hours of coursework is required. A student must pass a written comprehensive examination over three core courses as described below. Plan II students must complete at least 18 semester hours of coursework before taking the written comprehensive examination. The examination may only be taken twice.

The following requirements and restriction apply to a student in either plan.

Course Requirements
All M.S. students must take three core courses from the options below:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 617</td>
<td>DES &amp; ANALY OF ALGORITHM</td>
<td>3</td>
</tr>
<tr>
<td>CS 613</td>
<td>COMPUTER ARCHITECTURES</td>
<td>3</td>
</tr>
<tr>
<td>or CS 690</td>
<td>ADVANCED OPERATING SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>CS 650</td>
<td>SOFT'W ENGINEERING PROC</td>
<td>3</td>
</tr>
<tr>
<td>or CS 687</td>
<td>DATA BASE SYSTEMS</td>
<td></td>
</tr>
</tbody>
</table>

Total Semester Hours 9

Additional Information
If a student has not had an undergraduate course in programming languages, CS 524 must be included in the program of study. No more than 50% of the semester hours in the program of study may be 500-level courses. No more than three semester hours of selected topics or independent study courses may be included in a program of study. Exceptions must be recommended by the student’s advisor and approved by the department chair.

Grade Requirements
A grade of B or better must be earned in each of the core courses. No grade lower than C can be counted toward a graduate degree. A 3.0 average must be maintained in all graduate work at UAH and in all work to be counted toward the degree.

Time Limit
The degree must be completed within six years. Courses older than six years may be validated according to Graduate School policy. Courses older than ten years may not be applied to the degree.

Transfer Credit
Graduate work may be transferred from another institution according to Graduate School policy.

Computer Science, MSSE
Students applying for the master’s program are expected to have an undergraduate background in Computer Science. Those students who do not have such a background must satisfy the breadth requirements described below. In particular, students who have not had an undergraduate course in programming languages must take CS 424 or CS 524 as a prerequisite to the MSSE program.

Unconditional Admission
Students applying to the M.S. program will be given unconditional admission if they meet all the requirements of the School of Graduate Studies and of the Computer Science Department including the breadth requirements listed below.
Conditional Admission

Conditional admission will be recommended for students who, in the judgment of the department, have the potential for successfully completing graduate work but who do not meet all of the requirements for admission.

Degree Requirements and Restrictions

The Master of Science in Software Engineering is conferred under Plan I or Plan II.

Breadth Requirements

Applicants to graduate programs in computer science must satisfy the following breadth requirements before admission to the program.

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<tr>
<th>Code</th>
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<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td>MA 171</td>
<td>CALCULUS A</td>
<td>4</td>
</tr>
<tr>
<td>MA 172</td>
<td>CALCULUS B</td>
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</tr>
<tr>
<td>MA 244</td>
<td>INTRO TO LINEAR ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>MA 385</td>
<td>INTRO TO PROBABILITY &amp; STATIST</td>
<td>3</td>
</tr>
<tr>
<td>CS 121</td>
<td>COMPUTER SCIENCE I 1</td>
<td>3</td>
</tr>
<tr>
<td>CS 221</td>
<td>COMP SCI II: DATA STRUCTURES 1</td>
<td>3</td>
</tr>
<tr>
<td>CS 321</td>
<td>INTRO OBJECT-ORIENTED PROG JAV 1</td>
<td>3</td>
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<tr>
<td>CS 214</td>
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</tbody>
</table>

Total Semester Hours: 38

1 An Introductory sequence covering Object-Oriented Programming and Data Structures in C/C++/Java

The breadth requirements can be satisfied in one of the following ways:

1. Completion of the course at UAH with a grade of B or better;
2. Completion of an equivalent course at another institution with a grade of B or better;
3. Testing out of the course, where permitted by departmental policy.

Consult a departmental advisor for additional information.

Transfer to Computer Science from other UAH Graduate Programs

Students enrolled in other graduate programs at UAH who wish to obtain a degree in Computer Science should see a Computer Science advisor for evaluation. Such a student must fulfill the Computer Science breadth requirements. Taking CS graduate courses without first checking with a departmental advisor will not eliminate the need for completing the breadth requirements.

The Program of Study

A program of study should be completed as soon as the course content of the program has been selected. The plan must be made in consultation with an advisor from the Computer Science faculty. The student’s faculty advisor, department chair, and the Dean of the School of Graduate Studies approve the program of study. After approval, student requested changes must be agreed to by the student’s advisor and submitted for approval.

Teaching Areas

The Computer Science Department offers an exceptionally broad spectrum of courses. For convenience, they are listed below by category. The teaching areas include software engineering, computer graphics and image processing, data and information technology, computer architecture and networking, artificial intelligence, languages and systems, and theoretical computer science. There is no requirement to stay within a particular area, and students may freely select from any of the areas when preparing the program of study with an advisor.
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Data and Information Technology

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<td>MODELING &amp; SIMULATION I</td>
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<td>CS 687</td>
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<td>DATA COMPRESSION</td>
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Computer Architecture and Networking

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<tbody>
<tr>
<td>CS 570</td>
<td>INTRO TO COMPUTER NETWORKS</td>
<td>3</td>
</tr>
<tr>
<td>CS 553</td>
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<tr>
<td>CS 565</td>
<td>NETWORK SECURITY</td>
<td>3</td>
</tr>
<tr>
<td>CS 570</td>
<td>INTRO TO COMPUTER NETWORKS</td>
<td>3</td>
</tr>
<tr>
<td>CS 585</td>
<td>INTRO TO COMPUTER SECURITY</td>
<td>3</td>
</tr>
<tr>
<td>CS 670</td>
<td>COMPUTER NETWORKS</td>
<td>3</td>
</tr>
<tr>
<td>CS 685</td>
<td>COMPUTER SECURITY</td>
<td>3</td>
</tr>
</tbody>
</table>

Plan I – Master of Science with Thesis

A minimum of 24 semester hours of coursework and the writing of an acceptable thesis is required. At least six semester hours of thesis credit (CS 699) must be earned. A student must present his/her thesis and pass an oral examination based on the thesis and related coursework. Plan I students must register for CS 699 each term they receive supervision form their advisor.

Plan II – Master of Science without Thesis

A minimum of 33 semester hours of coursework is required. A Plan II student must pass a written comprehensive examination over the core courses given below. Plan II students must complete at least 18 semester hours of coursework before taking the written comprehensive examination. The examination may only be taken twice.

The following requirements apply to a student in either plan. A Plan II student must take an additional 9 hours of elective courses approved by the department.

Course Requirements

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 617</td>
<td>DES &amp; ANALY OF ALGORITHM</td>
<td>3</td>
</tr>
<tr>
<td>CS 650</td>
<td>SOFT’W ENGINEERING PROC</td>
<td>3</td>
</tr>
<tr>
<td>CS 613</td>
<td>COMPUTER ARCHITECTURES</td>
<td>3</td>
</tr>
<tr>
<td>or CS 690</td>
<td>ADVANCED OPERATING SYSTEMS</td>
<td>3</td>
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</tbody>
</table>

Required Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 652</td>
<td>OBJECT-ORIENTED DESIGN</td>
<td>3</td>
</tr>
<tr>
<td>CS 656</td>
<td>SOFTWARE TESTING</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Semester Hours 15

Additional Information

Students completing the M.S.S.E. under Plan II (non-thesis) must take 9 additional semester hours of general elective courses. Students completing the M.S.S.E. under Plan I (thesis) must take 3 additional semester hours of a general elective course. A general elective can be any graduate-level course that is pre-approved by the advisor.

No more than 50% of the semester hours in the program of study may be 500-level courses. No more than three semester hours of selected topics or independent study courses may be included in a program of study. Exceptions must be recommended by the student’s advisor and approved by the department chair.
Grade Requirements
A grade of B or better must be earned in each of the core courses. No grade lower than C can be counted toward a graduate degree. A 3.0 average must be maintained in all graduate work at UAH and in all work to be counted toward the degree.

Time Limit
The degree must be completed within six years. Courses older than six years may be validated according to Graduate School policy. Courses older than ten years may not be applied to the degree.

Transfer Credit
Graduate work may be transferred from another institution according to Graduate School Rules.

Earth System Science
National Space Science and Technology Center
Room 4044
Telephone: 256.961.7877
Email: ats@uah.edu
Chair: Larry Carey, Associate Professor

The Earth System Science department offers the following graduate degree programs:

Master of Science - Atmospheric Science
Master of Science - Earth Systems Science
Doctor of Philosophy - Atmospheric Science

The Earth System Science program is administered by the Department of Atmospheric Science.

Admission Requirements
Refer to the appropriate section of the Graduate Catalog for general admission and degree requirements. Students should have an appropriate foundation with at least two semesters of calculus, two semesters of physics, an introductory course in computer programming, and preferably chemistry before entering the program. Please consult the department for guidance.

Program Objective
The M.S. in Earth System Science program specifically enables students to gain not only an understanding of the physics of the climate system and the environment but also a working hands-on knowledge of how data and information is used to aid decision makers. Our graduates will be successful in writing or presenting a scientific research paper in a peer-reviewed scientific journal, book chapter, or at a national or international scientific conference or workshop. Our final objective is to produce graduates who successfully obtain professional employment in the Earth System Science field within one year of graduation.

Learning Outcomes
Students will demonstrate

- Knowledge of the reviewed literature in the earth system sciences that is relevant to their specific research
- Effective use of remotely sensed environmental data, image processing and GIS toward decision making or policy related applications in the earth system sciences
- Effective oral communication skills in reporting the results of their scientific research

Master’s Program in Earth System Science
http://nsstc.uah.edu/ess/ess_ms.html

The Earth System Science program is administered by the Department of Atmospheric Science.

Degree Requirements:

- To earn a master’s degree in Earth System Science, each student must satisfy all requirements of the School of Graduate Studies and of the Atmospheric Science Department.
• Students must formulate an appropriate Program of Study (POS), in consultation with a faculty advisor and chair, **before the end of the second semester.**
• Students must maintain a cumulative GPA of at least 3.0.

**Option 1 - Thesis**

Minimum degree requirements under this plan include completion of at least 24 credit hours of core (9 credit hours) and elective (15 credit hours) coursework and at least 6 credit hours of thesis research. At least 50% of the required 24 semester hours must be from 600 level (or higher) courses. In addition, all MS in ESS students are required to take 6 credit hours of supporting courses, which do not count toward minimum degree requirements.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS 507</td>
<td>ENVRNMTL THRTS PBL PY DEC MKG</td>
<td>3</td>
</tr>
<tr>
<td>ESS 514</td>
<td>GEOSPATIAL APPLICATIONS</td>
<td>3</td>
</tr>
<tr>
<td>ESS 630</td>
<td>PHYSICAL CLIMATOLOGY</td>
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**Required Supporting Courses**

<table>
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<th>Title</th>
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<tr>
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<td>PYTHON FOR ID ESS APPLICATIONS</td>
</tr>
<tr>
<td>or ESS 509</td>
<td>APPLI COMPUTERS IN METEOROLOGY</td>
</tr>
<tr>
<td>ESS/ATS 780</td>
<td>SEMINAR</td>
</tr>
<tr>
<td>ESS/ATS 781</td>
<td>STUDENT SEMINAR</td>
</tr>
<tr>
<td>ESS/ATS 782</td>
<td>PROFESSIONAL DEVELOPMENT</td>
</tr>
</tbody>
</table>

**Elective Courses**

Select 15 semester hours of electives

**Thesis Credits**

ESS 699 | MASTER'S THESIS | 6 |

**Total Semester Hours**

36

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1 Students must earn a B or above in core courses.
2 Students who have earned a B or better in the undergraduate equivalent of ESS 507, ESS 508 (or ESS 509) and ESS 514 at UAH do not have to re-take the course at the graduate level. However, their Program of Study must include alternative semester hours to replace ESS 507 and ESS 514 at an appropriate level approved by their advisor and chair of the department.
3 If a student has advanced GIS experience, the ESS 514 core may be replaced with an advanced course at the discretion of the Department Chair.
4 9 of these Elective semester hours must be from 600 level (or higher) courses.
5 Three Elective semester hours may be outside of the ESS/ATS only with advisor’s approval.

**Additional Information**

One of the goals of this program is to train the student in transitioning research and observational products related to Earth System Science into public policy and decision-making arenas. Therefore, it is necessary that the student spend time working with a decision-making organization. The student must submit a 5 page thesis proposal to be approved by the advisor and committee by the end of the third full semester.

**Option 2 - Non-Thesis**

Minimum degree requirements under this plan include completion of at least 30 semester hours of graduate course work, which includes core (12 CH) and elective courses (18 CH). At least 50% of the required 30 credit hours must be from 600 level (or higher) courses. Students are also required to take 6 credit hours of supporting courses. The supporting courses do not count toward minimum degree requirements.

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<tr>
<td>ESS 514</td>
<td>GEOSPATIAL APPLICATIONS</td>
<td>3</td>
</tr>
<tr>
<td>ESS 632</td>
<td>ENERGY, CLIMATE, ENVIRONMENT</td>
<td>3</td>
</tr>
</tbody>
</table>
Select 3 semester hours from 500 or 600 level courses within ESS/ATS  
Select 3 semester hours from 600 level courses within ESS/ATS  
Select 3 semester hours from 500 or 600 level courses and may be outside of ESS/ATS  
Select 9 semester hours from 600 level courses and may be outside of ESS/ATS

Required Supporting Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS 698</td>
<td>MASTERS CAPSTONE</td>
<td>3</td>
</tr>
<tr>
<td>ESS 780</td>
<td>SEMINAR</td>
<td>1</td>
</tr>
<tr>
<td>ESS 781</td>
<td>STUDENT SEMINAR</td>
<td>1</td>
</tr>
<tr>
<td>ESS 782</td>
<td>PROFESSIONAL DEVELOPMENT</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Semester Hours: 36

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2. Students who have earned a B or better in the undergraduate equivalent ESS 507, ESS 508 (or ESS 509), and ESS 514 at UAH do not have to re-take the course at the graduate level. However, their Program of Study must include alternative semester hours at the appropriate level approved by their advisor and chair of the department.
3. If a student has advanced GIS experience, the ESS 514 core may be replaced with an advanced course at the discretion of the Department Chair.
4. Course selection from outside the department and colleges must be done with approval and guidance from faculty mentors and the department chair; faculty mentors will guide the student to pursue a coherent suite of complementary courses outside ESS.
5. ESS 690 Special Topics course will be replaced by ESS 690, Internship/MS Capstone course.

Additional Information

Non-thesis students will pursue approved external internship programs with the help of their mentor; in the event that a student does not receive an external internship, they will be required to do a capstone project with an ATS faculty member or approved ESSC scientist/researcher.

M.S. Supervisory Committee

The committee must consist of a minimum of three members and be approved by the Department Chair. Two of the three members must be full-time, tenured or tenure-earning, or emeritus faculty members in the department. The other member must be from a decision-making/end-user organization. The student must work closely with the advisor and the committee members to select a thesis topic. Advisors have the responsibility to shape the research and ensure that a thesis can be written and defended within the time needed for graduation.

Comprehensive Examination/Thesis Defense

A final comprehensive examination is required of all candidates for a master’s degree. In accordance with the Graduate Studies Dates and Deadlines, a written notice of the time and place of the examination/defense must be sent to the Graduate Dean. After approval by the Graduate Dean, the Department Chair sends a copy of the written Notification of Oral Examination/Defense to the candidate and each member of the committee. The candidate will be examined primarily on the thesis but they may also be tested on relevant course work. The examination is conducted by a committee of at least three faculty members appointed by the Department Chair and approved by the Graduate Dean. The examination must be given at least six weeks before the end of the semester in which degree requirements are expected to be completed, and the results reported within two working days to the Graduate Dean. A student may take the examination only twice.

- **Thesis** candidates will be examined *primarily* on the thesis by a committee of at least three faculty members appointed by the Department Chair and approved by the Graduate Dean.
- **Non-thesis** students will write up a Masters-level research capstone project, present their findings in a formal presentation, and respond to questions from their faculty mentor, other faculty, and the public; successful and approved completion of this, as determined by the faculty mentor and department chair, will result in a pass for the non-thesis option.

Paperwork

- Students must formulate an appropriate Program of Study (POS), in consultation with a faculty advisor and chair, before the end of the second semester.
- Application for Graduate Degree according to Graduate Studies Dates & Deadlines.
- Notification of Oral Examination/Defense according to Graduate Studies Dates & Deadlines.

ESS 501 - SURVEY ATMOSPHERIC SCIENCE

Semester Hours: 3

General survey of the field of atmospheric science includes thermodynamics, atmospheric dynamics, cloud physics, and atmospheric radiation. Quantitative examination of atmospheric properties including atmospheric composition, structure and dynamics.
ESS 502 - SCI & SOC ASPTS NATRL DISASTER  
Semester Hours: 3

Examination of the physical causes of major natural geophysical hazards and their impact on the natural and built environment, society and the economy. Evaluation of the ability to forecast events, and develop sound mitigation and recovery measures. Specific case studies are considered.

ESS 507 - ENVRNMTL THRTS PBL PY DEC MKG  
Semester Hours: 3

Researchers, policymakers and environmental campaigners have identified 25 potential future threats to the global environment. This course examines the nature and consequences of these threats and their potential impacts for the survival of the human race.

ESS 508 - PYTHON FOR ID ESS APPLICATIONS  
Semester Hours: 3

Introduction to GIS model building, Python programming, and automation of scripts for ArcGIS. Techniques in Model Builder, Python, and the methods for automation will be taught using data from numerous available data sources across the internet with heavy emphasis on the Earth Sciences.

ESS 509 - APPLI COMPUTERS IN METEOROLOGY  
Semester Hours: 3

Survey of data types and languages commonly used in the meteorological community along with practical application to meteorology. Course is designed to prepare students for graduate work and research in atmospheric science.

ESS 510 - OPERATIONAL WEATHER FORECAST'G  
Semester Hours: 3

Operational Meteorology covers subjective and objective methods of atmospheric prognosis, including techniques for forecasting operationally-important weather elements. Course explores interpretation, use and systematic errors of computer-generated products, human factors within forecasting, and application of meteorological theory in an operational setting. Course instruction is accomplished through analysis of various weather events from beginning to completion.

ESS 514 - GEOSPATIAL APPLICATIONS  
Semester Hours: 3

An introductory look at the ways in which GIS can be put to use in different fields of study, drawing examples from Demography, Sociology, Archaeology, History and Ecology. Focus on cartography and map creation principles and public geospatial data acquisition.

ESS 515 - ADVANCED TOPICS IN GIS  
Semester Hours: 3

Advanced continuation of concepts applied in Geospatial Applications. Students will learn through modules of real world scientific research how to use further tools in ArcGIS including: 3D Analyst, Spatial Analyst, Network Analyst. Topics include web data dissemination, spatiotemporal analysis and some basic spatial statistics measures. Prerequisite: ESS 514.

ESS 561 - ATMOSPHERIC RADIATION I  
Semester Hours: 3

ESS 590 - SPECIAL TOPICS IN ESS  
Semester Hours: 3

Selected topics of interest not included under other courses.

ESS 610 - LAND USE APP & SUSTAINABILITY  
Semester Hours: 3

Study of land use and sustainability issues using satellite image processing and GIS. International examples of urbanization, agriculture, transportation, water management, and natural resources exploitation. Discussions of current literature and quantitative analyses of satellite and situ data. Prerequisite: ESS 515 or consent of instructor.

ESS 612 - ADV GIS EARTH ATMOSPHERE PROBL  
Semester Hours: 3

Advanced GIS and remote sensing/image processing. Discussion, guided readings, and group labs to interact with student peers and instructor to develop geospatial solutions to problems relevant to their thesis research including appropriate research design, data collection, and analysis. Prerequisites: ESS 515 and ESS 610.
ESS 625 - AIR POLL APP & DEC MAKG REMOTE  
Semester Hours: 3  
Course will review principles of air pollution, measurement methods, regulation, national and international standards and how research is used to make decisions regarding air quality. The course will use ground-based, satellite, and numerical modeling information through a case study approach. Prerequisites: ESS/ATS 501.

ESS 630 - PHYSICAL CLIMATOLOGY  
Semester Hours: 3  
This course examines the physical aspects of the global climate system, including the global energy balance, surface energy balance, hydrologic cycle, climate classification, ocean circulation, natural and anthropogenic climate change and other selected topics such as climate sensitivity. Prerequisites: ATS 501 or ATS 541.

ESS 632 - ENERGY, CLIMATE, ENVIRONMENT  
Semester Hours: 3  
This course focuses on energy and its impact on the environment including climate change and air pollution. Specific energy forms, such as fossil fuels, nuclear energy, solar energy, are discussed.

ESS 670 - SATELLITE REMOTE SENSING I  
Semester Hours: 3  
Using a hands on approach, this course covers a broad range of topics concerning digital image processing applied to the remote sensing of atmospheric, cloud and surface properties using various satellite data sets. Prerequisites: ESS 509.

ESS 680 - NUMERICAL MOD APPL ESS  
Semester Hours: 3  
This course will provide the physical basis for numerical model applications in the earth-atmosphere system including spatial and temporal scales. Prerequisites: ESS 501 and ESS 509.

ESS 690 - SPECIAL TOPICS IN ESS  
Semester Hours: 3  
Selected topics of interest not included under other courses.

ESS 698 - MASTERS CAPSTONE  
Semester Hours: 3  
An extended research project resulting in a substantive paper that involves the original collection, analysis and/or interpretation of scientific data and/or results. Conducted under the guidance of an advisor. Required for MS ESS non-thesis option.

ESS 699 - MASTER'S THESIS  
Semester Hours: 3-6  
A minimum of six thesis credit hours is required for MS degree.

ESS 780 - SEMINAR  
Semester Hour: 1  
Speakers are invited to report on research relevant to the field of Atmospheric and Earth System Science. Students are expected to attend at least twelve seminars and to write short descriptions of the presentations.

ESS 781 - STUDENT SEMINAR  
Semester Hour: 1  
Guest speakers reports on research relevant to the fields of Atmospheric and Earth System Science. Students are expected to attend weekly seminars, submit a paper based on at least ten talks, and make a 15 minute conference-type presentation on a research topic in atmospheric science selected in agreement with their advisor.

ESS 782 - PROFESSIONAL DEVELOPMENT  
Semester Hour: 1  
Topics concerning professional ethics, writing scientific journal articles, proposals and resumes, preparing budgets, networking, time management, conference presentations, research administration, funding agencies, stress and burnout will be discussed.

Earth System Science, MS  
The Earth System Science program is administered by the Department of Atmospheric Science.
Degree Requirements

- To earn a master’s degree in Earth System Science, each student must satisfy all requirements of the School of Graduate Studies and of the Atmospheric Science Department.
- Students must formulate an appropriate Program of Study (POS), in consultation with a faculty advisor and chair, before the end of the second semester.
- Students must maintain a cumulative GPA of at least 3.0.

**Option 1 - Thesis**

Minimum degree requirements under this plan include completion of at least 24 credit hours of core (9 credit hours) and elective (15 credit hours) coursework and at least 6 credit hours of thesis research. At least 50% of the required 24 semester hours must be from 600 level (or higher) courses. In addition, all MS in ESS students are required to take 6 credit hours of supporting courses, which do not count towards minimum degree requirements.

<table>
<thead>
<tr>
<th>Code</th>
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</tr>
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<tbody>
<tr>
<td><strong>Required Core Courses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESS 507</td>
<td>ENVRNMTL THRTS PBL PY DEC MKG</td>
<td>3</td>
</tr>
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<td><strong>Required Supporting Courses</strong></td>
<td></td>
<td></td>
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<tr>
<td>ESS 508</td>
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<td>1</td>
</tr>
<tr>
<td><strong>Elective Courses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select 15 semester hours of electives</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td><strong>Thesis Credits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESS 699</td>
<td>MASTER’S THESIS</td>
<td>6</td>
</tr>
</tbody>
</table>

Total Semester Hours: 36

1. Students must earn a B or above in core courses.
2. Students who have earned a B or better in the undergraduate equivalent of ESS 507, ESS 508 (or ESS 509) and ESS 514 at UAH do not have to re-take the course at the graduate level. However, their Program of Study must include alternative semester hours to replace ESS 507 and ESS 514 at an appropriate level approved by their advisor and chair of the department.
3. If a student has advanced GIS experience, the ESS 514 core may be replaced with an advanced course at the discretion of the Department Chair.
4. 9 of these Elective semester hours must be from 600 level (or higher) courses.
5. Three Elective semester hours may be outside of the ESS/ATS only with advisor’s approval.

**Additional Information**

One of the goals of this program is to train the student in transitioning research and observational products related to Earth System Science into public policy and decision-making arenas. Therefore, it is necessary that the student spend time working with a decision-making organization. The student must submit a 5 page thesis proposal to be approved by the advisor and committee by the end of the third full semester.

**Option 2 - Non-Thesis**

Minimum degree requirements under this plan include completion of at least 30 semester hours of graduate course work, which includes core (12 CH) and elective courses (18 CH). At least 50% of the required 30 credit hours must be from 600 level (or higher) courses. Students are also required to take 6 credit hours of supporting courses. The supporting courses do not count towards minimum degree requirements.

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<tr>
<td>Course Code</td>
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<td>Credit Hours</td>
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<td>ESS 632</td>
<td>ENERGY, CLIMATE, ENVIRONMENT</td>
<td>3</td>
</tr>
</tbody>
</table>

**Elective Courses**

- Select 3 semester hours from 500 or 600 level courses within ESS/ATS
- Select 3 semester hours from 600 level courses within ESS/ATS
- Select 3 semester hours from 500 or 600 level courses and may be outside of ESS/ATS
- Select 9 semester hours from 600 level courses and may be outside of ESS/ATS

**Required Supporting Courses**

- ESS 780 SEMINAR
- ESS 781 STUDENT SEMINAR
- ESS 782 PROFESSIONAL DEVELOPMENT
- ESS 690 SPECIAL TOPICS IN ESS

Total Semester Hours: 36

1. Students must earn a B or above in core courses.
2. Students who have earned a B or better in the undergraduate equivalent ESS 507, ESS 508 (or ESS 509), and ESS 514 at UAH do not have to re-take the course at the graduate level. However, their Program of Study must include alternative semester hours at the appropriate level approved by their advisor and chair of the department.
3. If a student has advanced GIS experience, the ESS 514 core may be replaced with an advanced course at the discretion of the Department Chair.
4. Course selection from outside the department and colleges must be done with approval and guidance from faculty mentors and the department chair; faculty mentors will guide the student to pursue a coherent suite of complementary courses outside ESS.
5. ESS 690 Special Topics course will be replaced by ESS 690, Internship/MS Capstone course.

**Additional Information**

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**M.S. Supervisory Committee**

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**Paperwork**

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- Application for Graduate Degree according to Graduate Studies Dates & Deadlines.
- Notification of Oral Examination/Defense according to Graduate Studies Dates & Deadlines.
The Mathematical Sciences department offers the following graduate degree programs:

Master of Arts
Master of Science
Doctor of Philosophy

Admission Requirements

In addition to fulfilling School of Graduate Studies admission requirements, all applicants for graduate study in mathematics or applied mathematics should have completed the equivalent of

- a complete calculus sequence,
- courses in linear algebra,
- abstract algebra,
- introduction to real analysis, and
- six additional semester hours in upper-division undergraduate mathematics courses.

Students deficient in more than two undergraduate courses in mathematics must remove these deficiencies before admission to the mathematics graduate program. Such students should consult the graduate program director of the department on how best to remove these deficiencies.

For unconditional admission, applicants must satisfy requirements of the School of Graduate Studies. Only the aptitude portion of the Graduate Record Examination (GRE) is required by the department.

Program Objective

Our objective is to provide excellent instruction and resources for the mathematics education of our students and to help produce the new generations of well-educated mathematicians that are critical for the progress of mankind. Our second objective is to have graduates prepared for careers in government, industry, teaching at a secondary school level, or for graduate study in mathematics, and be admitted to graduate school or employed within one year of graduation.

Learning Outcomes

Students will demonstrate:

- Critical thinking skills to construct clear, valid, and succinct proofs
- Knowledge of a variety of technological tools, including computer algebra systems, probability, statistical packages, or computer programming languages
- Good mathematical communication skills, including the ability to convey mathematical knowledge in a variety of settings, both orally and in writing

Master's Programs in Mathematical Sciences

The Master of Science degree is conferred under Plan I (thesis) or Plan II (non-thesis). Students should explore with their faculty advisor which plan is better for their particular objectives. For the M.S. degree, a Program of Study must include a minor area in the College of Engineering (http://catalog.uah.edu/search/?P=College%20of%20Engineering) or the College of Science (http://catalog.uah.edu/search/?P=College%20of%20Science). All minors must be outside of the department and must include at least six semester hours of approved graduate coursework. Master’s programs that include a thesis (Plan I) require at least 18 semester hours of graduate coursework in mathematics and at least 24 semester hours of total graduate coursework, and programs without a thesis (Plan II) require at least 33 semester hours of graduate coursework and at least 24 semester hours of these should be in mathematics. At least 50 percent of the coursework semester hours must be completed in 600-level courses and 50 percent of mathematics courses should be numbered 609 or above. MA 539 (http://catalog.uah.edu/search/?P=MA%20539) and MA 544 (http://catalog.uah.edu/search/?P=MA%20544) should be included in every Program of Study.

Students should plan a Program of Study for the master’s degree with the help of a faculty advisor prior to the completion of 12 semester hours of coursework. Courses taken without an approved Program of Study may not apply toward a degree. Various areas of mathematics may be stressed in
the program of study depending on the student’s needs. For example, the coursework for a non-thesis Program of Study concentrating in probability and statistics might be:

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<td>MA 686</td>
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</tr>
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<td>ST 787</td>
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<td>3</td>
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</tbody>
</table>

Total Semester Hours 27

In addition, three approved graduate courses, including at least one mathematics course numbered 609 or above.

The coursework for a non-thesis program of study concentrating in numerical analysis might be:

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<tr>
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<td>PARTIAL DIFF EQUA I</td>
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<tr>
<td>MA 715</td>
<td>NUM METHODS PART DIFF EQ II</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Semester Hours 24

In addition, three approved graduate courses, including at least two mathematics courses numbered 609 or above.

Other possible concentration areas include differential equations and discrete mathematics.

**Master’s Degree Final Examination**

A final comprehensive examination is required of all candidates for a master’s degree. The candidate will be examined on the coursework and thesis in Plan I and on the coursework in Plan II. In the Mathematical Sciences Department this examination is oral, except that Plan II students who have passed a joint program examination for the Ph.D. degree in applied mathematics may use that examination as their master’s degree final examination.

**Mathematical Sciences, MA**

**Additional Information**

**Master of Arts with Class A Teaching Certification**

Teachers who hold the Alabama Class B Middle/Junior High or High School Certificate may pursue a program of study in mathematics that leads to a Master of Arts degree with Alabama Class A certification. The coursework for such a Program of Study is as follows:

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</tr>
<tr>
<td>ST 687</td>
<td>THEORY OF STATISTICS I</td>
<td>3</td>
</tr>
</tbody>
</table>
9 semester hours of appropriate graduate education courses 9

One approved MA or ST course numbered 609 or above 3

Individuals who are interested in obtaining a Master of Arts degree with Alabama Class A certification in mathematics, but who have not completed more than 12 semester hours in teacher education (graduate or undergraduate) courses, should consider the Non-Traditional Fifth Year Program. The MA and ST courses given in the preceding paragraph would be appropriate for such a program. Students should contact the Education Department for preliminary advisement on admission, general program requirements, and more details on the Non-Traditional Fifth Year Program.

**Applied Mathematics, PhD**

The Ph.D. degree program in Applied Mathematics is designed to enable students to master a significant body of mathematics, including a specialty in Applied Mathematics; to relate this knowledge to a coherent area of science or engineering other than mathematics; and to carry on fundamental research in Applied Mathematics. Students who are interested in the program should contact the graduate program director of the department.

Each Program of Study requires at least 54 semester hours of graduate coursework, and must include a major area of concentration consisting of at least six courses in addition to the four common core courses, and a minor consisting of at least four related graduate courses in some area outside of the department. The major, minor, and other courses in the Program of Study must be selected so that the student will be prepared to conduct research in an area of Applied Mathematics.

Students must pass three examinations:

- Joint program examination
- Comprehensive qualifying examination
- Dissertation defense

The joint program examination is a written test of the student’s ability to successfully pursue a Ph.D. in Applied Mathematics. It covers a four course common core in real analysis (MA 653 (http://catalog.uah.edu/search/?P=MA%20653), MA 654 (http://catalog.uah.edu/search/?P=MA%20654)) and linear and numerical linear algebra (MA 544 (http://catalog.uah.edu/search/?P=MA%20544), MA 614 (http://catalog.uah.edu/search/?P=MA%20614)). The joint program examination cannot be taken more than twice.

The comprehensive qualifying examination covers the entire Program of Study and the student’s proposal for a dissertation topic, and is administered by the student’s graduate study supervisory committee on behalf of the School of Graduate Studies. The examination is part written and part oral. It cannot be taken more than twice. Upon successful completion of the comprehensive qualifying examination and dissertation proposal, the student is admitted to candidacy for the Ph.D. degree.

The dissertation defense is an oral presentation of the dissertation in the form of a seminar before the student’s graduate study supervisory committee. The dissertation is evidence that the student can independently identify a problem of contemporary significance through familiarity with the current literature in some area of Applied Mathematics, organize and execute a program of research, recognize and analyze the results, and present them in cogent, well-written exposition. It must include mathematical results suitable for publication in a nationally recognized journal.

The Ph.D. degree program in Applied Mathematics is a joint program with the other two campuses (Birmingham and Tuscaloosa) of the University of Alabama System. All requirements of the program can be completed at the University of Alabama in Huntsville.

**MA 502 - INTRO TO REAL ANALYSIS**

Semester Hours: 3

Individualized special projects in mathematics and its applications for inquisitive and wellprepared senior level undergraduate students. No credit allowed toward a major or minor in mathematics. S/U grading.

**MA 503 - INTRO COMPLEX ANALYSIS**

Semester Hours: 3

Complex algebra, analytic functions, Cauchy-Riemann equations, exponential, trigonometric, and logarithmic functions, integration, Cauchy integral theorem, Morera’s theorem, Liouville’s theorem, maximum modulus theorem, residue theory, Taylor and Laurent series, and applications.

**MA 506 - METHODS PARTIAL DIFF EQUA**

Semester Hours: 3

Survey of theory and methods for solving elementary partial differential equations. Topics include first-order equations and the method of characteristics, second-order equations, reduction to canonical form, the wave equation, the heat equation, Laplace’s equation, separation of variables, and Fourier series.
MA 508 - APPLIED LINEAR ALGEBRA
Semester Hours: 3

Fundamental concepts of linear algebra are developed with emphasis on real and complex vector spaces, linear transformations, and matrices. Solving systems of equations, finding inverses of matrices, determinants, vector spaces, linear transformations, eigenvalues and eigenvectors, normal matrices, canonical forms of matrices, applications to systems of linear differential equations, and use of computer software such as MATLAB.

MA 515 - INTRO NUMERICAL ANALYSIS
Semester Hours: 3

Rigorous analysis and derivation of numerical methods for the approximate solution of nonlinear equations; interpolation and integration of functions, and approximating solutions of ordinary differential equations.

MA 520 - INTERM DIFFERENTIAL EQUATIONS
Semester Hours: 3

This is a second course in differential equations. Course topics include series solutions for second order differential equations and the method of Frobenious; eigenvalue and eigenvector methods for solving systems of linear first order equations; the qualitative theory of nonlinear equations; boundary value problems and the Sturm-Liouville theory. No credit given to students who have successfully completed MA 524.

MA 524 - DYNAMICAL SYSTEMS I
Semester Hours: 3

Scalar autonomous equations: existence, uniqueness, stability, elementary bifurcations; planar autonomous equations; general properties and geometry, conservative systems, elementary bifurcations linear systems, reduction to canonical forms, stability and instability from linearization. Liapunov functions, center manifolds, Hopf bifurcation.

MA 526 - PARTIAL DIFF EQUA I
Semester Hours: 3

Introduction to the theory for solving partial differential equations. No graduate credit given to students who have completed MA 506 for graduate credit. Topics include second-order equations, reduction to canonical form, well-posedness, the classical equations (wave, heat, and Laplace?) in one and several dimensions, separation of variables, Fourier series, general eigenfunction expansions, Sturm-Liouville theory, first-order linear and quasilinear equations, and shocks. Prerequisite: MA 502.

MA 538 - METRIC SPACES W/APPLICA
Semester Hours: 3


MA 539 - MULTIDIMENSIONAL ANALYSIS
Semester Hours: 3

Finite-dimensional Euclidean space and sequential approach to its topology, continuous functions and their properties, differentiability and implicit function theorem, Riemann integral, elements of vector calculus, flows and their generating vector fields, introduction to metric spaces. Prerequisite: MA 544.

MA 540 - COMBINATORIAL ENUMERATION
Semester Hours: 3

Counting, pigeonhole principle, permutations and combinations, generating functions, principle of inclusion and exclusion, Polya's theory of counting.

MA 542 - ALGEBRA
Semester Hours: 3

Topics from group theory and ring theory: subgroups, normal subgroups, quotient groups, homomorphisms, isomorphism theorems, ideals, principal ideal domains, Euclidean domains, fields, extension fields, elements of Galois theory.

MA 544 - LINEAR ALGEBRA
Semester Hours: 3

Vector spaces over a field, bases, linear transformations, matrices, determinants, eigenvalues, similarity, Jordan canonical forms, dual spaces, orthogonal and unitary transformations.

MA 561 - INTRO TO FOURIER ANALYSIS
Semester Hours: 3

See MA 460. This course is taught as MA 460/561. Course completion and/or grade requirements for the MA 561 course will differ from those for the MA 460 course.
MA 562 - INTERMEDIATE FOURIER ANALYSIS
Semester Hours: 3

(Formerly MA 560). Brief review of classical Fourier analysis, Parseval's equality, Gaussian test functions. Introduction to generalized functions, the generalized transform, the generalized derivative, sequences and series of generalized functions, regular periodic arrays of delta functions, sampling, the discrete transform, the fast Fourier transform (other topics as time and interest permit).

MA 565 - INTERM MATH MODELING
Semester Hours: 3

Designed for beginning graduate students. No prior experience in formal mathematical modeling is required. In-depth discussion of some types of models from physics, the life sciences, and/or the social sciences, with formulation, analysis, and criticism of the models. Process of and factors involved in formulating a model is of prime importance. Content is divided into approximately one-half deterministic modeling and one-half stochastic modeling.

MA 585 - PROBABILITY
Semester Hours: 3

Course topics include probability spaces, random variables, conditional probability, independence, modes of convergence, and an introduction to sigma-algebras and measurability; distributions, including discrete, continuous, joint and marginal distributions, transformations of random variable, distribution and quantile functions, and convergence in distribution; expected value, including properties of general expected value, mean, variance, covariance, generating functions, and conditional expected value; special models and distributions, including Bernoulli trials and the binomial and negative binomial distributions, the Poisson model and the Poisson and gamma distributions, the normal distribution, finite sampling models and the hypergeometric distribution; the law of large numbers and the central limit theorem.

MA 590 - SELECTED TOPICS IN MATH
Semester Hours: 3

Requested selected topics.

MA 607 - MATHEMATICAL METHODS I
Semester Hours: 3

Review of vector calculus and coordinate systems, introduction to tensors, matrices, infinite series, complex variables with applications to calculus of residues, partial differential equations, and Sturm-Liouville theory. Orthogonal functions, gamma functions, Bessel functions, Legendre functions, special functions, Fourier series, integral transform and equations. (Same as PH 607.).

MA 609 - MATHEMATICAL METHODS II
Semester Hours: 3

Continuation of MA 607. (Same as PH 609.) Prerequisite: MA 607.

MA 614 - NUM METHODS/LINEAR ALGEBRA
Semester Hours: 3

Norms and vector spaces, matrix factorizations and direct solution methods, stability and conditioning, iterative methods for large linear systems, the algebraic eigenvalue problem. Prerequisites: MA 515 and either MA 508 or MA 544.

MA 615 - NUM METHODS PARTIAL DIFF EQ
Semester Hours: 3

Finite difference methods for parabolic, elliptic, and hyperbolic partial differential equations, error analysis, stability, and convergence of finite difference methods. Prerequisites: MA 515 and (either MA 506 or MA 526) and (either MA 508 or MA 544 or MA 614).

MA 624 - DYNAMICAL SYSTEMS II
Semester Hours: 3

Brief review of linear systems; local theory for nonlinear systems; existence, uniqueness, differentiability, asymptotic behavior, the stable manifold theorem, Hartman-Grobman theorem, Hamiltonian systems; global theory for nonlinear systems; limit sets and attractors, the Poincare map, the Poincare-Bendixson theorem; some aspects of bifurcation theory and chaos; bifurcations at nonhyperbolic fixed points and periodic orbits, homoclinic bifurcations, Melnikov's method, chaos. Prerequisite: MA 524 and either MA 508 or MA 544.

MA 626 - PARTIAL DIFF EQUA II
Semester Hours: 3

Continuation of MA 526. Qualitative results for solutions to the classical equations (energy inequalities, propagation of discontinuities, maximum principles, smoothness of solutions, existence and uniqueness, etc.), non-homogeneous equations, Poisson's equation, Green's functions, and the Cauchy-Kowalewski theorem. Prerequisite: MA 526.
MA 633 - GEOMETRY
Semester Hours: 3

Axioms of incidence and order, affine and metric properties, isometries, similarities, transformation groups, projective planes.

MA 638 - GENERAL TOPOLOGY
Semester Hours: 3

Set theory, logic, well-ordering principle, axiom of choice, topological spaces, product spaces, quotient spaces, continuous functions, connectedness, path connectedness, local connectedness, compactness, local compactness, countability and separation, generalized products, Tychonoff theorem.

MA 640 - GRAPH THEORY
Semester Hours: 3

Graphs, subgraphs, trees, connectivity, Euler tours, Hamilton cycles, matchings, edge colorings, independent sets, vertex colorings, planar graphs, Kuratowski's theorem, four color theorem, directed graphs, networks, cycle and bond spaces. Prerequisite: MA 540 or MA 542.

MA 643 - GROUP THEORY
Semester Hours: 3

MA 644 - MATRIX THEORY
Semester Hours: 3

Functions of matrices, invariant polynomials, elementary divisors, similarity of matrices, normal forms of a matrix, matrix equations, generalized inverses, non-negative matrices, localization of eigenvalues. Prerequisites: MA 508 or MA 503 or MA 544.

MA 645 - COMBINATORIAL DESIGN
Semester Hours: 3

Systems of distinct representatives, difference sets, coding theory, block designs, finite geometries, orthogonal Latin squares, and Hadamard matrices. Prerequisite: MA 540 and MA 544.

MA 653 - REAL ANALYSIS I
Semester Hours: 3


MA 654 - REAL ANALYSIS II
Semester Hours: 3

Differentiability of monotone functions, functions of bounded variation, absolute continuity, convex functions, Minkowski and Holder inequalities, Lp spaces, Riesz-Fischer representation theorem, Fubini's theorem and selected topics. Prerequisite: MA 653.

MA 656 - COMPLEX ANALYSIS I
Semester Hours: 3

Topology of the complex plane, analytic functions of one complex variable, elementary functions and their mapping properties, power series, complex integration, Cauchy's theorem and its consequences, isolated singularities, Laurent series, residue theory.

MA 658 - INTRO TO FUNCTIONAL ANALYSIS
Semester Hours: 3

Normed and inner product spaces, finite dimensional spaces, product and quotient spaces, equivalent norms, Hahn-Banach theorem, principle of uniform boundedness, openmapping theorem, Riesz representation theorem, complete orthonormal sets, Bessel's inequality, Parseval's identity, and conjugate spaces. Prerequisite: MA 538.

MA 661 - SPECIAL FUNCTIONS
Semester Hours: 3

MA 662 - ASYMPT/PERTURBATION METHOD
Semester Hours: 3

Asymptotic series, regular and singular perturbation theory, asymptotic matching, Laplace's method, stationary phase, steepest descents, WKB theory. Prerequisites: MA 502, and one of the following: MA 503, MA 504, MA 624.

MA 667 - CALC VAR/OPTIMAL CONTROL
Semester Hours: 3

Euler necessary condition for local extremum, Euler-Lagrange equation, Weierstrass necessary condition, Jacobi's necessary condition, corner conditions, problems of optimal control, Pontryagin maximum principles, transversality conditions, applications.
MA 685 - STOCHASTIC PROC/APPLI I
Semester Hours: 3
Discrete and continuous Markov chains, Poisson processes, counting and renewal processes, and applications. Prerequisite: MA 585.

MA 686 - STOCHASTIC PROC/APPLI II
Semester Hours: 3
Gaussian and Wiener processes, general Markov processes, special types of processes from queueing and risk theory, and selected advanced topics. Prerequisite: MA 685.

MA 690 - SP TOPICS IN MATHEMATICS
Semester Hours: 3
Offered upon demand. Advanced selected topics of interest in areas such as discrete mathematics, numerical analysis, differential equations, and stochastic processes.

MA 695 - GRADUATE SEMINAR
Semester Hour: 1
Selected topics in advanced mathematics, conducted as a research seminar.

MA 699 - MASTER'S THESIS
Semester Hours: 3-9
Required each semester a student is receiving direction on a master's thesis. A minimum of two terms is required. Maximum of nine hours credit awarded upon successful completion of the master's thesis.

MA 715 - NUM METHODS PART DIFF EQ II
Semester Hours: 3
Finite element methods for parabolic, elliptic, and hyperbolic partial differential equations; error analysis stability, and convergence. Prerequisites: MA 538 and MA 615.

MA 726 - THRY PART DIFFERNTL EQUA
Semester Hours: 3
Hilbert space theory of existence, uniqueness, and regularity for partial differential equations.

MA 740 - COMBINATORIAL ALGORITHMS
Semester Hours: 3
Linear, polynomial and exponential graph theoretic algorithms, generating combinatorial objects, and NP-completeness.

MA 756 - COMPLEX ANALYSIS II
Semester Hours: 3
Applications of residue theory, harmonic functions and their applications, Mittag-Leffler theorem, infinite products, Weierstrass product theorem, conformal mapping and Riemann mapping theorem, univalent functions, analytic continuation and Riemann surfaces, Picard's theorems, and selected topics.

MA 785 - ADV PROBABILITY THEORY
Semester Hours: 3
Measure and integration, probability spaces, convergence concepts, law of large numbers, random series, characteristic functions, central limit theorem, random walks, conditioning, Markov properties, conditional expectations, and elements of martingale theory.

MA 790 - SPECIAL TOPICS
Semester Hours: 3
Offered upon demand. Advanced selected topics of interest in areas such as discrete mathematics, numerical analysis, differential equations, and stochastic processes.

MA 795 - GRADUATE SEMINAR
Semester Hour: 1
Selected topics in advanced mathematics, conducted as a research seminar.

MA 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9
Required each semester a student is receiving direction on a Ph.D. dissertation.
Applied Mathematics, PhD

The Ph.D. degree program in Applied Mathematics is designed to enable students to master a significant body of mathematics, including a specialty in Applied Mathematics; to relate this knowledge to a coherent area of science or engineering other than mathematics; and to carry on fundamental research in Applied Mathematics. Students who are interested in the program should contact the graduate program director of the department.

Each Program of Study requires at least 54 semester hours of graduate coursework, and must include a major area of concentration consisting of at least six courses in addition to the four common core courses, and a minor consisting of at least four related graduate courses in some area outside of the department. The major, minor, and other courses in the Program of Study must be selected so that the student will be prepared to conduct research in an area of applied mathematics.

Students must pass three examinations:

- the joint program examination,
- the comprehensive qualifying examination, and
- the final examination.

The joint program examination is a written test of the student’s ability to successfully pursue a Ph.D. in Applied Mathematics. It covers a four course common core in real analysis (MA 653, MA 654) and linear and numerical linear algebra (MA 544, MA 614). The joint program examination cannot be taken more than twice.

The comprehensive qualifying examination covers the entire Program of Study and the student’s proposal for a dissertation topic, and is administered by the student’s graduate study supervisory committee on behalf of the School of Graduate Studies. The examination is part written and part oral. It cannot be taken more than twice. Upon successful completion of the comprehensive qualifying examination and dissertation proposal, the student is admitted to candidacy for the Ph.D. degree.

The final examination is an oral presentation of the dissertation in the form of a seminar before the student’s graduate study supervisory committee. The dissertation is evidence that the student can independently identify a problem of contemporary significance through familiarity with the current literature in some area of Applied Mathematics, organize and execute a program of research, recognize and analyze the results, and present them in cogent, well-written exposition. It must include mathematical results suitable for publication in a nationally recognized journal.

The Ph.D. degree program in Applied Mathematics is a joint program with the other two campuses (Birmingham and Tuscaloosa) of the University of Alabama System. All requirements of the program can be completed at the University of Alabama in Huntsville.

Mathematical Sciences, MA

The Master of Arts is conferred under Plan I (thesis) or Plan II (non-thesis). Students should explore with their faculty advisor which plan is better for their particular objectives. For the M.S. degree, a Program of Study must include a minor area in the College of Engineering or the College of Science. All minors must be outside of the department and must include at least six semester hours of approved graduate coursework. Master’s programs that include a thesis (Plan I) require at least 18 semester hours of graduate coursework in mathematics and at least 24 semester hours of total graduate coursework, and programs without a thesis (Plan II) require at least 33 semester hours of graduate coursework and at least 24 semester hours of these should be in mathematics. At least 50 percent of the coursework semester hours must be completed in courses numbered 609 or above. MA 538 and MA 544 should be included in every Program of Study.

Students should plan a Program of Study for the master’s degree with the help of a faculty advisor prior to the completion of 12 semester hours of coursework. Courses taken without an approved Program of Study may not apply toward a degree. Various areas of mathematics may be stressed in the program of study depending on the student’s needs. For example, the coursework for a non-thesis Program of Study concentrating in probability and statistics might be:

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In addition, three approved graduate courses, including at least one numbered 609 or above.

The coursework for a non-thesis program of study concentrating in numerical analysis might be:

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In addition, three approved graduate courses, including at least two courses numbered 609 or above.

Other possible concentration areas include differential equations and discrete mathematics.

**Additional Information**

**Master of Arts with Class A Teaching Certification**

Teachers who hold the Alabama Class B Middle/Junior High or High School Certificate may pursue a program of study in mathematics that leads to a Master of Arts degree with Alabama Class A certification. The coursework for such a Program of Study is as follows:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA 538</td>
<td>METRIC SPACES W/APPLICA</td>
<td>3</td>
</tr>
<tr>
<td>MA 542</td>
<td>ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>MA 544</td>
<td>LINEAR ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>MA 585</td>
<td>PROBABILITY</td>
<td>3</td>
</tr>
<tr>
<td>MA 614</td>
<td>NUM METHODS/LINEAR ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>MA 633</td>
<td>GEOMETRY</td>
<td>3</td>
</tr>
<tr>
<td>ST 687</td>
<td>THEORY OF STATISTICS I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>9 semester hours of appropriate graduate education courses</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>One approved MA or ST course numbered 609 or above</td>
<td>3</td>
</tr>
</tbody>
</table>

Individuals who are interested in obtaining a Master of Arts degree with Alabama Class A certification in mathematics, but who have not completed more than 12 semester hours in teacher education (graduate or undergraduate) courses, should consider the Non-Traditional Fifth Year Program. The MA and ST courses given in the preceding paragraph would be appropriate for such a program. Students should contact the Education Department for preliminary advisement on admission and general program requirements. More details on the Non-Traditional Fifth Year Program are given in the Education Department section.

**Master’s Degree Final Examination**

A final comprehensive examination is required of all candidates for a master’s degree. The candidate will be examined on the coursework and thesis in Plan I and on the coursework in Plan II. In the Mathematical Sciences Department this examination is oral, except that Plan II students who have passed a joint program examination for the Ph.D. degree in applied mathematics may use that examination as their master’s degree final examination.

**Mathematical Sciences, MS**

The Master of Science degree is conferred under Plan I (thesis) or Plan II (non-thesis). Students should explore with their faculty advisor which plan is better for their particular objectives. For the M.S. degree, a Program of Study must include a minor area in the College of Engineering (http://catalog.uah.edu/search/?P=College%20of%20Engineering) or the College of Science (http://catalog.uah.edu/search/?P=College%20of%20Science). All minors must be outside of the department and must include at least six semester hours of approved graduate coursework. Master’s programs that include a thesis (Plan I) require at least 18 semester hours of graduate coursework in mathematics and at least 24 semester hours of total graduate coursework, and programs without a thesis (Plan II) require at least 33 semester hours of graduate coursework and at least 24 semester hours of these should be in mathematics. At least 50 percent of the coursework semester hours must be completed in courses numbered 609 or above. MA 538 and MA 544 should be included in every Program of Study.
Students should plan a Program of Study for the master’s degree with the help of a faculty advisor prior to the completion of 12 semester hours of coursework. Courses taken without an approved Program of Study may not apply toward a degree. Various areas of mathematics may be stressed in the program of study depending on the student’s needs. For example, the coursework for a non-thesis Program of Study concentrating in probability and statistics might be:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA 538</td>
<td>METRIC SPACES W/APPLICA</td>
<td>3</td>
</tr>
<tr>
<td>MA 544</td>
<td>LINEAR ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>MA 585</td>
<td>PROBABILITY</td>
<td>3</td>
</tr>
<tr>
<td>MA 653</td>
<td>REAL ANALYSIS I</td>
<td>3</td>
</tr>
<tr>
<td>MA 656</td>
<td>COMPLEX ANALYSIS I</td>
<td>3</td>
</tr>
<tr>
<td>MA 685</td>
<td>STOCHASTIC PROC/APPLI I</td>
<td>3</td>
</tr>
<tr>
<td>ST 687</td>
<td>THEORY OF STATISTICS I</td>
<td>3</td>
</tr>
<tr>
<td>MA 686</td>
<td>STOCHASTIC PROC/APPLI II</td>
<td>3</td>
</tr>
<tr>
<td>ST 787</td>
<td>THEORY OF STATISTICS II</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Semester Hours 27

In addition, three approved graduate courses, including at least one numbered 609 or above.

The coursework for a non-thesis program of study concentrating in numerical analysis might be:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA 515</td>
<td>INTRO NUMERICAL ANALYSIS</td>
<td>3</td>
</tr>
<tr>
<td>MA 526</td>
<td>PARTIAL DIFF EQUA I</td>
<td>3</td>
</tr>
<tr>
<td>MA 538</td>
<td>METRIC SPACES W/APPLICA</td>
<td>3</td>
</tr>
<tr>
<td>MA 544</td>
<td>LINEAR ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>MA 614</td>
<td>NUM METHODS/LINEAR ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>MA 615</td>
<td>NUM METHODS PARTIAL DIFF EQ</td>
<td>3</td>
</tr>
<tr>
<td>MA 626</td>
<td>PARTIAL DIFF EQUA II</td>
<td>3</td>
</tr>
<tr>
<td>MA 715</td>
<td>NUM METHODS PART DIFF EQ II</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Semester Hours 24

In addition, three approved graduate courses, including at least two courses numbered 609 or above.

Other possible concentration areas include differential equations and discrete mathematics.

**Master’s Degree Final Examination**

A final comprehensive examination is required of all candidates for a master’s degree. The candidate will be examined on the coursework and thesis in Plan I and on the coursework in Plan II. In the Mathematical Sciences Department this examination is oral, except that Plan II students who have passed a joint program examination for the Ph.D. degree in applied mathematics may use that examination as their master’s degree final examination.

**Physics and Astronomy**

201C Optics Building
Telephone: 256.824.2482
Email: physics@uah.edu

Chair: Miller, J. A., Professor

The Physics and Astronomy department offers the following graduate degree programs:

**Master of Science**

**Doctor of Philosophy**
Admission Requirements

Refer to the Graduate Studies section of the Graduate Catalog for general admission and degree requirements. Additional information on Graduate Teaching and Research Assistantships is available on the department web site http://physics.uah.edu. Undergraduate preparation should include courses typically required for a Physics major, such as modern physics, quantum mechanics, and upper level classical mechanics, electrodynamics, and thermal physics.

Program Objective

The primary objective of the Physics and Astronomy department is to educate and train the next generation of physicists, perform cutting-edge and internationally-recognized research, and support the education of students in allied areas such as engineering, chemistry, atmospheric science, and the biological sciences. Our second objective prepares Physics majors for employment in industrial research or for further graduate studies in physics or related fields, including astrophysics, optics, biophysics, engineering, or medicine.

Learning Outcomes

Students will:

- Exhibit a post-graduate level of knowledge in general physics topics
- Conduct a focused and thorough investigation of a topic and effectively communicate the results in a timely manner
- Possess the preliminary experience necessary for working in the private sector, academia, or industry

Master’s Program in Physics

There are three M.S. options in Physics:

- Thesis
- Non-thesis
- Secondary Education Certification

Required core courses for each are:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 601</td>
<td>CLASSICAL DYNAMICS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 607</td>
<td>MATHEMATICAL METHODS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 609</td>
<td>MATHEMATICAL METHODS II</td>
<td>3</td>
</tr>
<tr>
<td>PH 621</td>
<td>STAT MECH KINETIC THRY I</td>
<td>3</td>
</tr>
<tr>
<td>PH 631</td>
<td>ELECTROMAGNETIC THEORY I</td>
<td>3</td>
</tr>
<tr>
<td>PH 651</td>
<td>QUANTUM MECHANICS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 652</td>
<td>QUANTUM MECHANICS II</td>
<td>3</td>
</tr>
<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR (two semesters) ¹</td>
<td>1</td>
</tr>
<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Semester Hours

23

¹ All M.S. students are required to complete two semesters of PH 792 with a grade of “S”; these semester hours do not, however, count toward minimum degree requirements given below.

Students should complete a Program of Study with the help of their faculty advisor before the completion of 12 semester hours of graduate coursework. A Program of Study is a detailed list of courses that the student will take to satisfy the appropriate degree requirements.

M.S. with Thesis

A student must take at least 24 semester hours in graduate courses, plus at least 6 semester hours of PH 699 (http://catalog.uah.edu/search/?P=PH%20699), culminating in the successful defense of their thesis. Students writing a thesis do not need to take the Comprehensive Examination.

Optics and Photonics Technology Curriculum

The OPT (PH) M.S. degree program is comprised of a minimum of 27 semester hours of graduate coursework, plus a minimum of 6 semester hours of PH 699 (http://catalog.uah.edu/search/?P=PH%20699). The thesis option is the only available route to the OPT degree. Students may pursue the OPT option through either the Physics Department (PH) or the Electrical & Computer Engineering Department (ECE). The OPT (PH) program of study, available on the Department website http://physics.uah.edu, meets the Department of Physics M.S. degree requirements and is suggested for students
coming from a Physics background. Students in this category, having a Physics Department faculty member as an advisor, will be designated as having Physics as their “home” department. Courses have been chosen such that little or no prior graduate work in physics is required. The OPT degree program does not prepare the student for taking the Physics Comprehensive Exam or the OSE Preliminary Exam. Requirements for students seeking the OPT degree through the Electrical Engineering department, OPT (ECE), may be significantly different.

**M.S. without Thesis**

A student must take at least 33 semester hours of graduate coursework, and achieve an M.S. passing grade on the Comprehensive Examination. This exam is offered every August, and also serves as the preliminary examination for the Ph.D. degree program. The Comprehensive Examination is on material covered in the core courses given above, and thus has sections dealing with quantum mechanics, electromagnetic theory and relativity and classical and statistical mechanics. Criteria for an M.S. or Ph.D. pass are given on the Department’s web site.

For students in the Optical Science and Engineering (OSE) Ph.D. program who desire an M.S. degree in Physics, a passing grade on the OSE Preliminary Examination is an acceptable substitute for the Comprehensive Examination.

A full-time course schedule leading to the Comprehensive Exam at the start of the Fall semester of the second year is listed below.

### Year 1

#### Fall

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 607</td>
<td>MATHEMATICAL METHODS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 651</td>
<td>QUANTUM MECHANICS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 601</td>
<td>CLASSICAL DYNAMICS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Term Semester Hours:</strong></td>
<td>10</td>
</tr>
</tbody>
</table>

#### Spring

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 609</td>
<td>MATHEMATICAL METHODS II</td>
<td>3</td>
</tr>
<tr>
<td>PH 652</td>
<td>QUANTUM MECHANICS II</td>
<td>3</td>
</tr>
<tr>
<td>PH 631</td>
<td>ELECTROMAGNETIC THEORY I</td>
<td>3</td>
</tr>
<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Term Semester Hours:</strong></td>
<td>10</td>
</tr>
</tbody>
</table>

#### Summer

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 621</td>
<td>STAT MECH KINETIC THRY I</td>
<td>3</td>
</tr>
<tr>
<td>Elective</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Term Semester Hours:</strong></td>
<td>6</td>
</tr>
</tbody>
</table>

**Total Semester Hours:** 26

**Nine (9) Remaining Semester Hours**

The remaining 9 semester hours of graduate coursework can be taken in the Physics Department (for advanced study in optics, space physics, astrophysics, or planetary science) or from another department such as Atmospheric Science. Students need to consult with their advisor regarding the selection of topical elective courses.

**M.S. with Certification**

With this option, also called the *Alternative Fifth-year Program* in the Education Department section of the Graduate Catalog, students are awarded an M.S. degree in Physics as well as Class A (Master’s level) Teaching Certification by the State of Alabama. **We strongly encourage students to investigate this rewarding career option.**

This program is available to students who do not already have a Class B (baccalaureate level) Teaching Certification. Requirements are 27 graduate semester hours in Education courses and 24 graduate semester hours in Physics courses. The Education courses are specified in the Education Department section of this catalog, and include a high school internship. The Physics courses include the core courses above, plus 9 additional semester hours. Three of the 9 additional hours will be PH 679 the required Capstone Course for this M.S. option. Neither the Comprehensive Exam nor a thesis is required for this option. However, a thesis can replace the Capstone Course, if desired.

**Doctoral Program in Physics**

To obtain the Ph.D. degree in physics, a student must satisfy all requirements of the Graduate School as well as those in the Department of Physics. The major steps toward a Ph.D. degree are as follows:

1. Take the required core courses and pass the Comprehensive Exam at the Ph.D. Level.
Required core courses for the Ph.D. degree are:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 601</td>
<td>CLASSICAL DYNAMICS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 607</td>
<td>MATHEMATICAL METHODS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 609</td>
<td>MATHEMATICAL METHODS II</td>
<td>3</td>
</tr>
<tr>
<td>PH 621</td>
<td>STAT MECH KINETIC THRY I</td>
<td>3</td>
</tr>
<tr>
<td>PH 631</td>
<td>ELECTROMAGNETIC THEORY I</td>
<td>3</td>
</tr>
<tr>
<td>PH 651</td>
<td>QUANTUM MECHANICS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 652</td>
<td>QUANTUM MECHANICS II</td>
<td>3</td>
</tr>
<tr>
<td>PH 732</td>
<td>ELECTROMAGNETIC TH II</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Semester Hours: 24

The Comprehensive Exam is offered every August, and covers the material in the core courses given above except PH 732, which is usually taken after the Exam. There are sections dealing with quantum mechanics, electromagnetic theory and relativity, and classical and statistical mechanics. A full-time course schedule leading to the Comprehensive Exam at the start of the Fall semester of the second year is listed below.

Admission to the Ph.D. program in physics is granted upon passing the Comprehensive Examination at the Ph.D. level. Students are permitted two attempts to pass the Comprehensive Examination. A student who fails on the first attempt must retake the examination the following year. Full-time students are generally expected to take the exam for the first time at the start of their second year. Further details are found on the Department’s website.

### Year 1

#### Fall

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 607</td>
<td>MATHEMATICAL METHODS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 651</td>
<td>QUANTUM MECHANICS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 601</td>
<td>CLASSICAL DYNAMICS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR</td>
<td>1</td>
</tr>
</tbody>
</table>

Term Semester Hours: 10

#### Spring

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 609</td>
<td>MATHEMATICAL METHODS II</td>
<td>3</td>
</tr>
<tr>
<td>PH 652</td>
<td>QUANTUM MECHANICS II</td>
<td>3</td>
</tr>
<tr>
<td>PH 631</td>
<td>ELECTROMAGNETIC THEORY I</td>
<td>3</td>
</tr>
<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR</td>
<td>1</td>
</tr>
</tbody>
</table>

Term Semester Hours: 10

#### Summer

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH 621</td>
<td>STAT MECH KINETIC THRY I</td>
<td>3</td>
</tr>
<tr>
<td>Elective</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

Term Semester Hours: 6

Total Semester Hours: 26

### 2. Form a supervisory committee and a Program of Study.

Once the Comprehensive Examination is passed, a student should proceed to form a supervisory committee and prepare a Program of Study. A Program of Study will consist of:

- a minimum of 48 credit hours of graduate coursework. A maximum of 9 semester hours of PH 699 (http://catalog.uah.edu/search/?P=PH%20699) from a completed M.S. degree with thesis may be allowed to count toward this 48 semester hour requirement.
- three semesters of PH 792 (http://catalog.uah.edu/search/?P=PH%20792) with a grade of “S”. Seminar semester hours do not count toward the 48 credit hours above.
- at least 18 semester hours of PH 799 (http://catalog.uah.edu/search/?P=PH%20799). No more than 9 of these semester hours may be taken prior to passing the Qualifying Examination (see below), and PH 799 does not count toward the 48 credit hours of graduate coursework.

Courses in addition to those enumerated above can be selected in consultation with the student’s advisory committee. Transfer of credit from other institutions requires approval of the advisory committee, the Department Chair, and the Graduate Dean.
3. Pass the Qualifying Examination.

After preliminary work on their chosen Ph.D. dissertation topic, the student must then pass the Ph.D. Qualifying Examination. This examination is conducted under the auspices of the Graduate School, and tests the student's general fitness for pursuing a research project in their chosen area and their general knowledge of Physics. There are written and oral components to this exam. The written part consists of the student's responses to questions submitted by their Committee; these questions can deal with the specific proposed research or the general area of research (such as optics or astrophysics, as covered, e.g., in the elective courses taken in this area). The oral part is a presentation and defense of the proposed research.

4. Complete and defend a research dissertation.

Each student must complete and successfully defend a research dissertation, which must be approved by the student's supervisory committee, the Chair of the Physics Department, the Dean of the College of Science, and the Dean of the Graduate School. A significant portion of the dissertation should be submitted for publication in an approved journal with international circulation.

PH 531 - INTRO TO PLASMA DYNAMICS
Semester Hours: 3
Single-particle motion in magnetic fields; fluid equations and fluid theory wave modes; MHD theory, stability, and wave modes; introduction to kinetic theory and hot plasma wave modes. (Same as MAE 531).

