College of Engineering

History and Objectives

Engineering instruction began at The University of Alabama in 1837. The College of Engineering was organized as a separate division of the University in 1909. As the original engineering college in the state of Alabama, our mission is to:

- provide high-quality undergraduate, graduate and continuing education in engineering and computer science to prepare our graduates for professional careers, leadership positions and a lifetime of learning
- conduct high-quality research programs that will assist in the economic development of the state and nation, advance the body of knowledge and improve the quality of human life
- serve individual practicing engineers and computer scientists; industry, government and educational entities and technical societies through professional expertise, active involvement and availability of facilities

To accomplish its mission, the College of Engineering offers students an outstanding faculty, accredited engineering and computer science programs and some of the most advanced facilities in the nation. Numerous research projects offer students opportunities to work with faculty in solving current societal problems and in developing technological resources for the future.

For more information about the College of Engineering and its programs and services, call or write: The University of Alabama, College of Engineering, Box 870200, Tuscaloosa, AL 35487-0200; (205) 348-6400; eng.ua.edu.

Accreditation

The following undergraduate engineering programs in UA’s College of Engineering are accredited by the Engineering Accreditation Commission of ABET:

- Aerospace Engineering
- Chemical Engineering
- Civil Engineering
- Construction Engineering
- Electrical Engineering
- Electrical Engineering – Computer Engineering Option
- Mechanical Engineering
- Metallurgical Engineering

The undergraduate Computer Science program in UA’s College of Engineering is accredited by the Computing Accreditation Commission of ABET.

Freshman Engineering Program

The Freshman Engineering Program at The University of Alabama offers a first-year experience designed to both motivate and engage our students. All engineering majors take a common first-year program with these goals:

- introduce students to the field of engineering
- ensure students have the skill sets necessary to successfully complete second-year engineering courses
- illustrate the relevance of mathematics and science to the field of engineering

If you, as a current or prospective student, have questions about the Freshman Engineering Program at The University of Alabama, please visit eng.ua.edu/fep; call 205-348-0750; or write to Freshman Engineering Program, College of Engineering, 290 Hardaway Hall, The University of Alabama, Box 870285, Tuscaloosa, AL 35487-0285.

Admission and Retention Requirements

The College of Engineering follows the admission and retention standards set by the University and reserves the right to change policies, procedures, degree requirements, schedules, courses offered and other standards in light of circumstances that may arise after the publication of this catalog.

Admission as a Freshman Student

A student who meets the criteria for admission to The University of Alabama as a freshman student is eligible for admission to the College of Engineering. Specific information about these criteria is available from The University of Alabama, Office of Undergraduate Admissions, Box 870132, Tuscaloosa, AL 35487-0132; (205) 348-5666 or toll-free 1-800-933-BAMA in the continental United States.

Entering freshmen may enroll in specific degree programs, or they may enroll as undesignated engineering students. Differences in students’ abilities and in the degree of their preparation make it necessary for each student to begin work in chemistry, mathematics and English at the level determined by placement tests offered by the departments of chemistry, English and mathematics. Grade points earned in preparatory courses are counted in the grade point average, but hours earned for such courses may not be applied to the requirements for a degree.

Common Freshman Year

All students in the College of Engineering have a common freshman-year experience. As part of this experience, all students must complete four hours of fundamental engineering courses. These four hours consist of:

| ENGR 111 | Engineering for the Future | 1 |
| ENGR 103 | Engineering Foundations | 3 |

Admission as a Transfer Student

A student seeking to transfer into the College of Engineering from another institution is required to have an official transcript sent directly to the UA Office of Undergraduate Admissions from each college or university previously attended. A grade point average of C (2.0 on a 4.0 scale) or better for all college-level work attempted is required for admission to the University and to the College. Transferred courses will be applied as appropriate to a student’s degree program. Courses where a grade of D was earned will not be applied if the course is a prerequisite to another course required for the student’s degree program. The authority to apply or to deny transferred credit rests with the college.

Transfers from Two-year Colleges

At most, 50 percent of the total number of hours required for an undergraduate degree in the College of Engineering may be taken at two-year colleges and applied toward graduation requirements. All courses for which credit is to be transferred must be of essentially the same quality as the equivalent courses at The University of Alabama.