PH 541 - GEOMETRICAL OPTICS
Semester Hours: 3
Foundations and physics of geometrical optics, Fermat's principles and Huygen wavelets, refraction and reflection. The many forms of Snell's Law. Optical path lengths, geometrical wavefronts and rays. Ray tracing, ynu-chart and matrix methods. Gaussian imagery and paraxial optics, conjugate elements, cardinal points, and image-object relations. Stops and pupils, chief and marginal rays, vignetting, and the optical or Lagrange invariant. The y-ybar diagram, design of common systems: objectives, magnifiers, microscopes, collimators and detectors. Optical glasses and chromatic aberrations, wavefront and transverse aberrations, spot diagrams and ray fan plots. (Same as OSE 541 and EE 541.) Fall.

PH 542 - PHYSICAL OPTICS
Semester Hours: 3
Scalar and electromagnetic waves, polarization, coherence, reflection and refraction; two beam and multiple beam interference, interferometers, Fabry-Perots, thin films, diffraction, and absorption and dispersion. (Same as OSE 542 and EE 542.) Fall, Spring.

PH 544 - OPTOELECTRONICS
Semester Hours: 3
Review of polarized light, the Jones and Mueller calculi. Propagation of light in birefringent material. Modulation of light using electro-optic effect, Kerr effect, acousto-optic effect, and Faraday effect. Elements of photodetection and detectors, signal processing, and signal-to-noise. Design and analysis of beam scanners, optical rf-spectrum analyzer, optical sensors, and optical communication systems. (Same as OPT 444 and OPE 451.) Fall even years.

PH 546 - RADIOMETRY, DETECTORS & SOURCE
Semester Hours: 3
Theory and practice of radiometry and photometry. Blackbody radiation and Lambertian sources. The propagation of radiant energy in free space and through optical systems. Detector classes, responsivity, bandwidth, and noise. Power spectral density, properties of sources, photon noise. (Same as OPT 446, OSE 546.) Spring even years.

PH 551 - QUANTUM MECHANICS I
Semester Hours: 3
Waves and particles; wave packets and the uncertainty principle; Schrodinger's equation and wave mechanics; postulates of quantum mechanics; simple systems in one, two and three dimensions; the hydrogen atom; angular momentum and spin; numerical solutions of the Schrodinger equation. Prerequisites require undergraduate quantum mechanics course(s).

PH 553 - Intro to Particle Physics
Semester Hours: 3
Survey of elementary particle physics with emphasis on the Standard Model of quarks, leptons and gauge bosons. Lorentz transformations, four-vectors and relativistic kinematics, angular momentum and spin. Lifetimes, cross-sections and Feynman rules. Quantum electro- and chromo-dynamics, Dirac equation and renormalization. Physics beyond the Standard Model. Prerequisite: PH 551 or PH 651.

PH 560 - INTRO TO SOLID STATE PHYSICS I
Semester Hours: 3
Crystal binding and crystal structure. Crystal structure determination. Phonons and lattice vibrations. Free electron gas. Electronic energy band theory. Prerequisite with concurrency: PH 551. (Same as MTS 660.) Fall, even years.
PH 561 - INTRO TO SOLID STATE PHYSIC II
Semester Hours: 3
Thermal properties of solids. Electronic properties, optical properties, electronic properties in a magnetic field, semiconductor devices, magnetism, superconductivity, defects and alloys, dislocations and crystal growth, non-crystalline solids, surfaces and interfaces. (Same as MTS 661.) Spring, odd years. Prerequisite: PH 560.

PH 570 - OPT & PHOTONIC SYSTEMS DESIGN
Semester Hours: 3
Review of paraxial optics, ray tracing codes, aberration and diffraction calculations; acousto- and electro-optic modulators, spatial light modulators; fibers, fiber splicers and connectors; gratings and diffractive optical elements; laser and light emitting diodes, photodetectors and CCD arrays; correlator systems; optical communication networks; signal processing systems design. Fall, even years. Prerequisite: PH 541.

PH 571 - STELLAR ASTROPHYSICS
Semester Hours: 3
Structure and physical processes of stars from the interior to the atmosphere: energy production and transfer, atmospheric properties, and observed spectral features. Models for stellar structure. Star formation and evolution, including the effects of a companion. Prerequisites: upper level undergraduate astrophysics course, and upper level undergraduate E&M course.

PH 572 - GALAXIES & COSMOLOGY
Semester Hours: 3
Galactic structure; Oort's constants; rotation curves; galaxy types; structure formation and evolution; Hubble expansion; Friedmann equation; cosmic microwave background; radiation and matter eras; primordial nucleosynthesis; dark matter/energy issues; development of structure in the early universe; horizon & flatness problems; inflation. Prerequisite: PH 571 or advanced undergraduate Astrophysics course, suggested PH 553, PH 621. Spring, odd years.

PH 574 - INTRO TO GENERAL RELATIVITY
Semester Hours: 3
An introductory course on general relativity and gravitational physics. General relativistic phenomena as inferred from the behavior of particles and light rays for a selection of spacetimes. Major properties of such objects as black holes, wormholes, gravitational waves, and the universe as a whole. Prerequisites: Undergraduate level special relativity and classical mechanics.

PH 579 - OBSERVATIONAL ASTROPHYSICS
Semester Hours: 3
Astronomical coordinate systems and time; spherical astronomy; telescope designs; basic optics; CCDs; infrared arrays; observational calibration and noise; high resolution imaging techniques (e.g., adaptive optics); spectroscopy; and high and low energy observational techniques (e.g., X-ray telescopes, radio interferometry). Students will also conceive their own projects, write observing proposals, and convene as a Time Allocation Committee to review proposals and schedule telescope time. Students will acquire, reduce, analyze and interpret data from one of the allocated projects, and present the results in a short paper. Prerequisites: upper-level undergraduate astrophysics courses.

PH 589 - SELECTED TOPICS
Semester Hours: 3

PH 601 - CLASSICAL DYNAMICS I
Semester Hours: 3
Variational principles and Lagrangian mechanics, rigid body motion, Hamilton?'s equations, and theory of small oscillations. Aspects related to modern physics. Fall.

PH 607 - MATHEMATICAL METHODS I
Semester Hours: 3
Continuation of PH 607. (Same as MA 607.) Spring. Prerequisite: PH 607.
PH 615 - INTRO TO RADIOLOGICAL PHYSICS
Semester Hours: 3
Prerequisite: PH 551.

PH 616 - PHYSICS OF RADIATION THERAPY
Semester Hours: 3

PH 621 - STAT MECH KINETIC THRY I
Semester Hours: 3
Statistical methods, systems of particles, statistical thermodynamics, applications of thermodynamics, methods of statistical mechanics, applications of statistical mechanics, equilibrium between phases of chemical species. Summer.

PH 622 - STAT MECH KINETC THRY II
Semester Hours: 3
Addresses the statistical description of collective processes in gases, plasmas, and fields based on the use of transport theory. The course provides the basis for the mathematical description of the basic kinetic and continuum models used in all fields of solar, space and astrophysics. Addresses specifically the transport of gases and Chapman-Enskog theory, magnetohydrodynamics in a collisional description, energetic particle transport in collisionless plasma, the transport of low-frequency turbulence, and if time permits, the transport of radiation. Prerequisite: PH 621.

PH 631 - ELECTROMAGNETIC THEORY I
Semester Hours: 3
Electrostatic and magnetostatic fields in vacuum and materials, Maxwell's equations, electromagnetic waves. Prerequisites: upper level undergraduate E&M course(s), PH 607. Fall.

PH 632 - FOURIER OPTICS
Semester Hours: 3
Introducing the optical system as an invariant linear system, convolution, Sommerfeld's diffraction integral, Fourier Transform, angular spectrum, coherent and incoherent imaging, optical transfer function. Prerequisite PH 542 (Same as OSE 632 and EE 632.) Spring.

PH 636 - INTRO TO SPACE PLASMA PHYSICS
Semester Hours: 3
Electromagnetic fields and particles in space; solar wind and solar energetic particles; currents and plasma waves in space; shocks and particle acceleration mechanisms; solar flares and coronal mass ejections. Spring, even years. Prerequisite: PH 531.

PH 642 - OPTICAL PHYSICS
Semester Hours: 3
Fundamental physics of optics and optical phenomena. Electromagnetic fields, sources and propagation. Coherence, interference, polarization, scattering, reflection, refraction, and diffraction. Optical properties of conductors and insulators. Introduction to quantum optics, lasers, and optical device physics. Offered Spring, even years. Prerequisite: PH 531.

PH 645 - LASERS I
Semester Hours: 3
Incoherent light sources; atomic and molecular energy levels; equation or motion for probability amplitudes using first-order time dependent perturbation theory; electric dipole interaction. Einstein rate equations and the Planck radiation law; induced dipole moments and frequency-dependent susceptibility. Homogeneous and inhomogeneous line broadening mechanisms; laser cavities and modes, elementary laser theory, practical lasers. Prerequisite: upper level undergraduate E&M courses. (This course may be substituted for OSE 645.) Summer.

PH 651 - QUANTUM MECHANICS I
Semester Hours: 3
Free particle motion. Principles of wave mechanics. The Schrodinger equation and one-dimensional potentials. Approximation techniques: WKB, variational method, perturbation theory. Numerical methods. Prerequisites: undergraduate quantum mechanics or modern physics, some high-level programming (e.g., C++, Fortran, Mathematica) experience. Prerequisite with concurrency: PH 607.
PH 652 - QUANTUM MECHANICS II
Semester Hours: 3

PH 654 - OPTICAL TESTING
Semester Hours: 3
Spherometry; refractive index measurements; optical bench measurements of imaging systems via T-bar nodal slide (effective focal length, f-number, axial color, field curvature and distortion, transverse ray aberrations); illumination falloff; image resolution tests (finite object); modulation transfer function; star image testing; knife edge tests; Hartmann tests; Fizeau interferometer and testing configurations; null lens testing of aspheres; wavefront measurements (point diffraction interferometer, radial shear interferometer); (Same as OSE 654.) Spring.

PH 655 - APPLIED QUANTUM MECHANICS
Semester Hours: 3
Application of quantum mechanics in solid state, electronics, materials science, and optics. Topics to include: Hydrogen atom and molecule, excitons, phonons, Bloch’s theorem, periodic boundary conditions, electrons and holes, band structure of simple semiconductors, dipole transitions, optical constants, absorption and emission processes. Introduction to device physics. (Same as OSE 655) Prerequisite: PH 651 or OSE 555.

PH 661 - DATA ANAL/STAT METH PH/ASTROPH
Semester Hours: 3

PH 670 - OPTOMECHANICAL DESIGN & MANUF
Semester Hours: 3
Practical aspects of optomechanical design, material selection, fabrication and integration of precision optical components and systems for commercial, space, and military applications. Topics include: fixture design, tolerance analysis, machining methods, thermal stabilization, integrated computer-aided design and analysis, diamond machining, finishing and plating techniques. (Same as OSE 670.) Fall, even years. Prerequisite: OSE 541.

PH 671 - OPTICAL FABRIC & TESTING
Semester Hours: 3
Fabrication and testing techniques of optical components and systems. Component measurements: refractive index, curvature, focal lengths, cardinal points and field curvature. Wavefront aberration and transverse aberration function measurements: geometric tests, interferometric tests, null tests. Basics of grinding, figuring, polishing and optical coating. Laboratory experience in manufacturing, polishing, testing, and coating reflective or transmissive optics. Offered on demand.

PH 673 - HIGH ENERGY ASTROPHYSICS
Semester Hours: 3
Radiative Transfer: Blackbody, scattering and diffusion, bremsstrahlung, synchrotron emission, Compton scattering. Relativistic electromagnetism. Plasma effects and introduction to magnetohydrodynamics. Observational aspects of white dwarves, neutron stars and black holes. Accretion and astrophysical jets. Active galactic nuclei and gamma-ray bursts. Offered Fall of odd years.

PH 674 - GEN RELATIVITY & GRAVITATION I
Semester Hours: 3
Special and general relativity: vector and tensor calculus; curved manifolds; elements of differential geometry; physics in curved spacetime; the Einstein equations; simple solutions of the Einstein equations; Schwarzschild geometry and the Kerr spacetime; black holes; sources, propagation, and detection of gravitational waves; a variational approach to general relativity; special topics.

PH 679 - EDUCATION CAPSTONE COURSE
Semester Hours: 3
Capstone experience for student pursuing secondary education certification option for MS degree. Student develops 1 credit, 100 level physics course on instructor-approved topic. Development includes syllabus, textbook evaluation, representative homework assignments, midterm, final, lecture outline, and lecture notes.

PH 680 - SELECTED TOPICS
Semester Hours: 3
Offered upon demand. Topics include: optical surface characterization, superconductivity, aeronomy, properties of solids, laser propagation, collision theory, magnetohydrodynamics. Fall, Spring, Summer.
PH 681 - SELECTED TOPICS  
Semester Hours: 3  
Offered upon demand. Topics include: optical surface characterization, superconductivity, aeronomy, properties of solids, laser propagation, collision theory, magnetohydrodynamics. Fall, Spring, Summer.

PH 682 - SELECTED TOPICS  
Semester Hours: 3  
Offered upon demand. Topics include: optical surface characterization, superconductivity, aeronomy, properties of solids, laser propagation, collision theory, magnetohydrodynamics. Fall, Spring, Summer.

PH 683 - SELECTED TOPICS  
Semester Hours: 3  
Offered upon demand. Topics include: optical surface characterization, superconductivity, aeronomy, properties of solids, laser propagation, collision theory, magnetohydrodynamics. Fall, Spring, Summer.

PH 689 - SELECTED TOPICS  
Semester Hours: 3  
Offered upon demand. Topics include: optical surface characterization, superconductivity, aeronomy, properties of solids, laser propagation, collision theory, magnetohydrodynamics. Fall, Spring, Summer.

PH 699 - MASTER'S THESIS  
Semester Hours: 3-6  
Minimum of 6 credit hours required for Plan I M.S. students. Maximum of nine hours credit toward Ph.D. course requirements awarded upon successful completion of master's thesis. Fall, Spring, Summer.

PH 731 - ADVANCED PLASMA THEORY  
Semester Hours: 3  
Vlasov theory; electrostatic and electromagnetic waves in a hot plasma; wave damping processes; micro-instabilities; quasilinear theory; numerical simulation of plasmas; applications to space and astrophysics. Spring, odd years.

PH 732 - ELECTROMAGNETIC TH II  
Semester Hours: 3  
Continuation of PH 631. Radiation from accelerated charges; Hamiltonian formulation of electrodynamics; covariant formulation of electrodynamics. Spring Prerequisite: PH 631.

PH 733 - QUANTUM DEVICES  
Semester Hours: 3  
Quantum aspects of optical, electronic, and semiconductor devices approached from a phenomenological/physical point of view. Topics will include: Quantum well devices, optical modulators, optical detectors, quantum Stark effects, electrooptic devices, high speed optical devices, frequency chirping in high speed devices and system applications. (Same as OSE 755.) Fall, odd years. Prerequisite: PH 551 or PH 651 or OSE 555.

PH 742 - OPTICAL SCATTERING THEORY  
Semester Hours: 3  
Scattering and absorption of radiation by particles with spherical symmetry and arbitrary shapes described using Maxwell's equations, vector Helmholtz equations, the Jones and Mueller calculus, and numerical techniques. Prerequisites: PH 631, or EE 609, or ATS 561.

PH 745 - LASERS II  
Semester Hours: 3  
The propagation of optical beams in homogeneous and lens-like media, optical resonators, interaction between radiation and atomic systems, laser oscillations and specific laser systems, qswitching and mode-locking of lasers, noise in laser amplifiers and oscillators, modulation of optical radiation. Fall, even years. Prerequisite: PH 645.

PH 746 - NON-LINEAR OPTICS  
Semester Hours: 3
PH 751 - COMPUTATIONAL QUANTUM MECH  
Semester Hours: 3  

PH 752 - QUANTUM MECHANICS II  
Semester Hours: 3  
PH 753 - QUANTUM FIELD THEORY  
Semester Hours: 3  
Formalism of quantum field theory, construction and evaluation of Feynman diagrams for quantum electrodynamics and the weak interaction, first-order processes, renormalization, particle scattering and decay, nucleon structure, introduction to quantum chromodynamics, accelerator experiments, and astrophysical applications. Prerequisites: PH 609 and PH 652.

PH 789 - SELECTED TOPICS  
Semester Hours: 3  
Topics include superconductivity, advanced plasma theory, properties of solids, laser propagation, collision theory, quantum electronics, gravitational theories. Fall, Spring, Summer.

PH 792 - PHYSICS SEMINAR  
Semester Hour: 1  
Students attend seminars by invited speakers. Two semesters are required for all M.S. students and three semesters for Ph.D. students. Does not count toward minimum degree requirements. Fall, Spring.

PH 795 - ADV PHYSICS PROJECT LAB  
Semester Hours: 3-6  
Advanced laboratory research in one of the departmental research groups. Student works on an independent or group project. Completion of the course requires a written report that becomes part of the student?s record. Fall, Spring, Summer.

PH 799 - DOCTORAL DISSERTATION  
Semester Hours: 3-9  
Prerequisites: Students must have passed the comprehensive examination at Ph.D. level and have Ph.D. advisor's approval. No more than 9 hours may be taken prior to passing the qualifying examination. Fall, Spring, Summer.

**Physics, PhD**

To obtain the Ph.D. degree in physics, a student must satisfy all requirements of the Graduate School as well as those in the Department of Physics. The major steps toward a Ph.D. degree are as follows:

**1. Take the necessary core courses and pass the Comprehensive Exam at the Ph.D. Level.**

Required core courses for the Ph.D. degree are:

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>PH 601</td>
<td>CLASSICAL DYNAMICS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 607</td>
<td>MATHEMATICAL METHODS I</td>
<td>3</td>
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<tr>
<td>PH 609</td>
<td>MATHEMATICAL METHODS II</td>
<td>3</td>
</tr>
<tr>
<td>PH 621</td>
<td>STAT MECH KINETIC THRY I</td>
<td>3</td>
</tr>
<tr>
<td>PH 622</td>
<td>STAT MECH KINETC THRY II</td>
<td>3</td>
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<tr>
<td>PH 631</td>
<td>ELECTROMAGNETIC THEORY I</td>
<td>3</td>
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<tr>
<td>PH 651</td>
<td>QUANTUM MECHANICS I</td>
<td>3</td>
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<tr>
<td>PH 652</td>
<td>QUANTUM MECHANICS II</td>
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<tr>
<td>PH 732</td>
<td>ELECTROMAGNETIC TH II</td>
<td>3</td>
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</tbody>
</table>

Total Semester Hours 27
The Comprehensive Exam is offered every August, and covers the material in the core courses given above except PH 622 and PH 732, which are usually taken after the Exam. There are sections dealing with quantum mechanics, electromagnetic theory and relativity, and classical and statistical mechanics. A full-time course schedule leading to the Comprehensive Exam at the start of the Fall semester of the second year is listed below.

Admission to the Ph.D. program in physics is granted upon passing the Comprehensive Examination at the Ph.D. level. Students are permitted two attempts to pass the Comprehensive Examination. A student who fails on the first attempt must retake the examination the following year. Full-time students are generally expected to take the exam for the first time at the start of their second year. Further details are found on the Department's (http://uah.edu/physics) website.

**Year 1**

**Fall**

<table>
<thead>
<tr>
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<th>Semester Hours</th>
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<tr>
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<td>MATHEMATICAL METHODS I</td>
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<td>PH 651</td>
<td>QUANTUM MECHANICS I</td>
<td>3</td>
</tr>
<tr>
<td>PH 601</td>
<td>CLASSICAL DYNAMICS I</td>
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<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR</td>
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<td><strong>Term Semester Hours:</strong></td>
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<td>QUANTUM MECHANICS II</td>
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<td>PH 631</td>
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<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR</td>
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<tr>
<td></td>
<td><strong>Term Semester Hours:</strong></td>
<td><strong>10</strong></td>
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<tr>
<td>PH 621</td>
<td>STAT MECH KINETIC THRY I</td>
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<tr>
<td>Elective</td>
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<td><strong>Term Semester Hours:</strong></td>
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<tr>
<td></td>
<td><strong>Total Semester Hours:</strong></td>
<td><strong>26</strong></td>
</tr>
</tbody>
</table>

2. Form a supervisory committee and a Program of Study.

Once the Comprehensive Examination is passed, a student should proceed to form a supervisory committee and prepare a Program of Study. A Program of Study will consist of

- a minimum of 48 credit hours of graduate coursework. A maximum of 9 semester hours of PH 699 from a completed M.S. degree with thesis may be allowed to count toward this 48 semester hour requirement.
- three semesters of PH 792 with a grade of “S”. Seminar semester hours do not count toward the 48 credit hours above.
- at least 18 semester hours of PH 799. No more than 9 of these semester hours may be taken prior to passing the Qualifying Examination (see below).

Courses in addition to those enumerated above can be selected in consultation with the student’s advisory committee. Transfer of credit from other institutions requires approval of the advisory committee, the Department Chair, and the Graduate Dean.

3. Pass the Qualifying Examination.

After preliminary work on their chosen Ph.D. dissertation topic, the student must then pass the Ph.D. Qualifying Examination. This examination is conducted under the auspices of the Graduate School, and tests the student’s general fitness for pursuing a research project in their chosen area and their general knowledge of physics. There are written and oral components to this exam. The written part consists of the student’s responses to questions submitted by their Committee; these questions can deal with the specific proposed research or the general area of research (such as optics or astrophysics, as covered, e.g., in the elective courses taken in this area). The oral part is a presentation and defense of the proposed research.

4. Complete and defend a research dissertation.

Each student must complete and successfully defend a research dissertation, which must be approved by the student’s supervisory committee, the Chair of the Physics Department, the Dean of the College of Science, and the Dean of the Graduate School. A significant portion of the dissertation should be submitted for publication in an approved journal with international circulation.
• thesis  
• non-thesis  
• secondary education certification  

Required core courses for each are:

<table>
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</thead>
<tbody>
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<td>PH 601</td>
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<tr>
<td>PH 607</td>
<td>MATHEMATICAL METHODS I</td>
<td>3</td>
</tr>
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<td>PH 609</td>
<td>MATHEMATICAL METHODS II</td>
<td>3</td>
</tr>
<tr>
<td>PH 621</td>
<td>STAT MECH KINETIC THRY I</td>
<td>3</td>
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<tr>
<td>PH 631</td>
<td>ELECTROMAGNETIC THEORY I</td>
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<tr>
<td>PH 651</td>
<td>QUANTUM MECHANICS I</td>
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<tr>
<td>PH 652</td>
<td>QUANTUM MECHANICS II</td>
<td>3</td>
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<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR (two semesters)</td>
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<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR</td>
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</table>

Total Semester Hours: 23

1 All M.S. students are required to complete two semesters of PH 792 with a grade of “S”; these semester hours do not, however, count toward minimum degree requirements given below.

Students should complete a Program of Study with the help of their faculty advisor before the completion of 12 semester hours of graduate coursework. A Program of Study is a detailed list of courses that the student will take to satisfy the appropriate degree requirements.

**M.S. with Thesis**

A student must take at least 24 semester hours in graduate courses, plus at least 6 semester hours of PH 699, culminating in the successful defense of their thesis. Students writing a thesis do not need to take the Comprehensive Examination.

**Optics and Photonics Technology Curriculum**

The OPT (PH) M.S. degree program is comprised of a minimum of 27 semester hours of graduate coursework, plus a minimum of 6 semester hours of PH 699. The thesis option is the only available route to the OPT degree. Students may pursue the OPT option through either the Physics Department (PH) or the Electrical & Computer Engineering Department (ECE). The OPT (PH) program of study, available on the Department website http://physics.uah.edu, meets the Department of Physics M.S. degree requirements and is suggested for students coming from a physics background.

Students in this category, having a Physics Department faculty member as an advisor, will be designated as having Physics as their “home” department. Courses have been chosen such that little or no prior graduate work in physics is required. The OPT degree program does not prepare the student for taking the Physics Comprehensive Exam or the OSE Preliminary Exam. Requirements for students seeking the OPT degree through the Electrical Engineering department, OPT (ECE), may be significantly different.

**M.S. without Thesis**

A student must take at least 33 semester hours of graduate coursework, and achieve an M.S. passing grade on the Comprehensive Examination. This exam is offered every August, and also serves as the preliminary examination for the Ph.D. degree program. The Comprehensive Examination is on material covered in the core courses given above, and thus has sections dealing with quantum mechanics, electromagnetic theory and relativity and classical and statistical mechanics. Criteria for an M.S. or Ph.D. pass are given on the Department’s web site.

For students in the Optical Science and Engineering (OSE) Ph.D. program who desire an M.S. degree in physics, a passing grade on the OSE Preliminary Examination is an acceptable substitute for the Comprehensive Examination.

A full-time course schedule leading to the Comprehensive Exam at the start of the Fall semester of the second year is listed below.

**Year 1**

**Fall**

<table>
<thead>
<tr>
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<tr>
<td>PH 607</td>
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<td>PH 651</td>
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<tr>
<td>PH 601</td>
<td>CLASSICAL DYNAMICS I</td>
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</tr>
<tr>
<td>PH 792</td>
<td>PHYSICS SEMINAR</td>
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</table>

Term Semester Hours: 10

**Spring**
<table>
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<tr>
<th>Course Code</th>
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<td>PH 652</td>
<td>QUANTUM MECHANICS II</td>
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<tr>
<td>PH 631</td>
<td>ELECTROMAGNETIC THEORY I</td>
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<td>PH 792</td>
<td>PHYSICS SEMINAR</td>
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**Summer**

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>PH 621</td>
<td>STAT MECH KINETIC THRY I</td>
<td>3</td>
</tr>
<tr>
<td>Elective</td>
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<td>3</td>
</tr>
</tbody>
</table>

**Total Semester Hours:** 26

### Nine (9) Remaining Semester Hours

The remaining 9 semester hours of graduate coursework can be taken in the Physics Department (for advanced study in optics, space physics, astrophysics, or planetary science) or from another department such as Atmospheric Science. Students need to consult with their advisor regarding the selection of topical elective courses.

### M.S. with Certification

With this option, also called the *Alternative Fifth-year Program* in the Education Department section of the Graduate Catalog, students are awarded an M.S. degree in physics as well as Class A (Master's level) Teaching Certification by the State of Alabama. **We strongly encourage students to investigate this rewarding career option.**

This program is available to students who do not already have a Class B (baccalaureate level) Teaching Certification. Requirements are 27 graduate semester hours in education courses and 24 graduate semester hours in physics courses. The education courses are specified in the Education Department section of this catalog, and include a high school internship. The physics courses include the core courses above, plus 9 additional semester hours. Three of the 9 additional hours will be PH 679 the required Capstone Course for this M.S. option. Neither the Comprehensive Exam nor a thesis is required for this option. However, a thesis can replace the Capstone Course, if desired.

### Space Science

Web Site: [http://www.uah.edu/science/departments/space-science](http://www.uah.edu/science/departments/space-science)

Cramer Research Hall/NSSTC  
Telephone: 256-961-7479  
Email: spa@uah.edu  
(space-science@uah.edu)

**Chair:** Gary P. Zank, Eminent Scholar and Distinguished Professor

The Space Science department offers the following graduate degree programs:

- Master of Space Science
- Doctorate of Space Science

### Program Objective

The Space Science department will provide opportunities through our graduate program for students to be introduced to and engage in cutting edge research in solar physics, heliospheric science, cosmic ray physics, and high-energy astrophysics with faculty from the Department of Space Science and with our research partners: The University of Alabama in Huntsville's (UAH's) Center for Space Plasma and Aeronomic Research (CSPAR) and Marshall Space Flight Center (MSFC). Additionally, the department will provide a unique unified Space Science graduate program under the umbrella of a single university department.

### Learning Outcomes

Students will demonstrate:

- Inculcated problem solving skills through introductory research in the field of space science for future use in science, engineering, teaching, and technology professions
- Ability to write a scholarly document
- Ability to prepare and deliver an effective oral scientific presentation
Master’s Program in Space Science

http://www.uah.edu/science/departments/space-science

Information below is intended for prospective students who are considering a Master's degree in Space Science from UAH.

All questions about enrolling in our M.S. program should be directed to Dr. Jacob Heerikhuisen (jacob.heerikhuisen@uah.edu), Chair of the SPA Graduate Committee.

Requirements for M.S. Degree - Thesis Option

1. Complete the core coursework (15 credit hours), see Core Courses below.
2. Complete an additional 9 credit hours of elective courses. These are chosen from the Elective Courses list.
3. Complete SPA 582 and SPA 796 once.
5. Write and defend a Master's thesis.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPA 522</td>
<td>INTRODUCTION TO PLASMA PHYSICS</td>
<td>3</td>
</tr>
<tr>
<td>SPA 610</td>
<td>ADV MATH METHODS FOR SPA SCI</td>
<td>3</td>
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<tr>
<td>SPA 622</td>
<td>CLASSICAL &amp; QUANTUM STATISTICS</td>
<td>3</td>
</tr>
<tr>
<td>SPA 624</td>
<td>SPACE PHYSICS I</td>
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</tr>
<tr>
<td>SPA 631</td>
<td>WAVES AND FIELDS</td>
<td>3</td>
</tr>
</tbody>
</table>

Required Courses

SPA 582 | SCIENCE CAREER PREP                      | 1              |
SPA 796 | JOURNAL CLUB                             | 1              |

Elective Courses

Choose 3 courses from the following: 9

SPA 526 | SPACE WEATHER                            |                  |
SPA 623 | TRANSPORT PROCESSES IN SPACE             |                  |
SPA 625 | SPACE PHYSICS II                         |                  |
SPA 627 | HIGH ENERGY RADIATION DET&MSRM           |                  |
SPA 628 | SOLAR PHYSICS                            |                  |
SPA 629 | ASTROPHYSICAL FLUID DYNAMICS             |                  |
SPA 630 | WAVES IN FLUIDS                          |                  |
SPA 662 | COMPUTATIONAL PHYSICS                    |                  |
SPA 663 | COMPUTATIONAL FLUID DYNMC &MHD           |                  |
SPA 689 | SELECTED TOPICS                          |                  |
SPA 741 | PHYSICS OF COSMIC RAYS                   |                  |
SPA 742 | GAMMA-RAY BURSTS AND JETS                |                  |
SPA 771 | COMPETITIVE GRANT WRITING WKSP           |                  |
SPA 789 | SELECTED TOPICS                          |                  |

Total Semester Hours 26

Year 1

Fall

<table>
<thead>
<tr>
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<tr>
<td>SPA 522</td>
<td>INTRODUCTION TO PLASMA PHYSICS</td>
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Term Semester Hours: 10

Spring

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<tr>
<td>SPA 624</td>
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**Requirements for M.S. Degree - Non Thesis Option**

1. Complete the core coursework (15 credit hours), see Core Courses below.
2. Complete an additional 15 credit hours of elective courses. These are chosen from the Elective Courses list.
3. Complete SPA 582 and SPA 796 once.
4. Pass a Comprehensive Examination (“Comps”). The Comps are offered annually during the summer semester and consist of three sections: (a) Electromagnetic Theory, (b) Classical and Quantum Statistics, and (c) Plasma Physics. A passing grade of 40% or above in all three sections is required for a M.S. pass.

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<tr>
<td>SPA 631</td>
<td>WAVES AND FIELDS</td>
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**Core Courses**

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<tr>
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<tr>
<td>SPA 699</td>
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**Required Courses**

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**Elective Courses**

Choose 5 courses from the following: 15

<table>
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<td>SPA 789</td>
<td>SELECTED TOPICS</td>
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Total Semester Hours: 32
Pathway

Year 1

Fall

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Term Semester Hours: 10

Spring

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Term Semester Hours: 9

Year 2

Fall

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Term Semester Hours: 10

Spring

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<tr>
<td>SPA 628</td>
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Term Semester Hours: 3

Total Semester Hours: 32

Doctoral Program in Space Science

http://www.uah.edu/science/departments/space-science

Requirements for a Ph.D. degree

1. Complete the core coursework (18 credit hours), see Core Courses below.
2. Complete an additional 30 credit hours of elective courses. These are chosen from the Elective Courses list.
3. Complete SPA 796 four times (only 1 credit hour counts toward degree hours).
4. Complete SPA 582 once.
5. Pass a Comprehensive Examination ("Comps"). The Comps are offered annually during the summer semester and consist of three sections: (a) Electromagnetic Theory, (b) Classical and Quantum Statistics, and (c) Plasma Physics. A passing grade of 60% or above in all three sections is required for a Ph.D. pass.
6. Pass a Ph.D. qualifier exam. This step involves writing a dissertation proposal and forming a Ph.D. committee, that would normally consist of the student's faculty adviser and at least four other members from the UAH graduate faculty. We encourage students to invite at least one committee member external to the department.
7. Complete 18 credit hours of dissertation units SPA 799.
8. Write and defend a Ph.D. dissertation.

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SPA 631  WAVES AND FIELDS  3

**Required Courses**

SPA 582  SCIENCE CAREER PREP  1
SPA 796  JOURNAL CLUB  1

**Elective Courses**

SPA 526  SPACE WEATHER
SPA 625  SPACE PHYSICS II
SPA 627  HIGH ENERGY RADIATION DETMSRM
SPA 628  SOLAR PHYSICS
SPA 629  ASTROPHYSICAL FLUID DYNAMICS
SPA 630  WAVES IN FLUIDS
SPA 662  COMPUTATIONAL PHYSICS
SPA 663  COMPUTATIONAL FLUID DYNMC &MHD
SPA 689  SELECTED TOPICS
SPA 741  PHYSICS OF COSMIC RAYS
SPA 742  GAMMA-RAY BURSTS AND JETS
SPA 771  COMPETITIVE GRANT WRITING WKSP
SPA 789  SELECTED TOPICS

1 Required to take class four times but only 1 credit hour counts toward degree hours

**Pathway**

**Year 1**

**Fall**

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**Spring**

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**Year 2**

**Fall**

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**Spring**

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**Year 3**

**Fall**

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<td>SPA 741</td>
<td>PHYSICS OF COSMIC RAYS</td>
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SPA 796 JOURNAL CLUB 1
SPA 799 DOCTORAL DISSERTATION

Term Semester Hours: 10

Spring
SPA 663 COMPUTATIONAL FLUID DYNMC MHD 3
SPA 771 COMPETITIVE GRANT WRITING WKSP 1
SPA 799 DOCTORAL DISSERTATION 6

Term Semester Hours: 10

Year 4
Fall
SPA 799 DOCTORAL DISSERTATION 9

Term Semester Hours: 9

Spring
SPA 799 DOCTORAL DISSERTATION 3-9

Term Semester Hours: 3-9

Total Semester Hours: 72-78

1 Required to take class four times but only 1 credit hour counts toward degree hours

SPA 522 - INTRODUCTION TO PLASMA PHYSICS
Semester Hours: 3

Provides students with an introduction to the basic physical processes associated with plasmas, which permeate all space environments. Both particle and fluid approaches are introduced, and a variety of elementary drift and wave phenomena are derived. Applications of the theory to various plasma instabilities are explored, along with specific examples of where these may occur in space science. While the goal of this course is to prepare students for more advanced topics in space physics, many of the fundamentals covered are equally relevant for students interested in plasma confinement and its associated engineering challenges.

SPA 526 - SPACE WEATHER
Semester Hours: 3

Physics of solar active regions, physics of solar flares and coronal mass ejections (CMEs), the propagation of CMEs, the acceleration and propagation of solar energetic particles, CME interaction with earth’s magnetosphere.

SPA 532 - SPACE ORIENTATION EDUCATORS
Semester Hours: 3

A weeklong course at the U.S. Space and Rocket Center in Huntsville, Alabama for pre-service and in-service teachers. The inquiry based workshops are taught around the theme of space exploration include activities to be done across the curriculum. All activities are correlated to National Math, Science, Technology, Social Studies, and Reading Standards. Activities based on curriculum developed by NASA, CAP, NSATA, and the USSRC. Topics include moon, mars, rocketry, propulsion, hydroponics, math, biology, history and literature.

SPA 582 - SCIENCE CAREER PREP
Semester Hour: 1

This course will review many of the soft skills necessary to function as a successful scientist, whether in an academic career, in a federal laboratory, a for-profit research career in a company, or even a commercial career. Your career begins with graduate school, and learning the skills for a successful graduate career will carry over to your professional career. The goal of the course is impart wisdom from successful graduate students and career scientists, providing both a basis for a successful graduate career and your subsequent career. The course will help students reduce the learning things "the hard way" approach by providing guidance for your career path. Each week will focus on a different skill that a career scientist requires.

SPA 610 - ADV MATH METHDS FOR SPA SCI
Semester Hours: 3

This course will focus on analytical methods for a series of advanced topics with an emphasis on practical applications to space science, such as Vector and Fourier Analysis, ODEs/PDEs in space science, and Green's functions, Spherical Harmonics, Spectral Analysis, Wavelet Transforms, Fractals and Complexity, and Inverse Problems.
SPA 622 - CLASSICAL & QUANTUM STATISTICS
Semester Hours: 3

SPA 623 - TRANSPORT PROCESSES IN SPACE
Semester Hours: 3
Course presents a systematic treatment of classical and anomalous transport theory for gases, plasmas, energetic particles, and low frequency turbulence. The Chapman-Enskog approach is used to derive transport coefficients for neutral gases and collisional plasmas. The relationship between multi-fluid and MHD models is presented. Weak solutions and shock waves are discussed. The transport of energetic particles that experience scattering by magnetic field fluctuations is presented, together with basic models of the turbulence responsible for scattering turbulence transport in expanding flows such as the solar wind. Prerequisite: SPA 622 and SPA 522.

SPA 624 - SPACE PHYSICS I
Semester Hours: 3
A broad introduction to particle, MHD, and kinetic phenomena in space. This course is intended for all students interested in space, astro-, and plasma physics. Course covers fusion processes inside the Sun, solar neutrinos, solar atmosphere, coronal magnetic fields, physical mechanisms of magnetic field line reconnection and magnetic dynamo, the interaction between the solar wind with planets and the interstellar medium, corotating and merged interaction regions, collisional and collisionless shock waves in space. Includes an introduction to charged particle acceleration in the heliosphere. Examines differences between planetary magnetospheres, solar-terrestrial relationships, solar activity, climate, and culture. Prerequisite: SPA 522, SPA 631 (w/concurrency).

SPA 625 - SPACE PHYSICS II
Semester Hours: 3
The course develops a deeper understanding and knowledge of plasma instabilities, kinetic dispersion relations, microinstabilities, electrostatic and electromagnetic instabilities; advanced magnetohydrodynamics including MHD turbulence, reconnection; wave-particle interactions, including basic quasi-linear theory; weak and strong wave turbulence; nonlinear waves; collisionless shock waves. Prerequisite: SPA 624.

SPA 627 - HIGH ENERGY RADIATION DET&MSRM
Semester Hours: 3
This course will provide students with basic understanding of radiation detection for space-based missions. This course will cover the basic nuclear processes in radioactive sources and the interaction of radiation with matter. The statistical treatment of experimental data will be reviewed. General characteristics common to all types of detectors will be given. We will then cover specific classes of detectors focusing on ionization, scintillation and semiconductor detectors. Light collection and detection techniques will follow. The student will then be introduced to basic signal processing and timing techniques important to a successful instrument design. This course will be taught from a physicist point of view emphasizing the physical processes and interactions that make detection of radiation possible. This course is suitable for those students interested in detector development or astrophysical data analysis using state-of-the-art technology.

SPA 628 - SOLAR PHYSICS
Semester Hours: 3
The workings of the sun, from its interior to the outer reaches of the corona with emphasis on the observations. Energy release in core of the Sun and its transport to the solar atmosphere. Dynamo process and the 11 year solar activity cycle. Formation of active regions and structure of sunspots. The structure of corona, with particular details on the active region corona and its heating to several million kelvin. Energy release processes including solar flares and coronal mass ejections.

SPA 629 - ASTROPHYSICAL FLUID DYNAMICS
Semester Hours: 3
Covers astrophysical phenomena occurring outside the boundaries of the solar system. Subjects include stellar structure and rotation, waves and instabilities in astrophysical plasmas, the physics of spherical and disk accretion, supernova blast waves, and charged particle transport and acceleration in cosmic plasmas. Introduction to the principles of stellar formation, helioseismology, stellar dynamo, coronal heating, and astrophysical turbulence. Prerequisite: SPA 522.

SPA 630 - WAVES IN FLUIDS
Semester Hours: 3
Comprehensive introduction to the science of wave motions in fluids. Waves and first-order (hyperbolic) equations, wave hierarchies; gas dynamics and fluid equations; acoustics, nonlinear plane waves, simple waves, shock waves and structure, shock reflection, similarity solutions, supersonic flows in gas dynamics; the wave equation, including plane, spherical and cylindrical waves, geometrical optics, including far-field approximation, caustics, nonhomogeneous media, anisotropy; water waves, including shallow water theory; group velocity, dispersion; nonlinear waves, including Korteweg-de Vries, sine-Gordon, and nonlinear Schrodinger equations, solitons. Prerequisite: SPA 610.
SPA 631 - WAVES AND FIELDS  
Semester Hours: 3  

SPA 636 - ADV SPACE WEATHER  
Semester Hours: 3  
Advanced topics in Space Weather with emphasis on practical effects and impacts on human technology and society: interaction of solar disturbances with Earth’s magnetosphere, Solar Energetic Particles, and their effects; Forecasting and Nowcasting of Space Weather; Space Weather at Mars and other planets. Prerequisite: SPA 522.

SPA 662 - COMPUTATIONAL PHYSICS  
Semester Hours: 3  

SPA 663 - COMPUTATIONAL FLUID DYNMC &MHD  
Semester Hours: 3  
Numerical simulations of various problems in space physics, astrophysics, engineering, and plasma dynamics. Finite- volume and finite-difference, shock-capturing and shock-fitting methods for hyperbolic equations, including gas dynamics, MHD, and shallow water equations. The hierarchy of numerical methods is introduced in a systematic way, starting from standard linear schemes and arriving at modern discontinuity-capturing non-linear methods. Exact and approximate Riemann solvers, characteristic analysis of underlying equations. Different implementations of boundary conditions are introduced in relation with the mathematical properties of quasilinear hyperbolic systems. Prerequisite: SPA 624, SPA 662.

SPA 689 - SELECTED TOPICS  
Semester Hours: 3  
Selected Topics in Space Science not covered in other courses.

SPA 699 - MASTER'S THESIS  
Semester Hours: 1-6

SPA 741 - PHYSICS OF COSMIC RAYS  
Semester Hours: 3  
Covers two principal areas of cosmic ray physics: (i) cosmic ray origin and acceleration, and (ii) cosmic ray transport and detection. Includes galactic cosmic rays, anomalous cosmic rays, and solar energetic particles. Transport theory, acceleration mechanisms and observational signatures. Prerequisite: SPA 623.

SPA 742 - GAMMA-RAY BURSTS AND JETS  
Semester Hours: 3  

SPA 771 - COMPETITIVE GRANT WRITING WKSP  
Semester Hour: 1  
This course is designed for senior level graduate students who are about to graduate and start their professional career. It will introduce students to the real and complete process of competing for grant support. It is comprised of a series of lectures (workshops), case studies, and ends with a formal proposal from each participant and a mock review process.

SPA 789 - SELECTED TOPICS  
Semester Hours: 3  
Selected Topics in Space Science not covered in other courses.

SPA 796 - JOURNAL CLUB  
Semester Hour: 1  
This course requires graduate students to read, interpret and present literature critically to fellow students, researchers, and faculty. Students stay abreast of current knowledge in the field, develop presentation skills and promote department unity. Faculty instructor will lead, assign, and provide students feedback on their presentations.
**Space Science, MS**

**Mission**

The Department of Space Science's primary objective is to prepare the next generation of space professionals and workforce by educating and providing opportunities for our graduate students to engage in cutting-edge research in solar physics, heliospheric science, cosmic ray physics, and high-energy astrophysics. Our graduate students will be afforded a unique unified Space Science graduate program under the umbrella of a single university department while introducing students to an academic discipline, solar and space physics, with global consequences that are both intellectually stimulating and relevant to society with faculty from the Department of Space Science and our research partners: The University of Alabama in Huntsville’s Center for Space Plasma and Aeronomic Research and Marshall Space Flight Center.

The Master's degree program in Space Science empowers our graduate students to think analytically on real science and technology problems to become part of a multi-talented, creative workforce for the future of the United States. The Department of Space Science strives to increase the diversification of the space professional and workforce population by encouraging the participation of women and underrepresented groups in the Space Science program.

Our secondary objective is to enhance and promote space subjects and disciplines locally at UAH, in the community of Huntsville, and within the state of Alabama through scientific research, outreach, and community partnerships with schools and other educational institutions. Our M.S. program teaches problem solving and communication skills for future science, engineering, and technology professionals through research in the field of Space Science in order to meet current and future technology needs and demands by training students to formulate and solve technical problems in general research, commercial, and industrial settings. We also provide teachers and educators with opportunities to develop and strengthen their knowledge and skills in space-related fields, as well as promote space science nationally and internationally through faculty and student research.

**Admission Requirements**

The Department of Space Science will follow the guidelines set by the Graduate School at The University of Alabama in Huntsville as the primary criteria for selecting students for admission into the program. In addition, the department faculty will carefully evaluate the past performance of each student, as documented in transcripts for all undergraduate and graduate courses. The GRE will be required for all students and TOEFL or IELTS is required for all international students. Letters of recommendation will be used to assess the student’s potential for graduate school. Finally, the student must demonstrate a strong interest in performing research in Space Science, as indicated in the personal statement on his or her application.

**Expectations of the students:**

- To be technically competent in space-related fields; able to work on diverse technical problems that typically arise in a technologically-based work and industry environment; able to communicate effectively the results of their work to the professional community through reports and presentations; or to present technical space-related material to students at the high school and junior college level, and to promote their science to the public with outreach activities.
- For those students desiring to enter a non-space science related field, we expect our students to have learned the technical and communications skills to meet the needs of a technologically-based society, and who can contribute to the broader research, industry, and commercial sectors, i.e., we do not just train our students to be future scientists but instead have the skills and training to contribute to a highly technological society throughout the world. The M.S. program will focus on the development and provision of technical skills to graduate students. M.S. graduates will fit more directly into technical/industry and educational workforce.

<table>
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<th>Fall</th>
<th>Semester Hours</th>
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<tbody>
<tr>
<td>SPA 522</td>
<td>INTRODUCTION TO PLASMA PHYSICS</td>
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<tr>
<td>SPA 622</td>
<td>CLASSICAL QUANTUM STATISTICS</td>
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<td>MATHEMATICAL METHODS I</td>
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<td>Spring</td>
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<tr>
<td>PH 631</td>
<td>ELECTROMAGNETIC THEORY I</td>
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<tr>
<td>MA 609</td>
<td>MATHEMATICAL METHODS II</td>
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### SPA 624
**SPACE PHYSICS I**

| Term Semester Hours: | 9 |

#### Year 2

**Fall**

- **SPA 628**: SOLAR PHYSICS 3
- **SPA 625** (or **SPA 625**): SPACE PHYSICS II 3
- **SPA 662**: COMPUTATIONAL PHYSICS 3
- **PH 732**: ELECTROMAGNETIC TH II 3

| Term Semester Hours: | 9 |

**Spring**

- **SPA 623**: TRANSPORT PROCESSES IN SPACE 3
- **SPA 699**: MASTER'S THESIS 3
- **SPA 526** (or **SPA 526**): SPACE WEATHER 3
- **SPA 699**: MASTER'S THESIS 3
- **SPA 663**: COMPUTATIONAL FLUID DYNMC &MHD 3

| Term Semester Hours: | 9 |

**Total Semester Hours**: 36

Information below is intended for prospective students who are considering a Master's degree in Space Science from UAH.

All questions about enrolling in our M.S. program should be directed to Dr. Robert Preece (rob.preece@nasa.gov), Chair of the SPA Graduate Committee.

**Requirements for M.S. Degree - Thesis Option**

1. Complete the core coursework (21 credit hours), see Core Courses below.
2. Complete an additional 9 credit hours of elective courses. These are chosen from the Elective Courses list.
4. Write and defend a Master's thesis.

**Requirements for M.S. Degree - Non Thesis Option**

1. Complete the core coursework (21 credit hours), see Core Courses below.
2. Complete an additional 15 credit hours of elective courses. These are chosen from the Elective Courses list.
3. Pass a Comprehensive Examination ("Comps"). The Comps are offered annually during the summer semester and consist of three sections: (a) Electromagnetic Theory, (b) Classical and Quantum Statistics, and (c) Plasma Physics. A passing grade of 40% or above in all three sections is required for a M.S. pass.

**Code** | **Title** | **Semester Hours**
--- | --- | ---
SPA 522 | INTRODUCTION TO PLASMA PHYSICS | 3
MA 607 | MATHEMATICAL METHODS I | 3
MA 609 | MATHEMATICAL METHODS II | 3
SPA 622 | CLASSICAL & QUANTUM STATISTICS | 3
PH 631 | ELECTROMAGNETIC THEORY I | 3
SPA 623 | TRANSPORT PROCESSES IN SPACE | 3
SPA 624 | SPACE PHYSICS I | 3

**Elective Courses**

Choose 5 courses from the following: 15

- SPA 625: SPACE PHYSICS II
- SPA 626: Course SPA 626 Not Found
- SPA 627: HIGH ENERGY RADIATION DET&MSRM
- SPA 628: SOLAR PHYSICS
- SPA 629: ASTROPHYSICAL FLUID DYNAMICS
- SPA 630: WAVES IN FLUIDS
- SPA 662: COMPUTATIONAL PHYSICS
SPA 522 - INTRODUCTION TO PLASMA PHYSICS  
Semester Hours: 3

Provides students with an introduction to the basic physical processes associated with plasmas, which permeate all space environments. Both particle and fluid approaches are introduced, and a variety of elementary drift and wave phenomena are derived. Applications of the theory to various plasma instabilities are explored, along with specific examples of where these may occur in space science. While the goal of this course is to prepare students for more advanced topics in space physics, many of the fundamentals covered are equally relevant for students interested in plasma confinement and its associated engineering challenges.

SPA 526 - SPACE WEATHER  
Semester Hours: 3

Physics of solar active regions, physics of solar flares and coronal mass ejections (CMEs), the propagation of CMEs, the acceleration and propagation of solar energetic particles, CME interaction with earth's magnetosphere.

SPA 532 - SPACE ORIENTATION EDUCATORS  
Semester Hours: 3

A weeklong course at the U.S. Space and Rocket Center in Huntsville, Alabama for pre-service and in-service teachers. The inquiry based workshops are taught around the theme of space exploration include activities to be done across the curriculum. All activities are correlated to National Math, Science, Technology, Social Studies, and Reading Standards. Activities based on curriculum developed by NASA, CAP, NSATA, and the USSRC. Topics include moon, mars, rocketry, propulsion, hydroponics, math, biology, history and literature.

SPA 582 - SCIENCE CAREER PREP  
Semester Hour: 1

This course will review many of the soft skills necessary to function as a successful scientist, whether in an academic career, in a federal laboratory, a for-profit research career in a company, or even a commercial career. Your career begins with graduate school, and learning the skills for a successful graduate career will carry over to your professional career. The goal of the course is impart wisdom from successfull graduate students and career scientists, providing both a basis for a successful graduate career and your subsequent career. The course will help students reduce the learning things "the hard way" approach by providing guidance for your career path. Each week will focus on a different skill that a career scientist requires.

SPA 610 - ADV MATH METHODS FOR SPA SCI  
Semester Hours: 3

This course will focus on analytical methods for a series of advanced topics with an emphasis on practical applications to space science, such as Vector and Fourier Analysis, ODEs/PDEs in space science, and Green's functions, Spherical Harmonics, Spectral Analysis, Wavelet Transforms, Fractals and Complexity, and Inverse Problems.

SPA 622 - CLASSICAL & QUANTUM STATISTICS  
Semester Hours: 3


SPA 623 - TRANSPORT PROCESSES IN SPACE  
Semester Hours: 3

Course presents a systematic treatment of classical and anomalous transport theory for gases, plasmas, energetic particles, and low frequency turbulence. The Chapman-Enskog approach is used to derive transport coefficients for neutral gases and collisional plasmas. The relationship between multi-fluid and MHD models is presented. Weak solutions and shock waves are discussed. The transport of energetic particles that experience scattering by magnetic field fluctuations is presented, together with basic models of the turbulence responsible for scattering turbulence transport in expanding flows such as the solar wind. Prerequisite: SPA 622 and SPA 522.
SPA 624 - SPACE PHYSICS I  
Semester Hours: 3

A broad introduction to particle, MHD, and kinetic phenomena in space. This course is intended for all students interested in space, astro-, and plasma physics. Course covers fusion processes inside the Sun, solar neutrinos, solar atmosphere, coronal magnetic fields, physical mechanisms of magnetic field line reconnection and magnetic dynamo, the interaction between the solar wind with planets and the interstellar medium, corotating and merged interaction regions, collisional and collisionless shock waves in space. Includes an introduction to charged particle acceleration in the heliosphere. Examines differences between planetary magnetospheres, solar-terrestrial relationships, solar activity, climate, and culture. Prerequisite: SPA 522, SPA 631 (w/concurrency).

SPA 625 - SPACE PHYSICS II  
Semester Hours: 3

The course develops a deeper understanding and knowledge of plasma instabilities, kinetic dispersion relations, microinstabilities, electrostatic and electromagnetic instabilities; advanced magnetohydrodynamics including MHD turbulence, reconnection; wave-particle interactions, including basic quasi-linear theory; weak and strong wave turbulence; nonlinear waves; collisionless shock waves. Prerequisite: SPA 624.

SPA 627 - HIGH ENERGY RADIATION DET&MSRM  
Semester Hours: 3

This course will provide students with basic understanding of radiation detection for space-based missions. This course will cover the basic nuclear processes in radioactive sources and the interaction of radiation with matter. The statistical treatment of experimental data will be reviewed. General characteristics common to all types of detectors will be given. We will then cover specific classes of detectors focusing on ionization, scintillation and semiconductor detectors. Light collection and detection techniques will follow. The student will then be introduced to basic signal processing and timing techniques important to a successful instrument design. This course will be taught from a physicist point of view emphasizing the physical processes and interactions that make detection of radiation possible. This course is suitable for those students interested in detector development or astrophysical data analysis using state-of-the-art technology.

SPA 628 - SOLAR PHYSICS  
Semester Hours: 3

The workings of the sun, from its interior to the outer reaches of the corona with emphasis on the observations. Energy release in core of the Sun and its transport to the solar atmosphere. Dynamo process and the 11 year solar activity cycle. Formation of active regions and structure of sunspots. The structure of corona, with particular details on the active region corona and its heating to several million kelvin. Energy release processes including solar flares and coronal mass ejections.

SPA 629 - ASTROPHYSICAL FLUID DYNAMICS  
Semester Hours: 3

Covers astrophysical phenomena occurring outside the boundaries of the solar system. Subjects include stellar structure and rotation, waves and instabilities in astrophysical plasmas, the physics of spherical and disk accretion, supernova blast waves, and charged particle transport and acceleration in cosmic plasmas. Introduction to the principles of stellar formation, helioseismology, stellar dynamo, coronal heating, and astrophysical turbulence. Prerequisite: SPA 522.

SPA 630 - WAVES IN FLUIDS  
Semester Hours: 3

Comprehensive introduction to the science of wave motions in fluids. Waves and first-order (hyperbolic) equations, wave hierarchies; gas dynamics and fluid equations; acoustics, nonlinear plane waves, simple waves, shock waves and structure, shock reflection, similarity solutions, supersonic flows in gas dynamics; the wave equation, including plane, spherical and cylindrical waves, geometrical optics, including far-field approximation, caustics, nonhomogeneous media, anisotropy; water waves, including shallow water theory; group velocity, dispersion; nonlinear waves, including Korteweg-de Vries, sine-Gordon, and nonlinear Schroedinger equations, solitons. Prerequisite: SPA 610.

SPA 631 - WAVES AND FIELDS  
Semester Hours: 3


SPA 636 - ADV SPACE WEATHER  
Semester Hours: 3

Advanced topics in Space Weather with emphasis on practical effects and impacts on human technology and society: interaction of solar disturbances with Earth's magnetosphere, Solar Energetic Particles, and their effects; Forecasting and Nowcasting of Space Weather; Space Weather at Mars and other planets. Prerequisite: SPA 522.
SPA 662 - COMPUTATIONAL PHYSICS  
Semester Hours: 3  

SPA 663 - COMPUTATIONAL FLUID DYNAMICS & MHD  
Semester Hours: 3  
Numerical simulations of various problems in space physics, astrophysics, engineering, and plasma dynamics. Finite-volume and finite-difference, shock-capturing and shock-fitting methods for hyperbolic equations, including gas dynamics, MHD, and shallow water equations. The hierarchy of numerical methods is introduced in a systematic way, starting from standard linear schemes and arriving at modern discontinuity-capturing non-linear methods. Exact and approximate Riemann solvers, characteristic analysis of underlying equations. Different implementations of boundary conditions are introduced in relation with the mathematical properties of quasilinear hyperbolic systems. Prerequisite: SPA 624, SPA 662.

SPA 689 - SELECTED TOPICS  
Semester Hours: 3  
Selected Topics in Space Science not covered in other courses.

SPA 699 - MASTER'S THESIS  
Semester Hours: 1-6

SPA 741 - PHYSICS OF COSMIC RAYS  
Semester Hours: 3  
Covers two principal areas of cosmic ray physics: (i) cosmic ray origin and acceleration, and (ii) cosmic ray transport and detection. Includes galactic cosmic rays, anomalous cosmic rays, and solar energetic particles. Transport theory, acceleration mechanisms and observational signatures. Prerequisite: SPA 623.

SPA 742 - GAMMA-RAY BURSTS AND JETS  
Semester Hours: 3  

SPA 771 - COMPETITIVE GRANT WRITING WKSP  
Semester Hour: 1  
This course is designed for senior level graduate students who are about to graduate and start their professional career. It will introduce students to the real and complete process of competing for grant support. It is comprised of a series of lectures (workshops), case studies, and ends with a formal proposal from each participant and a mock review process.

SPA 789 - SELECTED TOPICS  
Semester Hours: 3  
Selected Topics in Space Science not covered in other courses.

SPA 796 - JOURNAL CLUB  
Semester Hour: 1  
This course requires graduate students to read, interpret and present literature critically to fellow students, researchers, and faculty. Students stay abreast of current knowledge in the field, develop presentation skills and promote department unity. Faculty instructor will lead, assign, and provide students feedback on their presentations.

SPA 799 - DOCTORAL DISSERTATION  
Semester Hours: 1-9  
Students must have passed the Comprehensive Examination at PhD level and have PhD advisor's approval. No more than 9 hours may be taken prior to passing the Qualifying Examination.

Space Science, PhD

Mission

The Department of Space Science's primary objective is to prepare the next generation of space professionals and workforce by educating and providing opportunities for our graduate students to engage in cutting-edge research in solar physics, heliospheric science, cosmic ray physics and high-energy astrophysics. Our graduate students are afforded a unique unified Space Science graduate program under the umbrella of a single university department, while introducing students to an academic discipline, solar and space physics, with global consequences that are both intellectually
stimulating and relevant to society with faculty from the Department of Space Science and our research partners: UAH’s Center for Space Plasma and Aeronomic Research and Marshall Space Flight Center.

The Doctoral degree program in Space Science empowers our graduate students to think analytically about real science and technology problems to become part of a multi-talented, creative workforce for the future of the United States. The Department of Space Science strives to increase the diversification of the space professional and workforce population by encouraging the participation of women and underrepresented groups on the Space Science program.

Our secondary objective is to enhance and promote space subjects and disciplines locally at UAH, in the community of Huntsville, and within the state of Alabama through scientific research, outreach, and community partnerships with schools and other educational institutions. Our Ph.D. program teaches problem solving and communication skills for future science, engineering, and technology professionals through research in the field of Space Science in order to meet current and future technology needs and demands by training students to formulate and solve technical problems in general research, commercial, and industrial settings.

Admission Requirements

The Department of Space Science will follow the guidelines set by the Graduate School at The University of Alabama in Huntsville as the primary criteria for selecting students for admission into the program. The Department Faculty will carefully evaluate the past performance of each student, as documented in transcripts for all undergraduate and graduate courses. The GRE will be required for all students and TOEFL or IELTS is required for all international students. Letters of recommendation will be used to assess the student’s potential for graduate school. Finally, the student must demonstrate a strong interest in performing research in Space Science, as indicated in the personal statement on his or her application.

Expectations of the students:

• Ph.D. degree recipients are expected to conduct original, independent research adhering to the principles of scientific rigor and research ethics. A person with a Ph.D. in Space Science will be able to communicate effectively the results of his or her work to the professional community through publications and conference presentations, and to promote science to the public with outreach activities. Graduates who choose to enter a research-oriented field will be ready to seek external funding and write research proposals, successfully competing with the nation’s top scientists in space related fields. They are also expected to serve the world’s scientific community through peer review, panel service, meeting organizing, and mentoring activities.

• For those students desiring to enter a non-space science related field, we expect our students to have learned the technical and communications skills to meet the needs of a technologically-based society, and who can contribute to the broader research, industry, and commercial sectors – i.e., we do not just train our students to be future scientists but instead have the skills and training to contribute to a technologically-based society across the world. The Ph.D. program will focus on original research and the development and provision of technical skills, especially programming and analytic, to graduate students.

http://www.uah.edu/science/departments/space-science

Requirements for a Ph.D. degree

1. Complete the core coursework (24 credit hours), see Core Courses below.
2. Complete an additional 18 credit hours of elective courses. These are chosen from the Elective Courses list.
3. Pass a Comprehensive Examination ("Comps"). The Comps are offered annually during the summer semester and consist of three sections: (a) Electromagnetic Theory, (b) Classical and Quantum Statistics, and (c) Plasma Physics. A passing grade of 60% or above in all three sections is required for a Ph.D. pass.
4. Give at least two seminar (Journal Club) presentations. Students are encouraged to share the results of their research work with their peers and faculty members. Journal Club presentations are part of the regular Space Science seminar series.
5. Pass a Ph.D. qualifier exam. This step involves writing a dissertation proposal and forming a Ph.D. committee, that would normally consist of the student’s faculty advisor and at least three other members from the UAH graduate faculty. We encourage students to invite at least one committee member from another department or research center.
6. Complete 18 credit hours of dissertation units (SPA 799).
7. Write and defend a Ph.D. dissertation.
8. Students must have a first authored peer reviewed paper published or accepted in a major international journal before their graduation date. Examples of acceptable journals include The Astrophysical Journal, Journal of Geophysical Research, Physics of Plasmas, Geophysical Research Letters, and Physical Review.

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**Year 1**

**Fall**

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**Year 2**

**Fall**

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**Year 3**

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|               | **Total Semester Hours:**                        | **64-76**      |

**SPA 489 - SELECTED TOPICS**

Semester Hours: 3

Selected topics in Space Science not covered in other courses.

**SPA 522 - INTRODUCTION TO PLASMA PHYSICS**

Semester Hours: 3

Provides students with an introduction to the basic physical processes associated with plasmas, which permeate all space environments. Both particle and fluid approaches are introduced, and a variety of elementary drift and wave phenomena are derived. Applications of the theory to various plasma instabilities are explored, along with specific examples of where these may occur in space science. While the goal of this course is to prepare students for more advanced topics in space physics, many of the fundamentals covered are equally relevant for students interested in plasma confinement and its associated engineering challenges.

**SPA 526 - SPACE WEATHER**

Semester Hours: 3

Physics of solar active regions, physics of solar flares and coronal mass ejections (CMEs), the propagation of CMEs, the acceleration and propagation of solar energetic particles, CME interaction with earth's magnetosphere.

**SPA 532 - SPACE ORIENTATION EDUCATORS**

Semester Hours: 3

A weeklong course at the U.S. Space and Rocket Center in Huntsville, Alabama for pre-service and in-service teachers. The inquiry based workshops are taught around the theme of space exploration include activities to be done across the curriculum. All activities are correlated to National Math, Science, Technology, Social Studies, and Reading Standards. Activities based on curriculum developed by NASA, CAP, NSATA, and the USSRC. Topics include moon, mars, rocketry, propulsion, hydroponics, math, biology, history and literature.

**SPA 582 - SCIENCE CAREER PREP**

Semester Hour: 1

This course will review many of the soft skills necessary to function as a successful scientist, whether in an academic career, in a federal laboratory, a for-profit research career in a company, or even a commercial career. Your career begins with graduate school, and learning the skills for a successful graduate career will carry over to your professional career. The goal of the course is impart wisdom from successfull graduate students and career scientists, providing both a basis for a successful graduate career and your subsequent career. The course will help students reduce the learning things "the hard way" approach by providing guidance for your career path. Each week will focus on a different skill that a career scientist requires.

**SPA 610 - ADV MATH METHODS FOR SPA SCI**

Semester Hours: 3

This course will focus on analytical methods for a series of advanced topics with an emphasis on practical applications to space science, such as Vector and Fourier Analysis, ODEs/PDEs in space science, and Green's functions, Spherical Harmonics, Spectral Analysis, Wavelet Transforms, Fractals and Complexity, and Inverse Problems.

**SPA 622 - CLASSICAL & QUANTUM STATISTICS**

Semester Hours: 3

SPA 623 - TRANSPORT PROCESSES IN SPACE
Semester Hours: 3

Course presents a systematic treatment of classical and anomalous transport theory for gases, plasmas, energetic particles, and low frequency turbulence. The Chapman-Enskog approach is used to derive transport coefficients for neutral gases and collisional plasmas. The relationship between multi-fluid and MHD models is presented. Weak solutions and shock waves are discussed. The transport of energetic particles that experience scattering by magnetic field fluctuations is presented, together with basic models of the turbulence responsible for scattering turbulence transport in expanding flows such as the solar wind. Prerequisite: SPA 622 and SPA 522.

SPA 624 - SPACE PHYSICS I
Semester Hours: 3

A broad introduction to particle, MHD, and kinetic phenomena in space. This course is intended for all students interested in space, astro-, and plasma physics. Course covers fusion processes inside the Sun, solar neutrinos, solar atmosphere, coronal magnetic fields, physical mechanisms of magnetic field line reconnection and magnetic dynamo, the interaction between the solar wind with planets and the interstellar medium, corotating and merged interaction regions, collisional and collisionless shock waves in space. Includes an introduction to charged particle acceleration in the heliosphere. Examines differences between planetary magnetospheres, solar-terrestrial relationships, solar activity, climate, and culture. Prerequisite: SPA 522, SPA 631 (w/concurrency).

SPA 625 - SPACE PHYSICS II
Semester Hours: 3

The course develops a deeper understanding and knowledge of plasma instabilities, kinetic dispersion relations, microinstabilities, electrostatic and electromagnetic instabilities; advanced magnetohydrodynamics including MHD turbulence, reconnection; wave-particle interactions, including basic quasi-linear theory; weak and strong wave turbulence; nonlinear waves; collisionless shock waves. Prerequisite: SPA 624.

SPA 627 - HIGH ENERGY RADIATION DET&MSRM
Semester Hours: 3

This course will provide students with basic understanding of radiation detection for space-based missions. This course will cover the basic nuclear processes in radioactive sources and the interaction of radiation with matter. The statistical treatment of experimental data will be reviewed. General characteristics common to all types of detectors will be given. We will then cover specific classes of detectors focusing on ionization, scintillation and semiconductor detectors. Light collection and detection techniques will follow. The student will then be introduced to basic signal processing and timing techniques important to a successful instrument design. This course will be taught from a physicist point of view emphasizing the physical processes and interactions that make detection of radiation possible. This course is suitable for those students interested in detector development or astrophysical data analysis using state-of-the-art technology.

SPA 628 - SOLAR PHYSICS
Semester Hours: 3

The workings of the sun, from its interior to the outer reaches of the corona with emphasis on the observations. Energy release in core of the Sun and its transport to the solar atmosphere. Dynamo process and the 11 year solar activity cycle. Formation of active regions and structure of sunspots. The structure of corona, with particular details on the active region corona and its heating to several million kelvin. Energy release processes including solar flares and coronal mass ejections.

SPA 629 - ASTROPHYSICAL FLUID DYNAMICS
Semester Hours: 3

Covers astrophysical phenomena occurring outside the boundaries of the solar system. Subjects include stellar structure and rotation, waves and instabilities in astrophysical plasmas, the physics of spherical and disk accretion, supernova blast waves, and charged particle transport and acceleration in cosmic plasmas. Introduction to the principles of stellar formation, helioseismology, stellar dynamo, coronal heating, and astrophysical turbulence. Prerequisite: SPA 522.

SPA 630 - WAVES IN FLUIDS
Semester Hours: 3

Comprehensive introduction to the science of wave motions in fluids. Waves and first-order (hyperbolic) equations, wave hierarchies; gas dynamics and fluid equations: acoustics, nonlinear plane waves, simple waves, shock waves and structure, shock reflection, similarity solutions, supersonic flows in gas dynamics; the wave equation, including plane, spherical and cylindrical waves, geometrical optics, including far-field approximation, caustics, nonhomogeneous media, anisotropy; water waves, including shallow water theory; group velocity, dispersion; nonlinear waves, including Korteweg-de Vries, sine-Gordon, and nonlinear Schroedinger equations, solitons. Prerequisite: SPA 610.
SPA 631 - WAVES AND FIELDS
Semester Hours: 3

SPA 636 - ADV SPACE WEATHER
Semester Hours: 3
Advanced topics in Space Weather with emphasis on practical effects and impacts on human technology and society: interaction of solar disturbances with Earth's magnetosphere, Solar Energetic Particles, and their effects; Forecasting and Nowcasting of Space Weather; Space Weather at Mars and other planets. Prerequisite: SPA 522.

SPA 662 - COMPUTATIONAL PHYSICS
Semester Hours: 3

SPA 663 - COMPUTATIONAL FLUID DYNMC &MHD
Semester Hours: 3
Numerical simulations of various problems in space physics, astrophysics, engineering, and plasma dynamics. Finite- volume and finite-difference, shock-capturing and shock-fitting methods for hyperbolic equations, including gas dynamics, MHD, and shallow water equations. The hierarchy of numerical methods is introduced in a systematic way, starting from standard linear schemes and arriving at modern discontinuity-capturing non-linear methods. Exact and approximate Riemann solvers, characteristic analysis of underlying equations. Different implementations of boundary conditions are introduced in relation with the mathematical properties of quasilinear hyperbolic systems. Prerequisite: SPA 624, SPA 662.

SPA 689 - SELECTED TOPICS
Semester Hours: 3
Selected Topics in Space Science not covered in other courses.

SPA 699 - MASTER'S THESIS
Semester Hours: 1-6

SPA 741 - PHYSICS OF COSMIC RAYS
Semester Hours: 3
Covers two principal areas of cosmic ray physics: (i) cosmic ray origin and acceleration, and (ii) cosmic ray transport and detection. Includes galactic cosmic rays, anomalous cosmic rays, and solar energetic particles. Transport theory, acceleration mechanisms and observational signatures. Prerequisite: SPA 623.

SPA 742 - GAMMA-RAY BURSTS AND JETS
Semester Hours: 3

SPA 771 - COMPETITIVE GRANT WRITING WKSP
Semester Hour: 1
This course is designed for senior level graduate students who are about to graduate and start their professional career. It will introduce students to the real and complete process of competing for grant support. It is comprised of a series of lectures (workshops), case studies, and ends with a formal proposal from each participant and a mock review process.

SPA 789 - SELECTED TOPICS
Semester Hours: 3
Selected Topics in Space Science not covered in other courses.

SPA 796 - JOURNAL CLUB
Semester Hour: 1
This course requires graduate students to read, interpret and present literature critically to fellow students, researchers, and faculty. Students stay abreast of current knowledge in the field, develop presentation skills and promote department unity. Faculty instructor will lead, assign, and provide students feedback on their presentations.
SPA 799 - DOCTORAL DISSERTATION
Semester Hours: 1-9

Students must have passed the Comprehensive Examination at PhD level and have PhD advisor's approval. No more than 9 hours may be taken prior to passing the Qualifying Examination.

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Accounting (ACC)

ACC 513 - CORP/PARTNERSHIP/ESTATE TAXES
Semester Hours: 3

Tax accounting for partnerships, corporations, Sub chapter S corporations, estates, and trusts. Tax administration and research are emphasized.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester Hours</th>
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</thead>
<tbody>
<tr>
<td>ACC 514</td>
<td>COST ACCOUNTING</td>
<td>3</td>
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<tr>
<td></td>
<td>Development and use of cost data for external reporting and internal planning and control. Topics include cost modeling, job and process costing, standard costing, and budgeting. Development of relevant cost information for special purposes is also considered.</td>
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<tr>
<td>ACC 517</td>
<td>ACC FOR STATE/LOCAL GOV/NON-PR</td>
<td>3</td>
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<tr>
<td></td>
<td>Fund accounting and local governments, hospitals, and universities. Special accounting principles, budgeting, accounting for various funds and account groups are emphasized.</td>
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<tr>
<td>ACC 520</td>
<td>STATE AND LOCAL TAXATION</td>
<td>3</td>
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<tr>
<td></td>
<td>Principles of state income tax, sales, and other excise taxes and property tax. Taxation of interstate commerce will be examined along with US constitutional restrictions on the ability of states to tax interstate commerce.</td>
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<tr>
<td>ACC 522</td>
<td>ADVANCED AUDITING</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Practical application of auditing concepts and standards. An understanding of auditing principles is reinforced and expanded by exposure to problems and cases.</td>
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<tr>
<td>ACC 533</td>
<td>FORENSIC ACCOUNTING</td>
<td>3</td>
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<td></td>
<td>Study of the nature and types of fraud. The course covers the tools and techniques used to prevent, investigate, and detect fraud.</td>
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<tr>
<td>ACC 540</td>
<td>BASIC GOVERNMENT CONTRACT ACCT</td>
<td>3</td>
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<tr>
<td></td>
<td>Basic coverage and principles of government contract accounting with an emphasis on the Federal Acquisition Regulation (FAR).</td>
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<tr>
<td>ACC 541</td>
<td>ADV GOVERNMENT CONTRACT ACCTG</td>
<td>3</td>
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<tr>
<td></td>
<td>Advanced issues in government contract cost accounting with an emphasis on the Federal Acquisition Regulation (FAR) and Cost Accounting Standards (CAS) cost allocation guidelines. Prerequisite: ACC 540.</td>
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<tr>
<td>ACC 570</td>
<td>SEMINAR/CONT ACCTG ISSUE</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Current topics in professional accounting.</td>
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<tr>
<td>ACC 580</td>
<td>PROFESSIONAL CERTIFICATION</td>
<td>3</td>
</tr>
<tr>
<td>ACC 590</td>
<td>SPECIAL PROJECTS</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Independent study in the field of accounting which is of interest to a student.</td>
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</tr>
<tr>
<td>ACC 595</td>
<td>INTERNSHIP IN ACCOUNTING</td>
<td>1-3</td>
</tr>
<tr>
<td></td>
<td>Internship with a business or government agency that has particular relevance to the educational goals of the program. Students must keep a log and submit a report on their internship.</td>
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</tr>
<tr>
<td>ACC 600</td>
<td>FOUNDATIONS ACC MANAGERS &amp; ENG</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>A graduate level introduction to the accounting framework and how it is used in evaluating economic conditions and success in decision making organizations. The course considers financial statements, accounting reports, and accounting terminology that constitutes the language of business. The course also introduces the use of accounting information for decision making, coordinating, motivating, and evaluating.</td>
<td></td>
</tr>
</tbody>
</table>
ACC 602 - MANAGERIAL ACCOUNTING  
Semester Hours: 3  
Examines the managerial uses of accounting. The focus is on the students gaining a comprehensive understanding of accounting concepts in decision-making, planning, and control. Prerequisite: ACC 600.

ACC 603 - FINANCIAL STATEMENT ANALYSIS  
Semester Hours: 3  
Concepts and techniques of financial statement analysis and decision-making. Topics include elements of financial statements, short and long term debt-paying ability, analysis of profitability, problems in specialized industries, forecasting, business valuation, and equity security analysis. Prerequisites: ACC 602 and FIN 601.

ACC 607 - ADV ACC INFORMAT SYSTEMS  
Semester Hours: 3  
In-depth examination of accounting information systems. Emphasis on computer-oriented systems and current developments in systems.

ACC 614 - COST MANAGEMENT  
Semester Hours: 3  
A study of various approaches to identifying and proactively managing the costs of providing services and products. Special attention is given to the development of cost data useful to managers for decision-making, current issues in cost management, and ethical considerations.

ACC 615 - ADV FINANCIAL ACCOUNTING  
Semester Hours: 3  
Analysis of issues and alternatives in advanced problem areas including partnerships, intercorporate investments, business combinations, and foreign exchange.

ACC 642 - ADV INTERN/OPR AUDITING  
Semester Hours: 3  
Introduction to the methodology of internal and operational auditing and to the utilization of results of the audit by management in decision making.

ACC 650 - SELECTED RESEARCH TOPICS  
Semester Hours: 3  
ACC 680 - FINANCIAL ACCOUNTING THEORY  
Semester Hours: 3  
A capstone course that includes a study of the historical development and theoretical structure of accounting followed by an appraisal of selected pronouncements of professional accounting organizations.

ACC 699 - MASTER'S THESIS  
Semester Hours: 1-3  
Required each semester a student is working on and receiving direction on a masters thesis. A minimum of 2 semesters is required, but not more than six hours of credit is allowed.

Astronomy (AST)  
AST 571 - STELLAR ATMOSP/INTERIORS  
Semester Hours: 3  
AST 572 - GALACTIC STRUC/COSMOLOGY  
Semester Hours: 3  
AST 573 - HIGH-ENERGY ASTROPHYSICS  
Semester Hours: 3

Atmospheric Science (ATS)  
ATS 501 - SURVEY OF ATMOSPHERIC SCIENCE  
Semester Hours: 3  
General survey of the field of atmospheric science includes thermodynamics, atmospheric dynamics, cloud physics, and atmospheric radiation. Quantitative examination of atmospheric properties including atmospheric composition, structure and dynamics.
ATS 509 - APPL COMPUTERS IN METEOROLOGY  
Semester Hours: 3  
Survey of scientific programming techniques used in atmospheric sciences. Various data types, control statements, and programming design using object oriented techniques are discussed, emphasizing efficient programming. Course prepares students for graduate work and research in atmospheric science.

ATS 510 - OPERATIONAL WEATHER FORECASTING  
Semester Hours: 3  
Subjective & objective methods of atmospheric prognosis. Forecasting critical weather elements. Interpretation, use & systematic errors of computer-generated products, human factors, & application of meteorological theory in an operational setting.

ATS 513 - GIS & REMOTE SENSING  
Semester Hours: 3  
Hands-on approach to GIS and satellite remote sensing. Popular satellite data sets such as LANDSAT and AVHRR are coupled with GIS data sets to increase understanding of the earth system. Topics include satellite sensors, basic radiative transfer, orbits, raster formats, atmospheric correction, distortion, image corrections, rotations and mapping, spatial resolution, image interpretation, radiometric and geometric enhancement, multispectral transformations, and classifications. (Same as ATS 413, ES 413, ES 513.) Spring. Prerequisite: ATS 511 or ESS 511.

ATS 515 - ADVANCED TOPICS IN GIS  
Semester Hours: 3  
Advanced special topics: visualization of GIS and remote sensing data, landscape characterization (pattern vs. process), multitemporal analysis, aggregation of data types, developing an integrated GIS environment for performing complex space-time modeling analyses, and land-atmosphere interactions. (Same as ATS 415, ES 415, ES 515.) Spring.

ATS 520 - INTRO ATMOS CHEM & AIR POLLUTI  
Semester Hours: 3  
An introduction designed to provide students with the basics of atmospheric chemistry and air pollution concepts. Topics include air pollutants, air-pollution meteorology, atmospheric gases and aerosols, and atmospheric processes.

ATS 522 - AIR POLLU:METEOROLOGY CONCEPTS  
Semester Hours: 3  
ATS 541 - ATM THERMODYN & CLOUD PHYSICS  
Semester Hours: 3  
Thermodynamic & cloud physical processes in the atmosphere. Atmospheric statics & stability. Role of aerosols in nucleation of cloud and ice particles. Physical processes that produce the growth of hydrometeors in cold and warm clouds. Applicable measurement techniques.

ATS 551 - ATMOS FLUID DYNAMICS I  
Semester Hours: 3  
Fluid dynamics in the atmosphere. Coriolis acceleration, scale analysis and appropriate approximations of the complete governing equations. Numerical analysis and interpretation of weather phenomena.

ATS 553 - ATS RADIATN/REMOTE SENSING  
Semester Hours: 3  
ATS 554 - FORECASTING MESOSCALE PROC  
Semester Hours: 3  
Detection and forecasting of atmospheric mesoscale phenomena including the structure and evolution of clouds, precipitation (including floods) thunderstorms and severe weather. Includes basics of instruments used to detect mesoscale phenomena, most notably satellite and radar. Prerequisites: ATS 551.

ATS 561 - ATMOSPHERIC RADIATION I  
Semester Hours: 3  
Fundamentals of terrestrial atmospheric radiation. Topics include: basic concepts, radiative transfer equation, gaseous absorption, scattering by molecules and particles, band models, transmittance along an inhomogeneous path.

ATS 571 - INTRO TO RADAR METEOROLOGY  
Semester Hours: 3  
Introduction to principles of radar meteorology, including radar operations, hardware, interpretation and analysis. Doppler, dual-polarization and dual-wavelength radar theory, methods and applications are covered. Prerequisite: ATS 541.
ATS 581 - ATS THERMODYNAMICS & CHEM
Semester Hours: 3

ATS 590 - SPECIAL TOPICS
Semester Hours: 1-3

Selected topics of interest not included in other courses.

ATS 603 - CLIMATE DYNAMICS
Semester Hours: 3

Origin and evolution of the climate system including underlying causes for past climates such as occurred during the ice ages. Statistical processing of various time series to extract climactic signals in the data. Determination of global-scale forcing mechanisms, which impact climate. Prerequisites: ATS 541 and ATS 551.

ATS 606 - DATA ANALY ATMOSPHERIC SCNTS
Semester Hours: 3

A theoretical and practical introduction to various data analysis methods commonly used in atmospheric science. Topics include forecasting techniques to generate models to fit data, assess models using parametric tests, probability theory and Monte Carlo methods to solve a variety of problems. Prerequisites: ATS 509.

ATS 620 - ATMOSPHERIC CHEMISTRY & AEROSI
Semester Hours: 3

Primary processes, thermodynamics, photochemistry, kinetics, models, and measurements applied to troposphere and stratosphere; natural and anthropogenic; chlorine, nitrogen, hydrogen, and oxygen catalytic cycles; ground- and satellite-based observations of trace species. Prerequisites: ATS 520.

ATS 622 - AIR POLLUTION MODELING
Semester Hours: 3

Air pollution Langrangian and Eulerian modeling concepts and methods from micro to synoptic scales; plume, large eddy simulations and urban-regional models in research and regulatory applications; transport, dispersion, chemistry, clouds, aerosols, and wet/dry deposition. Prerequisites: ATS 520 and ATS 551.

ATS 630 - PHYSICAL CLIMATOLOGY
Semester Hours: 3

This course examines the physical aspects of the global climate system, including the global energy balance, surface energy balance, hydrologic cycle, climate classification, ocean change and other selected topics such as climate sensitivity. Prerequisites: ATS 501 or ATS 541.

ATS 635 - GENERAL CIRCULATION
Semester Hours: 3

Detailed examination of the observed dynamic, thermodynamic and chemical structure of the atmosphere, including mid-latitude baroclinic systems, tropical systems, global-scale energy, mass and momentum budgets and the fundamental climatology of the atmosphere. Prerequisites: ATS 541 and ATS 551.

ATS 642 - PRECIP PHYSICS FOR RADAR
Semester Hours: 3

Cloud microphysics theory, models, in-situ and radar observations of hydrometers will be utilized together to explore advanced concepts in precipitation physics and their connection to radar meteorology, including coalescense, break-up, freezing, size sorting, aggregation, riming and melting. Prerequisite: ATS 531 and ATS 571.

ATS 651 - ATMOS FLUID DYNAMICS II
Semester Hours: 3

Wave motions in the atmosphere with emphasis of Rossby, Kelvin and gravity waves. Systematic scaling of primitive equations to develop quasi-geostrophic and Ekman-layer theory. Shallow water theory, stratified flows, and barotropic and baroclinic instability. Prerequisites: ATS 551.

ATS 652 - ADV SYNOPTIC METEOROLOGY
Semester Hours: 3

Analysis, interpretation and forecasting synoptic-scale and mesoscale phenomena, including air masses, frontal systems, cyclones, anti-cyclones and waves toward understanding process dynamics. Emphasize the use of observational, satellite and numerical model data, including radars and profilers. Prerequisites: ATS 541 and ATS 551.
ATS 654 - FORECASTING MESOSCALE PROCESSES  
Semester Hours: 3

ATS 655 - BOUNDARY LAYER METEOROLOGY  
Semester Hours: 3

Survey of atmospheric boundary layer (ABL) properties. Review of turbulence, convective and stable boundary layers, surface forcing, boundary layer discontinuities, and singular phenomena within the ABL. Atmospheric field measurements are used to enhance understanding of ABL process.  
Prerequisites: ATS 541 and ATS 551.

ATS 656 - TROPICAL METEOROLOGY  
Semester Hours: 3

Overview concepts of the dynamics and climatology of the tropics and of significant tropical precipitation systems. Topics also include Kelvin waves, equatorial flows, convective scale dynamics, island meteorology, tropical cyclones, ENSO, radiative-convective equilibrium, gregarious cloud systems.  
Prerequisites: ATS 541 and ATS 551.

ATS 657 - NOWCASTING THEORY METHODS  
Semester Hours: 3

Theory, methods and applications of 0-6 hour weather and ecological prediction, which is a forecast time period when numerical prediction models have low skill. Topics include predictability, data assimilation, statistical methods, and algorithms using Earth and atmospheric science observations.

ATS 670 - SATELLITE REMOTE SENSING I  
Semester Hours: 3

Using a hands-on approach, this course covers a broad range of topics concerning digital image processing applied to the remote sensing of atmospheric, cloud and surface properties using various satellite data sets. Prerequisites: ATS 509.

ATS 671 - GROUND BASED REMOTE SENSING  
Semester Hours: 3

Principles and measurement capabilities of active and passive ground-based remote sensing systems: radar, wind profiler, lidar, sodar, and passive radiometer systems. Integration of remote sensing measurements to retrieve properties of atmospheric phenomena. Hands on usage and field measurements. Prerequisites: ATS 541.

ATS 672 - DUAL POLARIZATION RADAR MTRLGY  
Semester Hours: 3

Theory, analysis and interpretation of dual polarization radar for meteorological applications. Course covers dual polarization radar system hardware; the basic theory underlying polarimetric radar data and methodology; analysis, interpretation and application of polarimetric radar variables; and dual meteorological and convective weather applications; specifically, precipitation measurement and hydrometeor identification. Example applications include rain rate estimation, drop size determination, hail identification, tornado detection, snow vs rain delineation, and cloud electrification studies. Prerequisites: ATS 571.

ATS 673 - LIGHTNING  
Semester Hours: 3

An introduction to lightning. Topics include qualitative and quantitative description of lightning discharges; electrification of thunderstorms; temporal and spatial variation of lightning on multiple scales; various types of lightning; basic lightning models; current methods of measuring lightning. Prerequisites: ATS 509.

ATS 675 - ATMOSPHERIC DATA ASSIMILATION  
Semester Hours: 3

Data assimilation methods and concepts including objective analysis and initialization as relevant to numerical weather prediction. Emphasis on variational methods, successive correction, optimal interpolation, adjoint and gradient concepts, singular vectors, Kalman filters and nudging. Prerequisites: ATS 541 and ATS 551.

ATS 681 - NUMERICAL ATMOS MODELING  
Semester Hours: 3

Introduction to numerical methods applied to simulation of the atmosphere. Basic numerical solution techniques, along with filtering, radiative parameterizations, thermodynamics, turbulent parameterization, initialization and coordinate transformation. Prerequisites: ATS 551.

ATS 690 - SEL TOPICS IN ATMOS SCI  
Semester Hours: 1-4

Selected topics of interest not included under other courses.
ATS 699 - MASTER'S THESIS
Semester Hours: 1-6

Required each semester a student is enrolled and receiving direction on a master's thesis.

ATS 740 - CLOUD PROCESSES
Semester Hours: 3

Theory and observations of the bulk microphysics and kinematic structures of clouds. Topics include: interactions among dynamical, microphysical and thermodynamic processes within cloud systems, the dynamics of organized convective systems, and remote sensing of clouds and precipitation features. Prerequisites: ATS 541 and ATS 551.

ATS 760 - ATMOSPHERIC RADIATION II
Semester Hours: 3

Advanced topics in atmospheric radiative transfer. Specific topics include Maxwell equations, Mie theory, polarization and radiative transfer in a scattering atmosphere. Prerequisites: ATS 561.

ATS 762 - MICROPARTICLE OPT & RADIOMETRY
Semester Hours: 3


ATS 770 - SATELLITE REMOTE SENSING
Semester Hours: 3

Using various satellite data sets and radiative transfer models, this course will train students to calculate and study cloud, aerosol, ocean and land surface properties to assess the radiative energy budget of the earth-atmosphere system. Prerequisites: ATS 670.

ATS 780 - ATMOSPHERIC SCIENCE SEMINAR
Semester Hour: 1

Speakers are invited to report on research relevant to the field of atmospheric science. Students are expected to attend at least twelve seminars and to write short descriptions of the presentations.

ATS 781 - STUDENT SEMINAR
Semester Hour: 1

Guest speakers report on research relevant to the fields of Atmospheric and Earth System Science. Students are expected to attend weekly seminars, submit a paper based on at least ten talks, and make a 15-minute conference type presentation on a research topic in atmospheric science selected in agreement with their advisor. Prerequisites: ATS/ESS 780.

ATS 782 - PROFESSIONAL DEVELOPMENT
Semester Hour: 1

Topics concerning professional ethics, writing scientific journal articles, proposals and resumes, preparing budgets, networking, time management, conference presentations, research administration, funding agencies, stress and burnout will be discussed. Selected topics of interest not included under other courses.

ATS 790 - SEL TOPICS IN ATMOS SCI
Semester Hours: 1-4

Selected topics of interest not included under other courses.

ATS 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9

Required each semester student is enrolled and receiving direction on a doctoral dissertation.

Biological Sciences (BYS)

BYS 505 - PSYCHOPHARMACOLOGY
Semester Hours: 3

Introduction to drug classification and action with emphasis on physiological and psychological interactions. Same as PY 505.
BYS 519 - GENE STRUCTURE & FUNCTION
Semester Hours: 3

Advanced studies of macromolecular structure and biological function of proteins and nucleic acids involved in the passage of genetic information and cellular response. Structural significance of viruses and molecular evolution included.

BYS 523 - PRINCIPLES OF VIROLOGY/A&M
Semester Hours: 3

Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Principles of viral infectivity, multiplication, and chemical constitution; laboratory techniques for their isolation, cultivation, identification, and enumeration.

BYS 524 - MYCOLOGY/A&M
Semester Hours: 3

Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Lines of phycymycetes using representative species; various series of actinomycetes; representative pathogenic (crop and vegetative pathogens) and nonpathogenic heterobasidiomycetideae organisms; order and families of homobasidiomycetideae. Ontogenetics, cellular, and structural study applied to all divisions, classes, series, orders and families.

BYS 526 - MICROBIAL ECOLOGY
Semester Hours: 4

Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Relationship of soil and aquatic microorganisms and their importance in ammonification, nitrification, and other biological processes.

BYS 529 - BIOSTATISTICS/AL A&M
Semester Hours: 4

BYS 532 - MEDICAL PHYSIOLOGY
Semester Hours: 4

Detailed study of physiology, covering membrane transport, muscle, nerve, heart, lung, gastrointestinal and renal function. Emphasis will be on homeostasis, genetic disease and pharmacological therapy.

BYS 532L - LABORATORY
Semester Hours: 0

BYS 534 - MEDICAL PHYSIOLOGY II
Semester Hours: 3

Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Continuation of mammalian physiology with consideration of kidney function, respiratory, digestive, reproductive, and endocrine systems.

BYS 535 - ADVANCED MICROBIOLOGY
Semester Hours: 3

Aspects of microbial behavior, development, morphogenesis or physiology.

BYS 537 - PSYCHOBIOLOGY STRESS & ILLNESS
Semester Hours: 3

Overview of physiological stress responses and their influence on health, behavior, and illness. Same as PY 536.

BYS 542 - NUTRITIONAL PHYSIOLOGY
Semester Hours: 3

Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Advanced laboratory dealing with modern techniques of molecular biology and biochemistry.

BYS 543 - MOLECULAR BIOLOGY OF THE CELL
Semester Hours: 3

Advanced study of cell structure and function of macromolecules (lipids, proteins, carbohydrates and nucleotides). In depth literature readings on subcellular organelles, metabolic pathways, cell cycle, cancer, and cell differentiation.

BYS 547 - BIOCHEMISTRY I
Semester Hours: 3

Structural chemistry and function of biomolecules, mechanisms of biochemical reactions, and enzyme kinetics. Same as: CH 561.
BYS 548 - BIOCHEMISTRY II
Semester Hours: 3

Energy transduction, metabolism, biosynthesis of macromolecular precursors, storage, transmission, and expression of genetic information. Same as CH 562. Prerequisites: BYS 547 or CH 561.

BYS 556 - ADV MOLECULAR TECHNIQUES
Semester Hours: 3

Laboratory techniques in molecular biology including current methodology in genomics, proteomics and RNA analysis. Prerequisites: BYS 519 with concurrency.

BYS 560 - ENVIRONMENTAL BIOLOGY/A&M
Semester Hours: 3

Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Principles of interaction between living systems and their resources. Current problems in management of natural resources including new approaches in management of pest populations.

BYS 562 - COMMUNITY ECOLOGY
Semester Hours: 4

Detailed consideration of ecological principles and concepts, as well as biotic and abiotic factors relevant to development of communities and ecosystems. Field trips required.

BYS 563 - POPULATION ECOLOGY
Semester Hours: 4

Distribution, population dynamics and behavior of populations in relation to environmental factors. Field trips required.

BYS 564 - LIMNOLOGY
Semester Hours: 3

Fresh-water environments and organisms exemplified by lakes, ponds, and streams in North Alabama.

BYS 600 - NEUROSCIENCE
Semester Hours: 3

An advanced survey of the field of neuroscience, from basic neuroanatomy and physiology, to current topics, such as neurodegenerative disease, learning and memory, consciousness, cognitive theory and neurocomputing.

BYS 601 - BIOINFORMATICS I
Semester Hours: 3

Practical use in Bioinformatics and X-ray crystallography.

BYS 602 - BIOINFORMATICS II
Semester Hours: 3

Practical use in Bioinformatics and applied Genomics.

BYS 619 - MICROBIAL GENETICS
Semester Hours: 3


BYS 630 - IMMUNOLOGY
Semester Hours: 4

Innate, humoral and cell-mediated immunity. Immune deficiencies and hyper sensitivities. Autoimmunity, transplantation and tumor immunology.

BYS 631 - MEDICAL PHARMACOLOGY/A&M
Semester Hours: 3

Course offered jointly by Alabama A&M University and UAH but which is taught on the A&M campus. Drug-receptor interaction, kinetics of drug absorption, distribution and elimination, and discussion of drugs affecting different systems. Pharmacogenetics, toxicity, mutagenesis, teratogenesis, carcinogenesis, and drug interactions. Mechanism of action of drugs, in relation to their use as therapeutic agents in medicine.

BYS 690 - SEMINAR
Semester Hour: 1

Student reports on current journal articles, research, or assigned readings. Graduate students should attend whether enrolled for credit or not. May be taken up to three times for credit.
BY 691 - SPECIAL TOPICS
Semester Hours: 1-4
Directed readings and/or written reports on topics of individual student interest carried out under the supervision of an instructor. Prerequisite: permission of instructor required before registration.

BY 692 - RESEARCH
Semester Hours: 2-4
Individual investigations of biological problems under supervision of a graduate faculty member. Permission of instructor required before registration.

BY 699 - MASTER’S THESIS
Semester Hours: 1-6
Required each semester student is working on and receiving direction on master's thesis. Minimum of six hours required for M.S. thesis students.

Business Legal Studies (BLS)

BLS 500 - LAW, ETHICS & BUSINESS
Semester Hours: 3
An analytical review of corporate ethics addressed from a legal and business standpoint. Focus on codes of ethics, integration of integrity into corporate cultures, top management commitment to ethics, civic involvement, employer-employee relations, consumer protection, and international business.

BLS 506 - GOVMT CONTRACT LAW
Semester Hours: 3
Application of the legal principles governing government contracts as developed from common law, statutes, regulations, and court decisions. Includes requests for proposals, negotiation, inspection, acceptance, delivery, warranties, modification of contracts, equitable adjustment, and disputes. Prerequisite: MGT 501 or ACC 540.

BLS 511 - BUS LAW FOR ACCOUNTANTS
Semester Hours: 3
In-depth study of legal principles and problems encountered in practice by professional accountants. This course covers legal topics from a Uniform Commercial Code perspective.

BLS 625 - LEGAL ASPECTS OF ENGRS
Semester Hours: 3
Legal problems and principles relevant to the practice of professional engineers. The legal system, contracts, torts, business organizations, employment law, intellectual property law, and environmental law.

Chemical Engineering (CHE)

CHE 540 - PHYSICAL PROP OF FLUIDS
Semester Hours: 3
Theoretical, experimental, and correlation methods for determining and predicting the thermodynamic and transport properties of various fluids. Critical properties, equations of state, vapor pressure and latent heat, heat capacity. Viscosity, thermal conductivity, diffusion coefficient, phase equilibrium, heat and free energy for formation.

CHE 541 - CHEMICAL KINETICS & REACTOR DE
Semester Hours: 3
Fundamental principles of chemical kinetics and chemical reactor engineering along with the design of both thermal and catalytic reactors.

CHE 549 - INTRO ENVIRONMENTAL ENGR
Semester Hours: 3
Engineering aspects of air, water, and thermal pollution. Hydrologic cycle, water sources and uses; industrial and other sources of primary and secondary pollutants. Transport process in environmental problems and in their control.

CHE 552 - EXPER TECH IN FLUID MECH
Semester Hours: 3
CHE 559 - SELECTED TOPICS/CHE
Semester Hours: 1-6
Discussion of biocompatible polymers and their application in drug delivery systems. Polymers of natural and synthetic origin will be studied, special emphasis will be placed upon the synthesis of biocompatible polymers. The formation of polymeric micelles, hydrogels and liposomes will be studied. The process of extravasation as uptake mechanism for polymeric delivery systems will be discussed. Reading material will be based on the latest publications in the field.

CHE 560 - INTRO TO BIOPROCESS ENGR
Semester Hours: 3
Application of engineering principles to the analysis of and the development and design of processes using biological catalysts including enzymes, plant and animal cells, and genetically engineered cells. Other topics include fermentation and biological mass transport processes.

CHE 561 - BIOSEPARATIONS RECOMBI TECH/PR
Semester Hours: 3
General characteristics of separation processes used in the biotechnology industry, including removal of insolubles, isolation and purification of thermally sensitive products for final use by the customer. Application of unit operation principles for biological separations, recombinant DNA techniques, protein engineering. Prerequisite: CHE 560.

CHE 594 - APPLIED MATERIALS PROCESSING
Semester Hours: 3
Synthesis and processing methods of materials for engineering applications. Selection and use of materials performance factors for design of structural and functional components. Use of computational methods in solving open-ended design problems that depend on an understanding of the nature and properties of materials will be emphasized. All classes of materials are covered.

CHE 595 - POLYMERIC ENGINEERING
Semester Hours: 3

CHE 641 - ADV THERMODYNAMICS
Semester Hours: 3
Application of classical thermodynamics. Treatment of problems involving nonideal gases and liquids, phase equilibrium, and chemical equilibrium.

CHE 642 - PHYSICOCHEMICAL HYDRODYNAMICS
Semester Hours: 3
Thermodynamics, transport, and kinetics of electrodes and cells. Systems analysis of batteries, fuel cells, porous electrodes, electroplating, electrowinning, and corrosion processes. Convective diffusion at high Schmidt numbers.

CHE 644 - INTRO ELECTROCHEM SYSTEM
Semester Hours: 3
Thermodynamics, transport, and kinetics of electrodes and cells. Systems analysis of batteries, fuel cells, porous electrodes, electroplating, electrowinning, and corrosion processes. Convective diffusion at high Schmidt numbers.

CHE 646 - THERMODYNAMICS OF MATRLS
Semester Hours: 3
Fundamental thermodynamic review, phase equilibrium, chemical reaction equilibrium, free energy, binary and ternary phase transformations, solution models and selected topics.

CHE 648 - TRANSPORT PHENOMENA I
Semester Hours: 3

CHE 649 - TRANSPORT PHENOMENA II
Semester Hours: 3
CHE 650 - PRINC LIQUID/SOLID INTER  
Semester Hours: 3  
Applies basic principles in thermodynamics and kinetics to characterize surfaces and surface phenomena. Fundamental properties of gas-liquid, liquid-liquid, solid-liquid, and solid-gas interfaces and phenomena occurring at these interfaces.

CHE 652 - INTRO TO AIR POLLU CONTROL  
Semester Hours: 3  
Technology of air pollution dealing with air pollutants, effects, sources, combustion processes, and abatement and control technology. Engineering contributions to both the problems and their solutions. Nature of air pollution problem and fundamental technological approaches to its solution.

CHE 657 - ADVANCED PROCESS CONTROL  
Semester Hours: 3  
Application of modern control theory to chemical processes; multivariable control; estimation and adaptive control, optimal control.

CHE 658 - CATALYSIS/REACTOR DESIGN  
Semester Hours: 3  
Treatment of homogeneous and heterogeneous reaction kinetics, transport in fluid-solid reactions, catalyst deactivation and their effects on the analysis and design of chemical reactors. Prerequisite: CHE 541.

CHE 659 - SELECTED TOPICS/CHE  
Semester Hours: 1-6

CHE 696 - GRAD INTERNSHIP CHE ENGR  
Semester Hours: 1-9  
Active involvement in an engineering project in an engineering enterprise, professional organization or government agency that has particular interest and relevance to the graduate student. Permission of CHE faculty member required.

CHE 699 - MASTER'S THESIS  
Semester Hours: 1-9

CHE 724 - INSTR METH/BIO-MTLS CHARACTERI  
Semester Hours: 3

CHE 725 - INSTR METH/BIO-MTLS CHARACTERI  
Semester Hours: 4

CHE 747 - ADV TOP/BIOENGINEERING  
Semester Hours: 3  
Engineering aspects of microbial processes and the processing of biological materials. Integrating knowledge of governing biological properties and principles with chemical engineering methodology. Emphasis on current literature in the areas of purification and separation technology, bioprocess development and biomaterials.

CHE 749 - MASS TRANSPORT  
Semester Hours: 3  
Mass transfer in solid and fluid systems under steady and transient conditions. Integration of momentum, heat and mass transfer equations with application to reactive, rheological and multicomponent systems.

CHE 757 - OPT TECH/FLUID MECHANICS  
Semester Hours: 3  
Laser courses, molecular interactions with light and diatomic spectroscopy needed fluorescence, Brillouin scattering, four wave mixing, CARS and other applications in optical fluid diagnostics.

CHE 799 - DOCTORAL DISSERTATION  
Semester Hours: 1-9  
Required each semester student is enrolled and receiving direction on doctoral dissertation.

Chemistry (CH)
CH 500 - TOPICS IN CHEMISTRY  
Semester Hours: 1-3  
Advanced laboratory research in one of the departmental research groups. The student works on an independent or group research project. Completion of the course requires an appropriate written and oral report. Prerequisites: Approval of instructor.

CH 521 - CHEMICAL INSTRUMENTATION  
Semester Hours: 4  
Use of basic instrumentation in NMR, mass spectrometric, chromatographic, and spectrophotometric analysis.

CH 540 - POLYMER SYNTHESIS & CHARACTERI  
Semester Hours: 3  
Same as MTS 649.

CH 549 - SPECTROSCOPY & MOLEC STR  
Semester Hours: 3  
Intermediate level treatment of principles of spectroscopy and their application to determination of molecular structure.

CH 553 - INTRO QUANTUM MECH I  
Semester Hours: 3  
Waves and particles; Bohr’s model; de Broglie waves, wave-packets, uncertainty principle; quantum mechanics postulates; Schroedinger equation; systems in 1, 2 & 3 dimensions; hydrogen atom. Same as PH 551, OSE 555, and MTS 651.

CH 554 - INTRO QUANTUM MECH II  
Semester Hours: 3  
Angular momentum and spin; atomic structure and spectrum; time-independent perturbation theory, variational methods; time-dependent perturbation theory and interactions of light with matter; scattering theory; electronic structure of solids; relativistic quantum mechanics. Same as: PH 552, MTS 652. Prerequisite: PH 551 or CH 553.

CH 561 - BIOCHEMISTRY I  
Semester Hours: 3  
Structural chemistry and function of biomolecules, mechanisms of biochemical reactions, enzyme kinetics, and energy transfer. Same as: BYS 547.

CH 562 - BIOCHEMISTRY II  
Semester Hours: 3  
Metabolism, biosynthesis of macromolecular precursors, storage, transmission, and expression of genetic information, and molecular physiology. Same as BYS 548. Prerequisites: CH 561 or BYS 547.

CH 600 - ADV INORGANIC CHEMISTRY  
Semester Hours: 3  
Survey with emphasis on structure and reactivity of inorganic compounds.

CH 602 - CHEM COORD COMPOUNDS  
Semester Hours: 3  
Modern bonding theory and stereo chemistry of coordination compounds.

CH 621 - METHODS OF CHEMICAL ANALYSIS  
Semester Hours: 3  
Literature, seminar course. Theory and methodology of various techniques of chemical analysis.

CH 631 - SYNTHETIC ORGANIC CHEMISTRY  
Semester Hours: 3  
Survey of certain reactions that enjoy widespread application to the synthesis of organic compounds.

CH 632 - PHYSICAL ORGANIC CHEMISTRY  
Semester Hours: 3  
Reactive intermediates, structure-activity relationships, reaction mechanisms and techniques used to determine them.
CH 633 - ORGANIC STRUCTURE DETERMINATION
Semester Hours: 3

Structure determination of organic molecules using spectroscopic methods, especially NMR, IR, and MS. Emphasis on the theory and interpretation of many NMR methods useful in chemistry research.

CH 634 - MOLECULAR MODELING
Semester Hours: 4

Molecular modeling methods, including molecular mechanics, molecular docking, molecular orbital theory, and density functional theory, will be used to investigate conformational properties of organic compounds, molecular interactions between biological macromolecules and organic ligands, electronic structure of organic and inorganic compounds, frontier molecular orbitals, pericyclic reactions, and reactive intermediates. Extensive computational laboratory work included.

CH 635 - CHEMICAL TOXICOLOGY
Semester Hours: 3

An introduction to the principles of chemical toxicology, including the effects of drugs, environmental pollutants, natural toxins and venoms and other potentially hazardous chemicals at the physiological, cellular, and molecular level.

CH 640 - ADV CHEMICAL THERMODYNAMICS
Semester Hours: 3


CH 641 - STATIST THERMODYNAMICS
Semester Hours: 3

Principles leading to the development of Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics. Thermodynamic properties calculated from partition functions.

CH 642 - ADV CHEMICAL DYNAMICS
Semester Hours: 3

Non-equilibrium thermodynamics, macroscopic and microscopic theories of diffusion, chemical reaction rate laws and mechanisms, transition state theory, gas phase molecular dynamics, electrical conduction in electrolyte solutions, electrode kinetics. Prerequisite: CH 640.

CH 643 - QUANTUM CHEMISTRY
Semester Hours: 3

Application of quantum theory to the chemical bond.

CH 644 - CHEM ELECTRODYNAMICS
Semester Hours: 3

Maxwell's equations applied to electrodynamic problems in chemistry. Theory of dielectrics, dipole moments, Beer's law, Landolt's rule, light scattering, magnetic properties, quantum theory of radiation.

CH 645 - POLYMER PHYSICAL CHEMISTRY
Semester Hours: 3

Introduction to structure, properties and processing of polymers. Physical behavior of polymers, structure-property relationships, polymer characterization, thermodynamics of polymer solutions and melts, mechanical evaluation of polymers. Same as MTS 747. Prerequisite: CH 540.

CH 646 - THERMODYNAMICS OF MATRLS
Semester Hours: 3

Fundamental thermodynamic review, phase equilibrium, chemical reaction equilibrium, free energy, binary and ternary phase transformations, solution models and selected topics. Same as CHE 646 and MTS 646.

CH 647 - ADV BIOPHYSICAL CHEMISTRY I
Semester Hours: 3

Topics include: computer data analysis & simulation, first & second laws of thermodynamics, free energy & equilibrium, calorimetry, protein stability, binding & interactions, solution thermodynamics, electrolytes. Students who have completed CH 347 cannot earn credit for CH 647.
CH 648 - ADV BIOPHYSICAL CHEMISTRY II  
Semester Hours: 3  
Advanced biophysical chemistry, including biochemical reaction kinetics, enzyme catalysis, quantum mechanics, statistical thermodynamics, spectroscopy, including UV-VIS, fluorescence, circular dichroism, NMR, and Structure determinations. An emphasis is placed on the current research literature. Prerequisite: CH 647 Students who have completed CH 348 cannot earn credit for CH 648.

CH 650 - PRINC LIQUID/SOLID INTER  
Semester Hours: 3  
Applies principles in thermodynamics & kinetics to characterize surfaces & surface phenomena. Fundamental properties of gas-liquid, liquid-liquid, solid-liquid and solid-gas interfaces and phenomena at these interfaces. Same as MTS 650 and CHE 650.

CH 699 - MASTER'S THESIS  
Semester Hours: 3-6  
Required each semester a student is enrolled and receiving direction on a masters thesis. Minimum of two terms is required. (A maximum of six hours may be applied towards the degree).

CH 700 - CURRENT TOPICS IN CHEMISTRY  
Semester Hours: 1-3  
Advanced laboratory research in one of the departmental research groups. The student works on an independent or group research project. Completion of the course requires a written and an oral report. Prerequisite: approval of instructor.

CH 705 - SEL TOP IN INORGANIC CHEM  
Semester Hours: 3  
Prerequisites: CH 600 and approval of instructor.

CH 721 - SP TOP IN ANALYTICAL CHEMISTRY  
Semester Hours: 3  
Prerequisites: CH 621 and approval of instructor.

CH 735 - SEL TOP IN ORGANIC CHEM  
Semester Hours: 3  
Prerequisites: CH 632 and approval of instructor.

CH 745 - SEL TOP IN PHYSICAL CHEM  
Semester Hours: 3

CH 746 - SOLID STATE CHEMISTRY  
Semester Hours: 3  
Chemical properties of solids. Includes phase equilibria, chemical bonding in ionic and covalent crystals, thermodynamics of atomic defects, ionic conductivity in solids, corrosion, & introduction to surfaces and adsorption.

CH 765 - SEL TOPICS IN BIOCHEM  
Semester Hours: 3  
Prerequisites: CH 560 and approval of instructor.

CH 780 - CHEMISTRY SEMINAR  
Semester Hour: 1  
Required during each semester of residence.

CH 799 - DOCTORAL DISSERTATION  
Semester Hours: 3-9

**Civil Engineering (CE)**

CE 511 - INTRO GEOGRAPHICAL INFO SYS  
Semester Hours: 3  
Introduces vector, raster and tabular concepts, emphasizing the vector approach. Topics include: spatial relationships, map features, attributes, relational database, layers of data, data ingesting, digitizing from maps, projections, output, applications, and availability of public data sets.
CE 520 - URBAN TRANSPORTATION PLANNING  
Semester Hours: 3

Planning of highway systems and terminals as part of a complete planning approach; public transportation system planning; transportation planning studies, projection analysis, plan formulation, and programming.

CE 541 - OPEN CHANNEL HYDRAULICS  
Semester Hours: 3

Design and analysis of erodible and non-erodible channels. Uniform flow, channel roughness, gradually and spatially varied flow, rapidly varied flow, hydraulic jumps, gradually varied unsteady flow, flood routing, flow measurements, channel models, channel and culvert design.

CE 549 - INTRO ENVIRONMENTAL ENGR  
Semester Hours: 3

Engineering aspects of air, water, and thermal pollution. Hydrologic cycle, water sources and uses; industrial and other sources of primary and secondary pollutants. Transport process in environmental problems and in their control.

CE 550 - ENVIRONMENTAL CONTROL  
Semester Hours: 3

Engineering design and synthesis of environmental control systems. Control of multiphase systems with application to air and water pollution control.

CE 552 - INDUSTRIAL WASTE TREATMENT  
Semester Hours: 3

Advanced topics in the area of hazardous waste management and water quality control. Emphasis on industrial waste, including hazardous waste management. Topics include: generation, storage, collection, transfer, disposal, recycling, economic, environmental, and regulatory considerations.

CE 554 - SOLID & HAZARDOUS WASTE MGMT  
Semester Hours: 3

Waste characterization, minimization, collection, treatment, transport, and disposal. Landfill design and incineration options. Leachate characteristics and potential groundwater contamination. Prerequisite: CE 549.

CE 555 - WATER QUALITY LABORATORY  
Semester Hours: 3

Properties of natural water sources and laboratory methods associated with water and wastewater treatment systems. Students design and demonstrate a water treatment system to bring a water sample into compliance with drinking water standards.

CE 556 - WATER QUALITY CONTROL PROC  
Semester Hours: 3

Principles of public water supply design. Source selection, collection, purification, and distribution for municipal use. Collection of waste waters, their treatment, and disposal. Prerequisite: CE 549.

CE 557 - HYDROLOGY  
Semester Hours: 3

Occurrence and movement of water over the earth's surface for engineering planning and design. Relationship of precipitation to streamflow with frequency analysis, flood routing, and unit hydrograph theory.

CE 558 - ENVIRONMENTAL ENGR DSGN  
Semester Hours: 3

Engineering design and project management of environmental quality/restoration systems. Students will complete a design project focusing on one of the following systems: sanitary landfill, municipal incinerator, or groundwater/site remediation. Lectures will address skills for technical presentations and proposal writing, as well as process design and decision making.

CE 559 - SEL TOPICS CIVIL ENGINEERING  
Semester Hours: 1-6

CE 561 - VIBRATIONS ELASTIC SYS  
Semester Hours: 3

Formulation of the equations of motion of discrete and continuous systems, analytical and numerical methods of solution, eigenvalue problems, and dynamic response.
CE 571 - ADVANCED SOIL MECHANICS
Semester Hours: 3
Continuum mechanics applied to soil behavior. Theoretical approaches to consolidation, shear strength, slope stability and soil stabilization.

CE 572 - SOIL DYNAMICS
Semester Hours: 3
Behavior of soils under dynamic, earthquake and blast loading. Analysis of foundation vibration and isolation.

CE 573 - EARTH STRUCTURES ENGINEERING
Semester Hours: 3
Principles of earth structure design. Theories of earth pressures and the design of retaining wall systems including gravity, cantilever, mechanically stabilized earth, flexible sheet pile, and anchored wall systems. Methods of stability analyses for retaining walls, earth slopes, and embankment design.

CE 574 - APP MECHANICS OF SOLIDS
Semester Hours: 3
Stresses and strains at a point, theories of failures, stress concentration factors, thick-walled cylinders, torsion of noncircular members, curved beams, unsymmetrical bending, and shear center.

CE 577 - EXP TECH SOLID MECHANICS
Semester Hours: 3
Experimental methods to determine stress, strain, displacement, velocity, and acceleration in various media. Theory and laboratory applications of electrical resistance strain gages, brittle coatings, and photoelasticity. Application of transducers and experimental analysis of engineering systems.

CE 581 - STRUCTURAL ANALYSIS II
Semester Hours: 3
Reactions, shears, moments and deformations in complex structural systems. Statically indeterminate systems, advanced geometric and energy methods.

CE 583 - REINFORCED CONCRETE DESIGN
Semester Hours: 3
Theory and practice of reinforced concrete design. Theory and design of high strength concrete mixtures. Design of reinforced concrete beams, slabs and columns using the ultimate strength design code of the American Concrete Institute.

CE 584 - STEEL DESIGN
Semester Hours: 3
Principles of the design of steel structures using ASD methods. Analysis and design of structural elements including beams, columns, connection details.

CE 585 - FOUNDATION ENGINEERING
Semester Hours: 3
Design of foundations with emphasis on reinforced concrete, footings, caissons, piles, retaining walls, and mat foundations. Effect of bearing pressure on foundations. Prerequisite: CE 583.

CE 586 - ADV CEMENTITIOUS & COMPOSITE
Semester Hours: 3
Concrete structures, rheology, mechanical properties, environmental durability, dimensional stability, advanced concrete technologies (such as high strength, fiber reinforced, and fracture mechanics), advanced fiber polymer composites, and repair/rehabilitation of concrete structures.

CE 587 - BRIDGE DESIGN
Semester Hours: 3
Bridge loads, load distribution, composite beam bridges, bridge bearings, reinforced and prestressed concrete slab and T-beam bridges, bridge evaluations and ratings, and upgrade methodology.
CE 603 - ADVANCED CONCRETE DESIGN  
Semester Hours: 3  
Design of concrete columns; bond, anchorage and reinforcing details; design of two-way slabs; design and analysis of multistory building frames; introduction to prestressed concrete; design of prestressed cross-sections for moment.

CE 611 - GIS IN CIVIL ENGINEERING  
Semester Hours: 3  
Advanced topics in geographical information systems (GIS) with civil engineering applications. Emphasis will be placed on spatial/temporal data analyses using digitized maps and database information in an area of CE specialization. Research project will be required.

CE 622 - ADVANCED TRAFFIC ENGRG DESIGN  
Semester Hours: 3  
In depth analysis of traffic engineering concepts related to intersection analysis (signalized and un-signalized) as well as arterial systems.

CE 646 - EROSION & SEDIMENTATION  
Semester Hours: 3  
River morphology and river response, incipient erosion and its prediction, bed form and roughness, degradation, aggradation, and local scour in alluvial rivers. Design of stable channels, computation of bed load.

CE 650 - ENVIRONMENTAL IMPACT ANAL  
Semester Hours: 3  

CE 651 - ENVIRONMENTAL REGULATIONS  
Semester Hours: 3  
Basic understanding of environmental law with an appreciation for the practical implementation of regulations for environmental engineers. Includes an overview of the major American environmental laws for protection of water and air resources, as well as permitting requirements and health/safety responsibilities. Prerequisite: CE 549.

CE 652 - INTRO TO AIR POLLUTION CONTROL  
Semester Hours: 3  
Technology of air pollution dealing with air pollutants, effects, sources, combustion processes, and abatement and control technology. Engineering contributions to both the problems and their solutions. Nature of air pollution problem and fundamental technological approaches to its solution.

CE 653 - GROUNDWATER ENGINEERING  
Semester Hours: 3  
Application of engineering principles to the movement of groundwater. Influence of physical and geological environment on groundwater hydraulics. Water well hydraulics and aquifer evaluation. Emphasis on practical groundwater engineering problems. Prerequisites: MA 526 or MAE 693.

CE 654 - ENVIRONMENTAL TRANSPORT  
Semester Hours: 3  
Fundamental principles of mass transport, chemical partitioning/transformations in environmental systems. Practical transport examples for surface water, ground water, and atmospheric systems will be presented and mathematical modeling will be utilized for solutions.

CE 655 - HAZARDOUS WASTE MGMT  
Semester Hours: 3  
Topics include definition of hazardous waste, regulatory considerations, risk assessments, and categories of waste. Current and emerging treatment and disposal technologies will be explored.

CE 656 - ENV SYSTEMS SAMPLING & ANAL  
Semester Hours: 3  

CE 657 - ADVANCED HYDROLOGY  
Semester Hours: 3  
Hydrologic cycle, including interrelationships between classical and statistical methods of hydrology. Evaluation of governing equations, linearizations, analytical approximations and numerical solution techniques for various boundary conditions. Stochastic hydrologic modeling in both temporal and spatial domains. Prerequisites: ISE 690, MAE 586, MAE 693, and CE 557.
The built environment has a substantial impact on energy and material resources as well as being a critical determinant of health and productivity. This course covers topics such as site planning and construction variables, energy and water alternatives, and current rating systems. Case studies and field trips of historic and contemporary projects exemplifying various sustainability features will be included.

**CE 659 - SEL TOPICS CIVIL ENGINEERING**  
Semester Hours: 1-6

**CE 660 - STRUCTURAL DYNAMICS**  
Semester Hours: 3


**CE 661 - GEOTECHNICAL ENGINEERING**  
Semester Hours: 3

Shallow foundation’s immediate and consolidated settlement, advanced deep foundations under lateral and axial loads, design of single and pile groups, soil-pile interaction, introduction to seismology, earthquake characteristics, dynamic soil properties and response, soil profile response spectra, soil liquefaction. Prerequisite: CE 585.

**CE 666 - EARTHQUAKE ENGR & STRUCT DYNAM**  
Semester Hours: 3

This allows structural engineers to consolidate their knowledge on the effect of earthquake ground motions on civil engineering structures. The course will cover the analysis and the theories of structures made of various materials that are located in active seismic zones. Finally, the course will allow structural engineers to acquire new basic knowledge in earthquake engineering that will allow them to communicate better with scientists and engineers of other disciplines in earthquake engineering (e.g. seismologist, geotechnical engineers, etc.).

**CE 671 - CONTINUUM MECHANICS**  
Semester Hours: 3

Kinematics and kinetics, various coordinate systems, constitutive equations for continuous media; governing partial differential equations from first and second laws of thermodynamics; applications to solids, liquids, and gases.

**CE 672 - THEORY OF ELASTICITY**  
Semester Hours: 3

Formulation of boundary-value problems of classical elasticity. Application to plane problems, prismatic members, and axisymmetric problems. Introduction to three-dimensional problems.

**CE 673 - PLASTICITY**  
Semester Hours: 3


**CE 674 - FINITE ELEMENT ANALYS I**  
Semester Hours: 3

Finite element theory, variational methods, weighted residuals. Applications to linear partial differential equations in continuous media. Solution of boundary value and initial value problems.

**CE 675 - ROCK MECHANICS**  
Semester Hours: 4

Principles of continuum mechanics applied to the design of structures in rock; tunnels, underground structures and foundations. Joint behavior; stresses; analysis of rock slopes; instrumentation.

**CE 676 - VISCOELASTICITY**  
Semester Hours: 3

CE 677 - OPTICAL TECH IN SOLID MECH  
Semester Hours: 3  
Overview of conventional methods for experimental stress analysis. Introduction to applied optics with emphasis on non-destructive, laser-based testing methods, fiber optic recording systems, photoelectronic-numerical data acquisition, and computer aided analysis.

CE 678 - MECHANICS OF COMPOSITE MATRLS  
Semester Hours: 3  
Introduction to composite materials, micro- and macro-mechanical behavior of laminae; bending, buckling and vibration of laminated plates.

CE 679 - HYPERVELOCITY IMPACT PHENOMENA  
Semester Hours: 3  
Fundamental principles of penetration mechanics. Analytical and numerical approaches to perforation and penetration problems. Shock jump conditions, hugoniot, and equations of state; low, high, and hypervelocity impacts of finite and thin targets.

CE 681 - ADVANCED STRUCTURAL ANALYSIS  
Semester Hours: 3  
Explores modern methods of structural analysis, matrix formulation of flexibility and stiffness methods, and analysis of structures with material and geometric nonlinearities. Also introduces energy methods for indeterminate structures. Prerequisite: CE 581.

CE 683 - GRADUATE SEMINAR  
Semester Hour: 1  
Professional activities designed to promote the skills required to organize and deliver oral technical presentations and to broaden the individual's awareness of technical issues. Required for all students pursuing a graduate degree. Students will be graded “S” (Satisfactory) or “U” (Unsatisfactory) based upon their performance and attendance. Students who do not receive an “S” grade must register for the course until an “S” is obtained.

CE 696 - GRAD INTERNSHIP CE ENGR  
Semester Hours: 1-9  
Active involvement in an engineering project in an engineering enterprise, professional organization or government agency that has particular interest and relevance to the graduate student. Permission of CEE faculty member required.

CE 697 - MASTER'S PLAN II PROJECT  
Semester Hours: 3  
Application-oriented student project designed to show competence in an area of civil engineering.

CE 699 - MASTER'S THESIS  
Semester Hours: 1-9  
Required each semester in which a student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of nine hours of credit is awarded upon successful completion of master's thesis. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.

CE 722 - SLIDING MODE CONTROL  
Semester Hours: 3

CE 756 - HAZARDOUS WASTE REMEDIAT  
Semester Hours: 3  
Engineering design skills applied to the solution of real world hazardous waste remediation problems. Remedy screening and selection; treatment train development for a Superfund facility.

CE 762 - WAVE MOTION CONT ELASTIC BODIE  
Semester Hours: 3  
Elements of stress wave propagation in bounded elastic media. Propagation of elastic waves in infinite and semi-infinite bodies, cylinders, rods and beams.

CE 765 - RAND VIBRAT ELASTIC SYSTEM  
Semester Hours: 3  
CE 772 - THEORY STRUCT STABILITY
Semester Hours: 3


CE 773 - THEORY OF SHELLS
Semester Hours: 3

Analysis of thin plates and shells, including higher approximations theories and transverse-shear deformations; illustration of theories by selected problems.

CE 774 - FINITE ELEMENT ANAL II
Semester Hours: 3

Advanced topics in finite element analysis: application to nonlinear partial differential equations in continuum mechanics: theoretical studies of convergence and stability of solutions.

CE 778 - FRACTURE MECHANICS
Semester Hours: 3

CE 779 - ADV PENETRATION MECHANIC
Semester Hours: 3

Advanced analytical modeling of penetration and perforation phenomena, hydrocode development and applications, and similitude analysis.

CE 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9

Communication Arts (CM)

CM 505 - ADVANCED MEDIA WRITING
Semester Hours: 3

This course offers an overview of various media writing genres, including Broadcast, Advertising and Public Relations. Students complete a mix of timed assignments with each context to acquire a more complete survey of media writing and prepare for a career within the mass media.

CM 508 - CLASSICAL RHETORICAL THEORY
Semester Hours: 3

This course surveys the early development of rhetorical theory in the Western world, from its sophistic origins in the 5th century BCE, through the Greek philosophers and educators, to the Romans and early Christians.

CM 509 - CONTEMPORARY RHETORICAL THEORY
Semester Hours: 3

This course surveys contemporary rhetorical thought, including modern and postmodern theories. The course requires rigorous academic analysis and critique as students explore historical and current rhetorical concepts.

CM 514 - CREATIVE NONFICTION WRITING
Semester Hours: 3

This course introduces students to the genre of creative non-fiction. Undergraduate students (CM 414) will write five essays and revise toward a final writing portfolio. Graduate students (CM 514) will write five essays and a collage assignment, revising toward a final portfolio.

CM 518 - LEGAL ARGUMENT
Semester Hours: 3

This course examines argumentation in legal communities, that is, the way lawyers and judges provide reasoned support for the positions they defend concerning what the law requires in a given case. It considers common forms of legal argument, sources and forms of evidence, and legal values that underlie legal argument. It provides students with a critical perspective from which to judge legal arguments and a basic set of tools for developing legal arguments. This course will not provide any in-depth consideration of the content of civil, criminal or constitutional law, but will use examples from various areas of law to illustrate how legal arguments are developed.
CM 520 - PUBLIC RELATIONS WRITING
Semester Hours: 3

This course provides students with professionalization in their writing and editorial skills in public relations. By emphasizing different audiences and various media, students will find and hone their public relations voice. Students will gain experience with instant responses, making ethical and legal decisions, and practicing a wide range of PR writing and design including the development of media kits, pitches, backgrounders, press releases, memos, newsletters, radio announcements, and brochures. Students will gain firsthand experience writing on a digital platform for a non-profit organization and building a digital audience.

CM 526 - BURKEIAN THEORY & CRITICISM
Semester Hours: 3

This course surveys key concepts in the theory of Kenneth Burke and their discussion and application of rhetorical scholars. Through readings, lectures and class discussions students will gain insight into this, the most important rhetorical theorist of the 20th century.

CM 530 - MASS MEDIA IN AMERICA
Semester Hours: 3

CM 533 - DARK SIDE INTERPERSONAL COMM
Semester Hours: 3

Research from the dark side of communication has typically been studied from a single standpoint confined to a specific context. This course offers a more complete view of human communication by exploring a variety of topics related to the "darker" side of interactions situated in the contexts of Interpersonal Communication, Organizational Communication, Computer Mediated Communication, Health Communication, and Blended Communication. By merging theory and practical application, the different contexts provide students with an enhanced understanding of how dark side behaviors are experienced and communicated.

CM 535 - SOCIAL MEDIA
Semester Hours: 3

This course focuses on uses and effects of social media in interpersonal, organizational, mass mediated, health, and political settings. It investigates questions such as: Who uses social media? Can we develop meaningful relationships through social media? How do people use social media to find information, get social support, and evoke political change? Is privacy dead? This course focuses on the history of social media and current computer-mediated communication theories.

CM 540 - PUBLIC RELATIONS CAMPAIGNS
Semester Hours: 3

This course provides professionalization and team work experience for students in the public relations track. Students practice the research, planning, implementation, and evaluation of strategic communication plans for various public relations contexts.

CM 542 - USABILITY STUDIES
Semester Hours: 3

Introduces students to the theory and practices of usability, which involves designing useful, easy-to-use websites, software, and products. The course involves group projects conducting real-world usability testing.

CM 544 - ADVERTISING
Semester Hours: 3

This course defines advertising and considers how it works, how it is developed, and some controversies surrounding its use.

CM 551 - ORGANIZATIONAL TRAIN & DEVELOP
Semester Hours: 3

Provides students with the opportunity to learn to design, and execute, professional organizational training programs. Students learn to design needs assessments, write training proposals and contracts, as well as design budgets, training scripts, presentations and post-evaluations for companies.

CM 552 - USER-CENTERED DESIGN
Semester Hours: 3

Introduces students to user-centered design principles that inform the practice of user experience design. Students will use visual thinking as they complete contextual inquiries and mapping exercises.

CM 554 - NEW MEDIA WRITING & RHETORIC
Semester Hours: 3

This course teaches students to consider and implement rhetorical principles across a variety of media and includes an examination of communication strategies used widely in academic and industry settings. The course focuses on new media through an exploration of digital technologies and the way digital culture and new media have dramatically impacted reading, writing and research practices.
CM 555 - COMMUNICATION AND CULTURE
Semester Hours: 3

This course explores the complex and dynamic relationship between communication and culture. It uses a contextual approach to examine significant similarities and distinctions between and among cultures from both macro and micro cultural perspectives, giving particular attention to how verbal and nonverbal communication moderates our cultural practices.

CM 610 - COMMUNICATION PEDAGOGY
Semester Hours: 3

This course is designed to prepare students for teaching in the field of communication. Toward this end, students will explore a mix of theories, methods, and strategies related to communication pedagogy. Students will also have the opportunity to develop their teaching competency by engaging in various teaching assignments.

CM 631 - ADVANCED COMMUNICATION THEORY
Semester Hours: 3

This course surveys major theories that inform the scholarly study of human communication. Through readings, discussions, and research, students learn how communication theories are developed, analyzed, evaluated, and applied. More specifically, the course goals are: 1) to enhance students’ ability to critically analyze current theories of human communication, and 2) to provide students with the opportunity to actively participate in research that tests major communication theories. Original works are read.

CM 633 - INTERPERSONAL COMMUNICATION
Semester Hours: 3

The art of communicating “one to one” is the focus of this course. This course surveys major theories that inform the scholarly study of interpersonal communication. Through readings, discussions, and research, we will learn how interpersonal communication theories are developed, analyzed, evaluated, and applied. More specifically, the course goals are: 1) to enhance students’ ability to critically analyze current theories of interpersonal communication, 2) to provide students with the opportunity to actively participate in research that tests major interpersonal communication theories.

CM 640 - SPECIAL TOPICS
Semester Hours: 3

CM 662 - INFORMATION ARCHITECTURE
Semester Hours: 3

This class reviews research in technical communication, information science, cognitive science, semiotics, and computer science that helps students understand how communities represent, organize, retrieve, and ultimately use information.

CM 670 - ADVANCED COMMUNICATION METHODS
Semester Hours: 3

This course is concerned with the methods and philosophy of scientific communication research. Having taken a basic course that covers elements of research design is highly recommended.

CM 675 - RHETORICAL CRITICISM
Semester Hours: 3

This course examines how rhetorical scholars analyze persuasive discourse, providing hands-on opportunities for students to engage in such analyses. It examines significant variables in rhetorical processes, a number of methods employed to understand adaptations to rhetorical needs, and considers pragmatic, ethical, social and ideological dimensions of persuasive discourse.

CM 699 - MASTERS THESIS
Semester Hours: 3-6

Required each semester during which a student is working and receiving direction on a masters thesis. No more than 6 hours credit may be applied toward the degree.

Computer Engineering (CPE)

CPE 512 - INTRO PARALLEL PROGRAMMING
Semester Hours: 3

CPE 523 - HARDWARE/SOFTWARE CO-DESIGN
Semester Hours: 3
Study and design of Systems On a Chip (SOC). Emphasis on Field Programmable realizations of SOC systems. Prerequisite: CPE 522 or CPE 526.