Transfers from Senior Colleges and Universities

Courses transferred from institutions accredited by ABET will be accepted within the broad limits of the graduation requirements of the College and the University. Students seeking to transfer credit from institutions not accredited by ABET or by a regional or national accrediting agency may be granted transfer credit on a provisional basis. Consult the director of Engineering Student Services or the UA Office of Undergraduate Admissions for more information.

Transfers from Other UA Divisions

Students who have earned fewer than 45 semester hours may transfer to the College of Engineering if they satisfy The University of Alabama Scholastic Progress Standard (see the Academic Records and General Academic Policies section of this catalog). A student who has earned 45 or more semester hours must have cumulative grade point averages of at least 2.0 and an average of at least 2.0 (on a 4.0 scale) for a minimum of 12 semester hours at The University of Alabama. Credit that another division of the University previously accepted for transfer from another institution will be reevaluated by the College of Engineering when a student transfers into the College from within the University.

Degrees and Programs Offered

The College of Engineering offers undergraduate programs leading to the bachelor of science degree in:

- aerospace engineering
- chemical engineering
- civil engineering
- computer science
- construction engineering
- electrical engineering
- mechanical engineering
- metallurgical engineering

An option in computer engineering is available in the electrical engineering program. The College offers graduate programs leading to the master of science degree in:

- aerospace engineering
- chemical engineering
- civil engineering
- computer science
- electrical engineering
- environmental engineering

The University of Alabama
The College offers programs leading to the doctor of philosophy degree in the fields of:

- chemical engineering
- civil engineering
- computer science
- electrical engineering
- engineering science & mechanics
- mechanical engineering
- metallurgical engineering

A PhD in the area of materials science is offered in collaboration with The University of Alabama at Birmingham and The University of Alabama in Huntsville. Students should consult The University of Alabama graduate catalog for information concerning the graduate degree programs.

Minors in Engineering for Non-engineering Majors

Two types of minors in the College of Engineering are available to students enrolled in other divisions of the University. The minors require a minimum of 18 hours in engineering courses.

- The Type 1 minor is a specialized program in any of the College’s engineering disciplines. Course requirements and advising are available from the appropriate department head, who will appoint an adviser for a student desiring this type of minor.
- The Type 2 minor is a general minor in engineering that requires a minimum of 18 hours in courses chosen from a list available from the associate dean for academic programs. The associate dean will appoint an adviser for a student pursuing a Type 2 minor.

Degree Requirements

The requirements specified in this catalog are intended for all students who begin their college careers during or after the fall of 2012. Students who have begun their careers prior to fall 2012 may choose to complete the requirements outlined in this catalog, but if they do so they must complete all of the requirements listed herein. Students may not choose some requirements from this catalog and some from previous catalogs. If a student does not complete requirements for the undergraduate degree within a period of seven years from the date of admission, the College of Engineering will modify the student's program to bring it into compliance with current degree requirements.

Application for Degree

Each candidate for graduation must submit an application for degree to Engineering Student Services (290 Hardaway Hall). Students who expect to complete degree requirements in May can submit their degree applications beginning on October 1 of the previous year. Those who expect to finish their requirements after the interim term, summer session or fall semester should submit their applications beginning the in March before the expected graduation. In all cases, an application for degree must be on file in Engineering Student Services no later than the time at which the degree candidates register for the final semester in residence. Students who apply for their degrees after registration for the final semester will not receive their diplomas until the following term.

Graduation Standards

Each student who expects to earn a baccalaureate degree from the College of Engineering must meet the following minimum standards of academic achievement:

- successfully complete all courses specified in the degree program
- complete at least one-half of the work required within the discipline on this campus
- earn at least a C average (2.0 on a 4.0 scale) for all work attempted
- earn at least a C average (2.0 on a 4.0 scale) for all work attempted on this campus
- earn at least a C average (2.0 on a 4.0 scale) for all work attempted in his or her professional courses
- earn at least a C average (2.0 on a 4.0 scale) for all work attempted in his or her professional courses on this campus
- meet any additional academic requirements of the program offering the degree

General Policy

Auditing Courses

Students may register for courses as auditors with the approval of the departments offering the courses. The deadline for registering as a course auditor coincides with the deadline for adding courses at the beginning of each semester. The requirements that auditors are expected to meet in an audited course are left to the discretion of the instructor. Audited courses do not count toward degree requirements.