CPE 526 - VLSI HARDWARE DESC LANG/MODL/S
Semester Hours: 3
Modern VLSI design techniques and tools, such as silicon compilers, (V)HDL modeling languages, placement and routing tools, synthesis tools, and simulators. Students will design, simulate, and layout using both programmable logic families and ASIC libraries.

CPE 527 - VLSI DESIGN I
Semester Hours: 3
Introduction to VLSI design using CAD tools, CMOS logic, switch level modeling, circuit characterization, logic design in CMOS, systems design methods, test subsystem design, design examples, student design project. Design project to be fabricated and tested in CPE 528. Students enrolling in CPE 527 must enroll concurrently in CPE 527L.

CPE 527L - LABORATORY
Semester Hours: 0
Students enrolling in CPE 527L must enroll concurrently in CPE 527.

CPE 528 - VLSI DESIGN II
Semester Hours: 3
Advanced experience with CAD tools for VLSI design, IC testing. Design project from CPE 527 will be fabricated and tested. Implementation and verification of test programs, IC testing and troubleshooting, legal, economic, and ethical design issues. Oral presentations and written reports are required. Students enrolling in CPE 528 must enroll concurrently in CPE 528L.

CPE 528L - LABORATORY
Semester Hours: 0
Students enrolling in CPE 528L must enroll concurrently in CPE 528.

CPE 531 - INTRO COMPUTER ARCHITECTURE
Semester Hours: 3
Existing computer structures. Computer organization with emphasis on busing systems, storage systems, and instruction sets. Special purpose architecture, performance models and measures, VLSI influence on architecture.

CPE 534 - OPERATING SYSTEMS
Semester Hours: 3
Study of the fundamentals of operating systems. Emphasis on processes, file management, interprocess communication, input-output, virtual memory, networking and security.

CPE 536 - INTERNALS OF MODERN OPER SYS
Semester Hours: 3
In depth study of the design of modern operating systems such as Unix, NT, and Linux. Emphasis on the internals and implementation details of interrupt processing, real-time clocks, device independent I/O, process management, memory management, file management.

CPE 538 - REAL TIME & EMBEDEED SYSTEMS
Semester Hours: 3
Study of design methodologies for reliable real time systems.

CPE 549 - INTRO TO CYBERSECURITY ENGINRG
Semester Hours: 3
Introduction to cryptography and computer security through hardware and physical security to a knowledge of audit methods, security management, and public law. The course will introduce security engineering skills such as business process analysis, software security, IAE evaluation, and IAE testing. Prerequisite: CPE 548.

CPE 549L - INTRO CYBERSECURITY ENG LAB
Semester Hours: 0
Students enrolling in CPE 549 must enroll concurrently in CPE 549L.
CPE 561 - TRANSLATION SYSTEMS
Semester Hours: 3
Grammars, parsers, and lexical analyzers; implementation of translators via top-down and bottom up techniques; grammar analysis to identify ambiguities. Practical applications of translators including conversion of file formats and compilation of traditional computer languages.

CPE 590 - SPECIAL TOPICS IN COMP ENGR
Semester Hours: 1-3

CPE 590L - SELECTED TOPICS LABORATORY
Semester Hours: 0

CPE 601 - SURVEY INFORMATION ASSURANCE
Semester Hour: 1

CPE 610 - SELECTED TOPICS IN COMPUTER EN
Semester Hours: 1-6

CPE 612 - PARALLEL ALGORITHMS
Semester Hours: 3
Introduction to metrics describing the performance and scalability of parallel algorithms. Performance analysis of parallel algorithms for performing sorting, matrix multiplication, solving linear equations, and FFT.

CPE 613 - GEN PURPOSE GPU COMPUTING
Semester Hours: 3
The focus of this course is to introduce emerging techniques and programming paradigms that can be used to accelerate the processing speed of scientific and other high performance applications using Graphics Processing Units, GPUs. GPUs represent low-cost highly parallel video processing hardware that can be programmed for general purpose applications using CUDA/OpenCL software architecture. The course will survey the current state of research and industrial activity and will give student's hands-on experience implementing design applications on real-world GPU facilities for a wide range of scientific applications. Prerequisite: CPE 512.

CPE 619 - MODELING & ANAL COMPU/COMMUN S
Semester Hours: 3

CPE 621 - ADVANCED EMBEDDED SYSTEMS
Semester Hours: 3
Deeply embedded low-power wireless sensors. Low-power microcontroller architectures, sensor platform architecture, wireless intelligent sensors, low power wireless communication standards, battery powered systems, resource constrained operating systems, data aggregation/sensor synergy, and collaborative signal processing.

CPE 625 - CMOS ANALOG CIRCUIT DESIGN
Semester Hours: 3

CPE 626 - ADVANCED VLSI DESIGN
Semester Hours: 3
Advanced VLSI Design. Case study of the VLSI design of a modern RISC processor using a Hardware Description Language. Prerequisite: CPE 526.

CPE 628 - TESTING OF HARDWARE SYSTEMS
Semester Hours: 3
Introduction to testing of digital electronic circuits and systems. Topics include: fault modeling, testing problems, testing schemes, test generation for combinational and sequential circuits, the complexity of testing, design for testability, built-in self-testing and boundary scan.

CPE 631 - ADV COMP SYSTEMS ARCHITECTURE
Semester Hours: 3
Study of architectural features of modern processors, including cache memories and memory systems, pipeline designs, branch prediction techniques. Design of superscalar, multithreaded VLIW processors, code optimization for such systems will be studied. Quantitative evaluation of architectural features are emphasized throughout the course. Prerequisite: CPE 512 and CPE 531.
CPE 633 - FULL-TOLERANT COMPUTING SYSTEM  
Semester Hours: 3

Analysis and design of very high reliability and availability systems. Fault types, reliability techniques, and maintenance techniques. Case studies of high-availability long-life, life-critical systems. Both hardware and software techniques for achieving fault-tolerance will be studied.

CPE 635 - SYSTOLIC ARRAY PROCESSING  
Semester Hours: 3

Systolic structure of fast algorithms and switchable array realizations.

CPE 641 - DATA & DIGITAL COMMUNICATIONS  
Semester Hours: 3

Introduction to digital and data communications; transmission channels; modulation and coding; telephone networks; data communication standards; noise and distortion; computer interfacing; protocols.

CPE 643 - OPTICAL COMMUNICATIONS  
Semester Hours: 3

CPE 645 - COMPUTER NETWORK SECURITY  
Semester Hours: 3

Principles and concepts of computer network security. Introduction to cryptography, confidentiality, authentication, digital signatures, E-mail security, IP security, web security, intruders, malicious software, firewall, and other network security-related issues. Prerequisite: CPE 548.

CPE 646 - MOBILE & WIRELESS NETWORKS  
Semester Hours: 3

High-level issues in mobile and wireless networks. The main topics are mobile IP, mobile Ad hoc NETworks (MANETS) wireless sensor networks, wireless LAN, Bluetooth, cellular networks, satellite systems and security issues in mobiles and wireless networks. Prerequisite: CPE 548.

CPE 647 - UBIQUITOUS COMPUTING  
Semester Hours: 3

The course is based on the new "anytime, anywhere" computing paradigm, also known as ubiquitous computing. This course is project oriented, and explores issues of mobile, wireless, and distributed computing in Internet environment, advanced human-computer interfaces, and power efficient computing.

CPE 648 - ADVANCED COMPUTER NETWORKS  
Semester Hours: 3

Advanced principles and concepts of general-purpose computer networks, with a special emphasis to internetworking and Internet. Transport and higher level protocols emphasis. Programming issues. High-speed networking, congestion control, data compression, security and distributed processing will be covered. Prerequisite: CPE 548.

CPE 649 - ADV CYBERSECURITY ENGINEERING  
Semester Hours: 3

Introduction to topics ranging from how to attack computer systems and networks to how to protect and recover from attacks on computer systems and networks. Basic process utilized by computer attackers in order to develop a complete understanding and appreciation of the threat to information assurance. Process of detecting, preventing, and recovering from information assurance attacks. Intrusion Detection and Prevention Systems, Auditing, Security Vulnerability Assessments, and the Incident Response process. Prerequisite: CPE 549.

CPE 649L - ADV CYBERSECURITY ENG LAB  
Semester Hours: 0

Students enrolling CPE 649 must enroll concurrently in CPE 649L.

CPE 656 - SOFTWARE ENGRG STUDIO I  
Semester Hours: 3

This is the first course in a two course studio series required for the MSSE degree in the College of Engineering. Students will work in small design teams on medium sized software projects. Activities include developing requirements, designing and constructing system prototypes, developing and implementing test and verification plans, and presenting the project for evaluation. The practice of software design and evaluation will be conducted in an iterative cycle using best software engineering practices, so that design and execution can be refined over the lifecycle of the project. Prerequisite: CS 650.
CPE 658 - SOFTWARE ENGRG STUDIO II  
Semester Hours: 3  
This is the second course in a two course studio series required for the MSSE degree in the College of Engineering. Students will work in small design teams on medium sized software projects. Activities include developing requirements, designing and constructing system prototypes, developing and implementing test and verification plans, and presenting the project for evaluation. The practice of software design and evaluation will be conducted in an iterative cycle using best software engineering practices, so that design and execution can be refined over the lifecycle of the project. Prerequisite: CPE 656.

CPE 690 - SELECTED TOPICS COMPUTER ENGRG  
Semester Hours: 1-6  

CPE 692 - CYBERSECURITY CAPSTONE  
Semester Hours: 3  
A capstone course emphasizing the integration of various principles, theories, and techniques for developing, implementing and using cybersecurity strategies and applications in organizations. Includes readings, lectures, tours, situation analysis, cases, and the completion of a major practical project. Normally taken in the last semester of a student's program. Minimum grade B required. Prerequisites: CS, 585, CPE 549, IS 660, IS 663.

CPE 695 - PROJECTS IN COMPUTER ENGRG  
Semester Hours: 3  

CPE 699 - MASTER'S THESIS  
Semester Hours: 1-9  
Required each semester student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of 9 hours credit is awarded upon successful completion of master's thesis. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.

CPE 710 - SEL TOPICS IN PARALLEL PROC  
Semester Hours: 3  

CPE 715 - SELECTED TOPICS IN COMPUTAT TH  
Semester Hours: 3  

CPE 720 - SELECTED TOPICS IN VLSI DESIGN  
Semester Hours: 3  
Prerequisite: CPE 626.

CPE 726 - ALGORITHMS FOR VLSI DESIGN TOO  
Semester Hours: 3  
Tools for VLSI Design. This course is concerned with the algorithms found in VLSI design tools.

CPE 730 - SELECTED TOPICS IN COMPUTER SY  
Semester Hours: 3  
Prerequisite: CPE 631.

CPE 731 - DISTRIBUTED SHARED MEMORY SYS  
Semester Hours: 3  
Study issues related to performance, granularity of sharing, multithreading, cache coherence, memory consistency models, pull vs push cacheing, false sharing, thread migration. Case studies systems, including DASH, FLASH ThreadMarks, SHRIMP, Calypso, Aelwifl to understand these issues.

CPE 735 - SELECTED TOPICS IN OPERATING S  
Semester Hours: 3  

CPE 740 - SPEC TOPICS COMPUTER NETWORKS  
Semester Hours: 3  
Prerequisite: CPE 648.

CPE 742 - PARALLEL PROCESS DESIGN  
Semester Hours: 3
CPE 748 - MOBILE & WIRELESS NETWORKS
Semester Hours: 3
High-level issues in mobile and wireless networks. The main topics are mobile IP, Mobile Ad hoc NETworks (MANETs), wireless sensor networks, wireless LAN, Bluetooth, cellular networks, satellite systems, and security issues in mobiles and wireless networks. Prerequisite: CPE 648 or CS 670.

CPE 760 - SEL TOPICS COMPILER/TRANSLATION
Semester Hours: 3

CPE 790 - SEL TOPICS COMPUTER ENGR
Semester Hours: 1-6

CPE 795 - RESEARCH IN COMPUTER ENGR
Semester Hours: 1-6

CPE 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9
Required each semester student is enrolled and receiving direction on doctoral dissertation.

**Computer Science (CS)**

CS 513 - INTRO TO COMP ARCHITECT
Semester Hours: 3
Review of combinational and sequential logic design, register transfer concept, logic design of memory, arithmetic unit, control unit, and I/O system of simple computer. Review of Machine and Assembler language programming. Architectural trade-offs.

CS 517 - DATA ORG ANALYSIS OF ALGORITHMS
Semester Hours: 3
Review of basic data structures such as stacks, queues, lists, B-Trees, and binary trees. Overview of file structures and access methods. Introduction to complexity analysis of algorithms. Basic algorithm design techniques such as divide & conquer, dynamic programming, and backtracking. Introduction to the classification of problems by class; i.e., tractable, NP, intractable, and unsolvable.

CS 524 - PROGRAMMING LANGUAGES
Semester Hours: 3

CS 526 - PROG TRANS & COMPILER CONSTRUCTION
Semester Hours: 3
Language representation; grammar classification; lexical analysis technique and tools; parsing technique and tools; compile-time and run-time symbol table design; code generation and optimization; error diagnostics. Compiler writing tools.

CS 530 - EXP SYS/HEURISTIC PROGRAMMING
Semester Hours: 3
Expert systems concepts and architectures. Languages and tools for knowledge engineering. Heuristic versus algorithmic methods, heuristics as used in expert systems, and heuristic programming techniques. Class and individual projects. Background in algorithms and programming languages assumed.

CS 537 - INTRO TO NEURAL NETWORKS
Semester Hours: 3
Introduction to artificial neural networks, covering the most prominent models. Neural networks solutions to classification, clustering, data compression, and constrained optimization applications. Experience with neural networks through projects.

CS 543 - INTRO TO MULTIMEDIA SYSTEMS
Semester Hours: 3
Multimedia authoring, color models for image and video, introduction to image and video compression, digital audio, multimedia networks, multimedia synchronization, multimedia retrieval. Students may not receive credit for both CS 443 and CS 543. Courses numbered at the 500-level may be taken for undergraduate credit with prior approval, except as otherwise noted. Courses at 600-level or above are reserved for graduate students. They may be taken by other students only by approval. Consult Seniors Taking Graduate Courses in the Graduate Admissions section of this catalog for specific policies and approval procedures. Taught as CS 443/543. Course completion and/or grade requirements for graduate credit will differ from those for undergraduate credit. Prerequisite: CS 617.
CS 545 - INTRO COMPUTER GRAPHICS  
Semester Hours: 3  
Introduces underlying theory and mechanics of interactive computer graphics. Basic modeling, raterization, 2D/3D transformations, and viewing. 3D graphics rudiments. Some hardware and historical perspectives. Many programs.

CS 546 - ADVANCED COMPUTER GRAPHICS  
Semester Hours: 3  
High resolution 3D graphics, including advanced topics in viewing, vertex processing, fragment processing, local and global illumination and shading, 3D modeling (including curve and surface representation), texture mapping, and some coverage of solid modeling and color theory. Game production pipeline. Hierarchical issues, visibility, and 3D processing algorithms may also be covered. A significant number of programming projects are involved, with some different program requirements and additional theoretical expectations for CS 546 students. (Same as CS 456; no credit for both). Prerequisite: CS 545.

CS 547 - GAME ENGINES & LEVEL DEV  
Semester Hours: 3  
(Same as CS 447) This course provides the opportunity for students to produce fully functional games from beginning to end with team members. Along the way, students work on homework/projects involving design document creation, prototyping and gameplay/implementation. Also, game software as artistic content has led to collaborations between engineers and artists. In this course, students focus on not only game engineering development but also art generation and management. Considers a 3D game design and development using game engines focusing on the fundamental components for developing cross-platform games. The course focus includes design, development, and distribution of computer games. Emphasis also is on user interface and menus, scripting for game programming, game physics, terrain generation, asset management, animation management, special effects, and cross-platform game development. Students may not receive credit for both CS 447 and CS 547.

CS 548 - HUMAN-COMPUTER INTERACTION  
Semester Hours: 3  
Introduces underlying theory and mechanics of interactive computer graphics. Basic modeling, raterization, 2D/3D transformations, and viewing. 3D graphics rudiments. Some hardware and historical perspectives. Many programs. Introduction to human-computer interaction and principles of graphical user interface design. Includes examination of interactive environments including windowing systems development tools, multimedia, and visual programming interfaces. Prerequisite: CS 545.

CS 553 - CLIENT/SERVER ARCHITECTURES  
Semester Hours: 3  
Aspects of client/server distributed computing, a paradigm that includes technologies addressing web services (such as AJAX using Javascript/PHP, ASP.NET) as well as distributed object (such as .NET remoting, CORBA). Students will apply the concepts in practical distributed programs.

CS 554 - INTRO TO CLOUD COMPUTING  
Semester Hours: 3  
Different cloud computing paradigms: IaaS, SaaS, PaaS. Open Source cloud software (for ex., OpenStack, CloudStack). RESTful interfaces, AWS interface. Cloud security. Students may not receive credit for both CS 454 and CS 554.

CS 555 - NETWORK SECURITY  
Semester Hours: 3  
Fundamentals of network security and cryptography. Examines security at different network layers. Wireless security. Firewalls. Intrusion detection and penetration analysis. Students may not receive credit for both 455 and 555.

CS 570 - INTRO TO COMPUTER NETWORKS  
Semester Hours: 3  
Organization and operation of computer networks. Physical, Data Link, Network, Transport, and Application-layer protocols and algorithms; LAN and WAN systems; TCP/IP; Wired and wireless organizations; security approaches. Prerequisite: CS 513.

CS 571 - MOBILE COMPUTING SFTWR ARC&DEV  
Semester Hours: 3  
Considers application design for the mobile space, focusing on the fundamental requirements for mobile applications that target mobile devices. The course focus includes development, testing, distribution of mobile applications in a cross-platform environment. Emphasis also is on multimedia and entertainment computing and games. This course will also cover various issues in mobile computing from the readings from research literature such as software engineering practices, analysis of social media and general mobile analytics.
CS 580 - MOBILE DIGITAL FORENSICS
Semester Hours: 3

This course examines digital forensics of mobile devices such as smart phones and tablets in a law enforcement context. Mobile device characteristics that make forensics examinations difficult are discussed. Various forensics tools are critically examined with an eye toward improved tool development.

CS 581 - MODELING & SIMULATION I
Semester Hours: 3

Discrete event simulation from a computer science perspective. Mathematics of probability distributions applied to simulation. Design, implementation, and application of discrete event simulation software. Application to computer and network system design.

CS 582 - MODELING & SIMULATION II
Semester Hours: 3

Advanced application of computer science methods to modeling and simulation software development. Design, development, and integration of software for real-time distributed simulations using standard network interoperability protocols. Team development of modeling and simulation software. Prerequisites: CS 581 or MOD 501.

CS 585 - INTRO TO COMPUTER SECURITY
Semester Hours: 3

This course examines the issues related to security policies, models and mechanisms applicable to providing security for computer-based systems including operating systems, database management systems, and networks.

CS 590 - PROGRAMMING ENVIRON W/UNIX
Semester Hours: 3

Strategies for design and development of systems and programs in the UNIX environment. Emphasis: automated tool and system development using UNIX tools. Advanced shell concepts including control flow and interrupt handling. Process and inter-process communication.

CS 595 - INDEPENDENT STUDY
Semester Hours: 3

Individual directed study under the supervision of an instructor. Must have approval of the instructor.

CS 596 - SPECIAL TOPICS
Semester Hours: 3

Individual directed study under the supervision of an instructor. Must have approval of the instructor.

CS 597 - SPECIAL TOPICS
Semester Hours: 3

Course offered by an instructor in a specialized area of computer science. Must have approval of instructor.

CS 598 - SPECIAL TOPICS
Semester Hours: 3

Course offered by an instructor in a specialized area of computer science. Must have approval of instructor.

CS 600 - INTERNSHIP IN COMPUTER SCIENCE
Semester Hour: 1

Work experience in Computer Science or a related field in a business or government agency; conducted under the direction of the agency supervisor and approved by a member of the CS faculty. A substantial report must be produced and approved by the supervisor and the faculty member.

CS 603 - FORMAL LANG/AUTOMAT THRY
Semester Hours: 3


CS 613 - COMPUTER ARCHITECTURES
Semester Hours: 3

Organization, operation, and analysis of advanced computer architectures. Topics include advanced pipelining approaches, multi-processor architectures, instruction set architectures, memory hierarchy design, hardware and software-based performance optimization, and system performance measurement. Prerequisite: CS 513.
CS 617 - DES & ANALYZE OF ALGORITHM  
Semester Hours: 3

Strategies of algorithm synthesis and analysis. Classical algorithm categories such as: divide-and-conquer, greedy method, dynamic programming, search and traversal. Computational complexity; theoretical results from lower- and upper-bound studies, NP-hard, and NP-complete problems. Prerequisite: CS 517.

CS 630 - ARTIFICIAL INTELLIGENCE I  
Semester Hours: 3

All concepts and methods for problem solving, heuristic search, planning, hypothesis formation, modeling and knowledge representation, knowledge acquisition and learning. Applications of AI in various areas. Background in algorithms and programming languages assumed. CS 530 recommended.

CS 635 - COMPUTATIONAL MODEL COGNITION  
Semester Hours: 3

Computational models of human information processing covering topics of current interest to both artificial intelligence and cognitive psychology. Use of computer simulations to test psychological theories. Application of psychological research to building AI systems. Prerequisite: CS 630.

CS 640 - MACHINE LEARNING  
Semester Hours: 3

Discriminant analysis, maximum likelihood decisions, deterministic and nondeterministic approaches for trainable classifiers, preprocessing and feature extraction, clustering, syntactic pattern recognition. Pattern recognition in image analysis.

CS 641 - DATA MINING  
Semester Hours: 3

Data preprocessing, distance measures, classification with decision trees, Bayesian classifiers, neural networks, support vector machines, frequent item set analysis, association rule generation, clustering methods.

CS 642 - COMP PROC/DIGITAL IMAGES  
Semester Hours: 3

Introduction to image processing systems; sensing, sampling and quantization; image transforms; image enhancement and restoration; image segmentation, and description; image correlation; image sequence analysis; practical applications of image processing.

CS 643 - DATA COMPRESSION  
Semester Hours: 3

Lossless and lossy compression algorithms, Huffman coding, Arithmetic coding, Dictionary-based compression, quantization techniques, differential encoding, transform coding, wavelet-based coding; image compression, video compression, audio compression, applications of compression algorithms to audio, image, and video compression standards. Prerequisite: CS 617.

CS 646 - COMPUTER GEOMETRY MODELING  
Semester Hours: 3


CS 650 - SOFTWARE ENGINEERING PROC  
Semester Hours: 3

The process of developing complex software products. Includes software life cycles, phases of development and disciplines such as CM, QA, V&V, and T&E. Issues of professionalism and the ethical use of computers. Background in algorithms and programming languages assumed.

CS 652 - OBJECT-ORIENTED DESIGN  
Semester Hours: 3

A survey of formal and informal techniques and methodologies for software analysis, requirements, architecture and design. Emphasis is on effective development processes. Comparison of different approaches, considering their advantages and disadvantages. Prerequisite: CS 650.

CS 655 - FORMAL METHODS IN SOFTWARE ENG  
Semester Hours: 3

Formal mechanisms to specify, validate, and verify software systems. Propositional and predicate calculi. Program verification through Dijkstra's weakest preconditions and Hoare's method. Formal specification via algebraic specifications and abstract model specifications. Prerequisites: CS 617 and CS 650.
CS 656 - SOFTWARE TESTING
Semester Hours: 3

Advanced software testing techniques, including white box, black box, integration testing, and system testing. Other topics may include test data adequacy, test data selection, and output oracle, including functional, structural, and fault-based testing methods. Prerequisite: CS 650.

CS 658 - SOFTWARE PROC & PROD IMPROVEMENT
Semester Hours: 3

Software quality assurance as an umbrella activity. Use of process, project, quality and product metrics to gain insight into the software development activity. Use of metrics to drive incremental process improvement techniques. Examination of CASE tools and how they affect the software process. Prerequisite: CS 650.

CS 666 - SOFTWARE STUDIO I
Semester Hours: 3

Students work in teams on medium-sized software projects to analyze and document software requirements, produce a project plan, design and build a prototype, and present the project for evaluation. The design-evaluation phases are repeated twice to generate a more mature design. Prerequisites: CS 650 and either CS 652, 656, or 658.

CS 668 - SOFTWARE STUDIO II
Semester Hours: 3

A continuation of CS 666. Students work in teams to continue the software engineering cycle with emphasis on software management, evolution, maintenance, quality analysis, testing, integration, validation, and security auditing. Prerequisite: CS 666.

CS 670 - COMPUTER NETWORKS
Semester Hours: 3

Detailed analysis of the organization and operation of computer networks, focusing on algorithms and organizations for the Transport Layer, Network Layer and Data Link Layer protocols of wired and wireless systems. Prerequisite: CS 570.

CS 685 - COMPUTER SECURITY
Semester Hours: 3

Advanced topics in security policies, models and mechanisms applicable to providing security for computer based systems, including operating systems, database management systems, and networks.

CS 686 - INFORMATION ASSURANCE
Semester Hours: 3

CS 687 - DATA BASE SYSTEMS
Semester Hours: 3

Basic concepts of database systems. Use of semantic models in database design. Data models with an major focus on the relational and object-oriented models. Relational query languages and normal forms. Database management system design issues. Security and integrity issues.

CS 690 - ADVANCED OPERATING SYSTEMS
Semester Hours: 3

Issues related to shared memory multiprocessors, multicore computers, clusters, grids and clouds. Concurrency and distributed process coordination. Introduction to network communication issues and systems such as client-server, peer-to-peer, transaction based. Prerequisite: CS 513.

CS 692 - COMPUTER SECURITY
Semester Hours: 3

CS 695 - INDEPENDENT STUDY
Semester Hours: 3

Individual directed study under the supervision of an instructor. Must have instructor approval.

CS 696 - SELECTED TOPICS IN CS
Semester Hours: 3

Course offered by an instructor in a specialized area of computer science. Must have instructor approval.

CS 699 - MASTER'S THESIS
Semester Hours: 3-6

Course offered by an instructor in a specialized area of computer science. Must have instructor approval. Required each semester a student is working and receiving direction on master's thesis. Prerequisite: instructor approval.
CS 703 - THEORY OF PROG LANGUAGES
Semester Hours: 3
Syntactic analysis and semantic interpretation of programming languages based on research and results in formal languages and associated compiler techniques. Identification of research directions and potential research projects in programming languages.

CS 717 - ADV ALGORITHM DES/ANALYSIS
Semester Hours: 3
Parallel algorithms, combinatorial algorithms, approximation algorithms for NP-complete problems, computational complexity. Distribution of algorithms across complex architectures. Prerequisite: CS 617.

CS 730 - ARTIFICIAL INTELLIGENCE II
Semester Hours: 3
Rigorous treatment of special topics in artificial intelligence. Topics may include knowledge representation, automated deduction, search control, machine learning, or meta-level architectures. Prerequisite: CS 630.

CS 742 - IMAGE PROC ALGO/ARCHITEC
Semester Hours: 3
Algorithms and data structures for image enhancement, segmentation, object recognition and image sequence analysis; real-time versus non real-time image processing; computer architectures for fast image processing; cellular logic array processors, distributed, systolic and binary array processors. Prerequisite: CS 613 and CS 642.

CS 790 - OPERATING SYSTEMS SEMINAR
Semester Hours: 3
Advanced research topics in operating system theory and practice. Students will read and discuss classic and current papers in the literature. Each student will present reports in class and prepare a substantial research paper. Prerequisite: CS 690.

CS 795 - ADVANCED SELECTED TOPICS
Semester Hours: 3
Individual directed study under the supervision of an instructor. Must have instructor approval.

CS 796 - ADVANCED SELECTED TOPICS
Semester Hours: 3
Course offered by an instructor in a specialized area of computer science. Must have instructor approval.

CS 799 - DOCTORAL DISSERTATION
Semester Hours: 3
Required each semester student is enrolled and receiving direction on doctoral dissertation. Maximum of 18 hours credit toward degree.

Earth System Science (ESS)

ESS 501 - SURVEY ATMOSPHERIC SCIENCE
Semester Hours: 3
General survey of the field of atmospheric science includes thermodynamics, atmospheric dynamics, cloud physics, and atmospheric radition. Quantitative examination of atmospheric properties including atmospheric composition, structure and dynamics.

ESS 502 - SCI & SOC ASPTS NATRL DISASTER
Semester Hours: 3
Examination of the physical causes of major natural geophysical hazards and their impact on the natural and built environment, society and the economy. Evaluation of the ability to forecast events, and develop sound mitigation and recovery measures. Specific case studies are considered.

ESS 507 - ENVNMTL THRTS PBL PY DEC MKG
Semester Hours: 3
Researchers, policymakers and environmental campaigners have identified 25 potential future threats to the global environment. This course examines the nature and consequences of these threats and their potential impacts for the survival of the human race.

ESS 508 - PYTHON FOR ID ESS APPLICATIONS
Semester Hours: 3
Introduction to GIS model building, Python programming, and automation of scripts for ArcGIS. Techniques in Model Builder, Python, and the methods for automation will be taught using data from numerous available data sources across the internet with heavy emphasis on the Earth Sciences.
ESS 509 - APPLI COMPUTERS IN METEOROLOGY  
Semester Hours: 3  
Survey of data types and languages commonly used in the meteorological community along with practical application to meteorology. Course is designed to prepare students for graduate work and research in atmospheric science.

ESS 510 - OPERATIONAL WEATHER FORECASTING  
Semester Hours: 3  
Operational Meteorology covers subjective and objective methods of atmospheric prognosis, including techniques for forecasting operationally-important weather elements. Course explores interpretation, use and systematic errors of computer-generated products, human factors within forecasting, and application of meteorological theory in an operational setting. Course instruction is accomplished through analysis of various weather events from beginning to completion.

ESS 514 - GEOSPATIAL APPLICATIONS  
Semester Hours: 3  
An introductory look at the ways in which GIS can be put to use in different fields of study, drawing examples from Demography, Sociology, Archaeology, History and Ecology. Focus on cartography and map creation principles and public geospatial data acquisition.

ESS 515 - ADVANCED TOPICS IN GIS  
Semester Hours: 3  
Advanced continuation of concepts applied in Geospatial Applications. Students will learn through modules of real world scientific research how to use further tools in ArcGIS including: 3D Analyst, Spatial Analyst, Network Analyst. Topics include web data dissemination, spatiotemporal analysis and some basic spatial statistics measures. Prerequisite: ESS 514.

ESS 561 - ATMOSPHERIC RADIATION I  
Semester Hours: 3  
ESS 590 - SPECIAL TOPICS IN ESS  
Semester Hours: 3  
Selected topics of interest not included under other courses.

ESS 610 - LAND USE APP & SUSTAINABILITY  
Semester Hours: 3  
Study of land use and sustainability issues using satellite image processing and GIS. International examples of urbanization, agriculture, transportation, water management, and natural resources exploitation. Discussions of current literature and quantitative analyses of satellite and situ data. Prerequisite: ESS 515 or consent of instructor.

ESS 612 - ADV GIS EARTH ATMOSPHERE PROBLEM  
Semester Hours: 3  
Advanced GIS and remote sensing/image processing. Discussion, guided readings, and group labs to interact with student peers and instructor to develop geospatial solutions to problems relevant to their thesis research including appropriate research design, data collection, and analysis. Prerequisites: ESS 515 and ESS 610.

ESS 625 - AIR POLL APP & DEC MAKER REMOTE  
Semester Hours: 3  
Course will review principles of air pollution, measurement methods, regulation, national and international standards and how research is used to make decisions regarding air quality. The course will use ground-based, satellite, and numerical modeling information through a case study approach. Prerequisites: ESS/ATS 501.

ESS 630 - PHYSICAL CLIMATOLOGY  
Semester Hours: 3  
This course examines the physical aspects of the global climate system, including the global energy balance, surface energy balance, hydrologic cycle, climate classification, ocean circulation, natural and anthropogenic climate change and other selected topics such as climate sensitivity. Prerequisites: ATS 501 or ATS 541.

ESS 632 - ENERGY, CLIMATE, ENVIRONMENT  
Semester Hours: 3  
This course focuses on energy and its impact on the environment including climate change and air pollution. Specific energy forms, such as fossil fuels, nuclear energy, solar energy, are discussed.
ESS 670 - SATELLITE REMOTE SENSING I  
Semester Hours: 3

Using a hands on approach, this course covers a broad range of topics concerning digital image processing applied to the remote sensing of atmospheric, cloud and surface properties using various satellite data sets. Prerequisites: ESS 509.

ESS 680 - NUMERICAL MOD APPL ESS  
Semester Hours: 3

This course will provide the physical basis for numerical model applications in the earth-atmosphere system including spatial and temporal scales. Prerequisites: ESS 501 and ESS 509.

ESS 690 - SPECIAL TOPICS IN ESS  
Semester Hours: 3

Selected topics of interest not included under other courses.

ESS 698 - MASTERS CAPSTONE  
Semester Hours: 3

An extended research project resulting in a substantive paper that involves the original collection, analysis and/or interpretation of scientific data and/or results. Conducted under the guidance of an advisor. Required for MS ESS non-thesis option.

ESS 699 - MASTER'S THESIS  
Semester Hours: 3-6

A minimum of six thesis credit hours is required for MS degree.

ESS 780 - SEMINAR  
Semester Hour: 1

Speakers are invited to report on research relevant to the field of Atmospheric and Earth System Science. Students are expected to attend at least twelve seminars and to write short descriptions of the presentations.

ESS 781 - STUDENT SEMINAR  
Semester Hour: 1

Guest speakers reports on research relevant to the fields of Atmospheric and Earth System Science. Students are expected to attend weekly seminars, submit a paper based on at least ten talks, and make a 15 minute conference-type presentation on a research topic in atmospheric science selected in agreement with their advisor.

ESS 782 - PROFESSIONAL DEVELOPMENT  
Semester Hour: 1

Topics concerning professional ethics, writing scientific journal articles, proposals and resumes, preparing budgets, networking, time management, conference presentations, research administration, funding agencies, stress and burnout will be discussed.

Economics (ECN)

ECN 511 - ECONOMICS OF INFORMATION TECH  
Semester Hours: 3

Economic theory underlying consumer and firm behavior and strategy in the information technology industry, with an emphasis on developing formal tools of analysis and applying them to real-world examples.

ECN 545 - GAMES & NETWORKS  
Semester Hours: 3

An introduction to game theory and economic- and social network analysis. Prerequisites: ECN 600.

ECN 554 - INTERNATIONAL ECONOMICS  
Semester Hours: 3

Behavior of foreign-exchange rates under different monetary standards, methods of financing international trade, historical development of international financial institutions, current and proposed methods for fostering international trade, and problems of international liquidity.

ECN 575 - ECON LABOR MARKETS & HUMAN RES  
Semester Hours: 3

Economic analysis of labor markets; labor demand and labor supply at the market and individual level. Topics include individual decisions to supply labor, compensating wage differentials, human capital investment, discrimination in labor markets, pay and productivity, and the role of labor unions.
ECN 580 - INTRODUCTION TO ECONOMETRICS  
Semester Hours: 3  
An introduction to the quantatative measurement and analysis of actual economic and business phenomena.  

ECN 590 - SPECIAL PROJECTS  
Semester Hours: 3  
Faculty guided independent study in an area of interest to the student and faculty member.  

ECN 600 - FOUNDATIONS OF ECONOMICS  
Semester Hours: 3  
This course covers the economic foundations in which businesses operate. Coverage includes output and pricing decisions of firms in various market structures; consumer and producer choice at the micro level; and macroeconomic issues, such as unemployment and inflation and government policy.  

ECN 626 - MANAGERIAL ECON & TECH  
Semester Hours: 3  
The principles of microeconomics are used to formulate and analyze problems and these principles are applied to business decisions. The course includes an introduction to regression analysis and forecasting. Basic international economic concepts and the importance of technology are explicitly introduced. Prerequisites: ECN 600 and MSC 600.  

**Education (ED)**  

ED 500 - SPEC TOPICS EDUCATION  
Semester Hours: 1-3  
Independent study, special projects, and special in-service programs.  

ED 501 - INTRO TO EDUCATION  
Semester Hour: 1  
Initial practicum experience designed to provide the opportunity to explore the role of the classroom teacher in today's diverse school settings. Required for graduate students receiving their initial certification.  

ED 510 - FOUNDATIONS OF LITERACY  
Semester Hours: 3  
This course includes a study of methods, materials, and strategies for reading instruction. Components of the course will include but not be limited to the five pillars of reading instruction identified by the National Reading Panel (2000): phonemic awareness, phonics, fluency, vocabulary, and comprehension. Emphasis is placed on the various stages of and approaches to literacy development, knowledge of which is required for the Alabama Reading Specialist licensure.  

ED 513 - LITERATURE FOR CHILDREN & ADOL  
Semester Hours: 3  
Course content will include the study of various genres of children's and adolescent literature and their relationship to beginning reading, enhancement of reading comprehension, and intervention instruction in the various content areas. (Same as EH 613) Must be admitted to the Teacher Education Program.  

ED 520 - COMPUTER BASED INSTRUCT'L TECH  
Semester Hours: 3  
Introduces prospective teachers to current state of the art in educational technology. Extensive hands-on experiences with microcomputers and other emerging technology. Emphasis on effectively integrating technology into instructional setting for both special and regular students.  

ED 521 - TCHNG ENGLISH MID & SEC SCHLS  
Semester Hours: 3  
This course is designed to provide graduate level English Education majors with the theory, tools and techniques for teaching middle and secondary students. The focus of the course is primarily, though not exclusively, on designing lessons that allow for maximum student participation and control while remaining aligned to Alabama Content Standards. Students will study, discuss, and implement a variety of environments middle and secondary students reside in, special attention will be given to the use of various technologies as a means of content exploration and student evaluation. As this is a graduate level course, students are expected to engage in substantive scholarly research. Admissions to the Teacher Education Program of permission of instructor is required before registering for this class.
ED 522 - TCHNG MATH MID & SEC SCHLS
Semester Hours: 3

The math methods course provides background for middle school and secondary teaching from the perspective of theory, research, and practice. It is designed to provide an introduction to and practice in ways in which to engage students in learning in mathematics in middle and secondary classrooms. Topics include specific educational philosophies of mathematics equation, lesson and unit planning, instructional strategies, use of mathematics manipulatives and technology, and student assessment within the content area. Applications will include microteaching and intensive school-based experiences in area schools. Intensive field experience required. Must be admitted to Teachers Education Program or permission of instructor required before registering for this course.

ED 523 - TCHNG SCIENCE MID & SEC SCH
Semester Hours: 3

This course is designed for students who are pursuing teaching certification in middle and/or secondary science. The course will first focus on how middle and secondary students learn science, and then from this knowledge base, the class context will focus on how to plan, design, and implement inquiry-based science instruction. Assessment development in science, the interpretation, and the use of assessment results to guide student understanding will also be incorporated in teaching methodology.

ED 524 - TCHNG SOC STUD MID & SEC SCH
Semester Hours: 3

This course is designed to study effective techniques and strategies employed by social science teachers at the middle and secondary levels. As well as learning theoretical foundations in social studies education, students will learn pedagogic skills, instructional strategies, and modes of reasoning unique to the social studies classroom. Intensive field experience required. Students are required to observe, participate, and teach a lesson in a secondary social studies classroom. Admission to the Teacher Education Program or permission of chair is required for this course.

ED 530 - APPLIED MULTICULTURALISM
Semester Hours: 3

Through an examination of constructs such as race, ethnicity, social class, gender, sexual orientation, and religious affiliation, students will develop an understanding of the connections between identity, difference, power, and privilege and the role(s) school (could/should) play in perpetuating or ending discriminatory practices. Furthermore and more importantly, students will develop an understanding of the ways research in both the humanities and social sciences can be used to interpret, analyze, and critique multiculturalism. Students will leave the course with research-based pedagogical practices designed to help all students learn to the best of their abilities.

ED 532 - SPACE ORIENTATION TEACHERS
Semester Hours: 3

A weeklong course at the U.S. Space and Rocket Center in Huntsville, Alabama for pre-service and in-service teachers. The inquiry based workshops are taught around the theme of space exploration include activities to be done across the curriculum. All activities are correlated to National Math, Science, Technology, Social Studies, and Reading Standards. Activities based on curriculum developed by NASA, CAP, NSATA, and the USSRC. Topics include moon, mars, rocketry, propulsion, hydroponics, math, biology, history and literature.

ED 535 - INTRO APPLIED EDUCATIONAL RES
Semester Hours: 3

Introduction to the nature of research and its relationship to educational thought and practice. Primary focus will be on planning and executing research activities (i.e. action research, thesis development) in the diverse classroom and analyzing the collected data to improve instruction, educational performance, and adding to the body of knowledge in educational practices.

ED 540 - COGN DEV THEORIES LEARNING
Semester Hours: 3

The course is designed to inform students about recent developments in Cognitive Psychology and their implications for teaching and learning. Students will leave the course with a variety of "cognitive understandings" for use in differentiated classrooms.

ED 545 - CURR & INSTR IN SEC SCHOOLS
Semester Hours: 3

This course is designed to address various contemporary teaching and learning strategies, as well as related issues, assessments strategies, and applicable theories related to secondary teaching and learning.

ED 560 - CURR/EMERGING INSTR TECH
Semester Hours: 3

Designed to build competency in computer technologies appropriate to instructional use. Concepts of authoring and scripting will be used to unify course materials. (Same as CS 560.)
ED 565 - INTRO DIFFERENTIATED INSTRUCTION
Semester Hours: 3

The course provides an introduction to the philosophy and practice of differentiation. Students will examine the elements, content, process, product, affect and environment by which instruction can be differentiated to address the complex challenges of meeting the diverse learning needs of all students.

ED 570 - DIFF INSTRUCTION SPEC POP
Semester Hours: 3

The course provides practical strategies to maximize learning for all students, particularly those with disabilities, gifted/talented, and English language learners (ELL).

ED 575 - READING PRIMARY GRADES
Semester Hours: 3

An introduction to the basic principles of literary instruction in culturally and linguistically diverse primary grade classrooms, including theoretical bases for instruction, methods of instruction and organization, developmentally appropriate strategies and materials, and assessment of children's literacy. Class activities include mini-lessons, discussions, group activities, and presentations. An intensive school-based practicum in grades preK-2 is required.

ED 580 - PROJECT BASED LEARNING
Semester Hours: 3

Develop a robust understanding of Project Based Learning (PBL) through critiquing, evaluating, and synthesizing PBL's core theoretical concepts.

ED 593 - ED EXCEPT CHILD & YOUTH
Semester Hours: 3

Introduction to the field of exceptional children and youth, including observations. This course, or equivalent, is a prerequisite to certification. Intensive field experience required.

ED 600 - SPEC PROB IN EDUCATION
Semester Hours: 1-3

Independent study, special projects, and in-service programs.

ED 604 - CONTRIBUTION PSY TO EDUC
Semester Hours: 3

Principles, theory, and practice of psychology for teaching and administrative service in educational institutions. Factors that determine learning and conditions of effective teaching. Administrator and supervisor as organizer of the milieu wherein teaching, learning, and growth occur. Intensive field required.

ED 605 - READING RESEARCH & INSTRUCTION
Semester Hours: 3

Elements of effective reading instruction for beginning readers as supported by current research and practice. Topics include balance, language-rich/ print-rich environment, language development, phonemic awareness, print awareness, phonics, writing, spelling, and comprehension. Intensive field experience required.

ED 607 - EDU LEADER AS EVALUATOR
Semester Hours: 3

Procedures and techniques of evaluation and research approaches. Emphasis on teachers as evaluators; based on action research in the classroom. Intensive field experience required.

ED 608 - EXPAND RDG ABIL CONT AREA INST
Semester Hours: 3

Strategies to enhance reading comprehension when using materials in all subject areas. Teacher-directed, integrated instruction; extensive use of authentic printed materials; discussion at literal and higher levels of understanding, motivation, vocabulary, and writing. Intensive field experience required.
ED 609 - CLASSROOM & BEHAVIOR MGMT  
Semester Hours: 3  
A focus on the variety of instructional management options to meet classroom and individual student needs to ensure success in school is integrated throughout all course activities. A range of management practices, including strategies for diverse and special populations, is offered. Theoretical and reflective practices are incorporated during classroom meetings. Students will observe, research, and discuss current classroom approaches. After reflections, effectiveness of observed practices will be assessed. Students will discuss and develop alternative activities that promote successful management techniques. Intensive field experience required. Admission to the Teacher Education program or permission of chair is required for this class.

ED 612 - DIAGNOSIS & ASSMNT OF READING  
Semester Hours: 3  
Focuses on ways to address the needs of students who do not read at grade level. Intervention strategies such as on-going assessment and evaluation, explicit instruction in phonemic awareness and phonics, extensive practice, comprehension strategies, and writing, along with careful examination of standardized state assessment measures. Intensive field experience required.

ED 615 - READING INTERMEDIATE GRD  
Semester Hours: 3  
This course provides an in-depth study in and application of the process of reading and reading instruction, theoretical approaches, instructional strategies, classroom organization, and the formal/informal assessment of reading in intermediate grades. This course is required of all elementary education majors and secondary education candidates who are pursuing a middle school endorsement. Intensive field experience required.  
Prerequisites: Admission to the Teacher Education Program.

ED 620 - USING TECH REACH SPEC POP  
Semester Hours: 3  
Prepares teachers to plan curriculum integration by using computer technology and software in various curriculum areas for both regular and special students. Students will develop competency in instructional design and production skill techniques and implement instructional events using long-distance technologies.

ED 635 - ASMT GUIDE DIFFRNT INSTRUCTION  
Semester Hours: 3  
The focus of this course would be to use a variety of norm-referenced, criterion-referenced and other assessment data to inform instruction for a diverse classroom within the RTI model. Students would learn to use formative and summative assessments to determine the type of strategies needed to teach content.

ED 640 - DIFD STRGTY RES & TEACH ELL  
Semester Hours: 3  
The course is designed to provide current educators the foundation for informed and effective classroom teaching in diverse classrooms with ELL students. The course includes theoretical underpinnings of historical and contemporary ELL education, instructional methods, analysis and critique of methodologies, and strategies for pedagogically sound classroom instruction and lesson planning within linguistically and culturally diverse classrooms.

ED 650 - DIFFNT ELEM MATH & SCI INSTRUC  
Semester Hours: 3  
This course will focus on guiding the learner to apply the concepts of differentiated instruction within mathematics and science contexts. Participants will learn how to implement effective strategies for managing flexible groups, acquire ideas for providing students with a variety of options to successfully target mathematics and science standards and understand how to plan strategically in order to reach the needs of diverse learners within the classroom through inquiry-based learning.

ED 665 - DIFFNT ELEM LITERACY (R & W)  
Semester Hours: 3  
This course will focus on guiding the learner to apply the concepts of differentiated instruction to elementary literacy concepts. Advanced teacher candidates will develop and implement differentiated instructional plans that utilize individual and flexible grouping strategies and resources to support the growth of strategic, independent readers and writers.

ED 671 - TCHG ELEM LANGUAGE ARTS  
Semester Hours: 3  
Introduction to current practices in language arts instruction with emphasis on the development of an integrated curriculum using children’s literature as a foundation. Includes appropriate techniques for teaching of grammar, spelling, and handwriting. Intensive field experience required. Prerequisites: Admission to the Teacher Education Program.
ED 672 - TCHG ELEM SOCIAL STUDIES  
Semester Hours: 3  
Teaching social studies in grades K-6. Helping beginning teachers acquire background skills in organizing and teaching units of work. Intensive field experience required. Prerequisites: Admission to the Teacher Education Program.

ED 673 - TCHG NATURAL/HLTH SCIENCE  
Semester Hours: 3  
Integrates concepts from reflective practice with elementary science teaching. Opportunity to refine teaching skills in the planning, implementation, and evaluation of science lessons and units of instruction. Intensive field experience required. Prerequisites: Admission to the Teacher Education Program.

ED 674 - TCHG ELEM. MATHEMATICS  
Semester Hours: 3  
Overview of the mathematics concepts and skills taught in grades K-6 with an emphasis on the principles, methods, and materials used in the teaching and evaluation of elementary school mathematics. Focuses on the attitudes and behaviors of students and teachers in the actual planning and implementation of mathematics instruction for an elementary school classroom. Intensive field experience required. Prerequisites: admission to the teacher education program.

ED 690 - MASTER'S ACTION RESEARCH PROJ  
Semester Hours: 3  
The capstone course will serve as a mechanism to support the research, methodology, development, and experimental stages of the required action research. The student's work will be approved and supervised by a selected faculty advisor with direct connections to the research area. A symposium in which students present their research report will be culminating activity.

ED 691 - PORTFOLIO SEMINAR & SYMPOSIUM  
Semester Hour: 1  
The seminar will provide a forum in which the student's culminating portfolio is refined and submitted for faculty review. The seminar will also serve as a mechanism to support the final writing stages of the required action research project or case study report. The student's work will be approved and supervised by the faculty advisor(s). A symposium in which students present their research will be the culminating activity.

ED 693 - ELEMENTARY INTERNSHIP  
Semester Hours: 6  
Observation, participation and teaching in elementary school (full-time, 15 week semesters). Students will also attend campus-based seminars designed to meet specific needs of the interns.

ED 696 - P-12 INTERNSHIP  
Semester Hours: 3-6  
ED 698 - HIGH SCHOOL INTERNSHIP  
Semester Hours: 3-6  
Observation, participation, and teaching in middle/high school (full-time, 15 week semester). Students will also attend campus based seminars designed to meet specific needs of interns.

**Education Collaborative (EDC)**

EDC 625 - ASSISTIVE TECH EDUC INDV W/ASD  
Semester Hours: 3  
This course provides an overview of assistive technology devices and services that are used in the instruction of students with autism spectrum disorders (ASD) and other communication disabilities.

EDC 636 - INTRO STUD AUTISM SPECTR DISOR  
Semester Hours: 3  
This course will provide advanced teacher candidates with an introduction to working with students diagnosed with autism spectrum disorders. Candidates will develop an understanding of the range of characteristics and behaviors associated with ASD, the effectiveness of early intervention on behaviors, and the theories regarding the etiology of the disorder.
EDC 645 - ASMT & BEHAVIOR APPLC ASD  
Semester Hours: 3  
This course focuses on assessment and intervention planning for children with ASD. Candidates will enhance their knowledge of various assessments appropriate to the ASD population and develop skills to administer and interpret assessments. The course will provide candidates with an overview of the Applied Behavioral Analysis approach to assessing and teaching students with ASD.

EDC 655 - COLLAB & TRANSITION PLANNG  
Semester Hours: 3  
Using case-based instructional strategies, this course is designed to assist advanced teacher candidates in learning to build supportive relationships with families, paraprofessionals, and related service providers, including community agencies, as a foundation for designing differentiated learning experiences for students with disabilities.

EDC 660 - PRCTL APPLC VIS INSTR STRATEGY  
Semester Hours: 3  
Advanced candidates will participate in an extensive summer clinic for children with ASD. Candidates learn how to create an appropriate learning environment, organize schedules for individual students, develop materials, engage in instruction, respond to behavioral issues, and document student progress.

**Electrical Engineering (EE)**

EE 500 - RANDOM SIGNALS & NOISE  
Semester Hours: 3  

EE 501 - DIGITAL SIGNAL PROC ARCHITECTU  
Semester Hours: 3  
Introduction to digital signal processor architecture, applications, assembly language programming, and development tools for designing and implementing DSP systems.

EE 503 - COMMUNICA SYS & SIMULAT W/LAB  
Semester Hours: 3  
Modern test equipment and computer-based simulation methods are used to conduct experiments in the area of communication systems. Hands-on experiments are conducted using digital oscilloscopes, arbitrary waveform generators, vector impedance meters and other relevant test and measurement equipment. Methods are investigated for signal modulation and demodulation; studies are conducted on AM, FM, PSK, PCM and delta modulation circuits and systems. Several types of filters are investigated, both analytically and experimentally. Properties and behavior of phase-locked loop are studied by using both hardware and numerical simulations.

EE 504 - INTRO DATA COMMUNICA NETWORKS  
Semester Hours: 3  
Overview of historic development of modern telephone and data communication system, system architecture, standards, broadband switching systems, modems, protocols, personal and mobile communications, digital modulation techniques.

EE 505 - INTRO CONTROL/ROBOTIC SY  
Semester Hours: 3  
The basic theories and analytical techniques for modeling, analysis and control of dynamical systems. Transfer functions, block-diagrams, frequency response, stability criteria, series and feedback controller design, digital control. Introduction to the dynamic analysis and control of robotic systems.

EE 506 - COMMUNICATION THEORY  
Semester Hours: 3  

EE 510 - SELECTED TOPICS/ECE  
Semester Hours: 1-6

EE 510L - SELECTED TOPICS LABORATORY  
Semester Hours: 0
EE 514 - ANALOG AND DIGITAL
Semester Hours: 3
Analog filter design via Butterworth, Chebyshev, and elliptical approximation. Active filter design using operational amplifiers. Digital filter design methods.

EE 516 - DIGITAL ELECTRONICS
Semester Hours: 3

EE 519 - DIGITAL ELECTRONICS LAB
Semester Hour: 1

EE 527 - ELECTROMAGNETIC ENGINEERING
Semester Hours: 3
Review of Maxwell's equations, uniform plane waves in different types of media, reflection and transmission of uniform plane waves, transmission lines, microwave and fiber optic waveguides, antennas, wireless applications.

EE 532 - OPTICAL SYSTEMS DESIGN
Semester Hours: 3
Introduction to the geometrical design and analysis of optical systems, and to the design principles of lens systems.

EE 534 - OPTICAL FIBER COMMUNICATIONS
Semester Hours: 3
Introduction to optical fibers and their transmission characteristics, optical fiber measurements, sources and detectors, noise considerations for digital and analog communications, optical fiber systems. Prerequisite: EE 527.

EE 541 - OPTICS I
Semester Hours: 3

EE 542 - PHYSICAL OPTICS
Semester Hours: 3
Scalar and electromagnetic waves, polarization, coherence, reflection and refraction; two beam and multiple beam interference, interferometers, Fabry-Perots, thin films, diffraction, and absorption and dispersion.

EE 543 - OPTICAL COMM SYS & NETWORKS
Semester Hours: 3

EE 553 - LASER SYSTEMS
Semester Hours: 3
Spontaneous and stimulated emission, population inversion, optical resonators, three- and four-level systems, Q-switching and modelocking, semiconductor lasers, integrated optic waveguides and couplers, scanning systems, high power industrial applications. Includes a research project and oral presentation.

EE 570 - OPT & PHOTONIC SYSTEMS DESIGN
Semester Hours: 3

EE 586 - INTRO MODERN CONTROL SYSTEMS
Semester Hours: 3
EE 601 - LINEAR SYSTEMS  
Semester Hours: 3

Formulation and solution by transform methods of differential equations of linear electrical and electromechanical systems, state equations, signal-flow graphs, and discrete-time systems.

EE 603 - RANDOM SIGNALS IN COMMUNICATION  
Semester Hours: 3

Random processes applied to communication and control. Concepts covered include stationarity, correlation, power spectrum, Brownian motion, thermal noise, Markov processes, and queuing theory. Emphasis on systems with noisy excitation.

EE 604 - DIGITAL IMAGE PROCESSING  
Semester Hours: 3


EE 605 - CLASSICAL CONTROL DESIGN  
Semester Hours: 3

Design of feedback, feedforward, and minor-loop controllers/compensators using classical control engineering techniques and classical performance criteria. Frequency domain synthesis of lead, lag, lead-lag, etc. compensators; tuning of PD and PID controllers; error budgets; use of commercial CAD software for classical control design and performance evaluation; digital simulation techniques. CAD laboratory sessions.

EE 606 - STATISTICAL COMM THEORY  
Semester Hours: 3


EE 607 - ROBOTIC SYSTEMS CONTROL  
Semester Hours: 3

In-depth study of information, decision and control problems associated with robotic system design. Sensor systems, recognition and decision algorithms, kinematics and dynamics, trajectory planning, analog and digital controllers, adaptive and optimal control.

EE 609 - ELECTROMAGNETIC FIELD THEORY  
Semester Hours: 3


EE 610 - SELECTED TOPICS/ECE  
Semester Hours: 1-6

Graduate design project in support of an M.S.E. program.

EE 612 - GRADUATE DESIGN PROJECT  
Semester Hours: 3

Graduate design project in support of an M.S.E. program.

EE 613 - LASER ELECTRONICS  
Semester Hours: 3


EE 614 - DATA COMPRESSION  
Semester Hours: 3

Introduction to the fundamental theories and techniques of lossless and lossy data compression. Topics include Huffman codes, arithmetic codes, Golomb-Rice code, dictionary techniques, context-based compression, scalar quantization, vector quantization, transform coding, subband coding, wavelets, compression standards, and selected advanced topics of data compression.

EE 615 - ANALOG CIRCUIT DESIGN  
Semester Hours: 3

Use of operational amplifiers to synthesize special-purpose filters and circuits for analog signal processing and conditioning; linear and switching power supplies; high-frequency effects; circuits for transmitters and receivers; digital circuits from an analog viewpoint; A/D and D/A converters; selected topics.
EE 616 - MICROELECT DEV/INTE CIRC  
Semester Hours: 3


EE 617 - VLSI INTEGRATION DEVICES  
Semester Hours: 3

Operation and modeling of the MOS transistor. Second-order considerations for a MOSFET, VLSI device fundamentals and scaling laws. Micron-length and submicron-length semiconductor devices. Basic technology and applications of VLSI. Impact of VLSI on computer architecture. VLSI computer aided design.

EE 618 - VLSI CIRCUITS  
Semester Hours: 3


EE 619 - INTRO RADAR SYSTEMS  
Semester Hours: 3

Topics include radar equation, CW radar, MTI and pulse Doppler radar, tracking radar, major systems components, detection in the presence of noise and clutter, ambiguity, and resolution.

EE 620 - CMOS ANALOG CIRCUIT DESIGN  
Semester Hours: 3


EE 629 - ANAL & COMP METH IN ELEC ENG I  
Semester Hours: 3

Analytic and numerical solution techniques applicable to problems arising in engineering, utilizing complex variable theory, linear algebra, matrix theory, and transform methods.

EE 630 - ANAL & COMP METHODS ELEC EG II  
Semester Hours: 3

Analytical and numerical solution techniques applicable to problems arising in electrical engineering. Partial differential equations, vector differential and integral calculus, special functions, Fourier analysis with applications and integral equations.

EE 632 - FOURIER OPTICS  
Semester Hours: 3

Introducing the optical system as an invariant linear system, convolution, Sommerfeld's diffraction integral, Fourier Transform, angular spectrum, coherent and incoherent imaging, optical transfer function.

EE 633 - ELECTRO-OPTICAL ENGINEER  
Semester Hours: 3

Propagation of optical beams in homogeneous and guiding media, optical resonators, and spectrum analyzers, theory of laser oscillation, some specific laser systems, parametric oscillators, electro-optical and acousto-optical modulators.

EE 634 - OPTICAL COMMUNICATIONS  
Semester Hours: 3

Optical communication systems; counting statistics; the optical detector response process; direct detection; heterodyne detection parameter estimation in optical communications; pointing, spatial acquisition and tracking.

EE 642 - DATA & DIGITAL COMMUNICATION  
Semester Hours: 3

Introduction to digital and data communications; transmission channels; modulation and coding; telephone networks; data communication standards; noise and distortion; computer interfacing; protocols. Prerequisite: EE 603.
EE 648 - DIGITAL SIGNAL PROCESSING  
Semester Hours: 3  
Theory and applications of signal processing by digital techniques. Difference equations, Z-transform theory, digital-filter design, fast Fourier transform, quantization effects, and discrete estimation. Applications in digital filtering, signal processing, data analysis and smoothing, and image processing. 
Prerequisite: EE 528.

EE 654 - OPTICAL TESTING  
Semester Hours: 3

EE 670 - OPTOMECHANICAL DESIGN & MANUF  
Semester Hours: 3

EE 672 - DIGITAL PROC RANDOM SIGNALS I  
Semester Hours: 3  
Discrete signals, linear systems, spectral analysis and probability; and random discrete-time signals. Introduction to statistical interference, time-series analysis and spectral estimation of random discrete-time signals. Cross correlation and cross spectra, multitaper spectrum estimation and multivariable spectral analysis.

EE 673 - DIGITAL PROC RANDOM SIGNALS II  
Semester Hours: 3  
Parametric models for random signal processing; AR (autoregressive), MA (moving average), ARMA (autoregressive moving average), and Prony method. Two-dimensional spectral estimation; higher-order spectral analysis and multiresolution signal analysis.

EE 690 - UNIFORM GEOM THY DIFFRAC  
Semester Hours: 3  
Geometrical optics fields, geometrical optics reflected fields, two-dimensional wedge diffraction (GTD and UTD), three-dimensional wedge diffraction and corner diffraction, equivalent currents, diffraction at a smooth convex conducting surface, radar cross section.

EE 693 - ECE CAPSTONE  
Semester Hours: 1-3  
The purpose of this course is for students to perform research in a subject gained from courses taken at the graduate level. Students will be introduced to rhetorical theory, training in oral and written communication skills. They are required to organize and deliver oral and written technical presentations on individual research, journal articles, or design projects.

EE 696 - GRAD INTERN EE ENGR  
Semester Hours: 1-9  
Active involvement in an engineering project in an engineering enterprise, professional organization or government agency that has particular interest and relevance to the graduate student. Permission of EE faculty member is required.

EE 699 - MASTER'S THESIS  
Semester Hours: 1-9  
Required each semester student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of nine hours of credit is awarded upon successful completion of master's thesis. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.

EE 700 - SAMPLED DATA CONT SYS  
Semester Hours: 3  
Classical and modern methods for analysis and design of sampled data-control systems; Z-transforms, transport lags, z and w plane analysis, state variables, and the transition matrix.

EE 701 - ADV LINEAR CONTROL THRY  
Semester Hours: 3  
Modern techniques for analysis and design of linear control systems. Matrix formulation, multivariable control systems, state variable concepts. Linear transformation, controllability, observability, discrete-time systems. Prerequisite: EE 505.
EE 703 - MODERN CONTROL DESIGN  
Semester Hours: 3  
Use of modern (state-variable) control concepts and theories to design high-performance controllers for multi-input/multi-output set-point regulation and servo-tracking/pointing problems. Modeling of uncertain disturbances; design of disturbance-accommodating controllers; introduction to adaptive and stochastic control. Use of commercial CAD software for modern control design and performance evaluation. CAD laboratory sessions. Prerequisite: EE 701.

EE 704 - NONLINEAR CONTROL SYSTEM  
Semester Hours: 3  
Classical and modern methods for analysis and design of nonlinear automatic control systems. State variables, phase plane, limit cycles, stability, describing functions, relay control, stabilization theory. Prerequisite: EE 701.

EE 705 - THEORY OPTIMAL CONTROL  
Semester Hours: 3  

EE 706 - KALMAN FILT TECH CON & SIG PRO  
Semester Hours: 3  
Basic concepts of Kalman Filtering Theory with applications to: 1) analysis and design of control systems for dynamic processes with noisy sensors and random-type disturbance inputs, and 2) estimation, smoothing and prediction of information in noisy signals; Optimum Stochastic Control and the Separation Principle. Matrix Riccati Equation, Covariance Matrix, Orthogonal Projection Theorem. Prerequisite: EE 701.

EE 707 - INFORMATION THEORY  
Semester Hours: 3  
Self-information, entropy, mutual information, and channel capacity, encoding, error detecting and correcting codes. Sampling theorem. Discrete and continuous channels.

EE 709 - DISCR RANDOM SIG/SPEC ES  
Semester Hours: 3  
Review of linear systems theory, random discrete processes, classical spectral estimation, parametric models of discrete random processes, autoregressive (AR), moving average (MA), autoregressive moving average (ARMA) models.

EE 710 - SELECTED TOPICS/ECE  
Semester Hours: 1-6

EE 711 - ANTENNA THEORY  
Semester Hours: 3  
Antennas and antenna arrays. Radiation patterns and impedance characteristics. Spheres, cylinders, horns, slots, microwave lenses, traveling-wave, and frequency independent antennas.

EE 716 - DEVICE MOD INTEG CIR DSG  
Semester Hours: 3  

EE 717 - SPACE APPLI/ELECTROMAGNE  
Semester Hours: 3  
Plasma as a dielectric; dielectric functions for cold, warm, isotropic and anisotropic plasmas, body-plasma interaction; space craft electrodynamics, antennas in plasmas; mode of radiation, input impedance and radiation pattern, scattering problems involving plasmas.

EE 718 - MICROWAVE TECHNIQUES  
Semester Hours: 3  
EE 721 - ROBUST AND ADAPTIVE CONTROL  
Semester Hours: 3

Introduction to fundamental ideas of robust and adaptive control. Effects of parameter and disturbance uncertainties, H-infinity and mu-synthesis ideas; parameter estimation techniques; adaptive control algorithms; stability considerations; model-reference and linear adaptive control techniques.

EE 722 - SLIDING MODE CONTROL  
Semester Hours: 3

The basic and advanced theories and analytical techniques for modeling and analysis of systems dynamics in sliding manifolds. Traditional and High Order Sliding mode controller design. Discontinuous and equivalent control, robustness. Applications to control of electro-mechanical systems, reusable launch vehicle, air craft, spacecraft, and DC-to-DC power converters. Prerequisite: EE 701.

EE 724 - RADAR WAVEFORMS & SIGNAL PROCE  
Semester Hours: 3

Stretch Processing. Synthetic Aperture Radar and SAR signal processing, Space-time adaptive processing (STAP). Phase coded waveforms and processing. Frequency hop waveforms Prerequisite: EE 619.

EE 725 - ADVANCED RADAR TECHNIQUE  
Semester Hours: 3

Modern radar systems for search and tracking are analyzed with emphasis on signal processing. Modeling and simulation of system and environment. Advanced techniques include CFAR, binary modulation, frequency agility, polarization agility, and synthetic aperture. Prerequisite: EE 603 and EE 619.

EE 726 - DECIS/ESTIMATION THEORY  
Semester Hours: 3

Classical detection theory, including maximum likelihood, Neyman-Pearson, Bayes and minimax criteria. Estimation theory concepts and criteria, linear estimators, Kalman filters, maximum likelihood and least-squares estimator, matched filters, Cramer-Rao lower bound. Introduction to pattern recognition.

EE 727 - NUMER METH ELECTROMAGNET  
Semester Hours: 3


EE 733 - NONLINEAR OPTICS APPLICATIONS  
Semester Hours: 3

Modeling of optical nonlinearities; Kerr, thermal and photorefractive effects; nonlinearity-induced beam distortion; applications of nonlinearities in crystals and fibers; quantum well and SEED devices; soliton-based communication system; nonlinear optical switches, deflectors and limiters; measurements of nonlinearities.

EE 734 - FIBER OPTICS  
Semester Hours: 3

Propagation in dielectric slab and fibers with step and graded index of refraction; electromagnetic and ray optical methods; eikonal equations; ray trajectory; WKB method; paraxial approximation; weakly guiding structures.

EE 735 - STATISTICAL OPTICS  
Semester Hours: 3

Introduction to random variables and random processes; first-order properties of light waves; coherence of optical waves, partial coherence and imaging systems, imaging in randomly inhomogeneous media, fundamental limits in photoelectric detection of light.

EE 737 - CHAN CHAR COMM RAND MEDI  
Semester Hours: 3

Modeling stationary and not strictly stationary random media; scatter communications channels; line of sight communication channels ? weak scattering and strong scattering.

EE 738 - OPT TRANSF/PATTN RECOGN  
Semester Hours: 3

Systems and transforms in diffraction theory; two-dimensional Fourier transform; Hankel transforms; generalized Hankel transforms; optical signals, correlation coherence; filtering; apodization; applications to optical pattern recognition.
EE 742 - WIRELESS COMMUNICATIONS  
Semester Hours: 3  
Design and analysis of wireless transmission systems. Prerequisite: EE 642.

EE 744 - CODING THRY & SPREAD SPECTRUM  
Semester Hours: 3  
Linear block coding techniques, convolutional codes and the Viterbi decoding algorithm, probability of error bounds, channels with intersymbol interference and additive Gaussian noise. Introduction to spread spectrum direct sequence and frequency hopping methods.

EE 745 - MOD/PHASE LOCK TECH COMM  
Semester Hours: 3  

EE 747 - PATTERN RECOGNITION ALGORITHMS  
Semester Hours: 3

EE 748 - DIGITAL SIG PROC ALG/APP  
Semester Hours: 3  
Introduction to digital signal processors hardware architecture. Applications of digital signal processing in telecommunications, speech and image processing, radar and sonar. Development and implementation of DSP algorithms; DSP laboratory session.

EE 799 - DOCTORAL DISSERTATION  
Semester Hours: 3-9  
Required each semester student is enrolled and receiving direction on doctoral dissertation.

Engineering Management (EM)

EM 660 - ENGR MGMT THEORY  
Semester Hours: 3  
Comparison of classical management principles and theory with the current systems in high technology, research and development, and other scientific-engineering organizations. Use of people systems to accomplish goals in high technology organizations. Cases used to illustrate contemporary problems and environments.

EM 661 - STRATEGIC ENGR MGMT  
Semester Hours: 3  
Analysis of industries; generic, market share, vertical integration, and life-cycle strategies as applied to technology-based organizations. Relationship between buyers and suppliers. Environment and competitor analysis in a global marketplace.

EM 662 - FOUND QUALITY SYSTEMS MGMT  
Semester Hours: 3  
Basic understanding of Quality Systems such as TQM and ISO 9000 in context of fundamental building blocks of effective management; measurement, problem solving, continuous improvement, teamwork, customer focus, and supportive culture.

EM 664 - TEAMS IN ACTION  
Semester Hours: 3  
To give students practice in observational data collection in the area of group development and teamwork. This course provides background in group development theory and trains the student in techniques and tools used in observational data collection. The student learns practical research methods and gains an understanding in how theory can be applied to analyze team development. Prerequisites: ISE 660 and ISE 666.

EM 665 - FINANCIAL METHODS FOR ENGRS  
Semester Hours: 3  
Financial and managerial accounting for the engineering manager; accounting fundamentals, transaction recording, understanding financial statements, and management applications including costing, budgeting, performance evaluation and control, and ratio analysis.
EM 666 - ENGR PROJECT MANAGEMENT  
Semester Hours: 3  
Management and control of multifaceted engineering and technological projects. Coordination and interactions between client and various service organizations. Project manager selection. Typical problems associated with various phases of project life cycle. Case studies illustrate theories and concepts.

EM 667 - LABOR RELATIONS/ENGRS  
Semester Hours: 3  

EM 679 - SELECTED TOPICS IN ENGR MGMT  
Semester Hours: 3-9  

EM 697 - ENGR MANAGEMENT PROJECT I  
Semester Hours: 3-9  
Application-oriented student project designed to show competence in engineering management.

EM 698 - ENGR MANAGEMENT PROJECT II  
Semester Hours: 3-9  
Application-oriented student project designed to show competence in engineering management. Continuation of EM 697.

EM 699 - MASTER'S THESIS  
Semester Hours: 1-9  
Required each semester student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of 9 hours of credit is awarded upon successful completion of master's thesis. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.

EM 711 - RES METHODS IN SURVEY DEVELOPM  
Semester Hours: 3  
To immerse the student in research method appropriate at the PhD level. To investigate survey development and to understand requirements necessary in establishing a psychometrically sound survey instrument. To thoroughly understand the research process in collecting appropriate data, using statistical methodologies in analyzing data, and reporting significant findings.

EM 760 - ENGR MGMT STRUCTURES & SYSTEMS  
Semester Hours: 3  
The capstone course studies the impact of various organization structures in relation to the goals of high technology enterprises. Use and effectiveness of contemporary organizational systems as related to the knowledge worker. Cases used to illustrate contemporary problems and environments. Prerequisite: EM 660.

EM 761 - EVOL THRY ENG MGMT/IND SYS ENG  
Semester Hours: 3  
Development of applicable engineering management or industrial & systems engineering using classical concepts, contemporary studies, and practices at successful technology-based organizations.

EM 762 - PERFORM MEAS & PRODUC IMPROVMT  
Semester Hours: 3  
Productivity and performance defined and used to analyze current competitive position of important sectors of US industry with respect to national and international competition. Students will conduct research into current practices and develop a detailed performance measurement system for an organization. Dissemination of knowledge and student publications will be emphasized. Course should be taken late in the student's Program of Study. Instructor approval required. Prerequisite: EM 660.

EM 766 - MANAGING CHG IN HIGH TECH ORG  
Semester Hours: 3  
Challenges to implementing advanced technology equipment, systems, and methods in engineering organizations. Justifying technology, assimilating change, changing management roles, personnel practices and organizational structure, and dealing with impact of new technologies on business policies and strategic planning. Prerequisite: EM 666.
EM 767 - CONTEMPORARY APPL EM/ISE  
Semester Hours: 3  
Application of key qualitative and quantitative principles of engineering management or industrial & systems engineering to real-world case problems. Students work both as teams and as individuals to solve multidimensional problems which require an integrative point of view.

EM 779 - SELECTED TOPICS IN ENGR MGMT  
Semester Hours: 3-9

EM 799 - DOCTORAL DISSERTATION  
Semester Hours: 3-9  
Required each semester student is enrolled and receiving direction on doctoral dissertation.

**English (EH)**

EH 500 - COMPOSITION STUDIES TCHRS  
Semester Hours: 3  
Introduction to effective strategies for the teaching of writing. Students will report on their own writing pedagogy as a result of reading and analyzing a range of writing research related to strategies of assigning, responding, and assessing writing.

EH 501 - THRY & PRACTICE TECHNICAL COMM  
Semester Hours: 3  
Explores the relationships between common practices in technical communication and the theories that legitimize those practices. Introduction to research and theories about fundamental issues in technical communication which may then become the basis for further graduate study in technical communication.

EH 502 - PROBS TECHNICAL EDITING  
Semester Hours: 3  
Advanced study of research and practice in common problems of technical editing, including documentation standards, document design, and management of complex editorial projects. Involves collaborative project with major professional writers in industry.

EH 503 - LITERARY CRITICISM AND THEORY  
Semester Hours: 3  
Major texts and approaches from Plato to the present. All 500-level courses are crosslisted with 400-level courses.

EH 504 - LITERARY RESEARCH  
Semester Hours: 3  
Introduction to the method and practice of advanced literary studies with emphasis on the development of literary critical research skills, the building of a critical lexicon, and the application of theory and criticism.

EH 506 - FEMINISM & COMPOSITITION  
Semester Hours: 3  
Explores issues of gender in writing: postmodern feminism, feminist theories and research, gender and forms of writing, and finally, gender, teaching and identity. Students will investigate and analyze composition scholarship through reading, writing, and collaborative inquiry.

EH 508 - HISTORY OF THE ENGLISH LANG  
Semester Hours: 3  
History of the emergence and development of English from the pre-Anglo-Saxon period to the present. Emphasis on cultural contexts.

EH 510 - ADV FICTION WRITING  
Semester Hours: 3  
Practice in writing fiction from conception to revision. Students will read and write contemporary literary fiction. Student work will be commented on and critiqued in regular class workshops. The class culminates in a revision portfolio.

EH 511 - POETRY WRITING  
Semester Hours: 3  
Practice in writing poetry from conception to revision. Students will read and write contemporary poetry. Student work will be commented on and critiqued in regular class workshops. The class culminates in a revision portfolio.
EH 512 - SP STUDIES IN CREATIVE WRITING
Semester Hours: 3
Topics in creative writing, professional writing, or other advanced writing announced in advance.

EH 513 - CHILDREN'S & ADOLESCENT LIT
Semester Hours: 3
Course content will include the study of various genres of children’s and adolescent literature and their relationship to beginning reading, enhancement of reading comprehension, and intervention instruction in the various content areas. Same as ED 513. Limited to students seeking teacher certification.

EH 514 - CREATIVE NONFICTION WRITING
Semester Hours: 3
This composition class introduces students to the genre of creative non-fiction through exploring various approaches to the non-fiction writing; developing expertise in writing strategies such as revising, peer responding, prose modeling, and conferencing; and developing expertise in rhetorical writing concepts.

EH 515 - STUD ANGLOPHONE/POSTCOLONI LIT
Semester Hours: 3
An introduction to major concepts, figures, and works with emphasis upon historical and cultural context. Specific focus will vary.

EH 522 - STUDIES IN THE NOVEL
Semester Hours: 3
Focuses on varying topics in the novel with special attention to form. Texts may be drawn from diverse national and cultural origins.

EH 523 - STUDIES CONTEMPORARY BRIT LIT
Semester Hours: 3
Major works after 1945 with emphasis on historical and cultural contexts. Specific focus will vary.

EH 524 - POETRY AND POETICS
Semester Hours: 3
An attempt to answer (at least provisionally) the questions “What is a poem?” and “What is poetry?”. How to read a poem closely and carefully, with attention to theory, history of genres, and especially the technical aspects of poetry.

EH 525 - LITERATURE, SCIENCE, & TECH
Semester Hours: 3
Considers the relationships among literature, scientific theories, and technological practices through a study of texts from ancient times to the present.

EH 529 - STUDIES IN AMERICAN CINEMA
Semester Hours: 3
Focuses on select topics in American cinema with an emphasis on film history, technique, aesthetics, and cultural context.

EH 530 - SPEC STUDIES IN AM LIT
Semester Hours: 3
Topics announced in advance.

EH 533 - WILLIAM FAULKNER
Semester Hours: 3
Critical study of the major novels.

EH 534 - SCIENCE FICTION
Semester Hours: 3
Selected short stories and novels, exploring the thematic and narrative concerns of both classic and contemporary science fiction. In alternate years, the course may focus on a specific problem or concern in science fiction.

EH 535 - SPECIAL STUDIES IN AMER LIT
Semester Hours: 3
Topics announced in advance.
EH 536 - READING THE EARLY REPUBLIC  
Semester Hours: 3  
This class will investigate cultural expression and literary critical traditions associated with the founding period of the American nation (1776-1828). Writers might include Franklin, Jefferson, Equiano, Sargent, Rowson, Brockden Brown, and Irving.

EH 538 - AFRICAN AMERICAN LITERATURE  
Semester Hours: 3  
Themes, concepts and imagery in the Black American literary tradition.

EH 540 - SPEC STUDIES IN ENGLISH LIT  
Semester Hours: 1-3  
Topics announced in advance.

EH 541 - THE CIVIL WAR  
Semester Hours: 3  
Cultural representations of the Civil War (1861-5) past and present in diaries, poetry, photography, novels, oratory, history writing, and film.

EH 542 - USABILITY STUDIES  
Semester Hours: 3  
Introduces students to the theory and practices of usability, which involves designing useful, easy-to-use websites, software, and products. The course involves group projects conducting real-world usability testing.

EH 548 - THE BIBLE AS LITERATURE  
Semester Hours: 3  
An introduction to the major literary forms of the Bible. Material will be approached analytically, involving both socio-historical and literary-critical perspectives.

EH 550 - CHAUCER  
Semester Hours: 3  
A study of Geoffrey Chaucer's Middle English works including the early dream visions, Troilus and Criseyde, and the Canterbury Tales.

EH 551 - ARTHURIAN ROMANCE  
Semester Hours: 3  
A study of Arthurian Literature focused on medieval Welsh, Scottish, English, and French poetry and prose, as well as later early modern and modern adaptations of Arthurian stories in poetry, prose, drama, and film.

EH 552 - USER-CENTERED DESIGN  
Semester Hours: 3  
Introduces students to user-centered design principles that inform the practice of user experience design. Students will use visual thinking as they complete contextual inquiries and mapping exercises.

EH 554 - NEW MEDIA WRITING & RHETORIC  
Semester Hours: 3  
This course teaches students to consider and implement rhetorical principles across a variety of media and includes an examination of communication strategies used widely in academic and industry settings. The course focuses on new media through an exploration of digital technologies and the way digital culture and new media have dramatically impacted reading, writing and research practices.

EH 565 - DRAMATIC LITERATURE  
Semester Hours: 3  
Studies in Drama and interpretive strategies for reading plays. May be organized nationally, by genre, or by theme/topic.

EH 570 - MILTON  
Semester Hours: 3  
A study of the development of Miltons thought and art as it appears in his early poems, selected prose, and later poetry, with particular attention given to Paradise Lost.

EH 571 - RENAISSANCE DRAMA  
Semester Hours: 3  
Non-Shakespearean drama of the sixteenth and early-seventeenth centuries in social, critical, and performative contexts. Specific focus will vary from term to term.
EH 573 - EARLY MODERN LITERATURE
Semester Hours: 3

This course will examine a particular theme, issue, and/or debate within the early modern period, roughly 1500-1700. The historical and geographical scope of the course will vary depending on the term, though the course will emphasize British literature. Within this literature, constructions of subjectivity and community vary greatly due to the influence of the European Renaissance, the Protestant Reformation, the exploration of the New World, as well as the rediscovery of the natural world through scientific investigation. While the course will introduce the complexities of early modern literary constructions of identity, the course will also illumine the ways in which these habits of thought were increasingly contested, sometimes to the point of violence. The course will likely include period-specific as well as modern scholarship.

EH 585 - THE ENLIGHTENMENT
Semester Hours: 3

The European Enlightenment was an intellectual and cultural movement in the seventeenth and eighteenth centuries that emphasized the importance of reasoned, open-eyed investigations into nature and human society. Stimulated by the Scientific Revolution, Enlightenment philosophes prized skepticism and decried superstition and unquestioned faith. They are often credited with providing a theoretical basis for the American and French Revolutions. Scholars have also counted among the Enlightenment's important legacies the scientific method, the valuation of universal human rights, and the emergence of such disciplines as economics and anthropology. Authors discussed in the course may include: Bacon, Behn, Hume, Swift, Voltaire, Montagu, Franklin, Jefferson, Equiano, and Wollstonecraft.

EH 596 - ROMANTIC LITERATURE
Semester Hours: 3

Poetry and prose, 1780-1832, with a focus on English language traditions. Emphasis may vary with instructor.

EH 601 - ACTION RESCH WRITING STUDIES
Semester Hours: 3

Analysis of research on writing in the workplace, the community, and educational settings.

EH 602 - PRACTICUM/TECHNICAL COMM
Semester Hours: 3

Designed to give technical communication graduate students on-the-job experience in industry or government, either through an internship or a major research project connected with an industry problem. Requires completion of a substantial research report. Prerequisites: EH 501 and EH 502.

EH 603 - EDITING FOR PUBLICATION
Semester Hours: 3

A comprehensive survey of best practices for editing documents for clarity, correctness, accuracy, style, design, and usability. Course involves working with writers to edit work for publication.

EH 615 - SEMINAR IN CRITICAL THEORY
Semester Hours: 3

Intensive study of a specific author or topic in literary or critical theory. Focus will vary.

EH 618 - STUDIES/WOMEN & LITERATURE
Semester Hours: 3

Selected authors, genres, and issues.

EH 629 - STUDIES IN 20TH CENT LIT
Semester Hours: 3

Selected poetry and prose with an emphasis on the Anglo-American Modernist tradition.

EH 630 - STUDIES AM LIT TO 1865
Semester Hours: 3

Major movements from Colonial times to 1865; selected major figures or special problems.

EH 631 - STUDY AM LIT SINCE 1865
Semester Hours: 3

Major movements since 1865; selected major figures or special problems.

EH 639 - ETHNIC AMERICAN LITERATURE
Semester Hours: 3

Selected authors, concepts, histories, and cultures.
EH 649 - SPECIAL STUDIES
Semester Hours: 1-3
Study of significant issues in literature, technical communication, or composition studies, announced in advance.

EH 655 - STUDIES IN MEDIEVAL LITERATURE
Semester Hours: 3
Topics in Medieval European and Eastern Literature.

EH 660 - SHAKESPEARE
Semester Hours: 3
Selected Shakespearean plays, with special attention to the major criticism, problems of interpretation, and current issues in Shakespearean study.

EH 662 - INFORMATION ARCHITECTURE
Semester Hours: 3
This class reviews research in technical communication, information science, cognitive science, semiotics, and computer science that helps students understand how communities represent, organize, retrieve, and ultimately use information.

EH 665 - RENAISSANCE LITERATURE
Semester Hours: 3
An in depth study of a major theme, debate or question in 16th and early 17th century literature. Includes Renaissance criticism and modern scholarship.

EH 670 - STUDIES SEVENTEENTH CENTURY LT
Semester Hours: 3
This course investigates one of the most volatile periods in Britain's history through a variety of literary and critical lenses, all geared toward a particular theme, issue, or debate. In this period, received bodies of knowledge and accompanying forms of authority - philosophical, religious, political and scientific - were increasingly called into question.

EH 680 - 18TH CENTURY STUDIES
Semester Hours: 3
Extensive and intensive study of various early modern texts, with attention to interdisciplinary contexts.

EH 695 - STUDIES IN 19TH CENTURY LIT
Semester Hours: 3
This class will investigate Anglophone cultural expression and literary critical traditions associated with long nineteenth century (1789-1919). Specific thematic concern or period of focus is left to the discretion of the instructor.

EH 698 - INDEPENDENT STUDY
Semester Hours: 3
Individual investigation into significant issues in linguistics, literature, technical communication, or composition studies under direct supervision of instructor. Prerequisites: Written approval by the instructor and the department chair of a project prospectus.

EH 699 - MASTER'S THESIS
Semester Hours: 3-6
Required each semester during which a student is working and receiving direction on a masters thesis. No more than 6 hours credit may be applied toward the degree. Prerequisites: approval of instructor.

English Linguistics (EHL)

EHL 505 - SURVEY OF GENERAL LINGUISTICS
Semester Hours: 3
Come to see the strange in familiar as you engage in the study of the system of language through focused analysis of the components of English. Language is usually the lens through which we observe and report on the world. In this course, it becomes the object of observations and discussion.

EHL 506 - CRITICAL ISSUES
Semester Hours: 3
Come to an understanding of the complex of policies, legislation, and practice that impact the progress of English Learners in elementary and secondary schools across the U.S. Understand the impact of federal, state, and local policies on classroom settings and teacher-student interactions.
EHL 507 - ADV ENGLISH GRAMMAR STUDIES
Semester Hours: 3

Through an in-depth analysis of the structure of sentences and discourse in contemporary English, you will understand more clearly the impact of the choices we make in the language we use in day-to-day conversations, instructional settings, political discourse, and beyond.

EHL 509 - SP STUDIES IN APPL LINGUISTICS
Semester Hours: 3

Special topics in linguistics. Focus and emphasis of topics announced in advance. Prerequisite: instructor permission.

EHL 610 - AP EH LI VI: PRACTICUM TESOL
Semester Hours: 3

Current issues, techniques, and materials in teaching English to speakers of other languages (TESOL). Direct and supervised teaching of English to non-native speakers of English.

**Finance (FIN)**

FIN 500 - INVESTMENT PRACTICUM
Semester Hours: 4

Small number of students work closely with finance faculty in the UAH Capital Management group (CMG) to manage actual investment portfolios. Emphasis is placed on individual stock selection and management of the portfolio to meet objectives. Prerequisite: FIN 560 and permission of instructor.

FIN 531 - ADVANCED CORPORATE FINANCE
Semester Hours: 3

The purpose of the course is to apply advanced corporate finance theories to solve practical corporate finance problems.

FIN 554 - INTERNATIONAL FINANCE
Semester Hours: 3

An introduction to international finance for tomorrow's global business leaders, with a focus on the financial management dimensions of leading a multinational enterprise.

FIN 560 - INVESTMENTS
Semester Hours: 3

A study of standard investment securities, as well as an overall view of the investment decision process. Securities covered include equities, fixed income, options, futures, and mutual funds. Associated topics include financial markets, valuation models, and fundamental portfolio theory.

FIN 561 - PORTFOLIO MANAGEMENT
Semester Hours: 3

A continuation of FIN 560 with an emphasis on the application of investment portfolio management. An understanding of the functional areas of portfolio management is stressed, including investment policy, investment strategy, portfolio construction, performance evaluation, and portfolio protection. Prerequisite: FIN 560.

FIN 595 - INTERNSHIP IN FINANCE
Semester Hours: 1-3

With the supervision of a faculty advisor the student serves as an intern in a position that enhances their discipline's educational goals. Subject to College's guidelines on internships.

FIN 601 - FIN DECIS UNDER UNCERTAINTY
Semester Hours: 3

Introduces students to financial decision-making in uncertain domestic and global markets and provides a set of tools and techniques for use in financial analysis. Topics include financial statement analysis, financial assessment of capital investments, cost of capital, and risk and return. Prerequisites: ACC 600 and ECN 600.

FIN 620 - SEMINAR IN BEHAVIORAL FINANCE
Semester Hours: 3

A study of the issues and anomalies related to the psychology of financial decision-making and the psychology of financial markets. The course content will consist of readings from the behavioral finance literature with an emphasis on student discussion.
FIN 650 - SELECTED RESEARCH TOPICS
Semester Hours: 3

Research in a particular topic in finance relevant to administrative science by once student or group of students. The research paper must be an original contribution showing a research design and results that meet the highest standards of social science research.

History (HY)

HY 501 - DAILY LIFE IN ANCIENT ROME
Semester Hours: 3

This course will re-create the daily lives of the ancient Romans using secondary readings, ancient literature, archaeology, and film. It focuses on the lives of ordinary people, with an eye to their struggles, everyday practices, beliefs, values and mentalities.

HY 510 - SPECIAL TOPICS PUBLIC HISTORY
Semester Hours: 3

Intensive examination of a particular problem, aspect, or methodology in public history.

HY 513 - THE OLD SOUTH
Semester Hours: 3

Southern society, economics, politics and culture concentrating on the nineteenth century South through Reconstruction.

HY 514 - THE NEW SOUTH
Semester Hours: 3

The post-Reconstruction South emphasizing the economic, social, and political readjustments made during the twentieth century.

HY 524 - THE ATLANTIC WORLD
Semester Hours: 3

Examines interactions across the Atlantic Ocean among Africans, Americans, and Europeans. This course meets the requirements for either American or non-American credit.

HY 526 - COLONIAL AMERICA
Semester Hours: 3

Explores the founding of New World colonies, including political, social, economic, and religious developments during the colonial period.

HY 527 - AGE OF AMERICAN REVOLUTI
Semester Hours: 3

Explores the multinational connections and conflicts that led some English colonists to revolt. Considers the political, social, and economic aspect of the time period.

HY 528 - EARLY AMERICAN REPUBLIC
Semester Hours: 3

Political, social and economic changes between the American Revolution and the nineteenth century that laid the foundation for the United States.

HY 529 - CIVIL WAR & RECONSTRUCTION
Semester Hours: 3

This course will examine the major historical events and modern historiographical interpretations of the Civil War and Reconstruction period in American history. Special focus will be given to the following themes: social, economic, military, political, constitutional, and intellectual.

HY 537 - THE RISE OF MODERN AMER
Semester Hours: 3

Economic and social changes, imperialism, and the growth of government in the United States from 1877 to the 1920s.

HY 538 - MODERN AMERICA
Semester Hours: 3

American society, politics, economics, and foreign affairs from the end of World War I to the origins of the Cold War.

HY 539 - RECENT AMERICAN HISTORY
Semester Hours: 3

Contemporary America from the 1950s to the present analyzing both domestic and foreign affairs.
HY 540 - FOREIGN REL U.S. SINCE 1920  
Semester Hours: 3  
The United States as a world power. American involvement in World War II, the Cold War, and in Asia, Latin America, and the Middle East.

HY 545 - COMPTVE MILITARY PLCY & STRAT  
Semester Hours: 3  
A comparative analysis of the military policy and strategy of states and empires in World History.

HY 572 - US MILITARY HISTORY SINCE 1920  
Semester Hours: 3  
The United States armed forces from 1920 to the present. The class will enhance understanding of the development and evolution of American strategy, doctrine, and operational issues.

HY 573 - US-LATIN AMERICAN RELATIONS  
Semester Hours: 3  
This class focuses on the history of political, economic, and cultural interactions between Latin America and the United States from 1800 to the present. Topics include military intervention, trade, cultural exchanges, the Cold War, the drug war, and immigration.

HY 574 - RENAISSANCE & REFORMATION  
Semester Hours: 3  
Selected topics in the Italian Renaissance and European Reformation.

HY 575 - SECTARIANISM ISLAMIC WORLD  
Semester Hours: 3  
This course focuses on sectarianism, the practice and rhetoric surrounding marginalization of certain social-religious groups in the Islamic world. It explores the historical foundations of sectarianism (from early 7th century to today) both within the Islamic world and across the globe.

HY 576 - BEING YOUNG MODERN MIDDLE EAST  
Semester Hours: 3  
This course focuses on the lives of young men and women of the Modern Middle East. It explores how children and youth experienced historical phenomena in the region, the ways in which these experiences affected the foundations of their adulthood, and how their actions shaped historical events.

HY 580 - ROMANS&BARBARIANS LATE ANTIQTY  
Semester Hours: 3  
This course explores the dynamic world of Late Antiquity including political developments, social and religious transformation, and exchange patterns in the Mediterranean. It is a history of cultural interaction, continuity, and change during a formative period in western civilization.

HY 581 - EMPIRES AND NATIONS  
Semester Hours: 3  

HY 582 - COMPARTVE SLAVERY & ABOLITION  
Semester Hours: 3  
Explore slavery around the world over time. Topics in the ancient world, Indian Ocean, Africa, the United States, and other locations from ancient times to the present.

HY 583 - WOMEN & GENDER LATIN AMERICA  
Semester Hours: 3  
Studies the history of women and gender relations in Latin America from the colonial period to the present.

HY 584 - LATIN AMERICAN HY THROUGH FILM  
Semester Hours: 3  

HY 585 - NAZI GERMANY AND THE HOLOCAUST  
Semester Hours: 3  
Seminar course on the historiography of Nazi Germany and the Holocaust.

HY 586 - COMMUNISM &LEGACY IN RUS/E-EUR  
Semester Hours: 3  
Overview and analysis of communist states and post-communist legacies in Russia and Eastern Europe.
HY 590 - RESEARCH SEMINAR IN HY  
Semester Hours: 3

Research and writing, focusing on primary sources and historiography.

HY 592 - PUBLIC MEMORY & INTERP  
Semester Hours: 3

Examines how public memory is created by looking at the social, political, and economic forces that shape public history and considers how historical knowledge is conveyed to the public.

HY 593 - FUNDAMENTALS OF ARCHIVES  
Semester Hours: 3

Survey of basic archival theory and practice, with emphasis on the role of the archivist in contemporary society.

HY 594 - DEVELOPING DIGITAL ARCHIVES  
Semester Hours: 3

Survey of the theory and practice of developing digital access tools in archives, libraries, and museums.

HY 595 - PUBLIC HISTORY INTERNSHIP  
Semester Hours: 3

Students will participate in a semester-long public history internship and be responsible for completing a significant project using historical skills in a professional setting. Students must complete a minimum of 125 hours of work during their internship.

HY 598 - STUDIES IN HISTORY  
Semester Hours: 1-3

A readings or research class on a particular problem, period or topic in history. This course may be repeated for credit.

HY 599 - INDEPENDENT STUDY  
Semester Hours: 3

In exceptional circumstances, a student and professor may work together on a specialized topic.

HY 605 - RECENT INTERPRETATIONS MOD HY  
Semester Hours: 3

Development of the ability to appraise critical historical issues through study and discussion of recent interpretations of key historical problems in modern western history. Required for history graduate students. Fall only.

HY 614 - STUDIES IN SOUTHERN HY  
Semester Hours: 3

Research, writing, and critical examination of selected topics in nineteenth- and twentieth-century southern history.

HY 618 - STUDIES EARLY AMER HY  
Semester Hours: 3

Research, writing, and critical examination of selected topics in early American history from 1607-1800.

HY 619 - STUDIES 19TH CENT AM HY  
Semester Hours: 3

Research, writing, and critical examination of selected topics in nineteenth-century American history.

HY 620 - STUDIES 20TH CENT AM HY  
Semester Hours: 3

Research, writing, and critical examination of selected topics in twentieth-century American history.

HY 645 - READINGS AMERICAN MILITARY HY  
Semester Hours: 3

Thematic course that will use readings and discussions to examine key historiographical issues in American military history from the colonial period to the present.

HY 650 - RESEARCH METHODS IN HY  
Semester Hours: 3

Exploration of contemporary research methods such as archival research, paleography, quantitative methods, and state/local research techniques.
HY 680 - STUDIES/EARLY MOD EUROPE  
Semester Hours: 3  
Research, writing, and critical examination of selected topics in the field of early modern European history.

HY 685 - HISTORY OF SCIENCE  
Semester Hours: 3  
Research, writing and critical examination of selected topics in the history of science.

HY 687 - STUDIES MIDDLE EAST HISTORY  
Semester Hours: 3  
Research, writing, and critical examination of selected topics in modern Middle East history (late 1800s-present).

HY 690 - STUDIES IN MODERN EUROPE  
Semester Hours: 3  
Research, writing, and critical examination of selected topics in the field of modern European history.

HY 695 - STUDIES IN WORLD HISTORY  
Semester Hours: 3  
Research, writing and critical examination of selected topics in the study and teaching of world history.

HY 696 - SPECIAL TOPICS IN HISTORY  
Semester Hours: 3  
A readings or research class on a particular problem, period, region or topic in history. This course may be repeated for credit.

HY 698 - NON-THESIS RESEARCH  
Semester Hours: 3  
Individual research not related to thesis work.

HY 699 - MASTER'S THESIS  
Semester Hours: 1-3  
Required each semester a student is working and receiving direction on a master's thesis. A minimum of two terms is required but no more than six hours credit is allowed for the thesis.

Industrial & Systems Engineering (ISE)

ISE 502 - INDUSTRIAL & ORGANIZA PSY  
Semester Hours: 3  
Application of basic principles of learning, motivation, and perception to typical industrial and organizational problems.

ISE 503 - HUMAN FACTORS PSYCHOLOGY  
Semester Hours: 3  

ISE 523 - INTR STATISTICAL QUALITY CONTR  
Semester Hours: 3  
This course introduces statistical theory and techniques to control quality of manufacturing products. This course will provide a solid foundation in Statistical Quality Control (SQC). The Six Sigma methodology is also introduced in this course. Students can take the certification exam to earn a Green Belt in Six Sigma.

ISE 526 - DESIGN/ANALY OF EXPERIMENT  
Semester Hours: 3  
Advanced topics in statistical experiments with emphasis on design aspect. Confounding, fractional replication, factorial and nested design.

ISE 530 - MANUF SYS & FACILITIES DESIGN  
Semester Hours: 3  
Overview of modern manufacturing systems design with emphasis on facility location and plant layout. Includes classical systems, just-in-time systems, basic principles of integrated manufacturing systems design, as well as analysis of process flow, process productivity, and available space to determine plant layout. Includes laboratory exercises.
ISE 533 - PRODUCTION/INVENTORY CONTR SYS
Semester Hours: 3
Inventory models including classical optimal economic order quantity models, manufacturing resource planning (MRP) systems, master production scheduling, material requirements planning, and purchase order control. Emphasis on manufacturing system revision, continuous process improvement, and the implementation of lean principles.

ISE 537 - ELECTRONICS MANUF PROCESSES
Semester Hours: 3
Current concepts, facilities, and technology utilized in the manufacture of electronic components and products. Includes printed wiring board fabrication and component mounting methods, automation, quality and reliability, product testing, and economic issues.

ISE 539 - SELECTED TOPICS/ISE
Semester Hours: 1-3

ISE 547 - INTRO TO SYSTEMS SIMULATION
Semester Hours: 3
Philosophy and elements of digital discrete-event simulation. Emphasis on modeling and analysis of stochastic systems, including probabilistic models, output analysis, and use of simulation software.

ISE 623 - ENGR ECON ANALYSIS
Semester Hours: 3
This course is designed for graduate students in industrial engineering, systems engineering and engineering management. This course involves mathematical models for expenditure analysis under uncertainty; investment decision criteria; capital planning and budgeting; and decisions involving expansion, acquisitions, replacement, and disinvestment.

ISE 624 - HUMAN FACTORS IN SYS DESIGN
Semester Hours: 3
Psychological, physiological, and anthropometric requirements for human beings and the integration of these requirements into the design of tools, machines, and systems.

ISE 626 - INTRO OPERATIONS RESEARCH
Semester Hours: 3
Philosophy and methodology of operations research. Includes linear programming, game theory, sequencing, and networks.

ISE 627 - ENGINEERING SYSTEMS
Semester Hours: 3
Development of a systems-scientific framework for the integration of systems theory, systems thinking, systems engineering, and systems management. Emphasis is on the conception, design, and management of systems to accommodate complex environments.

ISE 630 - COMPUTER INTEGRATED MANUFACT
Semester Hours: 3
In-depth analysis of integrated manufacturing/computer integrated manufacturing. Reviews the tools, concepts, and enabling technologies necessary to integrate the physical, information, and managerial aspects of a manufacturing enterprise.

ISE 635 - LINEAR PROGRAMMING
Semester Hours: 3
Application of linear programming to complex allocation problems. Methods for determining maximum or minimum of objective functions whose variables are subject to constraints. Simplex methods, degeneracy, modified simplex, transportation problems, flows, goal programming, and sensitivity analysis.

ISE 637 - SYSTEMS MODELING & ANALYSIS
Semester Hours: 3
System analysis and modeling of large complex systems using systems engineering fundamentals. Life cycle simulations developed as a focus for the multidisciplinary analysis integration using computational systems engineering techniques including probability, statistics, design of experiments, response surfaces, and optimization. State of the art software tools will be used for simulation development.

ISE 638 - ENGINEERING RELIABILITY
Semester Hours: 3
Methodology of reliability prediction including application of discrete and continuous distribution models. Reliability estimation, reliability logic diagrams, life testing, and reliability demonstrations.
ISE 639 - SELECTED TOPICS/ISE  
Semester Hours: 1-6  

ISE 641 - ADVANCED QUALITY CONTROL  
Semester Hours: 3  
This capstone course uses advanced statistical quality tools such as autocorrelated data, multi-variate quality controls charts, response surface methodology, ridge analysis, and evolutionary operations (EVOP). Advanced Six Sigma concepts will be taught and students will have the opportunity to earn a Black Belt in Six Sigma upon successful completion of the certification exam and an acceptable project.  

ISE 647 - ADVANCED SYSTEM SIMULATION  
Semester Hours: 3  
Methods and procedures for simulation of large and complex systems. Discrete increment, continuous time and combined models. Comparison of discrete-event simulation languages. Model verification and validation. Statistical inference. Input data collection and analysis, output analysis, and comparison of alternatives.  

ISE 670 - INTEGRATED PRODUCT & PROC DES  
Semester Hours: 3  
This capstone course incorporates curriculum materials to support an integrated products and process design process. Particular attention is devoted to multifunctional teams and their value in promoting the concept of life-cycle engineering. Provides experience with tools and technologies that support the IPPD philosophy.  

ISE 690 - STATISTICAL METHODS FOR ENGR  
Semester Hours: 3  
Application of statistics for estimation and inference using parametric and nonparametric methods. Descriptive statistics, sampling distributions, point and interval estimates, tests of hypotheses, ANOVA, and linear regression.  

ISE 696 - GRAD INTERN ISE ENGR  
Semester Hours: 1-9  
Active involvement in an engineering project in an engineering enterprise, professional organization, or government agency that has particular interest and relevance to the graduate student. Permission of ISE faculty member required.  

ISE 697 - INDUS & SYSTEMS ENGR PROJECT I  
Semester Hours: 3-9  
Application oriented student project designed to show competence in Industrial and Systems Engineering.  

ISE 698 - IND & SYSTEMS ENGR PROJECT II  
Semester Hours: 3-9  
Required each semester student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of 9 hours of credit is awarded upon successful completion of master's thesis.  

ISE 699 - MASTER'S THESIS  
Semester Hours: 1-9  
Required each semester student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of 9 hours of credit is awarded upon successful completion of master's thesis. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.  

ISE 726 - SYSTEMS MODELING  
Semester Hours: 3  
The capstone course for the operations research option studies the philosophy and methodology for modeling probabilistic systems. Includes Markov processes, queueing theory, and inventory theory. Team project required.  

ISE 728 - OPTIMIZA METH OPER RES  
Semester Hours: 3  
Classical optimization theory with introduction to search techniques, the Jacobian, and Lagrangian methods. Kuhn-Tucker conditions, quadratic programming, geometric and dynamic programming, and several search procedures.
ISE 729 - ADV NONLINEAR PROGRAM
Semester Hours: 3
Continuation of ISE 728 with emphasis on development and application of nonlinear programming algorithms. SUMT algorithm, Zoutendijk's method of feasible directions, Rosen's gradient method, and selected algorithms from current literature.

ISE 730 - MULTI-CRITERIA DEC ANALY
Semester Hours: 3
Methods for analysis of management-decision problems involving multiple goals and constraints. Linear and nonlinear goal programming; risk programming and decision making in fuzzy environments.

ISE 732 - INDUST FORECASTING/ANALY
Semester Hours: 3
Industrial forecasting methods. Simple forecasting models, multivariate regression, correlation, and spectral analysis, exponential smoothing, and Box-Jenkins forecasting.

ISE 734 - DECISION ANALYSIS
Semester Hours: 3
Decision making for systems engineering and engineering management, with an emphasis on applications to complex systems. Builds a rigorous foundation in decision making under uncertainty using expected utility theory. Topics include decision trees, value models, predictive models, preferences and bias.

ISE 735 - DISCRETE OPTIMIZATION
Semester Hours: 3
Integer programming and network analysis. Zero-one problem formulation and Balas method, cutting plane techniques, branch and bound, out-of-kilter algorithm, and special applications of integer programming.

ISE 738 - RELIAB/AVAILAB/MAINTAINA
Semester Hours: 3
In-depth application of decision theory and MIL-HDBK-217, and maintenance engineering techniques in order to achieve targeted reliability, availability and maintainability design goals.

ISE 739 - SELECTED TOPICS/ISE
Semester Hours: 1-6

ISE 741 - QUALITY ENGINEERING
Semester Hours: 3
Application of quality engineering techniques to the design and improvement of products and processes. Topics include: multivariate analysis, Taguchi methods, mixture experiments, and response surface analysis.

ISE 761 - EVOL THRY ENG MGMT/IND SYS ENG
Semester Hours: 3
Development of applicable engineering management or industrial and systems engineering theory using classical concepts, contemporary studies and practices at successful technology-based organizations.

ISE 767 - CONTEMPORARY APPL EM/ISE
Semester Hours: 3
Application of key qualitative and quantitative principles of engineering management or industrial and systems engineering to real-world case problems. Students work both in teams and as individuals to solve multidimensional problems which require an integrative point of view.

ISE 790 - ADV STATISTICAL APPLICATIONS
Semester Hours: 3
Continuation of ISE 690 with extension to regression models and nonparametric methods.

ISE 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9
Required each semester student is enrolled and receiving direction on doctoral dissertation.

Information Systems (IS)
IS 501 - INTRO TO INFORM SYS ASSURANCE  
Semester Hours: 3

This course is designed to provide a general overview of the concepts of information security to students, both from a management and a technology perspective. Students will be introduced to the complexity of the security issues facing today's networked organizations. Practices and standards will be presented to assess and plan for risks and the security needs to minimize the risks both technically and managerially. The integration of security concerns within the entire organizational planning and implementation processes and practices will be explored.

IS 512 - MODERN SYSTM ANALYSIS & DESIGN  
Semester Hours: 3

Identifying, analyzing, developing and acquiring information systems are central to the information systems discipline. The course has to do with identifying, conceptualizing and analyzing business opportunities where information systems applications can add value followed by design, development, and implementation of such applications. Planning for and management of this core IS activity is a critical organizational competence. Prerequisites: IS 600 or passing score on the Information Systems Competency exam.

IS 520 - WEB PORTALS & APPLICATIONS  
Semester Hours: 3

This course bridges the boundary between consumer of Web applications and the ability of enterprises to derive value from web technologies and platforms by developing portals that integrate disparate organizational silos and databases. The course explores concepts in digital content and communication, technology infrastructure and social media. Utilization of SAP tools to develop an enterprise portal front end to organization's back-end business systems.

IS 522 - SUPPLY CHAIN MANAGEMENT SYS  
Semester Hours: 3

This course presents the main concepts of supply chain management systems and software including ERP, CRM, and SCM systems as well as the underlying technologies and managerial implications. It provides hands on familiarity with SAP supply chain modules. Cross listed with IS 422.

IS 540 - WEB PROG & DATABASE INTEGRATIO  
Semester Hours: 3

Prerequisite: IS 520.

IS 560 - TELECOMMUNICATIONS & NETWRK'G  
Semester Hours: 3

An overview of the IT infrastructure in modern organizations. The course starts from basic telecommunications networking concepts to digital platforms and ecosystems in the market. The course will cover internet, LAN & WAN protocols.

IS 571 - BUSINESS INTELLIGENCE & ANALYT  
Semester Hours: 3

This course will change the way you think about the relationship between data and business decision-making. We will examine real-world examples and cases to understand how Business Intelligence and Analytics (BIA) can enhance business competitiveness. We will use many BIA tools, giving students hands-on experience mining data. More importantly, this course will help students to develop data-analytical thinking in the era of "big data."

IS 577 - NETWORK DEFENSE & OPERATING SY  
Semester Hours: 3

Provides an introduction to the area of network security. Addresses security issues and practical applications related to Network Address Translation, packet filtering, proxy servers and firewalls, and Virtual Private Networks. This course assumes familiarity with the Internet and basic networking concepts such as TCP/IP, gateways, routers, and Ethernet. Prerequisites: IS 560.

IS 580 - SEMINAR IN MGT INFO SYSTEMS  
Semester Hours: 3

Selected topics in Management Information systems. Topics will reflect the contemporary issues and current technological advancements which impact the development, implementation and management of effective information systems in organizations.

IS 595 - INTERNSHIP INFORMATION SYSTEMS  
Semester Hours: 1-3

Under the direction of a faculty advisor, student gains experience with information systems and technology professionals in industry.
IS 600 - INFORMATION SYSTEMS MANAGEMENT
Semester Hours: 3
Develops an understanding of how information technology (IT) can enable organizations to conduct business more effectively in a rapidly changing business environment. Includes strategies to manage and leverage the organization's IT capabilities to deploy digital business models and maintain efficient and profitable business operations. Students will use systems and business process thinking to create and analyze strategies for technology enabled organizational transformation. Students will also use Enterprise Systems like SAP and other technologies as part of the course to understand their integrative capabilities to meet the Information needs of an organization.

IS 640 - DATA MGT AND DATA MINING
Semester Hours: 3
Explores the theories, features, and capabilities of relational database management systems in a business environment. Examines how to read and interpret database design documents and how to query database driven business applications. Emphasizes the use of database management systems and data mining tools in real-world business settings and how these technologies can be applied effectively to solve business problems.

IS 650 - SELECTED RESEARCH TOPICS
Semester Hours: 3
Research in a particular topic relevant to management information systems by one student or a group of students. Each students research paper must be an original contribution showing a research design and results that meet the highest standard of management information systems research.

IS 660 - CYBERSECURITY MANAGEMENT
Semester Hours: 3
Examines the management issues associated with the control and audit of information systems. Specific emphasis is on IT controls and their evaluation, computer-based auditing techniques, encryption, and security policies. Recent developments in IT, such as client-server systems and the Internet and their impact on auditing control, and security, are also considered.

IS 663 - COMPUTER FORENSICS
Semester Hours: 3
This course covers most of the important topics in computer forensics. It examines the problems and concerns related to computer investigations. It introduces systematical problem-solving techniques and applies them to computing investigations. It implements a variety of computer forensic tools in real-life scenarios.

IS 670 - BUSINESS CONTINGENCY PLANNING
Semester Hours: 3
Introduces the theories and concepts of business contingency planning through risk analysis and disaster recovery planning. This course is designed to provide a greater understanding of the assessment and management of risk and disaster recovery within the organization. The course will emphasize the nature of risk, risk assessment, risk management, and disaster recovery and how these concepts can be addressed effectively through business contingency planning. Prerequisites: IS 600 or IS 660.

IS 680 - ENTERPRISE RESOURCE PLNG SYS
Semester Hours: 3
This course examines the concepts, design, configuration and implementation of enterprise resource planning (ERP) systems with a view to integrate all aspects of an organization into one information system. Specific attention is given as to how ERP systems facilitate the flow of information supporting core business processes and the organization's supply chain. The course will emphasize the SAP configuration and strategic use of ERP systems to support the organizational structures and business processes of the particular company to efficiently and effectively manage a firm's business. Extensive use of SAP software is made in illustrating the configuration, implementation, and use of ERP systems in business and governmental organizations. Prerequisite: IS 600 or passing grade on Information Systems Competency Exam.

IS 691 - INFORMATION SYS STRATEGY & APP
Semester Hours: 3
This capstone course emphasizes the integration of various principles, theories, and techniques for developing, implementing and using information systems strategies and applications in organizations. It aims at providing a holistic view of Information Systems and Technology (IS/T) function in an organization with a view to serve an organization's mission and strategy throughout the value and supply chain. These skills will be placed in the context of business processes where they will be applied. Thus, in this course we will explore ways and means to help executives and managers make better decisions in the manufacturing and service sectors through a strategic use of IS/T. Normally taken during student's last semester. Must be completed with a grade of B or better. Prerequisites (with concurrency): IS 512, IS 560, IS 571, IS 640, and IS 680.
IS 692 - CYBERSECURITY PRACTICUM
Semester Hours: 3

A capstone course emphasizing the integration of various principles, theories, and techniques for developing, implementing and using cybersecurity tools and strategies and applications in organizations. Includes readings, lectures, situation analysis, cases, and the completion of a major practical project. Must be completed with a grade of B or better. Prerequisites: CS 585, CPE 549, IS 660, IS 663.

IS 699 - MASTER'S THESIS
Semester Hours: 3

Required each semester a student is working and receiving direction on a masters thesis. A minimum of two terms is required but no more than six hours credit is allowed for the thesis. Credit awarded upon successful completion of thesis.

Management (MGT)

MGT 501 - INTRO TO CONTRACT MANAGEMENT
Semester Hours: 3

General survey in contracting basics, covering procedures as described by Federal Acquisition Regulations, statutes, ethics, policies, and other pertinent authorities.

MGT 502 - CONTRACT EVALUATION & AWARD
Semester Hours: 3

This course introduces the student to topics related to the evaluation, award and post award portions of the contracting process. Elements of evaluation related to competitive acquisitions and past performance evaluation are reviewed. Steps related to the proposal receipt process such as contractor responsibility, debarred/suspended, and certificate of competency are covered. The award process is also covered by a discussion offeror, and preparation of award. Post award topics such as contract administration functions, contract closeout, contract modifications, remedies, claims, disputes and request for equitable adjustments are covered. Prerequisite: MGT 501.

MGT 503 - CONTRACT PRICING & COST ANALYSIS
Semester Hours: 3

Techniques for cost estimating, cost analysis, and price analysis. Sources of data, statutory requirements, rates, factors, and definitions, projection methods, factors affecting profit or fee, weighted guidelines technique, application of statistical analysis including regression analysis, and learning curve theory. Prerequisite: MGT 501 and ACC 540.

MGT 505 - NEW VENTURES STRATEGIES
Semester Hours: 3

Theory and application of both marketing and management strategies for start-up, operation and control of new ventures. The course also discusses the role of entrepreneurship in the economy. Prerequisite: MGT 600 and MKT 600.

MGT 508 - TEAMWORK & TEAM PROCESSES
Semester Hours: 3

This course provides an introduction to teams and teamwork processes. The foundation of the course is research-based; topics will be approached from the context of empirical research that has been conducted. The types of research designs that are typically used in team research are addressed. There are hands-on activities, so that students can put the theoretical material into context and into practice. This course is ideal for students who plan to work in business settings or in team-oriented fields (e.g., engineering, the military) or become involved in human resources or team training.

MGT 550 - INTERNATIONAL BUSINESS
Semester Hours: 3

This course combines theoretical and practical aspects of doing business in the global market. It addresses the complex environment of international business and the need to investigate its various economic, social, political, cultural, and legal dimensions from conceptual, methodological and applications perspectives. It then considers how these environmental factors would affect, and can be integrated into, business programs and strategies.

MGT 560 - EMPLOYEE STAFFING & DEVELOP
Semester Hours: 3

Study of the fundamental concepts, issues and tools of employee staffing and development. Topics include forecasting staffing needs, recruitment strategies, development and validation of selection procedures, placement, socialization, and development of employees, and the utilization of contingent workers.
MGT 561 - STRATEGIC COMPENSATION MGMT
Semester Hours: 3

Introduction to the management of employees compensation. Provides an overview of compensation practices, behavioral and economic theories of compensation, and research on compensation programs.

MGT 562 - EMPLOYMENT LAW FOR MANAGERS
Semester Hours: 3

Analysis of the impact of government regulation on the management of human resources. Examines the implications for employer responsibilities and employee rights of evolving public policies pertaining to separations, discrimination, compensation, occupational safety and health, privacy, union-management relations, and other terms of employment.

MGT 570 - SPEC TOPICS SEM MGT OF TECH
Semester Hours: 3

In depth study of a selected special topic relevant to the management of technology. Different sections of this course may address different topics.

MGT 595 - INTERNSHIP IN MANAGEMENT
Semester Hours: 1-3

Under the direction of a faculty advisor, student gains experience with an entrepreneur in a small business firm or a manager in a large firm.

MGT 600 - ORGAN THRY, BEHAV & ENVIRONMEN
Semester Hours: 3

Provides the conceptual tools to analyze the behavioral and organizational influences on systematic outputs such as quality, profitability, and employee well-being. Focuses both on macro-level issues (e.g. organizational design, culture, power and politics, and strategic leadership) and on micro-level issues (e.g. motivation, decision-making, socialization, and diversity). Covers these topics in the broader social, legal, regulatory, environmental, and ethical context.

MGT 601 - TECH & INNOVATION MGMT
Semester Hours: 3

This course covers the principles, theories, and practices to enhance an organization’s competitive position through the management of technology and innovation. Topics include the environmental and industry drivers of technological change, organizational issues in the adoption of new technologies, innovation and disruption, development of technical core competencies, and leadership challenges posed by innovation and change. It includes readings, lectures, cases, and the completion of a major research/practical project.

MGT 611 - SUPPLY CHAIN MANAGEMENT
Semester Hours: 3

This course discusses the concepts and components of the entire supply chain from a system of systems perspective. Emphasis is on integration, collaboration and planning related to major functional areas required to organize the flow of products from inception through delivery to satisfy final customer needs. Information and communication technology as an enabler of supply chain management strategies is also discussed. Concepts are emphasized utilizing experiential learning and case studies. Prerequisite: MSC 600.

MGT 622 - MGT TECHNI PROFESSIONALS
Semester Hours: 3

Differences in the nature of the research task and in the talents and skills required of scientists and engineers create special problems for the manager. Examines special issues in managing engineers, scientists, and technical support personnel. Emphasizes creating an organizational climate for increasing both individual and organizational innovation. Topics include incentive systems and motivation of technical professionals, problems in team decision making, job design, evaluating performance of technical professionals, leadership in the R&D organization, and career development for technical professionals. Prerequisite: MGT 600.

MGT 629 - LEADERSHIP: THRY & PRACTICE
Semester Hours: 3

The course explores what is known about leadership with particular emphasis on those attributes and skills that allow leaders to be effective in a variety of organizational situations. The theories of leadership are explored in a framework that includes the relationship of the leader to followers and situations. Frequent appearances by guest speakers who are themselves leaders provide the critical linkage to real world practice and allow for student interaction. Prerequisite: MGT 600.

MGT 631 - HRM & ORGANIZATIONAL BEHAVIOR
Semester Hours: 3

The major functions of human resource management are reviewed including performance management, employment law, staffing, HR planning, compensation, labor relations, and training. Behavioral management topics include motivation, leadership, communication, managing conflict, and managing teams. Prerequisite: MGT 600.
MGT 640 - PRIN OF PROJECT MGMT
Semester Hours: 3
Conceptual foundation and organization of project management. The project life cycle, planning, control, marketing, utilization of human resources, and financial management.

MGT 650 - SELECTED RESEARCH TOPICS
Semester Hours: 3
Research in a particular topic relevant to a business discipline by one student or a group of students. The research paper must be an original contribution showing a research design and results that meet the highest standards of social science research. Permission of instructor required.

MGT 690 - SEMINAR IN TECH MANAGEMENT
Semester Hours: 3
Practical management of technology methods and techniques from current research and successful industrial practice. Examines the state of the art in industrial new product development management. Lectures, cases, readings, and an emphasis on student discussions, presentations and interactions. The course has a strong research orientation while at the same time focusing on management policies and principles.

MGT 693 - SUPPLY CHAIN STRATEGY & PRACT
Semester Hours: 3
This integrative course discusses the strategic role of supply chain management in organizations and develops a working knowledge of the process of formulating and implementing supply chain strategies to gain competitive advantage in a global environment. Topics covered include the linkage of supply chain strategies with corporate strategy, customer relationship and supplier relationship strategies, outsourcing strategies and related infrastructure needs to implement supply chain strategies. A team based practicum project helps students apply concepts and methods to real world problems. Prerequisites: Completion of (or concurrent enrollment in) MGT 611. Normally taken last semester of program. Must be completed with a grade of B or higher.

MGT 694 - MANAGEMENT PRACTICUM
Semester Hours: 3
This course will serve as the capstone for the M.S. in Management degree. Students will work with faculty on either a research or consulting project which will allow the student to explore an area of interest in greater depth or gain additional experience by applying the concepts they have learned in the degree program to a real world challenge faced by an organization. Prerequisites: Completion (or concurrent enrollment in) all other required courses. Normally taken during the last semester of the program. Must be completed with a B grade or higher.

MGT 698 - STRATEGIC MANAGEMENT
Semester Hours: 3
Administrative decision making with emphasis on analyzing a complex business situation, evaluating historical trends, current operational conditions, and environmental settings, in order to establish a unifying strategy; implementation of integrated functional policies; and a plan of action to achieve established objectives. Normally taken during the last semester of a student's program. Prerequisites: MGT 601, ACC 602, ECN 626, FIN 601, MKT 600, and MSC 600.

MGT 699 - MASTER’S THESIS
Semester Hours: 1-3
Required each semester that student is working and receiving direction on a masters thesis. A maximum of 6 hours credit may be applied toward degree.

MGT 770 - ORGANIZATIONAL RESEARCH METHOD
Semester Hours: 3
Theory and practice of research methodology for study of administrative, industrial, and consumer behavior and organizations; questionnaire, field, and laboratory experimentation and statistical analysis of pre-gathered time-series and cross-sectional data; and examples of good and poor research in business disciplines. A completed project of potentially publishable nature is formally presented in class.

Management Science (MSC)

MSC 500 - DEC SUPPORT SYS/EXPT SYS
Semester Hours: 3
Analysis of information support systems which aid the manager in the decision making process.
MSC 510 - TRANSPORTATION & LOGISTICS  
Semester Hours: 3

An analysis of transportation and logistical services to include customer service, distribution operations, purchasing, order processing, facility design and operations, carrier selection, vehicle routing, and transportation costs. Understanding of business statistics is required. Prerequisite: MGT 600.

MSC 512 - ARMY SENIOR LOGISTICIAN-ADV  
Semester Hours: 3

The Senior Logistician Advanced Course (SLAC) is part of the U.S. Army's new Master Logistician Certificate Program for logistics management specialists within the 0346 occupational series. SLAC is an 80-hour academic learning experience designed to improve senior logistician competencies at the strategic level. The program is organized around the logistics management specialist's 12 competencies, and the coursework is specially designed to better develop and further enrich the thinking and skills of the Army's Senior Logisticians. Special approval and enrollment in CPCS U.S. Army Senior Logistician Advanced Course required.

MSC 570 - SPECIAL TOPICS IN MGMT SCI  
Semester Hours: 3

In depth study of a selected topic relevant to contemporary management science. Different sections of this course may address different topics.

MSC 595 - INTERNSHIP IN MANAGEMENT SCIEN  
Semester Hours: 1-3

Active involvement in a project in a business enterprise, professional organization or government agency that has particular interest and relevance to the student.

MSC 600 - QUANTITATIVE METHODS  
Semester Hours: 3

An introduction to and application of several fundamental quantitative methods and business analytics tools in business. Topics include probability distributions, sampling distributions, confidence interval estimation, hypothesis testing, ANOVA, linear regression, linear optimization, and simulation. Basic proficiency in Excel is required. Prerequisite: MSC 600.

MSC 605 - OPERATIONS MANAGEMENT  
Semester Hours: 3

This course discusses the management of the operations function for the creation of goods and services and its relationship with other business functions in service, manufacturing, and government organizations. Topics include operations strategy and infrastructure decisions, merging process technologies, planning and scheduling, inventory management, just-in-time systems, quality management, six sigma and lean operations. Concepts are illustrated using the SAP software. Prerequisite: MSC 600.

MSC 615 - DECISION MODELING  
Semester Hours: 3

This course focuses on tools and methods for modeling, analyzing and solving problems involving business decision making. Spreadsheet analysis, optimization, and simulation techniques will be covered. Topics include linear and nonlinear optimization, network models, decision analysis and simulation of complex models in a spreadsheet environment as well as using other commercial software packages. Proficiency in Excel is required. Prerequisite: MSC 600.

MSC 641 - ADVANCED ANALYTICS  
Semester Hours: 3

This course focuses on concepts and methods in business analytics. Topics include data quality and cleaning, predictive modeling, design of experiments, segmentation, forecasting, usage and limitations of models, and interpretation and presentation of results. This course provides a hands-on environment using real data to prepare students to apply these techniques in business environments. Proficiency in Excel is required. Prerequisite: MSC 600.

MSC 650 - SELECTED RESEARCH TOPICS  
Semester Hours: 3

Research in a particular topic relevant to management science by one student or a group of students. Each student's research paper must be an original contribution showing a research design and results that meet the highest standard of management science research.

MSC 690 - MANAGING TECH DEVELOPMENT  
Semester Hours: 3
MSC 692 - BUSINESS ANALYTICS PRACTICUM
Semester Hours: 3

A capstone course emphasizing rigorously interpreting the results of analytic models and intuitively communicating the derived business insights to business clients and corporate executives. The majority of this course is devoted to a major practical project in which students apply skills learned from previous analytics courses to a real world business problem, preferably in cooperation with a local organization. Prerequisite: Completion (or concurrent enrollment in) all other required courses. Normally taken during the student's last semester of studies.

MSC 699 - MASTER'S THESIS
Semester Hours: 1-3

Required each semester a student is working and receiving direction on a masters thesis. A minimum of two terms is required, but no more than six hours credit is allowed for the thesis.

Marine Science (MS)

MS 501 - INTRO TO OCEANOGRAPHY
Semester Hours: 4

Physics, chemistry, biology, and geology of oceans. For graduate students and those preparing for graduate school or intending to enter marine sciences professionally.

MS 502 - MARINE BOTANY
Semester Hours: 4


MS 503 - MAR INVERTEBRATE ZOO I
Semester Hours: 4


MS 505 - MARINE VERTEBRATE ZOO
Semester Hours: 4


MS 509 - MARINE ECOLOGY
Semester Hours: 4

Bioenergetics, community structure, population dynamics, predation, competition, and speciation in marine ecosystems. Lecture, laboratory, and fieldwork. Students admitted without previous marine courses. For engineers and other non-biologists interested in marine environment. Individual species as they relate to ecological principles exemplifying taxonomic and ecologic backgrounds.

MS 510 - MARSH ECOLOGY
Semester Hours: 4

Basic understanding of ecology of salt marsh. Habitat analysis, natural history studies, and population dynamics of selected vertebrates. Specific field problem terminated by a technical paper assigned to each student. For advanced undergraduates and graduate students.

MS 515 - COASTAL ORNITHOLOGY
Semester Hours: 4

Coastal and pelagic birds with emphasis on ecology, taxonomy, and distribution. Food habits, field identification, and population dynamics.

MS 520 - MARINE GEOLOGY
Semester Hours: 4

Sampling techniques, laboratory analysis of sediments, application of research process to problems in identifying sedimentary environments, topography, sediments, and history of world oceans. Beneficial for understanding sedimentary substrate on or in which a large percentage of marine organisms live. Lecture, laboratory, and fieldwork.

MS 525 - MARINE BIOL FOR TEACHERS
Semester Hours: 6
MS 599 - RESEARCH ON SPECIAL TOPICS
Semester Hours: 1-4

Enrollment by special arrangement in any subjects listed.

MS 691 - SPECIAL TOPICS IN MARINE SCIEN
Semester Hours: 1-4

**Marketing (MKT)**

MKT 505 - NEW VENTURE STRATEGIES
Semester Hours: 3

Theory and application of both marketing and management strategies for start-up, operation and control of new ventures. The course also discusses the role of entrepreneurship in the economy. Same as MGT 505.

MKT 515 - INTERNATIONAL MARKETING
Semester Hours: 3

Procedures and problems associated with establishing and carrying out marketing operations in or with foreign countries and companies. Institutions, principles, and methods involved in solving these business problems. Effect of national differences in business practices and regulation.

MKT 520 - SERVICES MARKETING
Semester Hours: 3

The course focuses on the unique challenges of managing services and delivering quality service to customers. The course is equally applicable to organizations whose core product is services (e.g., banks, hospitals, aerospace and defense firms, non-profit organizations) and to organizations that depend on service excellence and services for competitive advantage (high technology firms, industrial firms).

MKT 565 - NEW VENTURE CHALLENGE
Semester Hours: 3

It is the intent of this course to create teams of students who will take a technology to the next level with the potential for the creation of a venture team. The course will take students through the process of conceiving and creating a new business. The goal is to provide a solid background with practical applications of important concepts for non-business majors or business majors with limited or no experience in an entrepreneurial environment. Finance, accounting, marketing and management will be addressed from a hands-on, entrepreneurial perspective. The course will rely on Podcast discussion, participation, case analysis, and the creation of a business plan. Prerequisite: MKT 505 and MKT 604.

MKT 575 - ADVANCED MARKETING SEMINAR
Semester Hours: 3

Investigation of advanced marketing topics that are relevant to contemporary marketing practices. The course will focus on current issues related to marketing in a high technology environment, relationship marketing, channel design and strategy, transportation, and logistics. Prerequisite: MKT 600.

MKT 580 - MARKETING MANAGEMENT
Semester Hours: 3

Management of marketing function of the firm: determination of objectives, organization and controls for effective utilization of marketing resources in coordinated effort with other major functional areas. Identification and selection of market opportunities. Competitive strategies and development of marketing policies and programs.

MKT 590 - SPECIAL PROJECTS
Semester Hours: 3

Independent study in an area of interest to the student in the field of marketing.

MKT 595 - INTERNSHIP IN MARKETING
Semester Hours: 3

Active involvement in a project in a business enterprise, professional organization, or in a government agency that has particular interest and relevance to the student.

MKT 600 - SURVEY OF MARKETING MGMT
Semester Hours: 3

Seminar format with case analysis is used to introduce students to the tools and concepts necessary for planning, organizing, and controlling marketing activities. Typical topics include market analysis and segmentation, market planning, market research, and product pricing, promotion, and distribution strategies.
MKT 602 - MARKETING RESEARCH DESIGN
Semester Hours: 3
Application based course exploring the principles and purposes of marketing research. Covers research design, questionnaire development, sample selection, data collection, data analysis, and report generation. Focus is on the gathering and use of information for better decision making.

MKT 604 - NEW PRODUCT DEVELOPMENT
Semester Hours: 3
Practical management of new product development methods and techniques from current research and successful industrial practice. An in-depth review of concepts, empirical findings, and paradigms that collectively form the foundation for the design and marketing of new products. An overview of emerging concepts, analytical techniques, empirical findings and paradigms that alter the nature, scope, and practice of marketing emerging technologies. Prerequisite: MKT 600 and MGT 601.

MKT 606 - MKT IN HIGH TECH ENVIRON
Semester Hours: 3
Investigation of the many functions, strategies, systems, environmental forces, and competitive activities involved in the marketing of ideas, goods, and services to organizational customers which include businesses, industries, institutions, and governments. These issues will be evaluated within the context of a high technology environment. Using a seminar format, case analysis and class participation will be important dimensions of the course. Prerequisite: MKT 604.

MKT 650 - SELECTED RESEARCH TOPICS
Semester Hours: 3
Research on a particular topic relevant to marketing by one student or a group of students. The research paper must be an original contribution showing a research design and results that meet the highest standards of social science research.

Materials Science (MTS)

MTS 601 - NATURE OF MATERIALS
Semester Hours: 3

MTS 602 - PROPERTIES OF MATERIALS
Semester Hours: 3

MTS 603 - STRUC COMP PROP MATLS I
Semester Hours: 3
How structure and composition determine a materials mechanical properties and performance. Topics covered include bonding and crystal structure, disorder, defects, phase diagrams, phase transitions, diffusion and other kinetic processes, deformation, fraction mechanics, strengthening processes as applied to metals, ceramics, semiconductors, polymers and composites.

MTS 604 - STRUC COMP PROP MATLS II
Semester Hours: 3
How reactive, electronic, magnetic, thermal and optical properties of metals, ceramics, semiconductors, and polymers are influenced by their structure and composition. Topics considered include corrosion, oxidation, degradation process, band structure, electrical and optical dielectric constants, magnetic susceptibility, electrical and thermal conductivity and superconductivity.

MTS 607 - MAT PROCESSING IN SPACE
Semester Hours: 3
Extensive review of solidification physics with emphasis on the role of fluid transport and its effects on the process in order to develop rationales for processing materials in space.