Course Substitution

Occasionally, a student may wish to substitute another course for a required course. All such requests should first be presented via written petition to the student's adviser and department head, who will:

- weigh the merits of course substitution and determine if the content of the proposed course is appropriate as a substitute
- make a recommendation to the Associate Dean for Academic Programs, who will decide on course substitution recommendations

Double/Second Majors

Students seeking a double major must complete the Double/Second Major form located in the Office of Engineering Student Services (290 Hardaway Hall). The same academic standards apply to a double/second major as to any other course sequence for a College of Engineering degree. The College of Engineering departmental adviser, as well as the adviser outside the College of Engineering, must approve all courses for the double/second major.

Engineering Alternative to the Statewide General Studies Curriculum

Act 94-202, enacted by the Alabama legislature in 1994, provided equivalency for first- and second-year courses taught by colleges in the state of Alabama. In 1995, engineering educators presented an engineering alternative to the general studies curriculum (GSC) that modified the Act to specific needs of engineering colleges statewide. The engineering alternative was unanimously approved by the statewide Articulation and General Studies Committee in December 1995 and was made a part of GSC. The details of the College of Engineering Core Curriculum/General Education Requirements are listed in the Academic Records and General Academic Policies section of this catalog.

Free Electives

Most college courses may be counted as free electives. Any exceptions for College of Engineering students are the mathematics courses below MATH 125 Calculus I. ROTC credit may be applied with the approval of the student's adviser and department head.

Mathematics

An entering student must enroll in the mathematics course determined by the student’s score on the mathematics placement test. A grade of C- or higher must be earned in each mathematics course that leads to another course in the sequence, preparing the student to enroll in calculus.

Online Courses

College of Engineering students may enroll in online courses through the College of Continuing Studies. An online course with the same course number as a regularly scheduled on-campus course fulfills the same degree requirements as an on-campus course. Further information about online courses is available through the College of Continuing Studies.

Pass/Fail Option

The pass/fail option cannot be exercised for courses that are to be applied to the requirements of an engineering or computer science degree. For further information about the pass/fail option see the Academic Records and General Academic Policies section of this catalog.

Prerequisites

The College of Engineering requires a grade of at least C- in each course that is a prerequisite to any course needed to meet a student's degree requirements. If a grade lower than C- is received in a prerequisite course, that course must be repeated. A grade of C- or higher must be earned before the student enrolls in the subsequent course. In such cases, it is the student's responsibility to make schedule changes through the drop/add process. Changes should be made before the beginning of the next term, and they must be made before the deadline for adding courses. Failure to make the changes on time will result in administrative withdrawal.
from the course. A student who is administratively withdrawn from a course after the deadline to add a course may not add another course in replacement.

**Advising**

The College of Engineering Academic Advising Center was established to provide advising support services to students that encourage success, independence and completion of an academic plan that incorporate students' goals and interests. Students must be advised each semester prior to registering for courses and are assigned an adviser in the College of Engineering by their last name. The Advising Center is located in 290 Hardaway Hall. Additional information is available through the Advising Center website.

**Repeating Courses**

The repetition of courses is governed by the following restrictions:

- • In computing the grade point average, a grade of I (Incomplete) is included as hours attempted with zero grade points earned. A student on probation must remove I grades within two weeks of the beginning of classes during his or her next term in residence. Students not on probation must remove I grades within four weeks of the beginning of classes during the next term. If the I grade was earned in a required course and is not removed, the course must be repeated.
- • A record of original and repeat enrollments appears on the student’s transcript.
- • Each enrollment in a course is included in the cumulative hours attempted and in the computation of grade point averages. However, only the final enrollment may count as credit toward the degree.
- • Courses completed with grades of A, B or C may not be repeated except on an audit basis.
- • Enrollment for credit in a course that is at a lower level than a course the student has already completed for credit with a grade of A, B or C is prohibited. For example, a student with credit for with a grade of A, B or C may not enroll for credit in the following courses or similar courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 100</td>
<td>Intermediate Algebra</td>
<td>3</td>
</tr>
<tr>
<td>MATH 110</td>
<td>Finite Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 112</td>
<td>Precalculus Algebra</td>
<td>3</td>
</tr>
<tr>
<td>MATH 113</td>
<td>Precalculus Trigonometry</td>
<td>3</td>
</tr>
<tr>
<td>MATH 115</td>
<td>Precalculus Algebra &amp; Trig</td>
<td>3</td>
</tr>
<tr>
<td>MATH 121</td>
<td>Calculus &amp; Applications</td>
<td>3</td>
</tr>
<tr>
<td>GES 255</td>
<td>Engineering Statistics I</td>
<td>3</td>
</tr>
</tbody>
</table>