MTS 613 - SYNTHESIS & PROC OF MATL
Semester Hours: 3
Metals, semiconductors, polymers, ceramics and composite materials are included.
MTS 646 - THERMODYNAMICS OF MATRLS
Semester Hours: 3
Fundamental thermodynamic review, phase equilibrium, chemical reaction equilibrium, free energy, binary and ternary phase transformations, solution models and selected topics.

MTS 649 - POLYMER SYNTHESIS & CHARACTERI
Semester Hours: 3
Synthesis of commercially relevant and novel polymers. Polymer characterization and discussion of the structural dependence of polymer properties.

MTS 650 - PRINC LIQUID/SOLID INTER
Semester Hours: 3
Applies basic principles in thermodynamics and kinetics to characterize surfaces and surface phenomena. Fundamental properties of gas-liquid, liquid-liquid, solid-liquid, and solid-gas interfaces and phenomena occurring at these interfaces.

MTS 651 - INTRO QUANTUM MECH I
Semester Hours: 3
Waves and particles; Bohr's model of the atom; de Broglie waves, wave-packets and the uncertainty principle; postulates of quantum mechanics; Schroedinger's equation; simple systems in one, two and three dimensions; the hydrogen atom.

MTS 652 - INTRO QUANTUM MECH II
Semester Hours: 3
Angular momentum and spin; atomic structure and spectrum; time-independent perturbation theory, variational methods; time-dependent perturbation theory and interactions of light with matter; scattering theory; electronic structure of solids; relativistic quantum mechanics. Prerequisite: PH 551 or CH 553.

MTS 660 - INTRO SOLID ST PHY I
Semester Hours: 3
Crystal binding and crystal structure. Crystal structure determination. Phonons and lattice vibrations. Free electron gas. Electronic energy band theory. Prerequisite: PH 551 or CH 553 or MTS 651 or OSE 555.

MTS 661 - INTRO SOLID ST PHY II
Semester Hours: 3
Thermal properties of solids. Electronic properties, optical properties, electronic properties in a magnetic field, semiconductor devices, magnetism, superconductivity, defects and alloys, dislocations and crystal growth, non-crystalline solids, surfaces and interfaces. Prerequisite: MTS 660 or PH 560.

MTS 690 - SP TPS/MATERIAL SCIENCE
Semester Hours: 3
Advanced selected topics of interest in such areas as materials processing, properties, analysis and testing. Prerequisites: MTS 501 and MTS 502.

MTS 699 - MASTER'S THESIS
Semester Hours: 3-6
Required each semester that a student is enrolled and receiving direction on a master's thesis. Minimum of two semesters required.

MTS 701 - FUND SOLID ST MAT PREP I
Semester Hours: 3
Equilibrium concepts and applications. Overview of solid state preparation (crystal growth) techniques. Treats appropriate thermodynamics, chemical equilibrium solid-liquid-vapor phase diagrams and application in materials preparation; segregation and applications (doping, normal freezing, zone refining, macro and micro distributions).

MTS 721 - FUND ELECTRON/X-RAY OPTICS
Semester Hours: 3
Fundamentals of materials characterization using electron and x-ray techniques. Topics include advanced crystallography, electron optics, and interactions of energetic electrons with solids. Some applications of x-ray diffraction (SRD) will be addressed.

MTS 722 - ELECT MICROSCOPIES/X-RAY DIFF
Semester Hours: 4
Applications of materials characterization using electron and x-ray techniques. Topics include imaging and x-ray spectroscopy (EDXA) using scanning electron microscopy (SEM); imaging, diffraction, and x-ray spectroscopy using transmission electron microscopy (TEM); and advanced x-ray diffraction (XRD) techniques.
MTS 723 - ELECTRON SPECTROSC SUR CHAR
Semester Hours: 4

Principles and operation of electron spectroscopies used in surface characterization. Techniques covered include Auger electron spectroscopy (AES), x-ray photoelectron spectroscopy (XPS), and other photoemission spectroscopies, such as ultraviolet photoelectron spectroscopy (UPS) and the use of synchrotron radiation. Students will carry out analysis of samples, prepare a written report, and present the results orally as part of the laboratory assignment.

MTS 724 - INSTR METH/BIO-MTLS CHARACTERI
Semester Hours: 3

MTS 747 - POLYMER PHYSICAL CHEM
Semester Hours: 3

Introduction to structure, properties and processing of polymers. Structural types, structureproperty relationships, thermodynamics and kinetics of polymerization and depolymerization, polymer characterization, thermodynamics of polymer solutions and blends, and mechanical evaluation of polymers. Prerequisite: CH 540.

MTS 780 - MATERIALS SCIENCE SEMINAR
Semester Hour: 1

Required of doctoral students during each semester of residence. This course may not be used to meet minimum degree requirements.

MTS 790 - SPECIAL TOPICS/MTS
Semester Hours: 3

Offered upon demand. Advanced selected topics of interest in materials science in such areas as materials processing, materials properties and analysis, testing.

MTS 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9

Required each semester student is enrolled and receiving direction on a doctoral dissertation. A minimum of 18 hours is required.

Mathematics (MA)

MA 502 - INTRO TO REAL ANALYSIS
Semester Hours: 3

Individualized special projects in mathematics and its applications for inquisitive and wellprepared senior level undergraduate students. No credit allowed toward a major or minor in mathematics. S/U grading.

MA 503 - INTRO COMPLEX ANALYSIS
Semester Hours: 3

Complex algebra, analytic functions, Cauchy-Riemann equations, exponential, trigonometric, and logarithmic functions, integration, Cauchy integral theorem, Morera’s theorem, Liouville’s theorem, maximum modulus theorem, residue theory, Taylor and Laurent series, and applications.

MA 506 - METHODS PARTIAL DIFF EQUA
Semester Hours: 3

Survey of theory and methods for solving elementary partial differential equations. Topics include first-order equations and the method of characteristics, second-order equations, reduction to canonical form, the wave equation, the heat equation, Laplace’s equation, separation of variables, and Fourier series.

MA 508 - APPLIED LINEAR ALGEBRA
Semester Hours: 3

Fundamental concepts of linear algebra are developed with emphasis on real and complex vector spaces, linear transformations, and matrices. Solving systems of equations, finding inverses of matrices, determinants, vector spaces, linear transformations, eigenvalues and eigenvectors, normal matrices, canonical forms of matrices, applications to systems of linear differential equations, and use of computer software such as MATLAB.

MA 515 - INTRO NUMERICAL ANALYSIS
Semester Hours: 3

Rigorous analysis and derivation of numerical methods for the approximate solution of nonlinear equations; interpolation and integration of functions, and approximating solutions of ordinary differential equations.
MA 520 - INTERM DIFFERENTIAL EQUATIONS
Semester Hours: 3

This is a second course in differential equations. Course topics include series solutions for second order differential equations and the method of Frobenious; eigenvalue and eigenvector methods for solving systems of linear first order equations; the qualitative theory of nonlinear equations; boundary value problems and the Sturm-Liouville theory. No credit given to students who have successfully completed MA 524.

MA 524 - DYNAMICAL SYSTEMS I
Semester Hours: 3

Scalar autonomous equations; existence, uniqueness, stability, elementary bifurcations; planar autonomous equations; general properties and geometry, conservative systems, elementary bifurcations linear systems, reduction to canonical forms, stability and instability from linearization. Liapunov functions, center manifolds, Hopf bifurcation.

MA 526 - PARTIAL DIFF EQUA I
Semester Hours: 3

Introduction to the theory for solving partial differential equations. No graduate credit given to students who have completed MA 506 for graduate credit. Topics include second-order equations, reduction to canonical form, well-posedness, the classical equations (wave, heat, and Laplace’s) in one and several dimensions, separation of variables, Fourier series, general eigenfunction expansions, Sturm-Liouville theory, first-order linear and quasilinear equations, and shocks. Prerequisite: MA 502.

MA 538 - METRIC SPACES W/APPLICA
Semester Hours: 3


MA 539 - MULTIDIMENSIONAL ANALYSIS
Semester Hours: 3

Finite-dimensional Euclidean space and sequential approach to its topology, continuous functions and their properties, differentiability and implicit function theorem, Riemann integral, elements of vector calculus, flows and their generating vector fields, introduction to metric spaces. Prerequisite: MA 544.

MA 540 - COMBINATORIAL ENUMERATION
Semester Hours: 3

Counting, pigeonhole principle, permutations and combinations, generating functions, principle of inclusion and exclusion, Polya’s theory of counting.

MA 542 - ALGEBRA
Semester Hours: 3

Topics from group theory and ring theory: subgroups, normal subgroups, quotient groups, homomorphisms, isomorphism theorems, ideals, principal ideal domains, Euclidean domains, fields, extension fields, elements of Galois theory.

MA 544 - LINEAR ALGEBRA
Semester Hours: 3

Vector spaces over a field, bases, linear transformations, matrices, determinants, eigenvalues, similarity, Jordan canonical forms, dual spaces, orthogonal and unitary transformations.

MA 561 - INTRO TO FOURIER ANALYSIS
Semester Hours: 3

See MA 460. This course is taught as MA 460/561. Course completion and/or grade requirements for the MA 561 course will differ from those for the MA 460 course.

MA 562 - INTERMEDIATE FOURIER ANALYSIS
Semester Hours: 3

(Formerly MA 560). Brief review of classical Fourier analysis, Parseval’s equality, Gaussian test functions. Introduction to generalized functions, the generalized transform, the generalized derivative, sequences and series of generalized functions, regular periodic arrays of delta functions, sampling, the discrete transform, the fast Fourier transform (other topics as time and interest permit).

MA 565 - INTERM MATH MODELING
Semester Hours: 3

Designed for beginning graduate students. No prior experience in formal mathematical modeling is required. In-depth discussion of some types of models from physics, the life sciences, and/or the social sciences, with formulation, analysis, and criticism of the models. Process of and factors involved in formulating a model is of prime importance. Content is divided into approximately one-half deterministic modeling and one-half stochastic modeling.
MA 585 - PROBABILITY
Semester Hours: 3

Course topics include probability spaces, random variables, conditional probability, independence, modes of convergence, and an introduction to sigma-algebras and measurability; distributions, including discrete, continuous, joint and marginal distributions, transformations of random variable, distribution and quantile functions, and convergence in distribution; expected value, including properties of general expected value, mean, variance, covariance, generating functions, and conditional expected value; special models and distributions, including Bernoulli trials and the binomial and negative binomial distributions, the Poisson model and the Poisson and gamma distributions, the normal distribution, finite sampling models and the hypergeometric distribution; the law of large numbers and the central limit theorem.

MA 590 - SELECTED TOPICS IN MATH
Semester Hours: 3

Requested selected topics.

MA 607 - MATHEMATICAL METHODS I
Semester Hours: 3

Review of vector calculus and coordinate systems, introduction to tensors, matrices, infinite series, complex variables with applications to calculus of residues, partial differential equations, and Sturm-Liouville theory. Orthogonal functions, gamma functions, Bessel functions, Legendre functions, special functions, Fourier series, integral transform and equations. (Same as PH 607.)

MA 609 - MATHEMATICAL METHODS II
Semester Hours: 3

Continuation of MA 607. (Same as PH 609.) Prerequisite: MA 607.

MA 614 - NUM METHODS/LINEAR ALGEBRA
Semester Hours: 3

Norms and vector spaces, matrix factorizations and direct solution methods, stability and conditioning, iterative methods for large linear systems, the algebraic eigenvalue problem. Prerequisites: MA 515 and either MA 508 or MA 544.

MA 615 - NUM METHODS PARTIAL DIFF EQ
Semester Hours: 3

Finite difference methods for parabolic, elliptic, and hyperbolic partial differential equations, error analysis, stability, and convergence of finite difference methods. Prerequisites: MA 515 and (either MA 506 or MA 526) and (either MA 508 or MA 544 or MA 614).

MA 624 - DYNAMICAL SYSTEMS II
Semester Hours: 3

Brief review of linear systems; local theory for nonlinear systems; existence, uniqueness, differentiability, asymptotic behavior, the stable manifold theorem, Hartman-Grobman theorem, Hamiltonian systems; global theory for nonlinear systems; limit sets and attractors, the Poincare map, the Poincare-Bendixson theorem; some aspects of bifurcation theory and chaos; bifurcations at nonhyperbolic fixed points and periodic orbits, homoclinic bifurcations, Melnikov's method, chaos. Prerequisite: MA 524 and either MA 508 or MA 544.

MA 626 - PARTIAL DIFF EQUA II
Semester Hours: 3

Continuation of MA 526. Qualitative results for solutions to the classical equations (energy inequalities, propagation of discontinuities, maximum principles, smoothness of solutions, existence and uniqueness, etc.), non-homogeneous equations, Poisson's equation, Green's functions, and the Cauchy-Kowalewski theorem. Prerequisite: MA 526.

MA 633 - GEOMETRY
Semester Hours: 3

Axioms of incidence and order, affine and metric properties, isometries, similarities, transformation groups, projective planes.

MA 638 - GENERAL TOPOLOGY
Semester Hours: 3

Set theory, logic, well-ordering principle, axiom of choice, topological spaces, product spaces, quotient spaces, continuous functions, connectedness, path connectedness, local connectedness, compactness, local compactness, countability and separation, generalized products, Tychonoff theorem.

MA 640 - GRAPH THEORY
Semester Hours: 3

Graphs, subgraphs, trees, connectivity, Euler tours, Hamilton cycles, matchings, edge colorings, independent sets, vertex colorings, planar graphs, Kuratowski's theorem, four color theorem, directed graphs, networks, cycle and bond spaces. Prerequisite: MA 540 or MA 542.
MA 643 - GROUP THEORY  
Semester Hours: 3  

MA 644 - MATRIX THEORY  
Semester Hours: 3  

Functions of matrices, invariant polynomials, elementary divisors, similarity of matrices, normal forms of a matrix, matrix equations, generalized inverses, non-negative matrices, localization of eigenvalues. Prerequisites: MA 508 or MA 503 or MA 544.

MA 645 - COMBINATORIAL DESIGN  
Semester Hours: 3  

Systems of distinct representatives, difference sets, coding theory, block designs, finite geometries, orthogonal Latin squares, and Hadamard matrices. Prerequisite: MA 540 and MA 544.

MA 653 - REAL ANALYSIS I  
Semester Hours: 3  


MA 654 - REAL ANALYSIS II  
Semester Hours: 3  

Differentiability of monotone functions, functions of bounded variation, absolute continuity, convex functions, Minkowski and Holder inequalities, Lp spaces, Riesz-Fischer representation theorem, Fubini's theorem and selected topics. Prerequisite: MA 653.

MA 656 - COMPLEX ANALYSIS I  
Semester Hours: 3  

Topology of the complex plane, analytic functions of one complex variable, elementary functions and their mapping properties, power series, complex integration, Cauchy's theorem and its consequences, isolated singularities, Laurent series, residue theory.

MA 658 - INTRO TO FUNCTIONAL ANALYSIS  
Semester Hours: 3  

Normed and inner product spaces, finite dimensional spaces, product and quotient spaces, equivalent norms, Hahn-Banach theorem, principle of uniform boundedness, openmapping theorem, Riesz representation theorem, complete orthonormal sets, Bessel's inequality, Parseval's identity, and conjugate spaces. Prerequisite: MA 538.

MA 661 - SPECIAL FUNCTIONS  
Semester Hours: 3  

MA 662 - ASYMPT/PERTURBATION METHOD  
Semester Hours: 3  

Asymptotic series, regular and singular perturbation theory, asymptotic matching, Laplace's method, stationary phase, steepest descents, WKB theory. Prerequisites: MA 502, and one of the following: MA 503, MA 504, MA 624.

MA 667 - CALC VAR/OPTIMAL CONTROL  
Semester Hours: 3  

Euler necessary condition for local extremum, Euler-Lagrange equation, Weierstrass necessary condition, Jacobi's necessary condition, corner conditions, problems of optimal control, Pontryagin maximum principles, transversality conditions, applications.

MA 685 - STOCHASTIC PROC/APPLI I  
Semester Hours: 3  

Discrete and continuous Markov chains, Poisson processes, counting and renewal processes, and applications. Prerequisite: MA 585.

MA 686 - STOCHASTIC PROC/APPLI II  
Semester Hours: 3  

Gaussian and Wiener processes, general Markov processes, special types of processes from queueing and risk theory, and selected advanced topics. Prerequisite: MA 685.

MA 690 - SP TOPICS IN MATHEMATICS  
Semester Hours: 3  

Offered upon demand. Advanced selected topics of interest in areas such as discrete mathematics, numerical analysis, differential equations, and stochastic processes.
MA 695 - GRADUATE SEMINAR  
Semester Hour: 1

Selected topics in advanced mathematics, conducted as a research seminar.

MA 699 - MASTER'S THESIS  
Semester Hours: 3-9

Required each semester a student is receiving direction on a master's thesis. A minimum of two terms is required. Maximum of nine hours credit awarded upon successful completion of the master's thesis.

MA 715 - NUM METHODS PART DIFF EQ II  
Semester Hours: 3

Finite element methods for parabolic, elliptic, and hyperbolic partial differential equations; error analysis stability, and convergence. Prerequisites: MA 538 and MA 615.

MA 726 - THRY PART DIFFERNTL EQUA  
Semester Hours: 3

Hilbert space theory of existence, uniqueness, and regularity for partial differential equations.

MA 740 - COMBINATORIAL ALGORITHMS  
Semester Hours: 3

Linear, polynomial and exponential graph theoretic algorithms, generating combinatorial objects, and NP-completeness.

MA 756 - COMPLEX ANALYSIS II  
Semester Hours: 3

Applications of residue theory, harmonic functions and their applications, Mittag-Leffler theorem, infinite products, Weierstrass product theorem, conformal mapping and Riemann mapping theorem, univalent functions, analytic continuation and Riemann surfaces, Picard's theorems, and selected topics.

MA 785 - ADV PROBABILITY THEORY  
Semester Hours: 3

Measure and integration, probability spaces, convergence concepts, law of large numbers, random series, characteristic functions, central limit theorem, random walks, conditioning, Markov properties, conditional expectations, and elements of martingale theory.

MA 790 - SPECIAL TOPICS  
Semester Hours: 3

Offered upon demand. Advanced selected topics of interest in areas such as discrete mathematics, numerical analysis, differential equations, and stochastic processes.

MA 795 - GRADUATE SEMINAR  
Semester Hour: 1

Selected topics in advanced mathematics, conducted as a research seminar.

MA 799 - DOCTORAL DISSERTATION  
Semester Hours: 3-9

Required each semester a student is receiving direction on a Ph.D. dissertation.

**Mechanical & Aerospace Engineering (MAE)**

MAE 520 - COMPRESSIBLE AERODYNAMICS  
Semester Hours: 3

Principles of compressible flow including area change, friction, and heat transfer. Fundamentals of acoustic waves, one and two-dimensional shock and expansion waves, shock-expansion theory, and linearized flow with applications to inlets, nozzles, wind tunnels, and supersonic flow over aerodynamic bodies and wings. (Same as MAE 420.).

MAE 530 - FUNDAMENTALS OF AERODYNAMICS  
Semester Hours: 3

Application of the principles of fluid mechanics and thermodynamics to the prediction of aerodynamic performance of aircraft, missiles and other flight vehicles. Topics include lift and drag, thrust and power, and the influence of wing loading, power loading, zero-lift drag, wing geometry, high lift devices Mach number, etc., on the performance and design trades of flight vehicles. (Same as MAE 430.).
MAE 531 - INTRO TO PLASMA DYNAMICS  
Semester Hours: 3

MAE 540 - ROCKET PROPULSION I  
Semester Hours: 3

Introduction to the operation, analysis and design of liquid and solid rockets. The course incorporates an experience in design and realization of a thermal system in which students work in teams to design a rocket motor or component.

MAE 541 - AIRBREATHING PROPULSION  
Semester Hours: 3

Survey of airbreathing propulsion systems with special emphasis on gas turbine engines for aircraft and rotorcraft. Thermodynamic power cycles, design of components, and overall engine performance analysis. Discussion of practical design and operations considerations including engine controls, reliability, and durability. The course incorporates an experience in design and realization of a thermal system in which students work in teams to design a turbine engine. Students majoring in Aerospace Engineering must take either MAE 440 or MAE 441 to satisfy the Aerospace propulsion elective. Prerequisite: MAE 520.

MAE 544 - INTRO TO ELECTRIC PROPULSION  
Semester Hours: 3

Elements of electrically-driven rocket propulsion for applications from low earth orbit to the outer planets. The physics of ionizing and heating gases and plasmas for electrothermal, electrostatic and electromagnetic acceleration. Characteristics of Resistojet, Arcjet, Magnetoplasmadynamic thrusters, Electrothermal, Pulsed plasma, Electrostatic, and Hall thrusters. Review thruster system performance, power requirements, and selection for space missions. Overview of current research efforts, including thruster systems, physics, and performance. Prerequisite: MAE 520.

MAE 545 - HEAT DISTRIBUTION SYSTEM DESIGN  
Semester Hours: 3

Design of hydronic and air distribution systems used in heating and air conditioning. Piping design, pump selection, heat coils, room air distribution, ducting design, fan selection, controls, and complete systems.

MAE 548 - ENERGY CONVERSION & POWER GENERATION  
Semester Hours: 3

Application of principles of thermodynamics, heat transfer, and fluid mechanics to combustion engines and turbines. Basic engine types, engine components, idealized cycles, combustion, fuels, engine variables, testing, exhaust gas analysis, and air pollution as related to spark-ignition, compression-ignition, and turbine engines.

MAE 552 - COMPRESSIBLE AERODYNAMICS  
Semester Hours: 3

Principles of compressible flow including area change, friction, and heat transfer. Fundamentals of acoustic waves, one and two-dimensional shock and expansion waves, shock-expansion theory, and linearized flow with applications to inlets, nozzles, wind tunnels, and supersonic flow over aerodynamic bodies and wings.

MAE 561 - VIBRATIONS ELASTIC SYSTEMS  
Semester Hours: 3

Formulation of the equations of motion of discrete and continuous systems, analytical and numerical methods of solution, eigenvalue problems, and dynamic response. (Same as MAE 461 and CE 461/561.)

MAE 563 - INTERMEDIATE DYNAMICS  
Semester Hours: 3

Kinematics and dynamics of particles, system of particles, and rigid-bodies. Variational principles and Lagrangian mechanics.

MAE 568 - ELEMENTS OF SPACECRAFT DESIGN  
Semester Hours: 3

Fundamentals of spacecraft engineering and design. Topics include: orbital mechanics, space environment, attitude determination and control, communications, space structures, thermal control, propulsion and power, and systems and mission design. (Same as MAE 468.) Prerequisite: MAE 520.

MAE 574 - APP MECHANICS OF SOLIDS  
Semester Hours: 3

Stresses and strains at a point, theories of failures, stress concentration factors, thick-walled cylinders, torsion of noncircular members, curved beams, unsymmetrical bending, and shear center. (Same as MAE 474 and CE 474/574.)
MAE 576 - COMP MATLS: FABRIC/DES/ANALY
Semester Hours: 3
Introduction to the mechanics of advanced composite materials. Design and analysis of composite structures. Analysis of orthotropic and transversely isotropic materials and systems. Hands on fabrication of a composite structure. (Same as MAE 476.).

MAE 577 - EXP TECH SOLID MECHANICS
Semester Hours: 3
Experimental methods to determine stress, strain, displacement, velocity, and acceleration in various media. Theory and laboratory applications of electrical resistance strain gages, brittle coatings, and photoelasticity. Application of transducers and experimental analysis of engineering systems. (Same as MAE 477 and CE 477/577.).

MAE 580 - AIRCRAFT STABILITY & CONTROL
Semester Hours: 3
Stability and control of aerodynamic vehicles. Design of aircraft to obtain good flying characteristics. Complete governing equations and analog solutions of linearized equations. (Same as MAE 480.) Prerequisite: MAE 530.

MAE 585 - NUM METH & ENGR COMPUTAT III
Semester Hours: 3
Advanced topics in numerical methods and engineering computation including: finite elements and finite differences in solving various engineering problems; Gaussian quadrature; interpolation, integration, and differentiation; and stability and convergence analysis of iterative methods. Numerical applications to fluid mechanics, heat transfer, structural mechanics, and machine design.

MAE 589 - COMPUTER AIDED ENGR
Semester Hours: 3
Application of computer methods in the analysis and design of structural, thermal, and dynamical systems. Use of state-of-the-art finite element and finite difference computer programs. Practical guidelines for discrete modeling; analysis of modeling errors. Comparison of exact and approximate solutions to boundary value problems. Use of microcomputers in engineering design and analysis. (Same as MAE 489.).

MAE 593 - ROCKET DESIGN
Semester Hours: 3
Design, build, test and fly a high-powered rocket with a payload to a specified altitude. Students work on multi-disciplinary teams to design payloads, avionics, recovery systems, structures and other sub-systems and then integrate them into the final vehicle. Course may be used for senior design credit.

MAE 594 - AIRCRAFT DESIGN
Semester Hours: 3
Design and build an unmanned aircraft to meet specified requirements, and then verify design through ground and flight tests. Students work on multi-disciplinary teams to address configuration aerodynamics, avionics, structures, propulsion/power and payloads. Systems engineering aspects including simulation, fabrication, integration, scheduling and cost estimation are also emphasized. Course may be used for senior design credit.

MAE 595 - SELECTED TOPICS MECH & AERO EG
Semester Hours: 1-6

MAE 610 - AERODYNAMICS
Semester Hours: 3
Fundamental concepts in aerodynamics including conservation laws, complex potential theory, thin airfoil theories, finite-wing lifting-line theory, boundary layers and Von Karman momentum integral equations.

MAE 620 - COMPRESSIBLE FLOW
Semester Hours: 3
Study of compressible subsonic, transonic and supersonic flows as described by the Euler equations. Linear and nonlinear theories of shockwaves, expansion waves, and their interactions. Applications to wind tunnels, nozzles, diffusers and aerodynamic bodies.

MAE 623 - COMPUTATIONAL FLUID DYNAMICS I
Semester Hours: 3
Formulations by finite difference, finite element, finite volume, and spectral element methods for incompressible and compressible flows. Explicit and implicit methods, Von Neumann error analysis, consistency, convergence, and accuracy.
MAE 631 - ROTORCRAFT DESIGN I
Semester Hours: 3

Conceptual design of rotorcraft systems with an emphasis on multidisciplinary design. Comprehensive methodologies for vehicle synthesis and sizing including consideration of aerodynamics, propulsion, materials and structures, flight performance and control, and operations. Integration of advanced technologies. Rotorcraft Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Rotocraft Systems Engineering. Corequisite: MAE 657.

MAE 632 - ROTORCRAFT DESIGN II
Semester Hours: 3

Continuation of Rotorcraft Design I including higher fidelity simulations and trade studies. Consideration of maneuverability, structural dynamics, drive train and hub design, advanced flight control system design, sensors, weapons, component integration, packaging, and life-cycle cost. Rotorcraft Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Rotocraft Systems Engineering.

MAE 633 - TACTICAL MISSILE DESIGN I
Semester Hours: 3

Conceptual design of missile systems with an emphasis on multi-disciplinary design. Comprehensive methodologies for vehicle synthesis and sizing including consideration of aerodynamics, propulsion, materials and structures, flight performance and control, and operations. Integration of advanced technologies. Tactical Missile Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Missile Systems Engineering. Prerequisite with concurrency: MAE 755.

MAE 634 - TACTICAL MISSILE DESIGN II
Semester Hours: 3

Continuation of Tactical Missile Design I including higher fidelity simulations and trade studies. Consideration of trajectory modeling and simulation, open-loop flight control system design, sensors, component integration and packaging, and life-cycle cost. Tactical Missile Design I and II are the capstone design courses for the MSE (Aerospace) program of study in Missile Systems Engineering. Prerequisite: MAE 633.

MAE 635 - AEROSPACE SYSTEMS ENGINEERING
Semester Hours: 3

Introduction to Integrated Product and Process Development (IPPD) and life cycle analysis with application to Aerospace Systems. Systems engineering and quality engineering methods and tools. Top-down design decision support process. Computer integrated environment and robust design simulation will be addressed. Prerequisite: ISE 601 or ISE 690.

MAE 639 - SYSTEM SAFETY
Semester Hours: 3

The process of system safety—from the creation and management of a safety program on a system under development to the analysis that must be performed as this system is designed and produced to assure acceptable risk in its operation. Full discussion of the management and analysis processes and procedures. Incorporates the safety procedures used by the Department of Defense and NASA. Basic statistical methods and network analysis methods which provide an understanding of the engineering analysis methods that follow are covered.

MAE 640 - ROCKET PROPULSION II
Semester Hours: 3

MAE 641 - ADV THERMODYNAMICS
Semester Hours: 3

Application of classical thermodynamics. Treatment of problems involving nonideal gases and liquids, phase equilibrium, and chemical equilibrium. (Same as CHE 641.)

MAE 643 - ADVANCED HEAT & MASS TRANSFER
Semester Hours: 3

Continuation of MAE 450 in the study of conductive, convective, and radiative heat transfer and mass transfer. Emphasis is placed on heat transfer in turbulent flows and high speed flows, combined mode heat transfer, and mass transfer in reacting flows.

MAE 644 - ADVCD SOLID ROCKET PROPUL
Semester Hours: 3

Overview of the design, manufacture and testing of solid rocket propulsion systems. Specific topics include propellant ballistics and combustion, grain design, motor case and nozzle design, thermal protection, motor performance, and reliability and failure. Prerequisite: MAE 540.
MAE 645 - COMBUSTION I  
Semester Hours: 3
Combustion chemistry, introduction to mass transfer, chemical kinetics, reactors, simplified governing equations for chemically reacting flow, laminar diffusion and premixed flames.

MAE 646 - COMBUSTION I  
Semester Hours: 3
Combustion chemistry, introduction to mass transfer, chemical kinetics, reactors, simplified governing equations for chemically reacting flow, laminar diffusion and premixed flames.

MAE 647 - UNCERTAINTY ANAL IN EXPER  
Semester Hours: 3
Uncertainty analysis concepts and techniques; application in planning, design, construction, debugging, execution, data analysis and reporting phases of experimental programs. Discussion of national and international standards and current engineering uncertainty analysis literature.

MAE 649 - TRANSPORT PHENOMENA  
Semester Hours: 3
Mass, energy, and momentum transport in steady and transient motions in real and rheological substances. (Same as CHE 649.)

MAE 651 - VISCOUS FLUID MECHANICS  
Semester Hours: 3
Fundamentals of incompressible viscous fluid motion, including development of Navier Stokes equation. Exact and approximate solutions for both large and small Reynolds number. Laminar and turbulent boundary layers.

MAE 657 - HELICOPTER THEORY  
Semester Hours: 3
Vertical flight, forward flight, performance, design, mathematics of rotating systems, rotary wing dynamics, rotary wing aerodynamics, helicopter aeroelasticity, stability and control, stall, and noise. Prerequisite: MAE 530.

MAE 658 - ROTORDYNAMICS  
Semester Hours: 3
Torsional and transverse rotor vibration, critical speed and stability analysis, response to unbalance, rotor balancing. Rotordynamic phenomena including: gyroscopic effects, fluid film bearings, annular seals, stiffness asymmetry.

MAE 660 - STRUCTURAL DYNAMICS  
Semester Hours: 3
Application of the theory of vibrations to discrete and continuous models of structures. Numerical methods of analysis for both spatial and temporal variables. Modal synthesis and step-by-step time integration methods. Finite element applications; substructuring techniques. (Same as CE 660.)

MAE 661 - ADVANCED DYNAMICS  
Semester Hours: 3
Variational methods, optimization, and dynamic stability. Lagrangian and Hamiltonian formulation for dynamical systems and Hamilton-Jacobi methods to orbital mechanics.

MAE 662 - NONLINEAR DYN & CHAOS  
Semester Hours: 3
Nonlinear and chaotic dynamical systems, phase plane, periodic and strange attractors, stability analysis, critical points, Piapunov exponents, bifurcation points, solitons, logistic maps, Poincare and Henon iterative maps, factals, Mandebrot and Julia sets, chaos in complex dynamical systems.

MAE 663 - ASTRODYNAMICS  
Semester Hours: 3
Astronomical coordinates and time systems; the many-body problems and disturbing functions. General perturbation methods, and application of classical mechanics and Hamilton-Jacobi methods to orbital mechanics.

MAE 671 - CONTINUUM MECHANICS  
Semester Hours: 3
Kinematics and kinetics, various coordinate systems, constitutive equations for continuous media; governing partial differential equations from first and second laws of thermodynamics; applications to solids, liquids, and gases. (Same as CE 671.)
MAE 672 - ELASTICITY  
Semester Hours: 3  
Formulation of boundary-value problems of classical elasticity. Application to plane problems, prismatic members, and axisymmetric problems. Introduction to three-dimensional problems. (Same as CE 672.).

MAE 673 - PLASTICITY  
Semester Hours: 3  
Fundamentals of mechanical behavior of metals and nonmetals for stress states greater than the yield stress state. Deformation and flow theories. Stress-strain relations and yield criteria. Solution of boundary value problems with plastic bodies. Limit analysis of structures. (Same as CE 673.).

MAE 674 - FINITE ELEMENT ANALYSIS I  
Semester Hours: 3  
Finite element theory, variational methods, weighted residuals; applications to linear partial differential equations in continuous media; solution of boundary-value and initial-value problems. (Same as CE 674.).

MAE 676 - VISCOELASTICITY  
Semester Hours: 3  

MAE 677 - OPTICAL TECH IN SOLID MECH  
Semester Hours: 3  
Overview of conventional methods for experimental stress analysis. Introduction to applied optics with emphasis on non-destructive, laser-based testing methods, fiber optic recording systems, photoelectronic-numerical data acquisition, and computer aided analysis. (Same as CE 677.).

MAE 678 - MECH COMPOSITE MATERIALS  
Semester Hours: 3  
Introduction to composite materials, micro- and macro-mechanical behavior of laminae; bending, buckling and vibration of laminated plates. (Same as CE 678.) Prerequisites: MAE 671 and MAE 672.

MAE 680 - PERFORMANCE FLIGHT TESTING  
Semester Hours: 3  
Fundamentals of rotorcraft test and evaluation. Topics include: test planning, requirements analysis, helicopter performance evaluation, fundamentals of propulsion testing, aviation safety, use of modeling and simulation in flight testing, Department of Defense and Federal Aviation Administration requirements and procedures.

MAE 681 - MISSILE TRAJECTORY ANALYSIS  
Semester Hours: 3  
Methods for generating trajectories of missiles and projectiles are studied as well as control mechanisms. Point mass approximations are developed using approximations and exact representations of drag and atmospheric conditions Full six degree-of-freedoms models are developed and solved numerically. Aerodynamic models are developed for both slowly spinning missiles and spin stabilized projectiles. Projectile linear theory is developed and used to discuss gyroscopic and dynamic stability and introduce rapid trajectory generation. Prerequisite: MAE 580.

MAE 683 - GRAD SEMINAR MECH ENGR  
Semester Hour: 1  
Professional activities designed to promote the skills required to organize and deliver oral technical presentations and to broaden the individual's awareness of technical issues. Required for all students pursuing a graduate degree. Students will be graded "S" (satisfactory) or "U" (unsatisfactory) based upon their performance and attendance. Students who do not receive an "S" grade must register for the course until an "S" is obtained.

MAE 684 - AEROSPACE SYSTEMS SEMINAR  
Semester Hour: 1  
Seminar course for students in the MSE (Aerospace) Rotorcraft Systems Engineering and Missile Systems Engineering programs of study. students participate in seminars on specific aspects of rotorcraft and missile systems engineering including system integration, modeling and simulation, operations, and advanced technologies.

MAE 692 - GRAD ENGR ANALYSIS I  
Semester Hours: 3  
Ordinary differential equations (ODEs), Bessel functions, Legendre polynomials, Laplace transformations, simultaneous differential equations, application of ODEs to mechanical systems, partial differential equations (PDEs) and boundary-value problems, application of PDEs to mechanical systems.
MAE 693 - GRAD ENGR ANALYSIS II  
Semester Hours: 3  
Green's functions, Fourier series and integrals, linear algebra, vectors, vector analysis and integral theorems, introduction to tensor analysis, analytical functions of a complex variable, Taylor and Laurent expansions, the residue theorem, stability criteria, and Calculus of Variations. Prerequisite: MAE 692.

MAE 695 - SELECTED TOPICS MECH & AERO EG  
Semester Hours: 1-9

MAE 696 - GRAD INTERN MECH & AERO ENGR  
Semester Hours: 1-9  
Active involvement in an engineering project in an engineering enterprise, professional organization, or government agency that has particular interest and relevance to the graduate student. Permission of MAE faculty member required.

MAE 698 - PLAN II MASTER'S PAPER  
Semester Hours: 3  
Required Plan II paper for a Plan II Masters degree. Completion of 18 semester hours of graduate course work required.

MAE 699 - MASTER'S THESIS  
Semester Hours: 1-9  
Required each semester in which a student is working and receiving direction on a master's thesis. Minimum of two semesters and 6 hours required for M.S.E. students. A maximum of 9 hours of credit is awarded upon successful completion of master's thesis. Requires thesis advisor permission. The 1 hour option is only available to students who have successfully defended their thesis and submitted it for approval, but do not meet the deadlines for graduation in the semester submitted. Students may only use the 1 hour option once in their career.

MAE 723 - COMPUTATIONAL FLUID DYNAMICS II  
Semester Hours: 3  
Continuation of Computational Fluid Dynamics I, advanced topics in finite difference, finite element, finite volume, and spectral element methods. Prerequisite: MAE 623.

MAE 724 - COMPUTATIONAL FLUID DYNAMICS III  
Semester Hours: 3  
Grid generation techniques with structured and unstructured meshes, adaptive meshes, domain decompositions, and parallel processing. Applications of generated meshes to any one of the following problems: turbulence, combustion, acoustics, radiation, multiphase flows, or magnetohydrodynamics. Prerequisite: MAE 723.

MAE 726 - ROTORCRAFT COMPUT FLUID DYNAMICS  
Semester Hours: 3  
Full potential, Euler, Navier-Stokes approaches, structural and unstructured grids, wake capturing, turbulence, and acoustics.

MAE 740 - AEROTHERMODYNAMICS  
Semester Hours: 3  
Description of the dynamic and thermal fluid flow environments associated with hypervelocity vehicles and propulsion systems with emphasis on thermochemical nonequilibrium behavior. Topics include thermostatistical basis for internal energies, specific heats and shock strengths in dissociated and ionized gases; formulation of reacting flow conservation equations; and recent experimental advances in aerothermodynamics.

MAE 741 - STATISTICAL THERMODYNAMICS  
Semester Hours: 3  

MAE 745 - COMBUSTION II  
Semester Hours: 3  
Droplet evaporation and burning, introduction to turbulent flow, turbulent diffusion and premixed flames, burning of solids, pollutant emissions, and detonation. Prerequisite: MAE 645.

MAE 746 - CONVECTIVE HEAT TRANSFER  
Semester Hours: 3  
Advanced theory of convective transport processes in fluids, including transport of momentum and energy in laminar flow, boundary layers and turbulent transport in shear flow. Engineering applications include boiling and two phase processes.
MAE 748 - RADIATIVE TRANSFER  
Semester Hours: 3
Physics and modeling of radiative transfer. Scattering, remote sensing, and absorption in participating media. Infrared through optical wavelengths. Computational methods in radiative transfer.

MAE 749 - MASS TRANSPORT  
Semester Hours: 3
Mass transfer in solid and fluid systems under steady and transient conditions. Integration of momentum, heat and mass transfer equations with application to reactive, rheological and multicomponent systems.

MAE 751 - BOUNDARY LAYER THEORY  
Semester Hours: 3
Development of boundary layers using singular perturbation theory. Curvature and compressible effects and the order of their importance. Modern applications and computational approaches.

MAE 752 - MECH OF RARIFIED GASES  
Semester Hours: 3
Application of kinetic theory to rarefied gas-flow problems. Boltzmann statistical distribution; gas-surface interaction, transport properties, free molecule flow; heat-free molecule flow; procedures for non-equilibrium flows. Offered upon demand.

MAE 753 - MAGNETO-GAS DYNAMICS  
Semester Hours: 3
Equations of motion for ionized gases with critical analysis of transport properties in steady and varying electric and magnetic fields. MHD shock waves and radiation effects.

MAE 754 - HYPersonic FLOW  
Semester Hours: 3
Theories for treating the laminar and turbulent boundary layers of reacting fluids, mixtures, related chemical, thermodynamic, and physical phenomena in hypersonic flows. Leading edge bluntness, shock wave interactions, and vorticity effects.

MAE 755 - ADVANCED AERODYNAMICS  
Semester Hours: 3
Transonic, supersonic, and hypersonic flows. Application of compressible potential theory, similarity rules, slender body theory and Newtonian flow theory to the analysis of aerodynamics of aircraft, missiles, re-entry vehicles, and other flight vehicles.

MAE 756 - NUM SIM OF MAGNETOHYDRODYNAMIC  
Semester Hours: 3
Finite difference methods for simulation of MHD flows. Methods include explicit scheme, FICE methods, LBL, ADI, artificial damping and projected characteristics for multidimensional timedependent flow.

MAE 757 - OPT TECH/FLUID MECHANICS  
Semester Hours: 3
Laser sources, molecular interactions with light and diatomic spectroscopy needed fluorescence, Brillouin scattering, four wave mixing, CARS and other applications in optical fluid diagnostics. (Same as CHE 757.).

MAE 758 - TURBULENCE  
Semester Hours: 3
Turbulence in gases and liquids; boundary layers, atmospheric phenomena. Prerequisites: MAE 651 and MAE 671.

MAE 760 - ANALY METH NONLIN DYNAM  
Semester Hours: 3
Application of averaging methods and perturbation methods to vibrations of nonlinear systems. Analysis of linear systems with periodic coefficients (Floquet theory). Elements of stability theory, Lyapunov functions, and Liapunov's direct method. Prerequisites: MAE 660 and MAE 661.

MAE 762 - WAVE MOT/CONT ELAS BODIES  
Semester Hours: 3
Elements of stress wave propagation in bounded elastic media. Propagation of elastic waves in infinite and semi-infinite bodies, cylinders, rods and beams. (Same as CE 762.).
MAE 765 - RANDOM VIBR/ELASTIC SYSTEMS  
Semester Hours: 3


MAE 768 - DYN AEROSPACE VEHICLES  
Semester Hours: 3

Elements of advanced rotational kinematics of rigid bodies. Attitude motion of space vehicles in circular and elliptic orbits. Methods of gravitation and spin stabilization of gyrostat.

MAE 772 - THEORY STRUCT STABILITY  
Semester Hours: 3


MAE 773 - THEORY OF SHELLS  
Semester Hours: 3

Analysis of thin plates and shells including higher order approximation theories and transverseshell deformations. Illustration of theories by selected problems. (Same as CE 773.)

MAE 774 - FINITE ELEM ANALY II  
Semester Hours: 3

Advanced topics in finite element analysis; application to nonlinear partial differential equations in continuum mechanics; theoretical studies of convergence and stability of solutions. (Same as CE 774.) Prerequisite: MAE 674.

MAE 776 - TH FIN ELAST FIN VISCOEL  
Semester Hours: 3

Theory of finite deformation analysis for elastic and viscoelastic materials. Constitute models are developed for a functional analysis approach leading to models based on the Cauchy-Green Deformation Tensor and the Strain Energy Density Function. Models discussed include: Mooney-Rivlin and Bernstein-Kearsley-Zappas.

MAE 778 - FRACTURE MECHANICS  
Semester Hours: 3

Theory of crack propagation, stress intensity factors, mapping techniques, series expansion, asymptotic approximations, field singularities, integral transforms, numerical solutions. (Same as CE 778.) Prerequisite: MAE 672.

MAE 780 - THEORY OF ACOUSTICS  
Semester Hours: 3

Simple harmonic oscillators, damped and forced oscillators, 1-D wave equation, vibration of a string, 2-D wave equation, vibration of membranes, the acoustic wave equation, plane waves, cylindrical and spherical waves, reflection and transmission, radiation and reception of acoustic waves, absorption and attenuation of sound, cavities and wave guides, and architectural acoustics. Prerequisite: MAE 692.

MAE 781 - NONLINEAR EFFECTS/PLASMA  
Semester Hours: 3

Fundamental physical concepts and methods of estimating various nonlinear interactions in plasmas. Analytical and numerical methods to deal with these problems.

MAE 782 - PLASMA TURBULENCE  
Semester Hours: 3

Methodology that deals with plasma turbulence together with current numerical techniques to solve these problems approximately, via super-computing.

MAE 795 - SELECTED TOPICS MECH & AERO EG  
Semester Hours: 1-9

MAE 799 - DOCTORAL DISSERTATION  
Semester Hours: 3-9

Required each semester student is enrolled and receiving direction on doctoral dissertation.
Nursing (NUR)

NUR 500 - SPECIAL TOPICS
Semester Hours: 2-4

Advanced study of a selected area of interest in nursing.

NUR 518 - GLOBAL HEALTH: INTERN'L STUDY
Semester Hours: 3

This course will focus on a selected international health care system. The international system will be compared with the US Health Care System in relation to economic, social, cultural, policy, and environmental influences. Culmination of the course will center on international experiences with health care facilities, policy making bodies, historical, and cultural introductions in another country.

NUR 524 - HEALTH CARE AND THE LAW
Semester Hours: 3

Introduction to basic health law in the context of application to nursing practice. Content relates to involvement with legal principles in nursing and healthcare. Federal, state and local aspects of law are included. (Cross listed with NUR 424).

NUR 525 - HUMAN SEXUALITY
Semester Hours: 3

Theory and issues related to human sexuality in health and illness. Emphasis on theory and values, clarification of human sexuality needs. Elective, open to all university students. (Cross listed with NUR 425).

NUR 526 - CONS:WKG W/IND & GRP COMM APPR
Semester Hours: 3

This course presents consultation as a process of interacting with individuals and groups to resolve issues related to clients and/or the delivery of health care. Students explore the consultation process, group dynamics, application-oriented approaches and strategies, and professional issues. The focus is on communication as the key to developing successful relationships.

NUR 527 - INTRO TO FORENSICS IN NURSING
Semester Hours: 3

This course is designed to provide basic theoretical knowledge related to nursing care of the donor/transplantation client and their families. Course content focuses on historical and current issues in donor/transplantation nursing including the impact of legal, ethical, political, economic, and socio-cultural issues. Students will examine the roles of the professional nurse and the interdisciplinary team in the management of care for the donor/transplant client and their families. Topics of future research and critical thinking will be discussed.

NUR 528 - GERONTOLOGICAL NURSING
Semester Hours: 3

Nursing care of older adults in multiple settings. Issues and trends are incorporated.

NUR 530 - HLTH CARE WKF:ISS/LDERSH STRAT
Semester Hours: 3

Description and analysis of contemporary issues regarding the health care workforce. Particular focus will be placed on the multifaceted nature of health care workforce shortages. Various models for analysis of workforce issues will be used and strategies being used will be examined. An evaluation of the nurse leader role in creating positive work environments and implementing solutions conclude the student experience.

NUR 534 - PALLIATIVE CARE
Semester Hours: 3

Palliative care is when there is no longer a medical treatment or cure for a physical problem. This palliative care course includes meeting the physical, emotional, social, cultural, and spiritual needs of individual and their families. A course focus will be on coping, grief, bereavement, pain relief and managing living implications for individuals with life-threatening illnesses. There will be recognition of the importance of individuality, vulnerability, and resilience in the quality of living during the dying process.

NUR 537 - NURSING AS A POLITICAL FORCE
Semester Hours: 3

The course explores the historical, current, and future impact of nursing on the political process. Local, state, national, and international aspects of nursing as a political force are analyzed. Emphasis is on political systems, regulatory processes, and organizational issues influencing health care delivery. Elective, open to all university students.
NUR 539 - NURSING MEDICAL MISSIONS  
Semester Hours: 3

This course will focus on global health and humanitarian concepts and issues, and the nursing care needed to impact those issues. These issues will be examined and analyzed in relation to the mission country’s economic, social, cultural, policy, and environmental influences. Culmination of the course will center on international experiences with supervised nursing care for a medical mission in another country. This course is an accepted elective in the Nursing Program. Additional work is required for graduate credit.

NUR 540 - ONCOLOGY NURSING  
Semester Hours: 3

This course provides a holistic approach to the nursing care of people with cancer. The nursing process is used as the basis for promoting health and facilitating adaptation in the person with cancer. The course includes clinical experiences in selected agencies.

NUR 550 - ISSUES IN TRANSPLANTATION  
Semester Hours: 3

This course is designed to provide basic theoretical knowledge related to nursing care of the donor/transplantation client and their families. Course content focuses on historical and current issues in donor/transplantation nursing including the impact of legal, ethical, political, economic, and socio-cultural issues. Students will examine the roles of the professional nurse and the interdisciplinary team in the management of care for the donor/transplant client and their families. Topics of future research and critical thinking will be discussed.

NUR 601 - THEORETICAL PERS ADV NUR PRAC  
Semester Hours: 3

NUR 602 - SCHOLARLY INQ ADV NUR PRAC  
Semester Hours: 3

Includes discussion of philosophical and theoretical bases of nursing research and the application of research findings to practice. Development of a research problem, including problem identification, evaluation of current knowledge, and the selection of an appropriate research approach. Focuses on research methodologies, both quantitative and qualitative, as they relate to data collection, data analysis including both interpretive and statistical strategies, and discussion of findings. Proposal generation and research funding mechanisms are included.

NUR 604 - HEALTH POLICY  
Semester Hours: 3

Local, state, and national health care policies, with emphasis on political systems, regulatory processes, and organizational issues influencing health care delivery. Elective; open to university students.

NUR 605 - ADVANCED HLTH ASSESSMENT  
Semester Hours: 3

This course provides an opportunity for the advanced practice nurse to utilize theoretical and evidence-based clinical practice guidelines to conduct a comprehensive and systematic assessment as a foundation for decision making in caring for clients across the lifespan.

NUR 605L - CLINICAL EXPERIENCE  
Semester Hours: 0

NUR 606 - PATHOPHYSIOLOGY  
Semester Hours: 3

Expands upon previous knowledge of anatomy, physiology, and developmental disease processes. Anticipated physiological alterations are discussed as they affect individuals throughout the lifespan.

NUR 607 - PHARMACOLOGY IN ADV PRAC  
Semester Hours: 3

This course is designed to provide the advanced practice nursing student with clinical reasoning skills necessary to analyze data obtained from findings of the patient health history, advanced physical and pharmacological assessment of patients across the lifespan. The student will utilize the findings to determine the appropriate treatment regimen based on the individual needs of the patient.

NUR 610 - FAMILY NURSE PRACTITIONER I  
Semester Hours: 6

This clinical course introduces the roles of the advanced practice nurse in direct and indirect health services for assessment, health promotion, illness prevention, and health management of patients across the lifespan. Prerequisite: NUR 605 and NUR 606 (concurrently).

NUR 610L - CLINICAL EXPERIENCE  
Semester Hours: 0
NUR 611 - FAM NURS PRACTITIONER II  
Semester Hours: 6  
This course encourages the advanced practice nurse to integrate principles of advanced practice nursing into broad organized, culturally appropriate planning, delivery, management, and evaluation in prevention and services of health through the lifespan/identified populations.

NUR 611L - CLINICAL  
Semester Hours: 0

NUR 612 - FAMILY NUR PRACTITIONER III  
Semester Hours: 6  
This course encourages the advanced practice nurse to define principles of advanced practice nursing including interventions that influence favorable health outcomes for common conditions through the lifespan/identified populations in collaboration with other health professionals. Prerequisites with concurrency: NUR 606 and NUR 607.

NUR 612L - CLINICAL EXPERIENCE  
Semester Hours: 0

NUR 613 - FAM NURS PRACTITIONER IV  
Semester Hours: 6  
This is the culminating primary care clinical course in which the advanced practice student initiates and maintains effective working relationships, appraise policy development and systems organization, establishes respectful communication within inter-professional groups with skills and care coordination, delegation and initiation of conflict resolution strategies. Prerequisites: NUR 610, 611, & 612.

NUR 613L - CLINICAL EXPERIENCE  
Semester Hours: 0

NUR 614 - FAMILY NURSE PRACTITIONER V  
Semester Hours: 3  
First of two culminating courses/seminar/clinical practicum in the family nurse practitioner certificate program. The clinical practicum will be completed in a primary care setting. Classroom seminar focuses on the role, trends, and health policy issues facing the family nurse practitioner. Prerequisite: NUR 610.

NUR 614L - CLINICAL EXPERIENCE  
Semester Hours: 0

NUR 615 - FAMILY NURSE PRACTITIONER VI  
Semester Hours: 3  
The culminating course/seminar/clinical practicum in the family nurse practitioner certificate. The clinical practicum will be completed in a primary care setting. Classroom seminar focuses on the role, trends, and issues facing the family nurse practitioner.

NUR 615L - CLINICAL EXPERIENCE  
Semester Hours: 0

NUR 620 - ADLT GER ACUTE CR NUR PRACT I  
Semester Hours: 6  
This is the culminating adult gerontology acute care clinical course in which the advanced practice student initiates and maintains effective working relationships, establishes respectful communication within inter-professional groups with skills and care coordination delegation, and initiation of conflict resolution strategies. Prerequisites with concurrency: NUR 602, NUR 605, NUR 606, NUR 607 Prerequisites: NUR 621, NUR 622, NUR 623.

NUR 620L - CLINICAL EXPERIENCE  
Semester Hours: 0

NUR 621 - ADLT GER ACUTE CR NUR PRACT II  
Semester Hours: 6  
This course allows the advanced practice nurse to refine principles of advanced practice nursing into the delivery of broad, organized, culturally appropriate planning, delivery, management, and evaluation of evidence based care of complex, acute critically and chronically ill diverse patients across the entire spectrum of adulthood. Prerequisites w/ concurrency: NUR 606 or NUR 607 or NUR 620.

NUR 621L - CLINICAL EXPERIENCE  
Semester Hours: 0
NUR 622 - ADLT GER ACUTE CR NUR PRAC III  
Semester Hours: 6  
Clinical course in care of adult patients with acute alterations in health in the hospital, home, or clinic setting focusing on the concept of managed care. Within a selected product line, the practitioner will develop protocols, care for and evaluate care for patients and practice consulting with client groups.  
NUR 622L - CLINICAL EXPERIENCE  
Semester Hours: 0  
NUR 623 - ADLT GER ACUTE CR NUR PRAC IV  
Semester Hours: 6  
Culminating course in the acute care nurse practitioner track. Student will complete a clinical residency in a selected acute care area/specialty. Classroom theory will focus on the role and legal trends and issues facing the acute care nurse practitioner. Prerequisites: NUR 620, NUR 621, NUR 622.  
NUR 623L - CLINICAL EXPERIENCE  
Semester Hours: 0  
NUR 629 - US HEALTHCARE SYSTEM  
Semester Hours: 3  
The focus of this course is to explore the structure and complexity of the US health care system. Content will include underlying values, major historical developments, reimbursement methods, stakeholders, and issues driving reform. Prerequisite w/ concurrency: NUR 630.  
NUR 630 - FND CONCEPTS NURSING ADMINATOR  
Semester Hours: 3  
This course focuses on the Nurse Administrator's relationships and roles in a variety of health care systems. Theories of management and organization are analyzed from the perspective of structure, communication, dynamics, trends, and key management, responsibilities, and functions in health care delivery systems.  
NUR 631 - LEADERSHIP HUMAN RESRC MGMT  
Semester Hours: 3  
This course focuses on the role of the nurse leader in resource allocation and management in health care systems and related organizations. Content related to human resource management includes workforce development, the healthcare workforce, recruitment, selection, retention, development, and labor relations.  
NUR 632 - ECONOMIC AND POLICY IMPLICATIONS FOR LEADERS IN HEALTH CARE SYSTEMS  
Semester Hours: 3  
This course focuses on economic and financial implications for nurse administrators with emphasis on executive level budget management and business planning skills. The course is designed to assist nurse administrators in gaining conceptual knowledge regarding budgeting in health systems and policy factors impacting cost, quality and access to healthcare.  
NUR 634 - INTERNSHIP IN NURS LEADERSHIP  
Semester Hours: 3  
This is the culminating course that provides opportunities to synthesize leadership learning, administrative theory, and operational skills in budgeting and finance, and resource management. This knowledge is applied through the identified nurse executive competencies in selected health care related organizations. Course objectives reflect the AONE competencies and QSEN standards. Clinical hours 3, Contact hours 135 Prerequisite: NUR 633.  
NUR 634L - CLINICAL EXPERIENCE  
Semester Hours: 0  
NUR 636 - BUDGETING IN HEALTH CARE SYS  
Semester Hours: 3  
This course is designed to assist nurse leaders in gaining conceptual knowledge regarding budgeting in health systems. The focus is on planning and controlling budgets. Topics include knowledge related to executive level budget management and business planning. Prerequisite: NUR 632.  
NUR 637 - CASE MGMT IN HEALTH CARE SYS  
Semester Hours: 2  
This course is designed as an introduction to health care delivery through case management model. The course focuses upon basic foundational information targeting the professional nurse's role in case management. Various types of case management are discussed and analyzed. The impact of managed care to case management and other care delivery methods is explored for a changing health care delivery system. Fiscal, ethical/legal and clinical implications of case management are considered.
NUR 638 - INFORMATICS NRSE ADMINISTRATOR  
Semester Hours: 1-6  
The focus of this course is on the structuring and processing of health information for making decisions in health care.

NUR 640 - CURRICULUM DEV IN NURSING  
Semester Hours: 3  
Principles and concepts of curriculum development are examined with respect to their application to development of both the theoretical and clinical components of nursing programs. Includes principle regarding theories of learning, the changing nature of knowledge and societal needs as basic considerations directing curricular planning and revision.

NUR 641 - TEACHING/LEARNING IN NURSING  
Semester Hours: 3  
Emphasis is on the development of classroom and clinical laboratory teaching skills and includes a critical appraisal of specific teaching strategies. The student is provided the opportunity to acquire knowledge in the use and design of common and innovative teaching methods including web-based and interactive delivery systems.

NUR 642 - TESTING & EVALUATION IN NURS  
Semester Hours: 3  
Major emphasis on the development of classroom and clinical skills in appraisal and evaluation methods of student performance. The student is provided with the opportunity to acquire skills in constructing various types of testing and evaluation (formative and summative) procedures as they relate to nursing education.

NUR 643 - FACULTY ROLE DEV IN NURSING  
Semester Hours: 3  
Role theory serves as the basis for the discussion and practice in developing teaching, service and research role of a faculty member in a nursing program. Discussion on legislative and professional agencies issues and policies impinging on the teaching role.

NUR 644 - PRACTICUM IN TEACHING  
Semester Hours: 3  
Opportunities to do practice teaching with nursing students in various phases of their basic educational programs. Learning activities will be planned on an individual basis and based on the specific teaching responsibilities of their primary course assignment. Selected baccalaureate degree and/or associate degree programs will be used as practice sites. Prerequisites with concurrency: NUR 640, NUR 641, NUR 642.

NUR 645 - CAPSTONE NURS EDUC CERTIF CRS  
Semester Hours: 3  
The major emphasis of this capstone education course is the development of the professional teaching role within an institutional setting. The focus is on the student's ability to function as a professional leader utilizing knowledge gained to promote change, engage in professional activities; promote continuous improvement; and serve as a mentor in an educational environment. Prerequisites: NUR 640, NUR 641, NUR 642, NUR 643, NUR 644.

NUR 647 - STRATEGIC PLANNING  
Semester Hours: 3  
The focus of this course is to prepare Nursing Administration graduate students to comprehend and actively engage in organizational strategic planning. Emphasis is on the development of organizational blueprints, tracking current trends, forecasting, and innovative strategies in healthcare to achieve an organization's mission and vision, thus remaining competitive in the healthcare industry. Prerequisite w/ concurrency: NUR 630.

NUR 648 - CONCEPTS OF HLTH ASMNT & PROM  
Semester Hours: 3  
This course focuses on concepts in health assessment and health promotion for individuals and populations. This course is designed for nurses preparing for leadership roles in healthcare organizations. Prerequisite w/ concurrency: NUR 630.

NUR 649 - QUALITY, SAFETY, & RISK MGMT  
Semester Hours: 3  
This course focuses on the quality, safety, and risk management concepts for nurse leaders. Content includes the use of quality tools and use of data to evaluate and promote quality outcomes. Prerequisite w/ concurrency: NUR 630.

NUR 650 - INDEPENDENT STUDY  
Semester Hours: 2-4  
Planning, implementation, and evaluation of related phenomena of special interest observed in nursing practice.
NUR 660 - ADLT GERONT CNS I
Semester Hours: 6

Primary focus is on nursing care of adults and families with long-term alterations in health. Subroles of the advanced practice nurse are introduced and reinforced. Theory concerning adult development, health promotion, and disease prevention practices, identifying populations at risk, cultural and environmental diversity issues, provides the background knowledge used by the student in giving care to patients/families in a variety of settings. Patient and caregiver needs and care interventions are central as the student practices the role of clinician caring for adults with chronic problems. Prerequisites: NUR 605, NUR 606.

NUR 660L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 661 - ADLT GERONT CNS II
Semester Hours: 6

Care management of the adult patient in the hospital or community setting. Rural and other vulnerable populations are of major concern. Health policy, fiscal regulations, and differing health delivery systems serve as points of discussion. Clinical experiences with vulnerable and underserved populations primarily in rural settings. Prerequisites: NUR 660 and either NUR 606 or NUR 607.

NUR 661L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 662 - ADLT GERONT CNS II
Semester Hours: 6

Advanced nursing care of adults of diverse populations in secondary or tertiary settings. Emphasis on special needs and advanced nursing care of adults with acute health alterations. Student clinical experiences are therapeutic nursing interventions with acutely ill patients with complex health problems.

NUR 662L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 663 - ADLT GERONT CNS IV
Semester Hours: 6

Culminating residency course where the student uses the sub-roles of the advanced practice nurse?clinician, teacher, manager, researcher, consultant, in providing direct and indirect care to the adult patient. Legal, ethical, and licensing issues affecting the role of the advanced practice nurse are points of classroom discussion, along with current issues and trends. Theories concerning ethical decision making, consultation, leadership, and methods of research utilization enhance the student?s practice. The clinical placement should strengthen the student?s area of concentration developed with the faculty advisor. Prerequisites: NUR 660, NUR 661, NUR 662.

NUR 663L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 670 - HUMAN FACTORS HEALTHCARE COMPU
Semester Hours: 3

Overview of epidemiologic methods with discussion of application to diagnosis and choice of therapy. Concepts and mechanisms related to transmission, acquisition of disease, trends and distribution of patterns of disease discussed. The application of epidemiology to human health problems and rural settings is emphasized. Prerequisite: NUR 638.

NUR 671 - USABILITY EVAL HEALTHCARE I.T.
Semester Hours: 3

This course examines usability methods for the design and testing of healthcare information technology including health information websites, electronic health records, clinical decision support systems, and medical equipment with an emphasis on the user experience. The iterative nature of user-centered design and usability testing of health IT will be emphasized. Prerequisite: NUR 679.

NUR 672 - EBP ADVANCED NURSING PRACTICE
Semester Hours: 3

This course focuses on developing the advanced practice nurse to critique and synthesize evidence for nursing for the purpose of improving healthcase outcomes. Emphasis is on the critical analysis of evidence to be used in formulating of information technology, data from practice, databases and research methods to appropriately generate evidence for advanced nursing practice. Prerequisite: NUR 602.
NUR 680 - CLINICAL NURSE LEADER I
Semester Hours: 6

This course will introduce key concepts that impact today’s healthcare environment and patient population as well as relevant quality management tools that improve patient care delivery and outcomes. In addition, the role of the clinical nurse leader will be explored.

NUR 680L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 681 - CLINICAL NURSE LEADER II
Semester Hours: 6

NUR 681L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 682 - CLINICAL NURSE LEADER III
Semester Hours: 6

Advancing nursing care of adults of diverse populations in secondary or tertiary settings. Emphasis on special needs and advanced nursing care of adults with acute health alterations. Student clinical experiences are therapeutic nursing interventions with acutely ill patients with complex health problems.

NUR 682L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 683 - CLINICAL NURSE LEADER IV
Semester Hours: 6

NUR 683L - CLINICAL EXPERIENCE
Semester Hours: 0

NUR 698 - PLAN II: OTHER RES ACTIVITIES
Semester Hours: 1-4

Application of activities appropriate to student program of study. Intended to expand student knowledge and enhance track specific content.

NUR 699 - PLAN I: THESIS
Semester Hours: 1-4

Independent research investigation related to practice of nursing under faculty guidance. Minimum of six hours required. Prerequisite: NUR 602.

NUR 700 - CLINICAL DATA MGT & ANALYSIS
Semester Hours: 3

This required course provides students with the knowledge base to understand, collect, manage, and measure clinical data. Students will explore data collection and management processes, levels of measurement, basic statistics, and measurement for improvement in order to effectively use clinical data. Data entry exercises employed through analytical tools and statistical software packages will allow the students practice and apply the basic data management and analysis skills needed for the evaluation of clinical data and evidence-based practice.

NUR 701 - WRITING FOR PUBLICATION
Semester Hours: 3

This course concerns the development of skills in writing, editing, and preparing manuscripts for publication from initial idea to submission of a publishable manuscript. The course emphasizes a writing process that encourages productivity and collegial peer review. Legal and ethical aspects of authorship prepare students for responsible practices expected of scholars. Students should have mastered basic writing skills, e.g. grammar, syntax, and computer skills, prior to enrolling in this course.

NUR 729 - EVID BASED PRACT DESGN & TRANS
Semester Hours: 3

The purpose of this course is to provide students with models for evidence-based practice (EBP) design and improvement translation. Students learn to formulate clinical questions in answerable format, and search for and identify best research evidence. The focus of the course is to evaluate and critically appraise evidence for rigor and applicability to the clinical problem and is designed to improve clinical outcomes. Students will translate evidence into practice environments for safe, quality care. Students will gain access to information that will support optimal clinical decision-making. Improvement translation sciences will also be introduced.
NUR 731 - PHIL/THEOR/CONC FOUN FOR APN
Semester Hours: 3
This required core course in the Doctor of Nursing Practice program provides an understanding of the use of theory and conceptual foundation to guide the complexity of specialty nursing practice at the doctoral level. The content is derived from the philosophical and scientific underpinnings of nursing, natural, and psycho-social sciences.

NUR 733 - INFORMATICS FOR APN
Semester Hours: 3
This required core course in the Doctor of Nursing Practice program focuses on the collection, organization, analysis, and dissemination of information in nursing and health care. Students are introduced to the specialty of nursing informatics, the information system life-cycle telemedicine, and the use of technology to enhance nursing care delivery and patient safety. Also, students learn how to design, use, and manipulate large and small patient databases for the analysis of patient outcomes.

NUR 734 - ADVANCED EXPERIENTIAL CLINICAL
Semester Hours: 1-7
This course is designed to validate Master's level competencies in clinical and organizational leadership. The course is required for post-master's DNP students who are graduates of programs in nursing with less than 500 clinical hours. The course is a pre-requisite to NUR 739 Scholarly Project.

NUR 735 - POPULATION HEALTH IN APN
Semester Hours: 3
This required core course in the Doctor of Nursing Practice program prepares the student to implement specialty population-based disease prevention and health promotion activities to achieve national and international goals of improving worldwide health status. The course focuses on a spectrum of issues affecting health which includes emerging infectious diseases, emergency preparedness, disparities in health and healthcare services, and the impact of behavior and lifestyle choices.

NUR 737 - INTDIS LDRSHP/ROLE DEV PRA EXC
Semester Hours: 3
This course is a required core course in the Doctor of Nursing Practice program that focuses on organizational and systems leadership and knowledge and skills critical to role development in independent and inter and intra-disciplinary practice. Content includes communication, conflict resolution, collaboration and negotiation, leadership, and team-functioning to maximize success in the establishment of safe, effective patient-centered care in complex environments.

NUR 738 - DNP PROJECT DEVELOPMENT
Semester Hours: 3
This course is a 2-hour seminar designed to assist the student in selecting an area of interest within a practice specialization and in demonstrating professional competencies related to that area of interest. The student will document previously acquired abilities and competencies in a professional portfolio. Students will participate in the seminar to obtain guidance and receive peer suggestions about the portfolio and project plans. Prerequisites: NUR 742 and NUR 743.

NUR 739 - DNP PROJECT
Semester Hours: 1-7
This is the capstone clinical course in all advanced practice tracks. The student presents evidence of achievements and competencies in a professional portfolio. The practice residency is completed in a specialty area of the student's choice. This course focuses on aspects of the final practice project and interventions that promote health, prevent illness and disability, and alleviate health disparities. The final project selected and planned by the student and advisor is implemented during this course. The student completes the project, evaluates the outcomes, disseminates findings, and makes a formal, scholarly presentation to peers and faculty. Prerequisite: NUR 738.

NUR 740 - HLH POLIC/POLIT:IMPLICATION HC
Semester Hours: 3
This course prepares students to assume complex leadership roles in order to advance specialty practice and health. This course focuses on the unique challenges of engaging and influencing health care policy in the U.S. and internationally. It is designed to develop skills, techniques, and approaches to the critical analysis of health policy proposals, health policies and related stakeholder in policy and public forums. The health policy framework is analyzed from a governmental, institutional and organizational perspective.

NUR 742 - PROGRAM EVAL & METHODS
Semester Hours: 3
The purpose of this course is to synthesize knowledge related to translation/implementation science models and strategies to improve health outcomes. The emphasis in the course is the use of program evaluation as a strategic planning tool to achieve positive changes in health status, to initiate quality improvement, to engage in risk anticipation, management and to facilitate organizational and system level changes. Prerequisite: NUR 738.
NUR 743 - EVID BASED PRACT STRATEGIES
Semester Hours: 3

Is a required course in the Doctor of Nursing Practice program, which expands on evidence-based practice concepts to refine a problem statement and derive a searchable and answerable clinical question. Content includes conducting a systematic review of the literature to guide the selection of methods, strategies, tools and metrics needed to complete a successful scholarly project. The course also addresses targeted strategies for disseminating evidence associated with scholarly projects. Prerequisites: NUR 729, NUR 738.

Optical Science Engineering (OSE)

OSE 506 - COMMUNICATION THEORY
Semester Hours: 3


OSE 534 - OPTICAL FIBER COMMUNICATIONS
Semester Hours: 3

Introduction to optical fibers and their transmission characteristics, optical fiber measurements, sources and detectors, noise considerations for digital and analog communications, optical fiber systems.

OSE 541 - GEOMETRICAL OPTICS
Semester Hours: 3

Foundations and physics of geometrical optics, Fermat’s principles and Huygen wavelets, refraction and reflection. The many forms of Snell’s Law. Optical path lengths, geometrical wavefronts and rays. Ray tracing, ynu-chart and matrix methods. Gaussian imagery and paraxial optics, conjugate elements, cardinal points, and image-object relations. Stops and pupils, chief and marginal rays, vignetting, and the optical or Lagrange invariant. The y-y bar diagram, design of common systems: objectives, magnifiers, microscopes, collimators and detectors. Optical glasses and chromatic aberrations, wavefront and transverse aberrations, spot diagrams and ray fan plots.

OSE 542 - PHYSICAL OPTICS
Semester Hours: 3

Scalar and electromagnetic waves, polarization, coherence, reflection and refraction; two beam and multiple beam interference, interferometers, Fabry-Perots, thin films, diffraction, and absorption and dispersion. (Same as OSE 542 and EE 542.) Fall, Spring.

OSE 546 - RADIOMETRY, DETECTORS & SOURCE
Semester Hours: 3

Theory and practice of radiometry and photometry. Blackbody radiation and Lambertian sources. Propagation of radiant energy in free space and through optical systems. Detector classes, responsivity, bandwidth and noise, power spectral density, properties of sources, photon noise.

OSE 555 - INTRO QUANTUM MECHANICS I
Semester Hours: 3

Waves and particles; Bohr’s model of the atom; de Broglie waves, wave packets and the uncertainty principle; postulates of quantum mechanics; Schroedinger’s equation; simple systems in one, two and three dimensions; the hydrogen atom.

OSE 632 - FOURIER OPTICS
Semester Hours: 3

Introducing the optical system as an invariant linear system, convolution, Sommerfeld’s diffraction integral, Fourier Transform, angular spectrum, coherent & incoherent imaging, optical transfer function.
OSE 645 - LASERS
Semester Hours: 3


OSE 653 - OPTICAL TESTING LAB
Semester Hour: 1

Provides students with hands-on experience via the in-depth testing of an aerial reconnaissance photographic lens. The main measurement tools are a 168-inch Collimator/T-Bar nodal slide for image plane measurements, and a Fizeau phase shifting interferometer for exit pupil measurements. Measurements include: effective focal length, F-number, axial color, spherical aberration, field curvature, distortion, astigmatism, transmission, relative illumination falloff, resolution, modulation transfer function, on-axis interferometry, fringe analysis. Prerequisite: OSE 654.

OSE 654 - OPTICAL TESTING
Semester Hours: 3

Spherometry; refractive index measurements; optical bench measurements of imaging systems via T-bar nodal slide (effective focal length, f-number, axial color, field curvature and distortion, transverse ray aberrations); illumination falloff; image resolution tests (finite object); modulation transfer function; star image testing; knife edge tests; Hartmann tests; Fizeau interferometer and testing configurations; null lens testing of aspheres; wavefront measurements (point diffraction interferometer, radial shear interferometer). Prerequisites: OSE 541 and OSE 542.

OSE 655 - APPLIED QUANTUM MECHANICS
Semester Hours: 3

Application of quantum mechanics in solid state, electronics, materials science and optics. Topics to include: Hydrogen atom and molecule, excitons, phonons, Bloch’s theorem, periodic boundary conditions, electrons and holes, band structure of simple semiconductors, dipole transitions, optical constants, absorption and emission processes, introduction to device physics.

OSE 656 - LENS DESIGN
Semester Hours: 3

Design of refractive imaging systems. Skills acquired include thin lens pre-design, first and third order analytical methods, and computer-based design using Zemax. Designs include: Wollaston and Chevalier landscape lenses, a 10X microscope objective, the Rapid Rectilinear and Celor lenses, Cooke triplet and Petzval portrait lenses, and a telephoto lens. Prerequisites OSE 541 or EE 541 or PH 541 or Permission of Instructor.

OSE 670 - OPT DESIGN & MANUFACTURING
Semester Hours: 3

Practical aspects of optomechanical design, material selection, fabrication and integration of precision optical components and systems for commercial, space, and military application. Topics include: fixture design, tolerance analysis, machining methods, thermal stabilization, integrated computer-aided design and analysis, diamond machining, finishing and plating techniques.

OSE 690 - SEL TOPICS IN OPT SCI & ENGR
Semester Hours: 1-3

Sample topics include optical thin films and optical instrument systems analysis.

OSE 710 - OPTICAL SYSTEM DESIGN
Semester Hours: 3

Integrated view of what it actually takes to build a real optical system. All the tools of the trade are utilized, including conceptual design and computer modeling (optical and mechanical), control system design, fabrication issues, cost/schedule and system testing. Use of geometric and physical optics, radiometry, sources and detectors, electro-optics controlled positioning and feedback, environmental influences, optical systems architecture, optomechanical design, precision optics fabrication technologies, optical metrology, and operational and survivability testing.

OSE 742 - OPTICAL SCATTERING THEORY
Semester Hours: 3

Scattering and absorption of radiation by particles with spherical symmetry and arbitrary shapes described using Maxwell’s equations, vector Helmholtz equations, the Jones and Mueller calculus, and numerical techniques. Prerequisites: PH 631, or EE 609, or ATS 561.

OSE 755 - QUANTUM DEVICES
Semester Hours: 3

Quantum aspects of optical, electronic, and semiconductor devices approached from a phenomenological/physical point of view. Topics will include: Quantum well devices, optical modulators, optical detectors, quantum Stark effects, electrooptic devices, high speed optical devices, frequency chirping in high speed devices and system applications.
OSE 790 - SEL TOPICS IN OPT SCI & ENGR
Semester Hours: 1-3
Sample topics include optical thin films and optical instrument systems analysis.

OSE 792 - OSE SEMINAR
Semester Hours: 0
This "brown bag" monthly seminar series is conducted jointly with the Huntsville Electro-Optical Society which sponsors the speakers. Presentations are given on a diverse range of optics and optics-related topics. All OSE students are expected to attend three of these seminars per semester.

OSE 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9
Required each semester student is enrolled and receiving direction on a doctoral dissertation. The following optics courses are also available to students in the OSE program. See listings under indicated departments.

**Physics (PH)**

PH 531 - INTRO TO PLASMA DYNAMICS
Semester Hours: 3
Single-particle motion in magnetic fields; fluid equations and fluid theory wave modes; MHD theory, stability, and wave modes; introduction to kinetic theory and hot plasma wave modes. (Same as MAE 531).

PH 541 - GEOMETRICAL OPTICS
Semester Hours: 3
Foundations and physics of geometrical optics, Fermat’s principles and Huygen wavelets, refraction and reflection. The many forms of Snell’s Law. Optical path lengths, geometrical wavefronts and rays. Ray tracing, ynu-chart and matrix methods. Gaussian imagery and paraxial optics, conjugate elements, cardinal points, and image-object relations. Stops and pupils, chief and marginal rays, vignetting, and the optical or Lagrange invariant. The y-ybar diagram, design of common systems: objectives, magnifiers, microscopes, collimators and detectors. Optical glasses and chromatic aberrations, wavefront and transverse aberrations, spot diagrams and ray fan plots. (Same as OSE 541 and EE 541.) Fall.

PH 542 - PHYSICAL OPTICS
Semester Hours: 3
Scalar and electromagnetic waves, polarization, coherence, reflection and refraction; two beam and multiple beam interference, interferometers, Fabry-Perots, thin films, diffraction, and absorption and dispersion. (Same as OSE 542 and EE 542.) Fall, Spring.

PH 544 - OPTOELECTRONICS
Semester Hours: 3
Review of polarized light, the Jones and Mueller calculi. Propagation of light in birefringent material. Modulation of light using electro-optic effect, Kerr effect, acousto-optic effect, and Faraday effect. Elements of photodetection and detectors, signal processing, and signal-to-noise. Design and analysis of beam scanners, optical rf-spectrum analyzer, optical sensors, and optical communication systems. (Same as OPT 444 and OPE 451.) Fall even years.

PH 546 - RADIOMETRY, DETECTORS & SOURCE
Semester Hours: 3
Theory and practice of radiometry and photometry. Blackbody radiation and Lambertian sources. The propagation of radiant energy in free space and through optical systems. Detector classes, responsivity, bandwidth, and noise. Power spectral density, properties of sources, photon noise. (Same as OPT 446, OSE 546.) Spring even years.

PH 551 - QUANTUM MECHANICS I
Semester Hours: 3
Waves and particles; wave packets and the uncertainty principle; Schrodinger's equation and wave mechanics; postulates of quantum mechanics; simple systems in one, two and three dimensions; the hydrogen atom; angular momentum and spin; numerical solutions of the Schrodinger equation. Prerequisites require undergraduate quantum mechanics course(s).

PH 553 - INTRO TO PARTICLE PHYSICS
Semester Hours: 3
Survey of elementary particle physics with emphasis on the Standard Model of quarks, leptons and gauge bosons. Lorentz transformations, four-vectors and relativistic kinematics, angular momentum and spin. Lifetimes, cross-sections and Feynman rules. Quantum electro- and chromo-dynamics, Dirac equation and renormalization. Physics beyond the Standard Model. Prerequisite: PH 551 or PH 651.
PH 560 - INTRO TO SOLID STATE PHYSICS I  
Semester Hours: 3

Crystal binding and crystal structure. Crystal structure determination. Phonons and lattice vibrations. Free electron gas. Electronic energy band theory. Prerequisite with concurrency: PH 551. (Same as MTS 660.) Fall, even years.

PH 561 - INTRO TO SOLID STATE PHYSICS II  
Semester Hours: 3

Thermal properties of solids. Electronic properties, optical properties, electronic properties in a magnetic field, semiconductor devices, magnetism, superconductivity, defects and alloys, dislocations and crystal growth, non-crystalline solids, surfaces and interfaces. (Same as MTS 661.) Spring, odd years. Prerequisite: PH 560.

PH 570 - OPT & PHOTONIC SYSTEMS DESIGN  
Semester Hours: 3

Review of paraxial optics, ray tracing codes, aberration and diffraction calculations; acousto- and electro-optic modulators, spatial light modulators; fibers, fiber splicers and connectors; gratings and diffractive optical elements; laser and light emitting diodes, photodetectors and CCD arrays; correlator systems; optical communication networks; signal processing systems design. Fall, even years. Prerequisite: PH 541.

PH 571 - STELLAR ASTROPHYSICS  
Semester Hours: 3

Structure and physical processes of stars from the interior to the atmosphere: energy production and transfer, atmospheric properties, and observed spectral features. Models for stellar structure. Star formation and evolution, including the effects of a companion. Prerequisites: upper level undergraduate astrophysics course, and upper level undergraduate E&M course.

PH 572 - GALAXIES & COSMOLOGY  
Semester Hours: 3

Galactic structure; Oort's constants; rotation curves; galaxy types; structure formation and evolution; Hubble expansion; Friedmann equation; cosmic microwave background; radiation and matter eras; primordial nucleosynthesis; dark matter/energy issues; development of structure in the early universe; horizon & flatness problems; inflation. Prerequisite: PH 571 or advanced undergraduate Astrophysics course, suggested PH 553, PH 621. Spring, odd years.

PH 574 - INTRO TO GENERAL RELATIVITY  
Semester Hours: 3

An introductory course on general relativity and gravitational physics. General relativistic phenomena as inferred from the behavior of particles and light rays for a selection of spacetimes. Major properties of such objects as black holes, wormholes, gravitational waves, and the universe as a whole. Prerequisites: Undergraduate level special relativity and classical mechanics.

PH 579 - OBSERVATIONAL ASTROPHYSICS  
Semester Hours: 3

Astronomical coordinate systems and time; spherical astronomy; telescope designs; basic optics; CCDs; infrared arrays; observational calibration and noise; high resolution imaging techniques (e.g., adaptive optics); spectroscopy; and high and low energy observational techniques (e.g., X-ray telescopes, radio interferometry). Students will also conceive their own projects, write observing proposals, and convene as a Time Allocation Committee to review proposals and schedule telescope time. Students will acquire, reduce, analyze and interpret data from one of the allocated projects, and present the results in a short paper. Prerequisites: upper-level undergraduate astrophysics courses.

PH 589 - SELECTED TOPICS  
Semester Hours: 3

PH 601 - CLASSICAL DYNAMICS I  
Semester Hours: 3

Variational principles and Lagrangian mechanics, rigid body motion, Hamilton's equations, and theory of small oscillations. Aspects related to modern physics. Fall.

PH 607 - MATHEMATICAL METHODS I  
Semester Hours: 3

Review of vector calculus and coordinate systems, introduction to tensors, matrices, infinite series, complex variables with applications to calculus of residues, partial differential equations, and Sturm-Liouville theory. Orthogonal functions, gamma functions, Bessel functions, Legendre functions, special functions, Fourier series, integral transforms and equations. Prerequisite: upper level undergraduate differential equations courses (s). (Same as MA 607.) Fall.
PH 609 - MATHEMATICAL METHODS II
Semester Hours: 3

Continuation of PH 607. (Same as MA 609.) Spring. Prerequisite: PH 607.

PH 615 - INTRO TO RADIOLOGICAL PHYSICS
Semester Hours: 3
Prerequisite: PH 551.

PH 616 - PHYSICS OF RADIATION THERAPY
Semester Hours: 3

PH 621 - STAT MECH KINETIC THRY I
Semester Hours: 3
Statistical methods, systems of particles, statistical thermodynamics, applications of thermodynamics, methods of statistical mechanics, applications of statistical mechanics, equilibrium between phases of chemical species. Summer.

PH 622 - STAT MECH KINETC THRY II
Semester Hours: 3
Addresses the statistical description of collective processes in gases, plasmas, and fields based on the use of transport theory. The course provides the basis for the mathematical description of the basic kinetic and continuum models used in all fields of solar, space and astrophysics. Addresses specifically the transport of gases and Chapman-Enskog theory, magnetohydrodynamics in a collisional description, energetic particle transport in collisionless plasma, the transport of low-frequency turbulence, and if time permits, the transport of radiation. Prerequisite: PH 621.

PH 631 - ELECTROMAGNETIC THEORY I
Semester Hours: 3
Electrostatic and magnetostatic fields in vacuum and materials, Maxwell’s equations, electromagnetic waves. Prerequisites: upper level undergraduate E&M course(s), PH 607. Fall.

PH 632 - FOURIER OPTICS
Semester Hours: 3
Introducing the optical system as an invariant linear system, convolution, Sommerfeld’s diffraction integral, Fourier Transform, angular spectrum, coherent and incoherent imaging, optical transfer function. Prerequisite PH 542 (Same as OSE 632 and EE 632.) Spring.

PH 636 - INTRO TO SPACE PLASMA PHYSICS
Semester Hours: 3
Electromagnetic fields and particles in space; solar wind and solar energetic particles; currents and plasma waves in space; shocks and particle acceleration mechanisms; solar flares and coronal mass ejections. Spring, even years. Prerequisite: PH 531.

PH 642 - OPTICAL PHYSICS
Semester Hours: 3
Fundamental physics of optics and optical phenomena. Electromagnetic fields, sources and propagation. Coherence, interference, polarization, scattering, reflection, refraction, and diffraction. Optical properties of conductors and insulators. Introduction to quantum optics, lasers, and optical device physics. Offered Spring, even years. Prerequisite: PH 551.

PH 645 - LASERS I
Semester Hours: 3
Incoherent light sources; atomic and molecular energy levels; equation or motion for probability amplitudes using first-order time dependent perturbation theory; electric dipole interaction. Einstein rate equations and the Planck radiation law; induced dipole moments and frequency-dependent susceptibility. Homogeneous and inhomogeneous line broadening mechanisms; laser cavities and modes, elementary laser theory, practical lasers. Prerequisite: upper level undergraduate E&M courses. (This course may be substituted for OSE 645.) Summer.
PH 651 - QUANTUM MECHANICS I
Semester Hours: 3
Free particle motion. Principles of wave mechanics. The Schrodinger equation and one-dimensional potentials. Approximation techniques: WKB, variational method, perturbation theory. Numerical methods. Prerequisites: undergraduate quantum mechanics or modern physics, some high-level programming (e.g., C++, Fortran, Mathematica) experience. Prerequisite with concurrency: PH 607.

PH 652 - QUANTUM MECHANICS II
Semester Hours: 3

PH 654 - OPTICAL TESTING
Semester Hours: 3
Spherometry; refractive index measurements; optical bench measurements of imaging systems via T-bar nodal slide (effective focal length, f-number, axial color, field curvature and distortion, transverse ray aberrations); illumination falloff; image resolution tests (finite object); modulation transfer function; star image testing; knife edge tests; Hartmann tests; Fizeau interferometer and testing configurations; null lens testing of aspheres; wavefront measurements (point diffraction interferometer, radial shear interferometer); (Same as OSE 654.) Spring.

PH 655 - APPLIED QUANTUM MECHANICS
Semester Hours: 3
Application of quantum mechanics in solid state, electronics, materials science, and optics. Topics to include: Hydrogen atom and molecule, excitons, phonons, Bloch's theorem, periodic boundary conditions, electrons and holes, band structure of simple semiconductors, dipole transitions, optical constants, absorption and emission processes. Introduction to device physics. (Same as OSE 655) Prerequisite: PH 651 or OSE 555.

PH 661 - DATA ANAL/STAT METH PH/ASTROPHE
Semester Hours: 3
Moments of a distribution, linear and non-parametric correlation, central limit theorem, error estimation, least squares modeling, estimating model parameters, Monte Carlo techniques. Bayes' theorem and likelihood methods. Energy and temporal spectral analyses. Power density spectra; periodic and quasi-periodic systems. Prerequisite: upper level undergraduate mathematics courses. Fall, even years.

PH 670 - OPTOMECHANICAL DESIGN & MANUF
Semester Hours: 3
Practical aspects of optomechanical design, material selection, fabrication and integration of precision optical components and systems for commercial, space, and military applications. Topics include: fixture design, tolerance analysis, machining methods, thermal stabilization, integrated computer-aided design and analysis, diamond machining, finishing and plating techniques. (Same as OSE 670.) Fall, even years. Prerequisite: OSE 541.

PH 671 - OPTICAL FABRIC & TESTING
Semester Hours: 3
Fabrication and testing techniques of optical components and systems. Component measurements: refractive index, curvature, focal lengths, cardinal points and field curvature. Wavefront aberration and transverse aberration function measurements: geometric tests, interferometric tests, null tests. Basics of grinding, figuring, polishing and optical coating. Laboratory experience in manufacturing, polishing, testing, and coating reflective or transmissive optics. Offered on demand.

PH 673 - HIGH ENERGY ASTROPHYSICS
Semester Hours: 3
Radiative Transfer: Blackbody, scattering and diffusion, bremsstrahlung, synchrotron emission, Compton scattering. Relativistic electromagnetism. Plasma effects and introduction to magnetohydrodynamics. Observational aspects of white dwarves, neutron stars and black holes. Accretion and astrophysical jets. Active galactic nuclei and gamma-ray bursts. Offered Fall of odd years.

PH 674 - GEN RELATIVITY & GRAVITATION I
Semester Hours: 3
Special and general relativity: vector and tensor calculus; curved manifolds; elements of differential geometry; physics in curved spacetime; the Einstein equations; simple solutions of the Einstein equations; Schwarzschild geometry and the Kerr spacetime; black holes; sources, propagation, and detection of gravitational waves; a variational approach to general relativity; special topics.

PH 679 - EDUCATION CAPSTONE COURSE
Semester Hours: 3
Capstone experience for student pursuing secondary education certification option for MS degree. Student develops 1 credit, 100 level physics course on instructor-approved topic. Development includes syllabus, textbook evaluation, representative homework assignments, midterm, final, lecture outline, and lecture notes.
PH 680 - SELECTED TOPICS  
Semester Hours: 3  
Offered upon demand. Topics include: optical surface characterization, superconductivity, aeronomy, properties of solids, laser propagation, collision theory, magnetohydrodynamics. Fall, Spring, Summer.

PH 681 - SELECTED TOPICS  
Semester Hours: 3  
Offered upon demand. Topics include: optical surface characterization, superconductivity, aeronomy, properties of solids, laser propagation, collision theory, magnetohydrodynamics. Fall, Spring, Summer.

PH 682 - SELECTED TOPICS  
Semester Hours: 3  
Offered upon demand. Topics include: optical surface characterization, superconductivity, aeronomy, properties of solids, laser propagation, collision theory, magnetohydrodynamics. Fall, Spring, Summer.

PH 683 - SELECTED TOPICS  
Semester Hours: 3  
Offered upon demand. Topics include: optical surface characterization, superconductivity, aeronomy, properties of solids, laser propagation, collision theory, magnetohydrodynamics. Fall, Spring, Summer.

PH 689 - SELECTED TOPICS  
Semester Hours: 3  
Offered upon demand. Topics include: optical surface characterization, superconductivity, aeronomy, properties of solids, laser propagation, collision theory, magnetohydrodynamics. Fall, Spring, Summer.

PH 699 - MASTER'S THESIS  
Semester Hours: 3-6  
Minimum of 6 credit hours required for Plan I M.S. students. Maximum of nine hours credit toward Ph.D. course requirements awarded upon successful completion of master?s thesis. Fall, Spring, Summer.

PH 731 - ADVANCED PLASMA THEORY  
Semester Hours: 3  
Vlasov theory; electrostatic and electromagnetic waves in a hot plasma; wave damping processes; micro-instabilities; quasilinear theory; numerical simulation of plasmas; applications to space and astrophysics. Spring, odd years.

PH 732 - ELECTROMAGNETIC TH II  
Semester Hours: 3  
Continuation of PH 631. Radiation from accelerated charges; Hamiltonian formulation of electrodynamics; covariant formulation of electrodynamics. Spring Prerequisite: PH 631.

PH 733 - QUANTUM DEVICES  
Semester Hours: 3  
Quantum aspects of optical, electronic, and semiconductor devices approached from a phenomenological/physical point of view. Topics will include: Quantum well devices, optical modulators, optical detectors, quantum Stark effects, electrooptic devices, high speed optical devices, frequency chirping in high speed devices and system applications. (Same as OSE 755.) Fall, odd years. Prerequisite: PH 551 or PH 651 or OSE 555.

PH 742 - OPTICAL SCATTERING THEORY  
Semester Hours: 3  
Scattering and absorption of radiation by particles with spherical symmetry and arbitrary shapes described using Maxwell's equations, vector Helmholtz equations, the Jones and Mueller calculus, and numerical techniques. Prerequisites: PH 631, or EE 609, or ATS 561.

PH 745 - LASERS II  
Semester Hours: 3  
The propagation of optical beams in homogeneous and lens-like media, optical resonators, interaction between radiation and atomic systems, laser oscillations and specific laser systems, qswitching and mode-locking of lasers, noise in laser amplifiers and oscillators, modulation of optical radiation. Fall, even years. Prerequisite: PH 645.

PH 746 - NON-LINEAR OPTICS  
Semester Hours: 3
PH 751 - COMPUTATIONAL QUANTUM MECH
Semester Hours: 3

PH 752 - QUANTUM MECHANICS II
Semester Hours: 3

PH 753 - QUANTUM FIELD THEORY
Semester Hours: 3

Formalism of quantum field theory, construction and evaluation of Feynman diagrams for quantum electrodynamics and the weak interaction, first-order processes, renormalization, particle scattering and decay, nucleon structure, introduction to quantum chromodynamics, accelerator experiments, and astrophysical applications. Prerequisites: PH 609 and PH 652.

PH 789 - SELECTED TOPICS
Semester Hours: 3
Topics include superconductivity, advanced plasma theory, properties of solids, laser propagation, collision theory, quantum electronics, gravitational theories. Fall, Spring, Summer.

PH 792 - PHYSICS SEMINAR
Semester Hour: 1
Students attend seminars by invited speakers. Two semesters are required for all M.S. students and three semesters for Ph.D. students. Does not count toward minimum degree requirements. Fall, Spring.

PH 795 - ADV PHYSICS PROJECT LAB
Semester Hours: 3-6
Advanced laboratory research in one of the departmental research groups. Student works on an independent or group project. Completion of the course requires a written report that becomes part of the student's record. Fall, Spring, Summer.

PH 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9
Prerequisites: Students must have passed the comprehensive examination at Ph.D. level and have Ph.D. advisor's approval. No more than 9 hours may be taken prior to passing the qualifying examination. Fall, Spring, Summer.

Political Science (PSC)

PSC 520 - FEDERALISM & INTERGOV RELATION
Semester Hours: 3
Designed to help students navigate complex relationships among the 90,000+ government in the U.S., this course examines the framework of federalism and the tools available to governments to influence public policy outcomes. Students will investigate the impacts of these relationships on policy.

PSC 540 - REGIONAL STUDIES
Semester Hours: 3
An examination of the politics of Asia, Latin America, the Middle East, or Africa, depending on the term. We focus on select countries or themes within each region as part of our study of political structures, history, and culture, for a deeper understanding of each area.

PSC 551 - LAW, COURTS & PUBLIC POLICY
Semester Hours: 3
Examines the role of the courts in the making of public policy in the United States, with an emphasis on the use of the courts by interest groups seeking to achieve specific policy goals.

PSC 562 - DECISION-MAKING FORGN & SEC PLY
Semester Hours: 3
An examination of the history, culture, policies, and structures shaping the development of U.S. foreign and national security policies. Special attention will be placed on the roles of Congress, the National Security Council, Defense Department, State Department, and the intelligence community.
PSC 564 - AMERICAN FOREIGN POLICY
Semester Hours: 3

An examination of the substance of the contemporary U.S. foreign policies and the goals the country seeks to achieve around the world. Students will attempt to evaluate the effectiveness of those policies and examine why it is often difficult for the country to achieve its goals.

PSC 566 - NATIONAL SECURITY STRATEGY & POLICY
Semester Hours: 3

An examination of current U.S. national security strategy and policy. The course will review current strategy and policy documents, examine specific responses to the variety of threats facing the United States, and evaluate whether those policies are effective at achieving their goals.

PSC 570 - ISSUES IN SECURITY POLICY
Semester Hours: 3

Examination of select security-related policy issues. The content of this course will vary during different terms, and students may take the course multiple times so long as the content differs.

PSC 580 - SPECIAL TOPICS IN POLITICAL SC
Semester Hours: 1-3

Selected topics in local, state, national and world politics. This course may be repeated for credit as long as content of course has changed.

PSC 600 - THE AMERICAN POLITY
Semester Hours: 3

Comprehensive and intensive review of the philosophical foundations; formal institutions; and social, economic, and political dynamics of the American polity, with particular emphasis on their relationship to the making of public policy.

PSC 601 - THE PUBLIC POLICY PROCESS
Semester Hours: 3

This course offers an analytical framework for critical thinking about public policy in the U.S.- the inputs, processes, and outputs of governmental activity. Also considers factors that influence policy processes, as well as impacts of decisions by different governments and actors.

PSC 610 - PUBLIC MANAGEMENT PROFESSIONS
Semester Hours: 3

Introduction to public management as a field of study and practice. Review of basic literature. Emphasis on ethics in public service.

PSC 611 - PUBLIC PERSONNEL ADMINIS
Semester Hours: 3

Purposes, functions, and processes of personnel management at the national, state, and local levels.

PSC 612 - BUDGETARY PROCESS
Semester Hours: 3

Governmental revenue and expenditure policies. Budget as a method of administrative and fiscal control.

PSC 615 - SPEC TOPICS IN PUBLIC AFFAIRS
Semester Hours: 3

Special and advanced topics in public affairs and public policy. Students must have complete 12 hours in the Public Affairs program. Instructor permission required. This course may be repeated for credit as long as content of this course has changed.

PSC 630 - PUBL VALUES/PUBL POLICY
Semester Hours: 3

Critical examination of the value assumptions of social theoretical paradigms that influence the formation, implementation, and evaluation of public policies. Major themes include ideological biases, ethics of social policies, and moral problems of economic distribution and redistribution.

PSC 635 - PROGRAM EVALUATION AND METHODS
Semester Hours: 3

This course focuses on program evaluation and methods of social science research. By learning they logic and practice of research design and methods, students will be equipped with the necessary skills and techniques to evaluate critically public policy programs and to design and execute research projects.
PSC 690 - CAPSTONE
Semester Hours: 3

Capstone projects - on-the-job learning - give students the opportunity to integrate classroom learning with relevant problem solving they might face in a professional work situation. Students will conduct independent research on a policy question and formulate recommendations based on their findings. Prerequisite: Instructor Permission.

PSC 695 - INTERNSHIP IN GOVERNMENT
Semester Hours: 1-6

Students may receive academic credit for an internship with a local, state, or federal governmental agency, or with a political, legal, or public policy related organization. Students must have completed 12 hours in the Public Affairs program. Prerequisite: Instructor Permission.

PSC 698 - DIRECTED READINGS & RESEARCH
Semester Hours: 3

Supervised in-depth readings and/or individual research in an area of specialized interest to both student and instructor.

PSC 699 - MASTERS THESIS
Semester Hours: 1-3

Required every semester a student is writing and receiving instruction on a master's thesis. A minimum of two terms and six thesis hours is required for the thesis option. No more than six hours credit may be applied toward the degree.

Psychology (PY)

PY 500 - INTRO CLINICAL & COUNSELING
Semester Hours: 3

PY500 introduces clinical/counseling psychology and professional psychology. History of diagnosis and treatment, theoretical models in counseling, contemporary practice models, research basis of clinical/counseling psychology, empirically validated techniques, and doctoral program models are covered.

PY 502 - INDUSTRIAL & ORGANIZA PSY
Semester Hours: 3

Application of basic principles of learning, motivation, and perception to typical industrial and organizational problems. Same as ISE 502.

PY 503 - HUMAN FACTORS PSYCHOLOGY
Semester Hours: 3


PY 505 - PSYCHOPHARMACOLOGY
Semester Hours: 3

Introduction to drug classification and action with emphasis on physiological and psychological interactions. Same as BYS 505.

PY 506 - PSYCHOLOGY OF WOMEN
Semester Hours: 3

Examines theory and research in the psychological functioning of women, both in the United States and other nations. Topics include achievement and education, mental and physical health issues, biological influences on women's behavior, and victimization of women.

PY 507 - CROSS-CULTURAL PSYCHOLOGY
Semester Hours: 3

Examines psychological similarities and differences between members of industrialized and non-industrialized cultures. Comparisons will include development, social interaction, personality, cognition, psychological health and treatment, work, and acculturation.

PY 508 - TEAMWORK & TEAM PROCESSES
Semester Hours: 3

This course provides a basic introduction to teams and teamwork processes. The foundation of the course is research-based; topics will be approached from the context of empirical research that has been conducted. The types of research designs that are typically used in team research are addressed.
PY 509 - PSYCHOLOGY OF AGING  
Semester Hours: 3  
PY 509 examines psychological processes in adulthood and aging. Emphasis is placed on contemporary theories, methodological issues and how psychological, biological, social and environmental factors interact to predict growth, maintenance or decline in abilities throughout adulthood and aging.

PY 515 - ADV. DEVELOPMENTAL PSYCHOLOGY  
Semester Hours: 3  
PY 520 - SPECIAL TOPICS  
Semester Hours: 3  
Pre-announced special areas in seminar discussion, laboratory work, or practicum. May be taken twice for credit.

PY 530 - PSYCHOMETRICS  
Semester Hours: 3  
History and development of psychological testing with special emphasis given to both theory and process of effective evaluation.

PY 533 - PSYCHOPATHOLOGY  
Semester Hours: 3  
Selected disorders such as depression, anxiety disorders, and personality disorders from different theoretical orientations with emphasis on cognitive behavioral theory.

PY 534 - PSYCHOLOGY AND LAW  
Semester Hours: 3  
This seminar is a survey of the major topics represented in the field of Psychology and Law. We will focus on how psychological research can contribute to a better understanding of issues related to law.

PY 537 - PSYCHOBIOLOGY OF STRESS/ILLNESS  
Semester Hours: 3  
Overview of physiological stress responses and their influence on health behavior and illness. Same as BYS 537.

PY 602 - PROSEMINAR:COGNITIVE  
Semester Hours: 3  
Critical examination of the cognitive approach to areas of study within psychology. Students are responsible for library research, writings, and presentation of selected topics.

PY 607 - PROFESSIONAL DEV IN RES & TCHG  
Semester Hour: 1  
Focus on developing knowledge and skills relevant to future goals, such as career exploration, internship opportunities, resume writing, and graduate program exploration. Required of first year students.

PY 608 - GRAD PRACT TCHG & CAREER EXPLO  
Semester Hour: 1  
Focus on developing knowledge and skills relevant to future goals, such as career exploration, internship opportunities, resume writing, and graduate program exploration. Required of first year students.

PY 610 - EXPERIMENTAL DESIGN  
Semester Hours: 3  
Design and use of the experiment as an inferential tool. Issues pertaining to reliability, validity, manipulation of independent variables and sampling will be examined. Statistical techniques for analysis of data generated by experimental designs.

PY 611 - STAT FOR EXPERI METHODS  
Semester Hours: 4  
Statistical techniques for analysis of data generated by experimental designs.

PY 615 - GRADUATE SEMINAR  
Semester Hours: 3  
Intensive analysis of selected theoretical or applied topics relating to psychological development. May be taken more than once for credit.
PY 624 - HUMAN FACTORS IN SYSTEM DESIGN  
Semester Hours: 3

Introduces basic principles of methods analysis and ergonomics. Methods analysis topics include: work measurement tools, work sampling, job analysis, job evaluation, and development and use of flow and activity charts for methods improvement. Same as ISE 624.

PY 641 - CONC READ/RES SPECIALIZ AREA  
Semester Hours: 3

Independent readings and/or experiments in an area within the student's field of specialization. One requirement is a research proposal, which will be reviewed by the faculty advisor. May be taken more than once for credit. Prerequisite: PY 650 or PY 699.

PY 650 - SUPERVISED RESEARCH  
Semester Hours: 3-6

Laboratory or applied research concerning a particular topic, approved and supervised by a PY faculty member. The student may work on an independent or group project. May be taken more than once for credit.

PY 675 - INTERNSHIP IN APPLD PSYCHOLOGY  
Semester Hours: 1-3

Students are placed in a field setting under the supervision of a faculty member and a site supervisor. Students receive site-specific training, experience, and individual supervision. Prerequisites: PY 502, PY 607, PY 608, PY 610, and PY 611.

PY 699 - MASTER'S THESIS  
Semester Hours: 1-6

Required each semester a student is working and receiving faculty direction on a master's thesis. Prerequisites: PY 641, a minimum of two terms is expected. Credit awarded upon successful completion of the thesis.

PY 762 - PERFORM MEASUR/PRODU IMPROVEMENT  
Semester Hours: 3

Productivity and performance defined and used to analyze current competitive position of important sectors of US industry with respect to national and international competition.

Space Science (SPA)

SPA 522 - INTRODUCTION TO PLASMA PHYSICS  
Semester Hours: 3

Provides students with an introduction to the basic physical processes associated with plasmas, which permeate all space environments. Both particle and fluid approaches are introduced, and a variety of elementary drift and wave phenomena are derived. Applications of the theory to various plasma instabilities are explored, along with specific examples of where these may occur in space science. While the goal of this course is to prepare students for more advanced topics in space physics, many of the fundamentals covered are equally relevant for students interested in plasma confinement and its associated engineering challenges.

SPA 526 - SPACE WEATHER  
Semester Hours: 3

Physics of solar active regions, physics of solar flares and coronal mass ejections (CMEs), the propagation of CMEs, the acceleration and propagation of solar energetic particles, CME interaction with earth's magnetosphere.

SPA 532 - SPACE ORIENTATION EDUCATORS  
Semester Hours: 3

A weeklong course at the U.S. Space and Rocket Center in Huntsville, Alabama for pre-service and in-service teachers. The inquiry based workshops are taught around the theme of space exploration include activities to be done across the curriculum. All activities are correlated to National Math, Science, Technology, Social Studies, and Reading Standards. Activities based on curriculum developed by NASA, CAP, NSATA, and the USSRC. Topics include moon, mars, rocketry, propulsion, hydroponics, math, biology, history and literature.

SPA 582 - SCIENCE CAREER PREP  
Semester Hour: 1

This course will review many of the soft skills necessary to function as a successful scientist, whether in an academic career, in a federal laboratory, a for-profit research career in a company, or even a commercial career. Your career begins with graduate school, and learning the skills for a successful graduate career will carry over to your professional career. The goal of the course is impart wisdom from successful graduate students and career scientists, providing both a basis for a successful graduate career and your subsequent career. The course will help students reduce the learning things "the hard way" approach by providing guidance for your career path. Each week will focus on a different skill that a career scientist requires.
SPA 610 - ADV MATH METHDS FOR SPA SCI
Semester Hours: 3

This course will focus on analytical methods for a series of advanced topics with an emphasis on practical applications to space science, such as Vector and Fourier Analysis, ODEs/PDEs in space science, and Green's functions, Spherical Harmonics, Spectral Analysis, Wavelet Transforms, Fractals and Complexity, and Inverse Problems.

SPA 622 - CLASSICAL & QUANTUM STATISTICS
Semester Hours: 3


SPA 623 - TRANSPORT PROCESSES IN SPACE
Semester Hours: 3

Course presents a systematic treatment of classical and anomalous transport theory for gases, plasmas, energetic particles, and low frequency turbulence. The Chapman-Enskog approach is used to derive transport coefficients for neutral gases and collisional plasmas. The relationship between multi-fluid and MHD models is presented. Weak solutions and shock waves are discussed. The transport of energetic particles that experience scattering by magnetic field fluctuations is presented, together with basic models of the turbulence responsible for scattering turbulence transport in expanding flows such as the solar wind. Prerequisite: SPA 622 and SPA 522.

SPA 624 - SPACE PHYSICS I
Semester Hours: 3

A broad introduction to particle, MHD, and kinetic phenomena in space. This course is intended for all students interested in space, astro-, and plasma physics. Course covers fusion processes inside the Sun, solar neutrinos, solar atmosphere, coronal magnetic fields, physical mechanisms of magnetic field line reconnection and magnetic dynamo, the interaction between the solar wind with planets and the interstellar medium, corotating and merged interaction regions, collisional and collisionless shock waves in space. Includes an introduction to charged particle acceleration in the heliosphere. Examines differences between planetary magnetospheres, solar-terrestrial relationships, solar activity, climate, and culture. Prerequisite: SPA 522, SPA 631 (w/concurrency).

SPA 625 - SPACE PHYSICS II
Semester Hours: 3

The course develops a deeper understanding and knowledge of plasma instabilities, kinetic dispersion relations, microinstabilities, electrostatic and electromagnetic instabilities; advanced magnetohydrodynamics including MHD turbulence, reconnection; wave-particle interactions, including basic quasilinear theory; weak and strong wave turbulence; nonlinear waves; collisionless shock waves. Prerequisite: SPA 624.

SPA 627 - HIGH ENERGY RADIATION DET&MSRM
Semester Hours: 3

This course will provide students with basic understanding of radiation detection for space-based missions. This course will cover the basic nuclear processes in radioactive sources and the interaction of radiation with matter. The statistical treatment of experimental data will be reviewed. General characteristics common to all types of detectors will be given. We will then cover specific classes of detectors focusing on ionization, scintillation and semiconductor detectors. Light collection and detection techniques will follow. The student will then be introduced to basic signal processing and timing techniques important to a successful instrument design. This course will be taught from a physicist point of view emphasizing the physical processes and interactions that make detection of radiation possible. This course is suitable for those students interested in detector development or astrophysical data analysis using state-of-the-art technology.

SPA 628 - SOLAR PHYSICS
Semester Hours: 3

The workings of the sun, from its interior to the outer reaches of the corona with emphasis on the observations. Energy release in core of the Sun and its transport to the solar atmosphere. Dynamo process and the 11 year solar activity cycle. Formation of active regions and structure of sunspots. The structure of corona, with particular details on the active region corona and its heating to several million kelvin. Energy release processes including solar flares and coronal mass ejections.

SPA 629 - ASTROPHYSICAL FLUID DYNAMICS
Semester Hours: 3

Covers astrophysical phenomena occurring outside the boundaries of the solar system. Subjects include stellar structure and rotation, waves and instabilities in astrophysical plasmas, the physics of spheroid and disk accretion, supernova blast waves, and charged particle transport and acceleration in cosmic plasmas. Introduction to the principles of stellar formation, helioseismology, stellar dynamo, coronal heating, and astrophysical turbulence. Prerequisite: SPA 522.
SPA 630 - WAVES IN FLUIDS
Semester Hours: 3

Comprehensive introduction to the science of wave motions in fluids. Waves and first-order (hyperbolic) equations, wave hierarchies: gas dynamics and fluid equations; acoustics, nonlinear plane waves, simple waves, shock waves and structure, shock reflection, similarity solutions, supersonic flows in gas dynamics; the wave equation, including plane, spherical and cylindrical waves, geometrical optics, including far-field approximation, caustics, nonhomogeneous media, anisotropy; water waves, including shallow water theory; group velocity, dispersion; nonlinear waves, including Korteweg-de Vries, sine-Gordon, and nonlinear Schroedinger equations, solitons. Prerequisite: SPA 610.

SPA 631 - WAVES AND FIELDS
Semester Hours: 3


SPA 636 - ADV SPACE WEATHER
Semester Hours: 3

Advanced topics in Space Weather with emphasis on practical effects and impacts on human technology and society: interaction of solar disturbances with Earth's magnetosphere, Solar Energetic Particles, and their effects; Forecasting and Nowcasting of Space Weather; Space Weather at Mars and other planets. Prerequisite: SPA 522.

SPA 662 - COMPUTATIONAL PHYSICS
Semester Hours: 3


SPA 663 - COMPUTATIONAL FLUID DYNAMICS & MHD
Semester Hours: 3

Numerical simulations of various problems in space physics, astrophysics, engineering, and plasma dynamics. Finite-volume and finite-difference, shock-capturing and shock-fitting methods for hyperbolic equations, including gas dynamics, MHD, and shallow water equations. The hierarchy of numerical methods is introduced in a systematic way, starting from standard linear schemes and arriving at modern discontinuity-capturing non-linear methods. Exact and approximate Riemann solvers, characteristic analysis of underlying equations. Different implementations of boundary conditions are introduced in relation with the mathematical properties of quasilinear hyperbolic systems. Prerequisite: SPA 624, SPA 662.

SPA 689 - SELECTED TOPICS
Semester Hours: 3

Selected Topics in Space Science not covered in other courses.

SPA 699 - MASTER'S THESIS
Semester Hours: 1-6

SPA 741 - PHYSICS OF COSMIC RAYS
Semester Hours: 3

Covers two principal areas of cosmic ray physics: (i) cosmic ray origin and acceleration, and (ii) cosmic ray transport and detection. Includes galactic cosmic rays, anomalous cosmic rays, and solar energetic particles. Transport theory, acceleration mechanisms and observational signatures. Prerequisite: SPA 623.

SPA 742 - GAMMA-RAY BURSTS AND JETS
Semester Hours: 3


SPA 771 - COMPETITIVE GRANT WRITING WORKSHOP
Semester Hour: 1

This course is designed for senior level graduate students who are about to graduate and start their professional career. It will introduce students to the real and complete process of competing for grant support. It is comprised of a series of lectures (workshops), case studies, and ends with a formal proposal from each participant and a mock review process.
SPA 789 - SELECTED TOPICS
Semester Hours: 3
Selected Topics in Space Science not covered in other courses.

SPA 796 - JOURNAL CLUB
Semester Hour: 1
This course requires graduate students to read, interpret and present literature critically to fellow students, researchers, and faculty. Students stay abreast of current knowledge in the field, develop presentation skills and promote department unity. Faculty instructor will lead, assign, and provide students feedback on their presentations.

SPA 799 - DOCTORAL DISSERTATION
Semester Hours: 1-9
Students must have passed the Comprehensive Examination at PhD level and have PhD advisor’s approval. No more than 9 hours may be taken prior to passing the Qualifying Examination.

Statistics (ST)

ST 687 - THEORY OF STATISTICS I
Semester Hours: 3

ST 787 - THEORY OF STATISTICS II
Semester Hours: 3
Continuation of hypothesis testing, likelihood ratio and unbiased tests, uniformly most powerful tests, power function, nonparametric tests, statistical decision theory, distribution and linear models.

Faculty

(Date refers to original appointment to the university.)

Faculty

A

Adams, Ellise, Associate Professor, Nursing, 2006, PhD, Texas Women's University.
Adams, Marsha, Dean and Professor, Nursing, 2014, PhD, University of Alabama at Birmingham.
Adan, Drew, Lecturer, Library, 2017, MLIS, Simmons Graduate School of Library and Information Science.
Adcock, Lawana, Lecturer, Biological Sciences, 2016, PhD, Alabama AM University.
Ai, Shangbing, Associate Professor, Math, 2002, PhD, University of Pittsburgh.
Ali, Aminta, Assistant Professor, Nursing, 2012, PhD, University of Alabama at Birmingham.
Allport, Christopher, Associate Professor, Accounting, 2005, PhD, Virginia Tech.
Amiri, Azita, Assistant Professor, Nursing, 2012, PhD, University of Alabama at Birmingham.
Anderson, Michael, Professor, Civil and Environmental Engineering, 1998, PhD, Iowa State University.
Argentina, Vincent, Assistant Professor, Art, Art History Design, 2014, MFA, University of Georgia.

Armentrout, Daniel, Lecturer, Mechanical and Aerospace Engineering, 2012, PhD, University of Denver.

Aultman, Anna, Clinical Assistant Professor, Nursing, 2018, MSN, University of Alabama.

Aygun, Ramazan, Associate Professor, Computer Science, 2003, PhD, New York State University.

B

Baginski, Melissa, Clinical Assistant Professor, Nursing, 2009, MSN, University of Virginia.

Baird, James, Professor, Chemistry, 1982, PhD, Harvard.

Baker, Karen, Lecturer, Communication Arts, 2018, MFA, University of Alabama.

Baldwin, Katie, Assistant Professor, Art, Art History Design, 2013, MFA, University of the Arts, Pennsylvania.

Balla, Angela, Associate Professor, English, 2006, PhD, University of Michigan-Ann Arbor.

Banish, R. Michael, Associate Professor, Chemical and Materials Engineering, 1999, PhD, University of Utah.

Bao, Yeqing, Associate Dean, Professor, Marketing, 2001, PhD, Virginia Polytechnic Institute and State University.

Bao, Yongchuan, Associate Professor, Marketing, 2014, PhD, University of Southern California.

Barnby, Elizabeth, Clinical Associate Professor, Nursing, 2009, DNP, University of Alabama in Huntsville.

Barnes, Dilcu, Clinical Assistant Professor, Management, 2017, PhD, Auburn University.

Baudry, Jerome, Professor, Biological Sciences, 2017, PhD, University of Paris - Sorbonne.

Baun, Dylan, Assistant Professor, History, 2016, PhD, The University of Arizona.

Beck, Monica, Clinical Assistant Professor, Nursing, 2009, MSN, University of Alabama in Huntsville.

Benton, Anna, Clinical Instructor, Nursing, 2008, MSN, University of Alabama in Huntsville.

Berbrier, Mitchell, Professor, Sociology, 1996, PhD, Marquette University.

Berkowitz, David, Professor, Marketing, 1996, PhD, University of Alabama.

Betancourt, José, Associate Professor, Art, Art History Design, 2006, MFA, Hunter College.

Bianchi, Ann, Associate Professor, Nursing, 2007, PhD, Texas Women’s University.

Bitzer, Phillip, Associate Professor, Atmospheric Science, 2011, PhD, University of Alabama in Huntsville.

Blackmon, James, Research Professor, Mechanical and Aerospace Engineering, 2001, PhD, University of California.

Bolen, Ron, Clinical Instructor, Nursing, 2017, MSN, University of Alabama.

Bollinger, Laurel, Professor, English, 1993, PhD, Princeton.

Bonamente, Massimiliano, Professor, Physics, 2002, PhD, University of Alabama in Huntsville.

Bowman, Elizabeth, Lecturer, Math, 2001, MA, University of Alabama in Huntsville.

Bowman, Ronald, Lecturer, Electrical and Computer Engineering, 2005, MSEE, Clemson University.

Boykin, Timothy, Professor, Electrical and Computer Engineering, 1992, PhD, Stanford University.

Bridges, Lindsay, Clinical Instructor, Nursing, 2003, MSN, Jacksonville State University.

Brothers, Rebecca, Lecturer, Library, 2017, MA, University of Washington.

Budisalich, Kimberley, Clinical Instructor, Nursing, 2017, MSN, Samford University.

Buksa, Irena, Associate Professor, World Languages and Cultures, 1990, DA, Syracuse.
Burel, Joshua, Assistant Professor, Music, 2017, PhD, Florida State University.

Burnett, John, Associate Professor, Finance, 1992, PhD, University of Alabama.

Burns, Laird, Associate Professor, Management Science, 2009, PhD, Michigan State.

Bushman, Karissa, Lecturer, Art, Art History Design, 2015, PhD, University of Iowa.

Byler, Kendall, Lecturer, Chemistry, PhD, Friedrich-Alexander Universität Erlangen-Nürnberg.

Caires, Angela, Clinical Associate Professor, Nursing, 2012, MSN, University of Alabama in Huntsville.

Carey, Lawrence, Associate Professor, Atmospheric Science, 2012, PhD, Colorado State University.

Carey, Matthew, Assistant Professor, Music, 2016, DMA, Texas Tech University.

Carmen, Christina, Clinical Associate Professor, Mechanical and Aerospace Engineering, 2006, PhD, University of Alabama in Huntsville.

Cassibry, Jason, Associate Professor, Mechanical and Aerospace Engineering, 2004, PhD, University of Alabama in Huntsville.

Cate-Gibson, Stephanie Ryan, Lecturer, Intensive Language Center, 2009, MA, North Carolina Central University.

Choup, Anne Marie, Associate Professor, Political Science, 2007, PhD, University of North Carolina at Chapel Hill.

Christopher, Sundar, Dean and Professor, Atmospheric Science, 1997, PhD, Colorado State.

Christy, John, Distinguished Professor, Atmospheric Science, 1991, PhD, Illinois.

Chronis, Themistoklis, Clinical Assistant Professor, Physics, 2017, PhD, University of Connecticut.

Chung, Haeyong, Assistant Professor, Computer Science, 2015, PhD, Virginia Tech.

Clemmons, Tammy, Clinical Instructor, Nursing, 2006, MSN, University of Alabama in Huntsville.

Cling, Andrew, Professor, Philosophy, 1988, PhD, Vanderbilt.

Coby, Jim, Lecturer, English, 2016, PhD, University of Louisiana.

Coe, David, Associate Professor, Electrical and Computer Engineering, 2002, PhD, Georgia Institute of Technology.

Coffey, Sharon, Clinical Assistant Professor, Nursing, 2016, DNP, University of Alabama in Huntsville.

Coleman, Richard, Lecturer, Computer Science, 2013, PhD, University of Florida.

Collopy, Paul, Professor, Industrial Systems Engineering, 2013, PhD, Stanford University.

Conners, Ryan T., Assistant Professor, Kinesiology, 2015, PhD, Middle Tennessee State University.

Conway, Joseph, Associate Professor, English, 2011, PhD, Washington University in St. Louis.

Cooper, Judy, Lecturer, Biological Sciences, 2015, M.S., University of Alabama in Huntsville.

Crook, Genevieve, Lecturer, Math, 1989, MA, University of Alabama in Huntsville.

Cross, Heather, Lecturer, English, 2007, MA, University of Alabama in Huntsville.

Cruz-Vera, Luis, Associate Professor, Biological Sciences, 2007, PhD, CINVESTAV-IPN, Mexico.

Culumber, Zachary, Assistant Professor, Biological Sciences, 2018, PhD, Texas AM University.

Curtis, Christine, Provost, Professor, Chemical and Materials Engineering, 2014, PhD, Florida State University.

Davis, Rebecca, Clinical Assistant Professor, Nursing, 2009, MSN, University of Alabama in Huntsville.

Delugach, Harry, Associate Professor, Computer Science, 1990, PhD, University of Virginia.
Deverapalli, Chakri, Director IT, Lecturer, Information Systems, 2008, MBA, University of Alabama in Huntsville.

Devlin, Anna, Assistant Professor, Management Science, 2014, PhD, University of Maryland.

Dillihunt, Monica, Associate Professor, Education, 2004, PhD, Howard University.

Doty, Johnna, Lecturer, Music, 2012, MFA, Boston University.

Doty, Johnna, Lecturer, Communication Arts, 2012, MFA, Boston University.

Duan, Lingze, Associate Professor, Physics, 2007, PhD, University of Maryland.

Elliott, Jeremy M., Assistant Professor, Kinesiology, 2015, PhD, University of Georgia.

Elsamadicy, Abdalla, Lecturer, Physics, 2002, PhD, Alabama AM University.

Emich, Cheryl, Clinical Assistant Professor, Nursing, 2013, MSN, University of Alabama.

English, Jennifer, Associate Professor, Electrical and Computer Engineering, 2000, PhD, Georgia Institute of Technology.

Etzkorn, Letha, Professor, Computer Science, 1993, PhD, University of Alabama in Huntsville.

Fahimi, Farbod, Associate Professor, Mechanical and Aerospace Engineering, 2010, PhD, Sharif U Tech, Tehran.

Fikes, David, Lecturer, Mechanical and Aerospace Engineering, 2016, MS, University of Tennessee - Knoxville.

Fischer, Jeremy, Assistant Professor, Philosophy, 2014, PhD, University of Washington.

Florinski, Vladimir, Associate Professor, Space Science, 2008, PhD, University of Arizona.

Fong, Eric, Associate Professor, Management, 2004, PhD, University of Florida.

Foster, John, Department Chair, Chemistry, 2017, PhD, Aston University.

Foster, Melissa, Clinical Assistant Professor, Nursing, 2012, DNP, University of Alabama in Huntsville.

Foy, Anna, Assistant Professor, English, 2012, PhD, University of Pennsylvania.

Frederick, Robert, Professor, Mechanical and Aerospace Engineering, 1991, PhD, Purdue.

Frendi, Kader, Professor, Mechanical and Aerospace Engineering, 1999, PhD, Brown University.

Friedman, Susan, Lecturer, English, 2008, PhD, University of South Florida.

Frith, Karen, Professor, Nursing, 2007, PhD, Georgia State University.

Frost, Alanna, Associate Professor, English, 2008, PhD, University of Louisville.

Gaede, Rhonda, Associate Professor, Electrical and Computer Engineering, 1992, PhD, University of Texas-Austin.

Gandila, Andrei, Assistant Professor, History, 2013, PhD, University of Florida.

Gentry, Sheila, Clinical Instructor, Nursing, 2018, MSN, University of Alabama in Huntsville.

George, Michael, Associate Professor, Chemistry, 1997, PhD, Arizona State University.

Gholston, Sampson, Associate Professor, Industrial Systems Engineering, 1997, PhD, University of Alabama in Huntsville.

Gilchrist-Petty, Eletra, Associate Professor, Communication Arts, 2008, PhD, University of Memphis.

Goebel, Rolf, Professor, World Languages and Cultures, 1985, PhD, University of Maryland.

Gorur, Ravi, Professor, Electrical and Computer Engineering, 2015, PhD, University of Windsor.
Graves, Sara, Professor, Computer Science, 1978, PhD, University of Alabama in Huntsville.

Greene, Jason, Dean and Professor, Finance, 2016, PhD, Indiana University.

Greene, Michelle, Lecturer, Chemistry, 2016, PhD, Indiana University.

Gregory, Don, Distinguished Professor, Physics, 1992, PhD, University of Alabama in Huntsville.

Griffin, Robert, Associate Professor, Atmospheric Science, 2012, PhD, Penn State University.


Guerin, Amy, Assistant Professor, Theatre, 2016, MFA, University of Houston.

Guerra, Donna, Clinical Assistant Professor, Nursing, 2015, EdD, University of Alabama in Huntsville.

Gunn, Sinceree, Lecturer, English, 2003, MA, University of Alabama in Huntsville.

Guo, Junpeng, Professor, Electrical and Computer Engineering, 2005, PhD, University of Illinois.

Gupta, Jatinder, Professor and Eminent Scholar, Information Systems, 2002, PhD, Texa Tech University.

Gyasi, Kwaku, Associate Professor, World Languages and Cultures, 1999, PhD, Ohio State University.

Haleem, Kirolos, Lecturer, Civil and Environmental Engineering, 2016, PhD, University of Central Florida.

Hamilton, Frances, Assistant Professor, Education, 2014, PhD, Tennessee State University.

Han, Qingyuan, Associate Professor, Atmospheric Science, 1997, PhD, Columbia University.

Harfouch, John, Assistant Professor, Philosophy, 2014, PhD, Penn State University.

Harwell, David, Associate Professor, Theatre, 2005, MFA, University of Illinois.

Hawk, Kathleen, Associate Professor, Political Science, 1998, PhD, University of Alabama.

Hazeli, Kavan, Assistant Professor, Mechanical and Aerospace Engineering, 2016, PhD, Drexel University.

Heerkhuisen, Jacob, Associate Professor, Space Science, 2008, PhD, University of Waikaet, New Zealand.

Heikes, Deborah, Professor, Philosophy, 1998, PhD, University of Illinois.

Herrin, Kristen, Clinical Assistant Professor, Nursing, 2004, DNP, University of Alabama in Huntsville.

Hile, Kimberly, Assistant Professor, Education, 2017, PhD, University of Illinois.

Hite, Dennis, Lecturer, Electrical and Computer Engineering, 2005, MSE, University of Alabama in Huntsville.

Ho, Fat, Professor, Electrical and Computer Engineering, 1980, PhD, Southern Illinois University.

Hollingsworth, Angela, Clinical Assistant Professor, Nursing, 2016, DNP, University of South Alabama.

Hollingsworth, Donald (Keith), Professor, Mechanical and Aerospace Engineering, 2011, PhD, Stanford University.

Hoy, Haley, Associate Professor, Nursing, 2006, PhD, Vanderbilt University.

Hsu, Liwu, Associate Professor, Marketing, 2012, PhD, Boston University.

Hu, Lei, Assistant Professor, Atmospheric Science, 2017, PhD, University of Kansas, Lawrence.

Hu, Qiang, Associate Professor, Space Science, 2012, PhD, Dartmouth.

Huang, Wenzhang, Professor, Math, 1994, PhD, Claremont Graduate School.

Hubbell, Gaines, Assistant Professor, English, 2015, PhD, Rensselaer Polytechnic Institute.

Hunter, Amy, Clinical Assistant Professor, Nursing, 2014, DNP, University of Alabama in Huntsville.
I

Ishak, Sherif, Professor, Civil and Environmental Engineering, 2017, PhD, University of Central Florida.

J

Jayawardena, Surangi, Assistant Professor, Chemistry, 2017, PhD, University of Massachusetts-Lowell.

Johnson, David, Associate Professor, History, 2005, PhD, Washington University in St. Louis.

Johnson, Kathryn, Professor, Art, Art History Design, 2003, MFA, University of Georgia.

Johnson, Molly, Associate Professor, History, 2003, PhD, University of Illinois.

Johnson, Terri, Lecturer, Math, 2011, PhD, University of Alabama in Huntsville.

Joiner, Laurie, Associate Professor, Electrical and Computer Engineering, 1998, PhD, Clemson University.

Jones, Holly, Associate Professor, English, 2006, PhD, Penn State University.

Jones, Keith, Associate Professor, Art, Art History Design, 1996, MFA, Louisiana Tech University.

Jones, Nicholas, Professor, Philosophy, 2007, PhD, Ohio State University.

Jovanov, Emil, Associate Professor, Electrical and Computer Engineering, 1998, PhD, University of Belgrade.

Joyce, Lillian, Associate Professor, Art, Art History Design, 1997, PhD, University of California, Los Angeles.

K

Kaiura, Leslie, Assistant Professor, World Languages and Cultures, 2007, PhD, University of Virginia.

Kang, Chang-kwon, Assistant Professor, Mechanical and Aerospace Engineering, 2013, PhD, University of Michigan.

Kanistras, Konstantinos, Assistant Professor, Mechanical and Aerospace Engineering, 2017, PhD, University of Denver.

Kansakar, Siroj, Lecturer, Math, 2012, PhD, University of Alabama in Huntsville.

Keller, Karl, Lecturer, World Languages and Cultures, 2007, MA, University of Alabama.

Kendall, Denise, Lecturer, Biological Sciences, 2017, PhD, University of Tennessee Knoxville.

Knight, Kyle, Associate Professor, Sociology, 2012, PhD, Washington State University.

Knupp, Kevin, Professor, Atmospheric Science, 1991, PhD, Colorado State University.

Kulick, Jeffrey, Professor, Electrical and Computer Engineering, 1990, PhD, University of Pennsylvania.

Kunin, Boris, Associate Professor, Math, 1992, PhD, University of Illinois - Chicago.

Kvach, John, Associate Professor, History, 2008, PhD, University of Tennessee at Knoxville.


L

Lampley, Sandra, Assistant Professor, Education, 2016, PhD, Middle Tennessee State.

Landrum, David, Associate Professor, Mechanical and Aerospace Engineering, 1992, PhD, North Carolina State University.

Lang, Joshua, Lecturer, Chemistry, 2016, PhD, University of Alabama in Huntsville.

Lanis, Candice, Assistant Professor, Communication Arts, 2016, Rensselaer Polytechnic Institute.

Lanz, Amelia, Clinical Assistant Professor, Nursing, 2012, EdD, University of Alabama in Huntsville.

Le Roux, Jakubus, Associate Professor, Space Science, 2008, PhD, Potchefstroom.

Lee, J. Seth, Lecturer, English, 2017, PhD, University of Kentucky.
Lee, Shanhu, Associate Professor, Atmospheric Science, 2015, PhD, University of Tokyo.

Lee, Yeolan, Assistant Professor, Management, 2013, PhD, Ohio State University.

Lei, Yu, Assistant Professor, Chemical and Materials Engineering, 2013, PhD, U of Ill, Chicago (UIC).

Lenahan, Shelby, Lecturer, Math, 2004, MA, Texas AM.

Li, Gang, Associate Professor, Space Science, 2008, PhD, Indiana University-Bloomington.

Li, Wei, Associate Professor, Computer Science, 1996, PhD, Virginia Polytechnic Institute State University.

Li, Xiaotong, Professor, Information Systems, 2001, PhD, University of Mississippi.

Lieu, Richard, Distinguished Professor, Physics, 1995, PhD, Imperial College - London.

Ligrani, Phillip, Professor, Mechanical and Aerospace Engineering, 2014, PhD, Stanford University.

Lin, Mark, Associate Professor, Mechanical and Aerospace Engineering, 2000, PhD, Virginia Polytechnic Institute.

Lindquist, Robert, Professor, Electrical and Computer Engineering, 2003, PhD, Pennsylvania State University.

Lioce, Bonnie (Lori), Clinical Associate Professor, Nursing, 2014, DNP, University of Alabama in Huntsville.

Liu, Jianqing, Assistant Professor, Electrical and Computer Engineering, 2018, PhD, University of Florida.

Love-Rutledge, Sharifa, Assistant Professor, Chemistry, 2017, PhD, The University of Alabama.

Lynch, Thuy, Assistant Professor, Nursing, 2017, PhD, University of Alabama.

MacGregor, Gordon, Assistant Professor, Biological Sciences, 2010, PhD, University of Dundee, Scotland.

MacKenzie, William (Ivey), Associate Dean and Associate Professor, Management, 2010, PhD, University South Carolina.

Magnuson, Roy, Associate Professor, Biological Sciences, 1999, PhD, Massachusetts Institute of Technology.

Mahafza, Hamsa, Lecturer, Education, 2017, PhD, University of Texas at San Antonio.

Mahalingam, Brinda, Lecturer, Economics, 2012, PhD, University of Colorado.

Mahalingam, Shankar, Dean and Professor, Mechanical and Aerospace Engineering, 2010, PhD, Stanford University.

Maier, Linda, Professor, World Languages and Cultures, 1993, PhD, University of Virginia.

Malak, Natalie, Assistant Professor, Economics, 2018, PhD, McMaster University.

Manasco, Michael, Lecturer, Library, 2012, MLIS, University of Alabama.

Marinova, Sophia, Associate Professor, Management, 2014, PhD, University of Maryland.

Marschalk, Lacy, Lecturer, English, 2014, PhD, Auburn University.

Mathis, Shannon L., Assistant Professor, Kinesiology, 2011, PhD, Middle Tennessee State University.

Mayeur, Jason, Assistant Professor, Mechanical and Aerospace Engineering, 2018, PhD, Georgia Institute of Technology.

McClellan, Lynn, Clinical Associate Professor, Nursing, 2017, DNP, University of Alabama at Birmingham.

McDavid, Nicole, Lecturer, Communication Arts, 2015, MA, Auburn University.

McFeeters, Robert, Associate Professor, Chemistry, 2008, PhD, Cornell.

McGinnis, Michael, Lecturer, English, 2015, PhD, Wayne State University.

McLaughlin, Erin, Lecturer, Management, 2017, PhD, University of North Texas.

Meade, Whitney, Assistant Professor, Education, 2011, PhD, Auburn University.
Mecikalski, John, Professor, Atmospheric Science, 2004, PhD, University of Wisconsin-Milwaukee.

Mendelson, Tobias, Clinical Assistant Professor, Accounting, 2017, JD, Samford University.

Mendenhall, Eric, Assistant Professor, Biological Sciences, 2013, PhD, University of Minnesota.

Menon, Vineetha, Assistant Professor, Computer Science, 2017, PhD, Mississippi State University.

Mesmer, Bryan, Assistant Professor, Industrial Systems Engineering, 2014, PhD, University of Buffalo.

Messimer, Sherri, Associate Professor, Industrial Systems Engineering, 1989, PhD, Texas AM.

Milenkovic, Aleksander, Professor, Electrical and Computer Engineering, 2001, PhD, University of Belgrade.

Miller, James, Professor, Physics, 1994, PhD, Maryland.

Mok, Wai Yin, Professor, Information Systems, 2001, PhD, Brigham Young University.

Moore, David, Lecturer, Library, 2002, MLS, University of Alabama.

Morales, Claudio, Professor, Math, 1982, PhD, University of Iowa.

Morgan, Tracie, Clinical Instructor, Nursing, 2016, MSN, University of Alabama in Huntsville.

Moriarity, Debra, Professor, Biological Sciences, 1984, PhD, Temple University.

Morphew, S. Melissa, Clinical Associate Professor, Professional and Continuing Studies, 2016, PhD, University of Georgia.

Morris, Tommy, Professor, Electrical and Computer Engineering, 2015, PhD, Southern Methodist.

Morrison, Katherine, Clinical Instructor, Nursing, 2017, MSN, Samford.

Mukherjee, Anusree, Assistant Professor, Chemistry, 2013, PhD, University of Minnesota.

Mukherjee, Tathagata, Assistant Professor, Computer Science, 2018, PhD, Florida State University.

Mullins, Frank, Associate Professor, Management, 2017, PhD, Syracuse University.

N

Nair, Udaysankar, Associate Professor, Atmospheric Science, 2011, PhD, Colorado State University.

Naviaux, Julie, Lecturer, English, 2016, PhD, University of Kentucky.

Nelson, George, Associate Professor, Mechanical and Aerospace Engineering, 2012, PhD, Georgia Tech.

Nelson, Jeffrey, Associate Professor, English, 1990, PhD, Chicago.

Neuschatz, Jeffrey, Professor, Psychology, 2000, PhD, Binghamton University.

Newchurch, Michael, Professor, Atmospheric Science, 1994, PhD, Georgia Institute of Technology.

Newman, Timothy, Professor, Computer Science, 1994, PhD, Michigan State.

Ng, Joseph, Professor, Biological Sciences, 1998, PhD, University of California, Riverside.

Ng, Ka Man (Melody), Assistant Professor, Music, 2013, PhD, University of Wisconsin.

Ng, Yeow Chye, Assistant Professor, Nursing, 2013, PhD, University of Alabama at Birmingham.

Niemiller, Matthew, Assistant Professor, Biological Sciences, 2017, PhD, University of Tennessee.


Norris, Casey, Clinical Assistant Professor, Nursing, 2014, MSN, Clemson University.

O

O’Brien, Jason, Associate Professor, Education, 2008, PhD, University of South Florida.
O’Keefe, Louise, Assistant Professor, Nursing, 2006, PhD, University of Alabama at Birmingham.

Olson, Charlotte, Lecturer, Library, 2007, MFA, University of Florida.

O’Neal, Pamela, Associate Professor, Nursing, 2005, PhD, Virginia Commonwealth University.

Ong, Belinda, Lecturer, Library, 2004, PhD, University of Kentucky.

Orman, Wafa, Associate Dean and Associate Professor, Economics, 2008, PhD, University of Arizona.

P

Pacino, Nicole, Assistant Professor, History, 2013, PhD, University of California, Santa Barbara.

Palmer, Jennifer, Clinical Instructor, Nursing, 2015, EdD, University of Alabama.

Pan, David, Associate Professor, Electrical and Computer Engineering, 2002, PhD, University of Southern California.

Park, Jae, Associate Professor, Information Systems, 2015, PhD, George Mason University.


Patterson, LaToya, Clinical Instructor, Nursing, 2014, MSN, University of Alabama in Huntsville.

Pekker, Mark, Professor, Math, 1987, PhD, Cornell.

Peng, Chao, Assistant Professor, Computer Science, 2014, PhD, Virginia Tech.

Petnga, Leonard, Assistant Professor, Industrial Systems Engineering, 2017, PhD, University of Maryland.

Petty, Mikel, Associate Professor, Computer Science, 2005, PhD, University of Central Florida.

Pogorelov, Nickolai, Professor, Space Science, 2008, PhD, Russian Academy of Sciences.

Poole, Jarmel, Clinical Instructor, Nursing, 2017, MSN, University of North Alabama.

Popp, Katie, Lecturer, Math, 2016, MA, University of Alabama at Birmingham.

Pottenger, John, Professor, Political Science, 1986, PhD, University of Maryland.

Pour, Maria, Assistant Professor, Electrical and Computer Engineering, 2015, PhD, University of Manitoba.

Prece, Robert, Associate Professor, Space Science, 2001, PhD, University of Maryland at College Park.

Price, Jodi, Associate Professor, Psychology, 2008, PhD, Georgia Institute of Technology.

Primeau, Marlena, Clinical Associate Professor, Nursing, 2004, DNP, University of Alabama in Huntsville.

Q

Que, Tingting, Assistant Professor, Finance, 2014, PhD, University of Iowa.

Quick, Beth, Dean and Professor, Education, 2013, Ed.D, Vanderbilt University.

R

Ragsdale, Christopher, Associate Professor, Music, 2006, DMA, University of Miami, Florida.

Rahman, Tauhidur, Assistant Professor, Electrical and Computer Engineering, 2017, PhD, University of Florida.

Ramachandran, Kerrin, Lecturer, Intensive Language Center, 2011, MA, University of Alabama in Huntsville.

Ranganath, Heggere, Professor, Computer Science, 1982, PhD, Auburn University.

Rani, Sarma, Associate Professor, Mechanical and Aerospace Engineering, 2011, PhD, U of Illinois-Urbana-Champaign.

Ravindran, Sivaguru, Professor, Math, 1999, PhD, Simon Fraser University, British Columbia.

Ray, Biswajit, Assistant Professor, Electrical and Computer Engineering, 2016, PhD, Purdue University.
Reeves, Andree, Associate Professor, Political Science, 1992, PhD, Rice University.

Reynolds, Mark, Clinical Assistant Professor, Nursing, 2009, DNP, University of Alabama in Huntsville.

Robinson, Joy, Assistant Professor, English, 2014, PhD, Illinois Institute of Technology.

Rochowiak, Daniel, Associate Professor, Computer Science, 1984, PhD, Notre Dame.

Roh, Kyung-Ho, Assistant Professor, Chemical and Materials Engineering, 2016, PhD, University of Michigan.

Roller, Sarah, Assistant Professor, Education, 2016, PhD, Michigan State.

Rose-Green, Ena, Associate Professor, Accounting, 2008, PhD, Florida State University.

Rountree, J. Clarke, Professor, Communication Arts, 1993, PhD, University of Iowa.

Sadeghi, Seyed, Associate Professor, Physics, 2007, PhD, University of British Columbia.

Salman, Abdullahi, Assistant Professor, Civil and Environmental Engineering, 2018, PhD, Michigan Technological University.

Sanders, Carolyn, Professor, Music, 1990, DMA, Florida State University.

Saunders, John, Lecturer, Communication Arts, 2017, PhD, The Pennsylvania State University.

Schneider, Judith, Professor, Mechanical and Aerospace Engineering, 2015, PhD, University of Califorina-Davis.

Scholz, Carmen, Professor, Chemistry, 1998, PhD, University of Technology, Dresden Germany.

Schwertfeger, Ron, Lecturer, Library, 2014, MA, University of Alabama.

Sears, Christine, Associate Professor, History, 2007, PhD, University of Delaware.

Seemann, Eric, Associate Professor, Psychology, 2003, PhD, Louisiana Tech University.

Setzer, Mary, Lecturer, Chemistry, 2005, MS, University of Alabama in Huntsville.

Sever, Thomas, Professor, Atmospheric Science, 2008, PhD, University of Colorado-Boulder.

Sheldon, Pavica, Associate Professor, Communication Arts, 2011, PhD, Louisiana State University.

Shen, Milton, Associate Professor, Accounting, 2011, PhD, University of Kentucky.

Shotorban, Babak, Associate Professor, Mechanical and Aerospace Engineering, 2008, PhD, University Illinois-Chicago.

Showalter, Darlene, Clinical Associate Professor, Nursing, 1998, DNP, University of Alabama in Huntsville.

Shtessel, Yuri, Professor, Electrical and Computer Engineering, 1993, PhD, Chelyabinsk/Russia.

Simon, Richard, Assistant Professor, Sociology, 2013, PhD, Penn State University.

Sims, Jennifer, Assistant Professor, Sociology, 2017, PhD, University of Wisconsin - Madison.

Sitaraman, Bhavani, Associate Professor, Sociology, 1993, PhD, University of Massachusetts.


Slavin, Laura, Lecturer, Library, 2017, MA, Lincoln Memorial University School of Business.

Smeal, Mary Alice, Professor, Math, 2015, PhD, Auburn University.

Smith, Derrick, Associate Professor and Department Chair, Education, 2008, EdD, Texas Tech University.

Smith, Eric, Professor, English, 2006, PhD, University of Florida.

Smith, Lenora, Clinical Assistant Professor, Nursing, 2013, PhD, Medical University of South Carolina.

Sommerkamp, Sandy, Clinical Assistant Professor, Nursing, 2011, MSN, Jacksonville State University.
Spencer, Sharon, Clinical Assistant Professor, Nursing, 2012, MSN, University of New Orleans.

St. John, Caron, Professor, Management, 2010, PhD, Georgia State University.

Stallsmith, Bruce, Associate Professor, Biological Sciences, 1999, PhD, University of Massachusetts.

Steidl, Christina, Associate Professor, Sociology, 2012, PhD, Emory University.

Stewart, David, Associate Professor, Art, Art History Design, 1989, PhD, Boston University.

Storer, Sallyann, Clinical Assistant Professor, Nursing, 2017, DNP, University of Alabama in Huntsville.

Strong, Carol, Lecturer, Physics, 1993, PhD, University of Alabama in Huntsville.

Sullivan, Veronica, Clinical Assistant Professor, Nursing, 2017, DNP, University of Alabama in Huntsville.

Sun, Ming, Associate Professor, Physics, 2014, PhD, Harvard.

Swain, James, Professor, Industrial Systems Engineering, 1992, PhD, Purdue.

Sysoeva, Tatyana, Assistant Professor, Biological Sciences, 2018, PhD, The Pennsylvania State University.

Tantaris, Richard, Lecturer, Mechanical and Aerospace Engineering, 2017, PhD, Vanderbilt University.

Taylor, Chris, Assistant Professor, Art, Art History Design, 2014, MFA, Alfred University.

Taylor, W. Joseph, Associate Professor, English, 2010, PhD, University of Texas.

Thomas, Chad, Associate Professor, English, 2011, PhD, University of Michigan.

Thomas, Chad, Associate Professor, Theatre, 2011, PhD, University of Michigan.

Thomas, Dale, Professor, Industrial Systems Engineering, 2015, PhD, University of Alabama in Huntsville.

Thornton, Tracy, Clinical Assistant Professor, Nursing, 2013, MSN, University of Alabama in Huntsville.

Torres, Aurora, Assistant Professor, Psychology, 1995, PhD, University of Oklahoma.

Tseng, Fan, Department Chair, Professor, Management Science, 1984, PhD, University of Texas.

Twigg, Pamela, Lecturer, Chemistry, 2014, PhD, Florida State University.

Vadrevu, Anuradha, MA, Math, 2017, MA, Mississippi State University.

Veasey, Roxie, Lecturer, Art, Art History Design, 2005, MFA, University of Georgia.

Verlaan, Wolfram, Associate Professor, Education, 2012, ABD, Texas AM.

Vogler, Bernhard, Associate Professor, Chemistry, 2001, PhD, University of Tuebingen.

Waddell, Emanuel, Associate Professor, Chemistry, 2004, PhD, Louisiana State University.

Wade, Ryan, Lecturer, Atmospheric Science, 2014, MS, University of Alabama in Huntsville.

Wang, Gang, Associate Professor, Mechanical and Aerospace Engineering, 2010, PhD, University of Maryland.

Waring, Stephen, Professor, History, 1988, PhD, University of Iowa.

Watson, John, Assistant Professor, Communication Arts, 2018, PhD, Louisiana State University.


Weber, Ryan, Associate Professor, English, 2011, PhD, Purdue.
Weger, Kristin, Assistant Professor, Psychology, 2017, PhD, Otto-Friedrich-University.
Weimer, Jeffrey, Associate Professor, Chemistry, 1990, PhD, Massachusetts Institute of Technology.
Weimer, Jeffrey, Associate Professor, Chemical and Materials Engineering, 1990, PhD, Massachusetts Institute of Technology.
Weir, Colleen, Lecturer, English, 2016, PhD, Catholic University of America.
Weisskopf, Mary Ellen, Assistant Professor, Computer Science, 1983, PhD, University of Alabama in Huntsville.
Wells, Earl, Professor, Electrical and Computer Engineering, 1992, PhD, University of Alabama.
Wessling, Francis, Professor, Mechanical and Aerospace Engineering, 1988, PhD, University of Minnesota.
Whitehead, Paul N., Assistant Professor, Kinesiology, 2017, PhD, University of Pittsburgh.
Wilhite, Allen, Department Chair and Professor, Economics, 1988, PhD, University of Illinois-Urbana.
Wilkerson, William, Dean, Philosophy, 1997, PhD, Purdue.
Word-Allbritton, Andrea, Clinical Assistant Professor, Education, 2002, EdD, University of Alabama, Tuscaloosa.
Wren, Brent, Associate Provost and Professor, Marketing, 1994, PhD, University of Memphis.
Wu, Dongsheng, Associate Professor, Math, 2006, PhD, Michigan State University.
Wu, Tingting, Assistant Professor, Civil and Environmental Engineering, 2014, PhD, University of Florida.
X
Xing, Xuejing, Professor, Finance, 2007, PhD, University of Missouri-Columbia.
Xu, Gabe, Associate Professor, Mechanical and Aerospace Engineering, 2012, PhD, Georgia Tech.
Y
Yoo, Seong-Moo, Associate Professor, Electrical and Computer Engineering, 2001, PhD, Texas University.
Z
Zank, Gary, Distinguished Professor, Space Science, 2008, PhD, University of Kwazulu Natal.
Zhang, Guangsheng, Assistant Professor, Mechanical and Aerospace Engineering, 2017, PhD, Xi'an Jiaotong University.
Zhang, Guo-Hui, Associate Professor, Math, 1993, PhD, Southern Illinois University.
Zhang, Huaming, Associate Professor, Computer Science, 2005, PhD, State University of New York at Buffalo.
Zhang, Jing, Assistant Professor, Accounting, 2014, PhD, McGill University.
Zhao, Shuang, Assistant Professor, Political Science, 2015, PhD, Indiana University, Bloomington.
Zhao, Shuang, Assistant Professor, Atmospheric Science, 2015, PhD, Indiana University, Bloomington.
Zheng, Dianhan, Assistant Professor, Psychology, 2015, PhD, University of Houston.
Zhou, Hongyu, Assistant Professor, Civil and Environmental Engineering, 2014, PhD, Arizona State University.
Zhu, Feng, Associate Professor, Computer Science, 2005, PhD, Michigan State University.

Financial Information

In the following section you will find information pertaining to financial aspects of attending UAH including how you will be billed, how to pay your bill, estimated cost of tuition and other fees, and information regarding financial aid options. The cost of attendance for students at The University of Alabama in Huntsville will vary by their course of study, personal needs, and place of residence. Please note that all fees, charges, and costs detailed in this catalog are subject to change without notice. Financial obligations must be satisfied by the established deadlines. For additional information or questions please contact the Bursar's Office (www.uah.edu/bursar).
Billing and Payment Procedures

Tuition, fees and all associated charges are to be paid in full by the first official day of the semester (click here to find first official day of semester). Acceptable forms of payment are:

- Cash
- Personal Checks
- Money Orders
- Cashier’s Checks
- Traveler’s Checks
- Electronic Checks
- Credit Cards/Debit Cards (VISA, MasterCard, American Express, or Discover - 2.75% service fee applies)

Payments may be made online through the student account, in person at the Bursar’s Office (SSB 123), or by phone at 256.824.2732. Students who do not pay their bill in full by the first day of the semester are assessed a $50.00 late fee. Students who do not pay their bill in full by the end of the second week of classes may be dropped from class rolls and their enrollment canceled. The University assumes no responsibility for students who attend classes without official enrollment. For summer sessions, please check dates in the Academic Calendar (http://catalog.uah.edu/general-information/academic-calendars) and on the UAH website (http://www.uah.edu/registrar/calendars).

Mail payments to:

The University of Alabama in Huntsville
Bursar’s Office
Student Services Building, Room 123
Huntsville, AL 35899-5050

Installment Plan

Installment plans are available to students fall and spring semesters for the management of that semester's costs. UAH partners with Tuition Management Systems (TMS) to offer student installment plan accounts. A student may set up a plan or give access to others so they may establish a plan on the student's behalf. Two plans are available - a 4 payment plan or a 5 payment plan. There is a $50.00 fee to establish a plan and the fee is due at the time the plan is initiated. Once a plan is established, all payments are to be made to TMS. Should you need to adjust your plan, contact TMS at 800-336-0528. For more information, or to set up an installment plan, click here.

Balances

Past due balances are a debt owed the State of Alabama and appropriate action will be taken to collect all balances. Holds will be placed on all student accounts that have past due balances. This hold prevents students from receiving grades and transcripts and from registering for another semester at UAH. To the extent permitted by the laws of the State of Alabama, any costs to collect a past due account, to include collection agency charges and attorney fees, will be charged back to the student who shall be liable for payment of those charges.

Refunds

Students may drop a class through the sixth day of class (fall and spring) and receive a 100% tuition refund. Please check the UAH website (http://www.uah.edu/registrar/calendars) for summer dates. A student desiring to drop one or more classes may do so on the UAH online registration site or by submitting a drop request form to the Records and Registration Office, SSB 120. The date of the drop request is the date the written request is received at the Records and Registration Office.

Financial Aid

Students who apply for financial aid are responsible for completing the necessary paperwork far enough in advance to assure aid is received in a timely manner. For further information, please check with the Office of Financial Aid, Student Services Building, Suite 124.

Graduate Student Aid

UAH has several programs to assist students in financing their college education. Comprehensive, updated information on all financial aid offered through the Office of Financial Aid is available here. It includes detailed information about types of aid, eligibility guidelines, application procedures, criteria for awards, disbursement methods and regulations, and institutional policy followed in administration of aid. Additional information and necessary forms are available online and in the Office of Financial Aid.

Students of academic promise who can demonstrate financial need are encouraged to apply for assistance. Realistic financial planning is an essential part of college preparation. UAH helps qualified students find employment, scholarships, and loans as resources permit.
Students should make financial plans well in advance of entering the University. There are two important priority dates for student aid—December 1 for scholarships and April 1 for federal aid (apply online at https://fafsa.ed.gov/). The priority dates are the dates by which completed scholarship applications are certain to be included in the first round of review and by which the Free Application for Federal Student Aid (FAFSA) can be processed in a timely manner. A new FAFSA application must be submitted each year aid is requested.

**Types of Financial Aid**

**Scholarships**
(See the Financial Aid (http://www.uah.edu/admissions/undergraduate/financial-aid/scholarships) website for Scholarship listings)

**Loans**

UAH participates in the William D. Ford Federal Direct Stafford Loan program. Student loan funds are made available directly from the U.S. Department of Education. Although it is sometimes necessary to borrow money to finance an education, caution is advised. Generally, a student should not rely primarily on loans and is advised not to borrow more than what is needed to meet expenses. Additional information regarding eligibility amounts, loan limits, application procedures and suggested application timelines may be found online at uah.edu/financialaid. This and other valuable information regarding the financial aid process are available in the Office of Financial Aid.

**Federal Work-Study Program**

The Federal Work-Study Program provides employment for students who need financial assistance. A participating student works part-time on campus or in a non-profit agency while attending the University. In determining eligibility, preference will be given to students with the greatest financial need.

**Return of Federal Financial Aid**

Federally funded financial aid awarded to a student who withdraws from all classes after registration but before the end of the refund period, or who earns no passing grades for a specific term, must be repaid to the respective program source. When withdrawal or reduction of class load occurs after the end of the refund period, all tuition charges will be paid from the awarded aid and any remaining aid must be repaid to the respective aid source. Specific regulations governing this policy may be found online at uah.edu/financialaid.

For more information regarding Federal Financial Aid programs, please review the Department of Education's Federal Student Aid website regarding graduate or professional program funding: https://studentaid.ed.gov/sa/

**Housing Semester Rates**

**Central Campus Residence Hall (CCH)**
Available for 1st Year Students
- Private Bedroom in 4-person suite $3,260

**Frank Franz Hall (FFH)**
Honors First Year Student Housing
- Private bedroom in 4-person suite $3,350

**North Campus Residence Hall (NCH)**
1st Year Student Overflow, Early Fall Sports Athletes, and Upperclassmen with Charger Excellence Scholarships
- Private bedroom in 4-person suite $3,475
- Studio Suite (one-bedroom suite) $3,715

**Charger Village (CGV)**
Available for 2nd Year Students
- Private Bedroom in 4-person suite $3,515
- Private Bedroom in 2-person suite $3,625
- Studio Suite (one-bedroom suite) $3,790

**Fraternity and Sorority Housing (FSH)**
Available for 2nd Year and Upperclassmen
- Private Bedroom in 10-bedroom house $3,280

**Southeast Campus Housing (SCH)**
Available for Sophomores, non 1st Year Charger Excellence Scholarships, Upperclassmen, and Graduate Students
- Private Bedroom in 3-bedroom suite (Graduate Students and Student Families - 12 month contract) $2,810
One Bedroom Unfurnished $8,280*
One Bedroom Furnished $8,900**

**Campus Apartments**
Available for 2nd Year (non-scholarship) and Upperclassmen (non-scholarship)

Private Bedroom in an Apartment* $3,625
*Ashford Terrace, Emerald Ridge, Highland Point, or Waterford Square

1 Payable $2,760 Fall semester, $2,760 Spring semester, $2,760 Summer semester.
2 Payable $2,967 Fall semester, $2,967 Spring semester, $2,967 Summer semester.

**Note:** All Housing rates include basic utilities, Internet access, and basic cable television for each suite and bedroom.

**Meal Plan Rates**
Graduate students are not required to purchase meal plans, but options are available if you would like to purchase a package. Please contact the charger card office for a list of meal plans. http://www.uah.edu/chargercard/accounts/charger-card

**Tuition and Fees**
The University reserves the right to change its tuitions, fees, charges, rules and regulations at the beginning of any semester and without prior notice. Generally, the Board of Trustees of the University of Alabama System considers proposals for changes in fees at the June meeting. These fees do not apply to any short term, off-campus, or noncredit offering. For additional information on these courses, see section on College of Professional and Continuing Studies. Current fees are available on the web at www.uah.edu.

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<th>Graduate Hours</th>
<th>Resident</th>
<th>Non-Resident</th>
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<td>1</td>
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</table>

Each additional semester hour is $464.00 for in-state students and $1044.00 for out-of-state students.

The University reserves the right to change its fees, charges, rules and regulations at the beginning of any semester and without prior notice.

**Facilities Fee**
$10 per hour

**The above tuition and fee rates apply to audited courses.**

**Campus Course and Other Instructional Fees**
College of Arts, Humanities, and Social Sciences - $21 per hour
AMS, ARH, ARS, CL, CM, EH, EHL, GS, GY, HY, MU, MUA, MUE, MUJ, MUX, PHL, PSC, PY, SOC, TH, WLC, WGS
ARS - additional $10 fee per hour
TH - additional $10 fee per hour
MU - Studio Fee of $50 per hour
MU 100 - additional $10 fee per hour

College of Business - $20 per hour
ACC, BLS, ECN, FIN, IS, MGT, MKT, MSC
College of Education - $21 per hour
ED, EDC, HPE, KIN
HPE courses have additional fees per course as follows:
1 credit hour course - $100
2 credit hour course - $125
3 credit hour course - $150

College of Education Additional Fees per Course

<table>
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<tr>
<th>Course Code</th>
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<td>ED 301</td>
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<td>HPE 221</td>
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</tbody>
</table>

College of Engineering - $42 per hour
CE, CHE, CPE, EE, EM, ISE, MAE, MTS, OPE, OSE

Honors College
Student Service Fee - $175 per semester

Office of International Services
International Fee (Fall and Spring Semesters) - $150 per semester
International Fee (Summer Semester) - $25 each 5-week term
International Fee (Summer Semester) - $50 each 10-week term
J Visa Processing Fee - $100 per request

College of Nursing - $43 per hour
NUR
HESI Exam Fee for 408-20 - $153

College of Professional and Continuing Studies - $21 per hour
PRO, ECH

College of Science - $28 per hour
AST, ATS, BSE, BYS, CH, CS, ESS, MA, MS (Summer only), MOD, OPT, PH, SPA, ST

Academic Transcript Fee
$10 per request

Listener's License
First Course, if taken in the Fall - $250
First Course, if taken in the Spring - $210
First Course, if taken in the Summer - $170

First Course fees include parking permit
Each Additional Course - $130
Credit by Departmental Exam
$10 per hour

2017 - 18 Other Fees

Parking Permit
Fall Semester Purchase - $120 (valid 09/01/17 to 08/31/18)
Spring Semester Purchase - $80 (valid through 8/31/18)
Summer Term Purchase - $40 (valid through 8/31/18)

Meal Plans
Required Meal Plans (https://www.uah.edu/chargercard/meal-plans/requirements)

Charger ID Cards
New Students - $10
Replacement Card - $25

2017-18 Intensive Language and Culture Program Rate Tuition
ILC - $250 per hour

2017-18 Distance Learner Rate Tuition
Students enrolled in online courses only during a semester/term are charged the distance learner rate. Students who are enrolled in on-campus courses and in on-campus/blended courses during a semester/term or are taking online courses while also taking on-campus courses during a semester/term are charged the campus rate, including the Facilities Fee, associated Campus Course Fees and Other Instructional Fees.

<table>
<thead>
<tr>
<th>Graduate Courses</th>
<th>Rate</th>
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<tbody>
<tr>
<td>College of Arts, Humanities, and Social Sciences</td>
<td>$396.00</td>
</tr>
<tr>
<td>College of Business</td>
<td>$487.00</td>
</tr>
<tr>
<td>College of Education</td>
<td>$396.00</td>
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<td>College of Engineering</td>
<td>$573.00</td>
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<tr>
<td>College of Nursing</td>
<td>$396.00</td>
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<td>College of Science</td>
<td>$573.00</td>
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<tr>
<td>Non-Degree Seeking Student</td>
<td>$573.00</td>
</tr>
</tbody>
</table>

Policies and Procedures
The University of Alabama in Huntsville has various policies and procedures that guide our faculty, staff, and students. This section of the catalog provides detailed information on these policies, with which you should be familiar. Failure to read and comply with the policies listed here will not exempt a student from being held accountable to them. Additional policies are listed in the Student Handbook (http://www.uah.edu/student-support/student-conduct/handbook). Please note that the policies identified in this catalog do not represent an entire repository of university policies, as colleges and departments may implement policies that are not listed here. In addition, policies may be amended throughout the year.

Academic Probationary Status
Any time a student’s overall grade point average on graduate courses drops below a 3.0, the student will be placed on academic probation. A student on academic probation is not a candidate for a degree and may not register for classes without approval from the graduate dean, nor may they schedule a masters or doctoral defense.

For unconditionally admitted students, probationary status is removed by raising the overall grade point average to 3.0 or better on all graduate work attempted in all terms up to and including the semester in which 12 semester hours of graduate work are completed following the semester the student is placed on probation.

Conditionally admitted students must maintain a B (3.0) average through the semester in which the first 12 semester hours is completed, or they are subject to dismissal from the graduate school. Conditionally admitted students whose GPA falls below a 3.0 may petition to be allowed to continue in the graduate program if their advisor and department chair are in support of this. Such students must submit a written, signed petition indicating the reason for the poor academic performance, and a plan for raising the GPA to at least a 3.0. Such a plan must give specific details of courses to be taken, course repeats to be used, etc. and must be signed by the advisor and the department chair before being submitted to the graduate dean. If approved, the graduate dean may stipulate other conditions to the plan in order to allow the student to remain in the graduate program.
Academic Responsibility

Students at the University of Alabama in Huntsville have the following academic responsibilities:

1. To enroll in only those courses for which the stated prerequisite(s) (if any) have been satisfactorily completed. Failure to comply with this procedure may result in administrative withdrawal;
2. To attend all meetings of each class in which they are enrolled. Instructors will announce at the beginning of the semester if they consider attendance in computing final grades;
3. To observe all regulations of their college and select courses according to the requirements of that college;
4. To consult their advisors on all matters pertaining to their academic careers, including changes in their programs;
5. To answer promptly all written notices from advisors, faculty, deans, and other university officers;
6. To maintain the integrity of the classroom by practicing academic honesty. Students should refer to the Graduate Student Handbook for details regarding academic misconduct;
7. To file an "Application for Advanced Degree" or "Application for Graduate Certificate," as appropriate, through the Office of the Registrar to the Graduate School at least 3 months before the expected date of completion of requirements;
8. To be personally responsible for fulfilling all requirements for graduation and observing all regulations at UAH.

Academic Honesty

Plagiarism and other forms of cheating are subject to penalties as outlined in the Graduate Student Handbook. A graduate student found guilty of plagiarism or falsification of research data/results is subject to dismissal from the University.

Academic Appeals Process

Academic appeals will originate in written form by the student and will be processed through the chair of the student's major department, the College Dean, and the Office of the Provost, in that order. The decision of the Provost is final.

Class Attendance

Education at UAH depends upon the cooperation of students and faculty. Students are held responsible for the full work of the course in which they are registered, including participation in the discussion and work of the class at each class meeting.

A student's final grade in each course is determined on the basis of identified course requirements; therefore, regular class attendance is important.

Confidentiality of Student Records

The Family Educational Rights and Privacy Act of 1974 (FERPA) is a federal law that protects the confidentiality of student education records. To implement FERPA, the University has formulated and adopted a written institutional policy governing the handling of these records.

The term "education records (http://www.uah.edu/registrar/ferpa/#educational_record)" under FERPA includes generally any record, whether in a printed, handwritten, audio, video, or computer media format, maintained by the University and containing information related to a student in his/her role as a student (http://www.uah.edu/registrar/ferpa/#student). Certain records are, however, excluded by FERPA from this broad definition, such as those made by instructional, supervisory, and administrative personnel and kept in their sole possession, those made by campus police, and those made by a physician or other professional medical personnel in connection with treatment of the student.

Under FERPA and University policy, a student has a right of access to his/her education records and may inspect and review the information contained in them. To exercise this right, the student should present a request to the University office where the record is located, and a response will be made no later than 45 days later. In certain cases, a copy of the record may be provided, with a copying fee, as an alternative to actual inspection. Some records are not within this right of review, such as financial information from the student's parents and confidential letters or statements of recommendation where the student has waived the right of access.

A student who believes his/her education records contain information that is inaccurate, misleading, or in violation of his/her privacy rights may bring the matter to the attention of the appropriate records official. If by informal discussion with this official the student does not obtain the corrective action desired, the student will then be entitled to a hearing at which he/she may challenge the objectionable item. Additional information about hearing procedures will be given to the student at that time. The decision of the hearing official or panel shall be final. If the decision is adverse to the student, he/she may insert in the education record an explanatory statement about the disputed item.
A student's privacy interest in the education record is further protected by the rule against unauthorized disclosure. Generally, the University may not, without the student's consent, release the education record or personally identifiable information (http://www.uah.edu/registrar/ferpa/#personally_identifiable_information) in it to other individuals or entities.

Disclosure in certain circumstances, however, is specifically excepted by FERPA from the foregoing rule. These circumstances include disclosure to certain parties—University personnel who have a legitimate educational interest in the information, officials of institutions where the student is seeking to enroll, parties to which the student is applying for financial aid, the parent of a dependent student, etc.; disclosure to comply with a judicial order or lawfully issued subpoena; or disclosure in connection with a health or safety emergency. Under the first exception, "University personnel (http://www.uah.edu/registrar/ferpa/#university_official)" includes any UAH employee, and a "legitimate educational interest (http://www.uah.edu/registrar/ferpa/#legitimate_educational_interest)" means that the employee has a need for access to the record to perform appropriate tasks clearly within the area of responsibility of the employee, to perform a task related to the education or discipline of the student, or to provide a benefit or service relating to the student. Personally identifiable information will be transmitted by the University under these exceptions only upon the condition that the recipient not permit any other party to have access to it without the student's consent.

The University may also release what is called "directory information (http://www.uah.edu/registrar/ferpa/#directory_information)" without obtaining the student's consent. Directory information is limited to the following: the student's name, address (local and permanent), telephone number, e-mail address, date and place of birth, enrollment status (full-time or part time), major field of study, participation in officially recognized activities and sports, dates of attendance, degrees and awards received, the previous educational institution most recently attended, and a photograph of the student. However, a student may prevent the release of even this information, if he/she wishes, by completing a form provided for this purpose in the Office of Student Records.

Any student who believes that his/her rights under FERPA have been violated by the University may notify and request assistance from the Provost and Executive Vice President for Academic Affairs. The student may also file a complaint with the Family Policy Compliance Office, U.S. Department of Education, 400 Maryland Avenue, SW, Washington, DC 20202-5920.

Course Repeat Policy

Students should be aware that course repeats, for any reason, may not be looked upon favorably by some employers and by professional schools; hence, they should avoid the need for repeats.

Students may repeat any course an unlimited number of times in order to achieve a passing grade or an improved understanding of the course material.

One course may be repeated with the previous grade excluded from the calculation of the student's grade-point average. The student must declare such a course repeat before the end of the regular registration period for the semester in which the course will be repeated. Only a course for which the student has received a grade of C, D, or F may be repeated under this option. When withdrawing from a course that has been declared as a course repeat, the previous grade will still be used in the computation of the GPA, and the course will not count toward the maximum of one repeat. Until a grade other than W is reported, the previous grade will be used for the GPA. The transcript will show both the original grades and the course repeat grades, but only the grade points and credit hours earned in the repeated course will count toward graduation and will be averaged into the student's GPA. Concurrent registration for multiple sections of a course is not allowed.

For all other courses repeated at UAH, both the original grade and the course repeat grade will show on the transcript and will be calculated in the student's GPA.

A student wishing to exercise the option of repeating a course with grade replacement must file the intent to do so in the Office of Student Records before the end of regular registration using a Graduate Course Repeat form.

Enrollment Status

Seniors Taking Graduate Courses

A student (other than a senior taking graduate courses with appropriate authorization; see "Seniors Taking Graduate Courses", or a student in a combined undergraduate/graduate program) must be admitted to the Graduate School to receive graduate credit for courses taken or to take courses at the 500 level or above.

Course Load

A full-time graduate student is one enrolled in courses totaling 9 (GTA or GRA) to 12 semester hours for fall and spring semesters and 6 semester hours for summer. The maximum course load for a graduate student is 13 semester hours. A student employed full-time (40 or more clock hours a week) may schedule no more than 6 hours of graduate work a semester without permission of the faculty advisor or the department chair if the student does not have an advisor. A full-time teacher working toward certification is limited to two courses a semester and a maximum of four three-semester-hour courses an academic year (nine months).
Thesis/Dissertation Requirements
Students working on a thesis or dissertation must register for thesis or dissertation credit each term in which they receive supervision or during which they are engaged in the formal preparation of the thesis/dissertation. Students must register for 3 credit hours of either 699 or 799 in the semester that they defend. Thesis and dissertation supervision courses are graded on satisfactory/unsatisfactory basis.

Continuous Registration Requirement
Students pursuing a doctoral degree must register for a minimum of 3 semester hours of graduate credit (to include dissertation credit) each fall and spring semester until all degree requirements are complete and the dissertation is complete and defended.

Credit to Audit
A student is permitted to change a course from credit to audit only during the first four weeks of classes. For students whose tuition is paid by the University through graduate assistantships or tuition scholarships, changing a course from credit to audit will require the student to reimburse the University for that course's tuition.

Examinations
During each semester, one or more announced examinations of class period length may be held. At the end of each semester, a final examination period is scheduled for each course. Absences from a scheduled final examination without previous arrangement with the course instructor (except in extenuating circumstances) will be classified unexcused and a failing grade in the course will be assigned.

Any student whose final examination schedule is such that he or she is scheduled to take three or more examinations during a single day shall have the right to have the middle examination rescheduled. The date and time of the rescheduled examination shall be by mutual agreement between the student and the affected faculty member and must be agreed upon prior to the final week of the semester. It is the student's responsibility to notify the instructor of this type of conflict, and it is the instructor's responsibility to verify that the conflict actually exists. If a student is scheduled to take four examinations during a single day, then the same procedure applies except that the student shall now have the right to have both the second and fourth examinations rescheduled.

Graduate Dean's List
In order to be considered eligible for the Graduate Dean's List, a graduate student must:

- have completed at least 12 hours of graduate coursework at UAH during the last 12 months\(^1\); and
- have maintained a GPA on graduate-level coursework at UAH of 3.85 overall and 4.0 for the past 12 hours.

The Graduate Dean's List is compiled by the Graduate School each spring prior to Honor's Day. Qualifying students will be recognized on the Graduate School's website.

\(^1\) Spring to fall semester of the previous year

Graduate Degree Requirements
The following scholastic requirements are those of the Graduate School. Individual colleges and/or departments may list additional requirements.

1. Overall grade point average must be B (3.0) or better on all graduate credit hours at UAH. In addition, the grade point average must be B (3.0) or better on courses taken in the current graduate degree program;
2. No grade lower than a C may be counted toward a graduate degree;
3. At least 30 percent of the hours required for a graduate degree must be completed in courses numbered 600 or above;
4. A majority of the credit hours (including dissertation credits) toward a doctoral degree must have been earned at UAH (or, in the case of joint/shared programs, at the participating institutions);
5. In the case of joint/shared programs, at least 33% of all hours earned for a degree must be earned at UAH.

The Master's Degree as First Graduate Degree
Students may follow one of two plans for the master's degree, except where modified by individual departments. To avoid delay, students are encouraged to submit a Program of Study with the help of a faculty advisor before the completion of 12 semester hours of graduate coursework, in order to assure that courses taken will apply to the degree.

Thesis Plan
Degree requirements under this plan include completion of at least 24 semester hours of graduate course work and at least 6 credit hours of coursework (699) toward the writing of an acceptable thesis. Students working on a thesis must register for thesis credit each term in which they receive supervision or during which they are engaged in the formal preparation and/or defense of the thesis. The thesis should show evidence of the student's capability for
research, independent thought, and analysis. Furthermore, the thesis should be written in fluent, acceptable English. The subject must be in the major field. All theses must be accessible to the general public. The thesis is supervised and approved by a faculty committee composed of at least three members of the graduate faculty and appointed by the chair of the department, with approval of the graduate dean. A majority of the committee must be from the major department/program. The chair and at least half of the committee must 1) be full-time UAH faculty members and 2) have full membership in the graduate faculty. If the committee chair is different from the advisor, the advisor must also be a full member of the graduate faculty.

A completed copy of the thesis must be submitted to the major department and the thesis defended according to the dates set by the Graduate School, typically at least eight weeks before the end of the semester in which degree requirements are expected to be completed. The specific dates and detailed procedures for submission of theses can be found at http://uah.edu (http://grad.uah.edu) (graduate (http://uah.edu/graduate)). After the student has passed his/her thesis defense a copy of the thesis signed by the committee, department chair and college dean must be submitted to the Graduate School for final proofreading and approval by the graduate dean. Theses must comply with the regulations set forth in the Graduate School's Thesis and Dissertation Manual, available online at uah.edu/graduate/resources/thesis-manual or in paper copy from the Graduate School. Students must be in good academic standing (3.0 or better) to schedule a thesis defense.

In exceptional cases, theses may be written in absentia. Before leaving the University, students must 1) select a thesis subject, 2) submit to the chair of the major department a satisfactory outline of the thesis, and 3) submit satisfactory evidence that adequate facilities are available where research is to be done. The student's advisor, the department chair, and the graduate dean must then approve such a plan.

Non-Thesis Plan
Degree requirements for the master's degree under this plan include the completion of a minimum of 30 semester hours of graduate coursework. Individual colleges and/or departments may have specific or additional requirements. A thesis is not required; however, a candidate working under this option may be required to participate successfully in a seminar or other courses for acquaintance with research methods and appreciation of the place and function of original investigation in the field.

Transfer Credit
With permission of the major department, students may transfer up to twelve (12) semester hours of acceptable graduate credit earned in an approved institution and may count it toward a master's degree. No transferred credit may be more than ten years old at the time of a student's graduation from UAH. Such credit may be transferred with the approval of the major department if completed with a grade of B or better.

In some circumstances a student may need to take a graduate course at another institution while enrolled in a UAH degree program. The transfer of such credit back to UAH must be approved by the department and by the graduate dean prior to the student enrolling at the other institution. (This does not apply to joint or shared programs with other schools).

Time Limit
All requirements toward the master's degree, including transfer credit, must have been earned during the six years (18 fall, spring, and summer semesters) immediately preceding the date on which the master's degree is to be awarded. Credit for individual graduate courses at UAH completed more than 18 semesters but less than 30 semesters before the completion of all requirements for the degree must be validated by the department that offered the course through the administering of a written or oral examination. Once a course is validated, it is considered valid through the tenth year only. Credit for courses more than ten years old cannot be validated. Up to six hours of transfer courses that are more than 18 semesters but less than 30 semesters may be validated by a committee of at least three members of the graduate faculty appointed by the department or program chair, with the results reported to the graduate dean.

Application for Degree
All candidates for a master's degree must apply for the degree by submitting the Application for Advanced Degree and fee to the Registrar's Office at least three months before the degree is to be conferred. Consult the graduate school website for specific deadline dates.

Final Examination
A final comprehensive examination, or satisfactory performance (B or better) in a capstone course, is required of all candidates for a master's degree. Capstone courses must be designated as such by the department/program during the course approval process and be approved by the College Dean, the Graduate Council Curriculum Committee, the Graduate Dean, and the Provost.

Final examinations for non-thesis candidates may be written, oral, or both. Thesis option candidates must pass a final examination that includes an oral presentation of the thesis in the form of a seminar before the student's supervisory committee; the oral presentation is open to the members of the University community. The examination must be given according to the dates set by the School of Graduate Studies, usually at least six weeks before the end of the semester in which degree requirements are expected to be completed, and the results reported within two working days to the graduate dean. A written notice of the time and place of examination is sent to the graduate dean at least two weeks before the examination date. The graduate dean appoints an additional member of the graduate faculty to act as observer for all thesis defenses. Once set the examination becomes an official Graduate School matter; the date cannot be changed without prior arrangement amongst the supervisory committee members and the student and without approval of the graduate dean. For more details, consult the Graduate School Handbook.

After approval by the graduate dean, the department sends a copy of the written notice to the candidate and each member of the committee. A student may take the final examination no more than twice.
Thesis Submission
After the student has passed their thesis defense and at least six weeks before the end of the semester in which degree requirements are expected to be completed, a final draft of the thesis with supervisory committee, department/program chair, and college dean signatures must be submitted to the Graduate School, with personal contact information. Theses must comply with the regulations set forth in the Graduate School's Thesis and Dissertation Manual, available online at uah.edu/graduate/resources/thesis-manual. Student not in compliance will be notified. Upon acceptance by the Graduate School of a student's thesis, the Graduate Dean will forward a signed copy to the student who will then upload it to Proquest. All theses must be accessible to the general public. Detailed procedures for submission can be obtained by calling (256)824-6002.

Second Master's Degree
A student is permitted to apply no more than six semester hours of credit earned for one graduate degree toward an additional master's degree. Such permission is granted at the discretion of the major department and approved by the graduate dean.

Summary of Checkpoints toward Completion of all Master's Degree Requirements
The following checkpoints have been established to assist a student in proceeding from admission to graduation. Timely completion of these forms, in sequence, will help to insure that a student's degree program is in order.

Program of Study: This form must be filed as early as possible and definitely before the completion of 18 semester hours. If a supervisory committee develops the program, the student should be invited to the committee meeting. Once approved, changes in the Program of Study must be submitted on a Change of Program form and approved by the committee chair, department chair and graduate dean. A valid reason must be given for the change.

Application for Advanced Degree: This is to be filed at least three months before the end of the semester in which degree requirements are expected to be completed. It is available in the Registrar's Office.

Notification of Thesis Defense/Final Examination: Notification of the examination date must be turned in to the Graduate School at least two weeks in advance of the examination. The final examination must be taken at least six weeks before the end of the semester in which degree requirements are expected to be completed, and according to the dates set by the Graduate School and not earlier than the semester in which the student will complete all required coursework. A member of the committee will be appointed to be the graduate observer.

Report of Thesis Defense/Final Exam: Following the thesis defense/final exam the committee shall submit a signed report to the Graduate School.

Doctoral Degrees
UAH offers doctoral level programs in the Colleges of Engineering, Science, and Nursing. For specific information about the Doctor of Nursing Practice (DNP) program please see the College of Nursing section of the catalog.

The Doctor of Philosophy Degree
The doctor of philosophy degree is a research oriented degree awarded upon the demonstration of scholarly competence. The degree program at UAH is based on the successful completion of a program of study designed by the student and a faculty committee. The program may include mastery of certain research skills (e.g., languages, computer programming, statistics, and others approved by the Graduate Council), and must include an independent research project, the results of which are presented in the form of a dissertation.

Degree Requirements
The following specific degree requirements are applicable to all Ph.D. degree programs within the University. Additional requirements may be specified by individual colleges and/or departments as shown in this catalog under the appropriate section.

Course Requirements
Course requirements, including at least 48 hours of graduate coursework (excluding dissertation research), are defined in the Program of Study and are determined by the appropriate department. Usually the student will take a majority of the courses in a given field with the remainder in a cognate field. This, however, is not a requirement. A maximum of nine semester hours credit in thesis/research work from the master's degree may be allowed to count toward the 48 hour requirement. Students must also satisfactorily complete a minimum of 18 semester hours of dissertation research (799). Students must register for dissertation research each semester in which they receive faculty supervision. The approval of the Program of Study should be accomplished as early as possible, but no later than one year after admission to the Ph.D. program. Once approved, the program may be amended only with the approval of the supervisory committee upon submission of the Change of Program form and approval of the graduate dean.

Continuous Registration Requirement
All students who have completed the minimum coursework requirements for the doctoral degree they are pursuing (excluding dissertation hours) must register for a minimum of 3 semester hours of graduate credit (to include dissertation credit) each fall and spring semester until all degree requirements are complete.
Transfer Credit
All credit toward the Ph.D. which has not been earned at UAH must be acceptable graduate credit from an approved institution. Such credit may be transferred with the approval of the major department if completed with a grade of B or better. A majority of the credit hours (including dissertation credits) toward a doctoral degree must have been earned at UAH (or, in the case of joint/shared programs, at the participating institutions).

Academic Residence Requirement
Residence at UAH as a doctoral student is required for evaluation of the student’s investigative abilities, independent thought, and scholastic progress by faculty members other than the major advisor. Residence may be established through either (1) being enrolled as a full-time student (at least 9 graduate semester hours) either for one continuous academic year, or for Spring and Fall semesters in the same calendar year, or (2) being enrolled in at least 6 hours of graduate course work in at least three of four consecutive semesters. Colleges and/or departments may have more stringent requirements and students should refer to the appropriate section of the catalog for details. All research effort presented for residence credit toward the Ph.D. degree must be performed under the direction of a full member of the graduate faculty.

Supervisory Committee
A supervisory committee is appointed for each student working toward the Ph.D., usually after satisfactory completion of a preliminary examination administered by the major department. The supervisory committee is appointed by the department chair with approval of the graduate dean as part of the Program of Study approval. The supervisory committee is composed of at least five members of the graduate faculty, with at least half being from the major department/program. The chair and at least half of the committee must 1) be full-time UAH faculty members and 2) have full membership in the graduate faculty. If the committee chair is different from the advisor, the advisor must also be a full member of the graduate faculty.

Qualifying Examination
The Qualifying Examination is given under the auspices of the Graduate School and must be administered by the Supervisory Committee within one year of the date the student completes the formal coursework on the Program of Study. It is conducted in two distinct stages which may be separated by a length of time deemed appropriate by the supervisory committee. The first stage is a demonstration through written and oral examination that the student is proficient in the subject matter in the Program of Study. The final stage is the dissertation proposal review in which the student prepares a written report and makes a subsequent oral presentation describing the proposed dissertation research. Both the dissertation topic and expected approach(es) must be clearly delineated to the committee’s satisfaction in order for a pass to be granted. The presentation of the oral dissertation research proposal must be scheduled through the Graduate School at least two weeks in advance. Once this review is complete, the results of the Qualifying Examination are reported to the Graduate School within two working days on the prescribed form. The presentation of the oral dissertation proposal may be given no more than twice.

Time Limit
All requirements for the doctoral degree must be completed no more than five years after the student has passed the qualifying examination. Failure to meet this time requirement requires the student to take and pass another qualifying examination.

Application for Degree
All candidates for a Ph.D. degree must apply for the degree by submitting the Application for Advanced Degree and fee to the Registrar’s Office at least three months before the end of the semester in which degree requirements are expected to be completed.

Dissertation
The dissertation is evidence that the student can independently identify a problem of contemporary significance through familiarity with the current literature in the major field, organize and execute a program of research, recognize and analyze the results, and present them in cogent, well written exposition. Furthermore, the dissertation should be written in fluent, acceptable English. Dissertation results are expected to be submitted for refereed scholarly publication. All dissertations must be accessible to the general public. A completed copy of the dissertation must be submitted to the major department at least eight weeks before the end of the semester in which degree requirements are expected to be completed. See the Graduate School website for specific deadlines. Dissertations must comply with the regulations set forth in the Graduate School’s Thesis and Dissertation Manual, which is available online at uah.edu/graduate/resources/thesis-manual.

Final Examination
The final examination must include an oral presentation of the dissertation in the form of a seminar before the student’s committee; this presentation is open to the members of the University community. The examination must be given at least six weeks before the end of the semester in which degree requirements are expected to be completed, and the results reported within two working days to the graduate dean. The committee appoints a member of the graduate faculty to act as observer for all dissertation defenses. Once set, the examination becomes an official Graduate School matter; the date cannot be changed without prior arrangement amongst the supervisory committee members and the student and without approval of the graduate dean. A student may take the final examination no more than twice. Students must be in good academic standing to schedule a dissertation defense.

Summary of Checkpoints toward Completion of Degree Requirements
The following checkpoints have been established to assist a student in proceeding from admission to graduation. Timely completion of the forms, in sequence, will help to insure that a student’s degree program is in order.
Program of Study: The supervisory committee and the student should meet to develop a complete program for the student. Once approved, changes in the Program of Study must be submitted on a Change of Program form and approved by the committee chair, department chair and graduate dean. A valid reason must be given for the change.

Notification of Qualifying Examination: Notification of the qualifying examination must be turned in to the Graduate School at least two weeks before the examination date.

Report of Qualifying Examination: Following the examination the committee shall submit a signed report to the Graduate School.

Application for Advanced Degree: This should be filed three months before the end of the semester in which degree requirements are expected to be completed. (Available from the Registrar's Office, SSB 120.)

Notification of Dissertation Defense: Notification of the defense must be turned in to the Graduate School at least two weeks before the examination date. This examination must be taken at least six weeks before the end of the semester in which degree requirements are expected to be completed. A member of the committee will be appointed to the graduate observer.

Report of Dissertation Defense: Following the defense the committee shall submit a signed report to the Graduate School.

Dissertation Submission
After the student has passed his/her dissertation defense and at least six weeks before the end of the semester in which degree requirements are expected to be completed, a final draft of the dissertation with supervisory committee, department/program chair, and college dean signatures must be submitted to the Graduate School, with personal contact information. Dissertations must comply with the regulations set forth in the Graduate School's Thesis and Dissertation Manual, available online at uah.edu/graduate/resources/thesis-manual. Student not in compliance will be notified. Upon acceptance by the Graduate School of a student's dissertation, the Graduate Dean will forward a signed copy to the student who will then upload it to Proquest. All dissertations must be accessible to the general public. Detailed procedures for submission can be obtained by calling (256)824-6002.

Registration
Dates, times, procedures, and eligibility conditions for registration are published in the Schedule of Classes on the UAH website at http://www.uah.edu/cgi-bin/schedule.pl. After the published deadline, registration requires approval from the Dean of the Graduate School. A student must submit a written petition with appropriate documentation to substantiate extenuating circumstances to the Graduate School. The petition must include signatures from the instructor and the chair of the department that offers the course. All financial obligations to the University must be cleared before a student may register for courses. Students should consult with their academic advisor prior to registration. Non-degree students have a lower registration priority for full classes.

Concurrent registration for multiple sections of a course is not allowed. A student who schedules courses during registration makes a financial commitment to the University. Schedule adjustments, drops, and withdrawals must be officially transacted either via UAH web registration or in writing on a Registration/Schedule Adjustment form and recorded by the Office of the Registrar by the published deadlines. Adjustments in fees, if any, will be made by the Office of the Bursar. The University assumes no responsibility for students who attend classes without proper registration.

A semester hour is an academic unit of credit awarded for the completion of educational activities. The amount of credit awarded depends on the expected amount of time required to complete in-class and out-of-class work during a semester for a course that is passed. For example, each semester hour awarded for a lecture course at UAH requires at least one hour of classroom or direct faculty instruction and a minimum of two hours out of class student work each week for approximately fifteen weeks for one semester. At least three hours of work per week is required for each semester hour awarded for practica, internships, activity courses, laboratory experiences, and distance learning courses, although there will be variations in the amount and type of instruction and the minimum amounts of outside student work to accommodate differences among academic disciplines and the natures of particular subject matters and courses. The institution reserves the right to make semester hour assignments that exceed the minimum time requirements stated. Time expectations for work outside of class are minimums and may be higher depending on the nature and level of the course as well as the ability, commitment, and learning style of the student.

Schedule Adjustments
After the beginning of an academic term, students seeking to change their course schedules must follow the Schedule Adjustment Process. Schedule adjustments fall into seven categories: Drop/Add, Late Addition, Credit/Audit, Withdrawal, Late Withdrawal, Retroactive Withdrawal, and Medical Withdrawal. The following definitions and procedures will govern the Schedule Adjustment Process.

Drop/Add
After classes have begun, students should consult with their academic advisor and other university officials for advice and approval before making any schedule changes. Students are advised to check the impact of dropping courses on things like financial aid, athletics eligibility, visa status, etc.

Through the sixth day of classes for a ten-week or fifteen-week semester, fourth day of a seven-week semester, or third day of a six-week or shorter semester, students may Add a course through the web-registration process, by meeting with their advisor, or by submitting a Registration/Schedule Adjustment form to the Office of the Registrar.
Through the sixth day of classes for a ten- or fifteen-week semester, fourth day of a seven-week semester, third day of a six week or shorter semester, students may Drop any or all courses from their schedule and receive a refund of tuition and fees associated with the dropped courses.

**Late Addition**

In rare circumstances a student may have a legitimate and substantial need to register, add a class or change a class section after the deadline (i.e., Last Day to Add a Class). In these instances the student must complete the Registration/Schedule Adjustment form, with recommendations (approval/ non-approval) from the instructor and the chair of the department that offers the course. The Office of the Registrar will process the request once approvals are obtained.

New international students who want to register after the deadline must obtain approval from the International Student Advisor, and in the case of graduate students, the Graduate Dean. Approvals for late registration for new international students will include the respective academic units.

**Credit to Audit**

A student is permitted to change a course from credit to audit through the fourth week of a fifteen-week semester, the third week of a seven- or ten-week semester, and the second week of a five-week or shorter semester. The instructor is not required to grade any written assignments that may be submitted by an auditing student. A student who elects to audit a course may not at any point after electing to audit, change to “for-credit”, i.e., graded status. Any student failing to follow established procedure for change to audit will continue to be enrolled in the class for credit and may receive a failing grade in that course.

**Withdrawal**

After the Drop/Add period a student may Withdraw from any course and receive a grade of W. The deadline for Withdrawal is the end of the tenth week of a fifteen-semester, end of the seventh-week of a ten-week session, the end of the fifth week of a seven-week session, the end of the third week of a five-week semester, or the end of the second week of a semester shorter than five weeks.

Withdrawal is accomplished by either 1) executing a withdrawal on the registration website or 2) by submitting a Registration/Schedule Adjustment form to the Office of the Registrar. No signatures or approvals are required for a Withdrawal, but students should consult with appropriate officials to determine the impact that withdrawing from a course may have on financial aid, athletics eligibility, visa status, etc.

Class non-attendance does not constitute withdrawal nor does notification to the instructor. Any student failing to follow the established procedure for withdrawal will continue to be enrolled in the class and may receive a failing grade in that course.

**Late Withdrawal**

After the Withdrawal period, a student may request a Late Withdrawal from a course under extenuating circumstances and with the approval of the dean of the college in which the student is enrolled. Avoidance of an undesirable grade does not justify withdrawal.

Students requesting a Late Withdrawal must submit the Late Withdrawal Form, along a written explanation of the extenuating circumstances and any appropriate documentation, to the Dean of Students for review. If the Dean of Students believes sufficient evidence exists to warrant a Late Withdrawal, the withdrawal request is forwarded to the Dean of the college in which the student is enrolled (minus personal documentation) for consideration.

Class non-attendance does not constitute withdrawal nor does notification to the instructor. Any student failing to follow the established procedure for withdrawal will continue to be enrolled in the class and may receive a failing grade in that course.

**Retroactive Withdrawal**

Undergraduate students may at times experience extraordinary problems during an academic semester. Within two years of having completed such a semester, a student may petition the Dean of Students to withdraw retroactively from ALL classes taken during that semester. A retroactive withdrawal is granted only under exceptional circumstances, such as extraordinary medical or personal problems. The petition should use the Retroactive Withdrawal form, and include clear and documented evidence whenever possible. The Dean of Students verifies the documentation and forwards the petition to the Associate Provost, who approves or denies the request. If the Associate Provost grants a retroactive withdrawal, the grades for ALL courses taken during the semester in question will be changed to W’s. Petitions for Retroactive Withdrawals are considered after final grades are posted. Students should be aware that retroactive withdrawals may have an impact on their ability to receive or retain financial aid and timely completion of their degree.

**Medical Withdrawal**

Students may at times experience medical hardships that prevent them from attending class and necessitate a withdrawal. Decisions on whether to award a Drop, Withdrawal, Refund, etc. must include sufficient documentation to justify the request. In such cases the student should contact the Dean of Students office for assistance.

**Recording of Withdrawals**

If the withdrawal process is completed during the first two weeks of the semester, the withdrawing student’s name does not appear on the final rolls of the class from which the student withdrew, and that course does not appear on the student’s permanent record. If the withdrawal process is completed
after the first two weeks, then the withdrawing student's name will be on the final roll of the class from which the student withdrew, and that course will be recorded on the student's permanent record with a final grade of W.

**Counseling**

Students need to be aware that many potential employers, as well as graduate and professional schools, view an excessive number of W's on a transcript as a flag that the student cannot be counted on to complete demanding projects. Advisors should be informed of this fact and students should be encouraged to discuss with their advisors any plans to withdraw from a course, especially after the first two weeks of the semester.

**Course Forgiveness and Repeat Policy**

Students should be aware that course repeats, for any reason, may not be looked upon favorably by some employers and by professional schools; hence, they should avoid the need for repeats.

Students may repeat any course an unlimited number of times in order to achieve a passing grade or an improved understanding of the course material.

One course may be repeated with the previous grade excluded from the calculation of the student's grade-point average. The student must declare such a course repeat before the end of the regular registration period for the semester in which the course will be repeated. Only a course for which the student has received a grade of C, D, or F may be repeated under this option. When withdrawing from a course that has been declared as a course repeat, the previous grade will still be used in the computation of the GPA, and the course will not count toward the maximum of one repeat. Until a grade other than W is reported, the previous grade will be used in the computation of the GPA. The transcript will show both the original grades and the course repeat grades, but only the grade points and semester hours earned in the repeated course will count toward graduation and will be averaged into the student's GPA. Concurrent registration for multiple sections of a course is not allowed.

For all other courses repeated at UAH, both the original grade and the course repeat grade will show on the transcript and will be calculated in the student's GPA.

A student wishing to exercise the option of repeating a course with grade replacement must file the intent to do so in the Office of the Registrar before the end of regular registration using a Graduate Course Repeat form.

**Grading System**

The University of Alabama in Huntsville's grading system includes grades of A, B, C, D, F, I, X, W, S, U, P, AU, N, and NC. Instructors have the option of augmenting the course grades of A, B, C, and D with symbols "+" and "-" signifying, respectively, high and low achievement within the assigned grade. These augmented letter grades become part of the student's permanent record and appear on transcripts, but augmentation of a letter grade does not affect its value for the purposes of the GPA computation.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Superior achievement. Four quality points given per semester hour.</td>
</tr>
<tr>
<td>AU</td>
<td>Audit. Course attendance as a listener. No credit given, no quality points assigned, no attendance requirement.</td>
</tr>
<tr>
<td>B</td>
<td>Above average achievement. Three quality points given per semester hour.</td>
</tr>
<tr>
<td>C</td>
<td>Average Achievement. Two quality points given per semester hour.</td>
</tr>
<tr>
<td>D</td>
<td>Passing work. One quality point given per semester hour.</td>
</tr>
<tr>
<td>F</td>
<td>Failing work. No credit given; no quality points assigned.</td>
</tr>
<tr>
<td>I</td>
<td>Incomplete. Assigned by the instructor when a student, due to circumstances beyond his or her control, has not satisfied some requirement of the course. The deadline for a student to remedy a grade of I is the last day of class of the next semester enrolled or one calendar year from the date of the grade whichever occurs first. If the grade of I is on a student's record at the time of graduation, it is treated as an F.</td>
</tr>
<tr>
<td>N</td>
<td>No grade. Assigned by the Office of the Registrar when the instructor does not report a grade.</td>
</tr>
<tr>
<td>P</td>
<td>Passing work. Assigned in some courses. See Pass-Fail Option.</td>
</tr>
<tr>
<td>S</td>
<td>Satisfactory work. Applicable to noncredit courses and to some specified credit courses, and will not be counted in the GPA.</td>
</tr>
<tr>
<td>U</td>
<td>Unsatisfactory work. Applicable to noncredit courses and to some specified credit courses.</td>
</tr>
<tr>
<td>W</td>
<td>Withdrawal. (See Withdrawal Policy.)</td>
</tr>
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Course Numbering System

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<th>Student Normally Takes Courses</th>
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<td>Refresher (noncredit)</td>
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<td>100-199</td>
<td>Freshman</td>
</tr>
<tr>
<td>200-299</td>
<td>Sophomore</td>
</tr>
<tr>
<td>300-399</td>
<td>Junior (upper-level)</td>
</tr>
<tr>
<td>400-499</td>
<td>Senior (upper-level)</td>
</tr>
<tr>
<td>500-599</td>
<td>Graduate</td>
</tr>
<tr>
<td>600-699</td>
<td>Graduate</td>
</tr>
<tr>
<td>700-799</td>
<td>Graduate, Ph.D. level</td>
</tr>
</tbody>
</table>

Change of Grade

When it is believed that a grading error may have occurred, a student is permitted a maximum of one semester from the date a grade is assigned to request a change of course grade. Grades submitted to the Office of the Registrar can normally be changed only by submission by the instructor on a Change of Grade form containing a written explanation of the error. The Change of Grade form must be approved by the department chair and received in the Office of the Registrar no later than two semesters from the date the original grade was assigned.

Transcripts

There are two ways to request an official UAH transcript:

1. Fill out the transcript request form (http://www.uah.edu/images/admissions/Registrar/Charger%20Central/Forms/offtran071116.pdf). The completed form and payment information can be sent via fax to 256.824.7780 (http://catalog.uah.edu/grad/academics/transcripts/tel;(256)%20824-7780), scanned and emailed to registrar@uah.edu, mailed to our office, or dropped off in-person.

2. You can also request electronic or paper official transcripts through the National Student Clearinghouse (https://www.studentclearinghouse.org/secure_area/Transcript/login.asp?FICEcode=00105500).
   - In order to send PDF transcripts, you must request them through the link above.

Please note: effective August 1, 2016, a 3% convenience fee will be added to all credit/debit card payments. However, if you use the National Student Clearinghouse (https://www.studentclearinghouse.org/secure_area/Transcript/login.asp?FICEcode=00105500) to request transcripts, you will not be charged the convenience fee.
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