This policy also prohibits repeating a course for credit if equivalent transfer credit with a grade of Pass has already been awarded.

- • Enrollment for credit in a course is not prohibited simply because credit was earned in a higher-numbered course. For example, a student with credit for or Department Approved GES Course may enroll for credit in the following courses:

<table>
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<tr>
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</tr>
</tbody>
</table>

Transfer Credit, Advanced Placement and Credit by Examination

The following policies apply to the transfer of credit by entering transfer students, to the transfer of credit that was earned while concurrently enrolled at The University of Alabama, to the transfer of credit earned as a transient student at another institution and to the transfer of credit from other divisions of The University of Alabama.

- • In order for credit to be transferred, courses completed at other institutions must be equivalent as nearly as possible to courses taught at The University of Alabama.
- • In the College of Engineering, grades of D will not be admissible if the grade was earned in a course that is a prerequisite to another course required for the student’s degree program.
- • The maximum amount of credit transferable from two-year institutions is 64 semester hours.

Transfers from Other University of Alabama Divisions

Credit that another division of the University previously accepted for transfer from another institution will be reevaluated by the College of Engineering when a student transfers into the College from within the University.

**Undergraduate Students in Graduate Courses**

Undergraduate students may be permitted to enroll in graduate courses if they have senior standing and at least a B average for work attempted at The University of Alabama.
Concepts of stress and strain; analysis of stresses and deformation in bodies loaded by axial, torsional, and bending loads; combined loads analysis; statically indeterminate members; thermal stresses; columns; and thin-walled pressure vessels.
Prerequisite(s): MATH 126 or MATH 146 and AEM 201.

AEM 251. Mechanics Of Materials I Lab. 1 sem. hr.
Mechanical tests of metallic and nonmetallic materials in the elastic and inelastic ranges; use of materials testing for acceptance tests, for the determination of properties of materials, and for illustration of the validity of assumptions made in mechanics of materials.
Prerequisite(s) with concurrency: AEM 250.

AEM 264. Dynamics. 3 sem. hrs.
Kinematics of particles and rigid bodies, Newton's laws of motion, and principles of work-energy and impulse-momentum for particles and rigid bodies.
Prerequisite(s): MATH 126 or MATH 146; and AEM 201.

AEM 311. Fluid Mechanics. 3 sem. hrs.
Fluid statics, application of conservation laws to simple systems, dimensional analysis and similitude, and flow in open and closed conduits.
Prerequisite(s): MATH 227 or MATH 247; and AEM 201.

AEM 313. Aerodynamics. 3 sem. hrs.
Introductory aerodynamics, including properties of the atmosphere; aerodynamic characteristics of airfoils, wings, propellers, and other components; drag phenomena; and topics of current interest.
Prerequisite(s): AEM 311 and AEM 264 and MATH 238
Prerequisite(s) with concurrency: MATH 238.

AEM 341. Aircraft Structural Analysis. 3 sem. hrs.
Methods of analyzing stressed skin structures of the types that are typically found in aircraft, missiles and space vehicles. Unsymmetrical bending and bending and twisting of multiple cell structures are also covered.
Prerequisite(s): AEM 249 and AEM 250.

AEM 349. Engineering Analysis. 4 sem. hrs.
Elements of analytical and numerical analysis with engineering applications including, but not limited to, differential equations, linear algebra, root-finding, Gaussian elimination, and Runge-Kutta integration.
Prerequisite(s): MATH 237 and MATH 238 and AEM 249.

AEM 360. Astronautics. 3 sem. hrs.
Survey of topics and basic concepts in astronautics: orbital mechanics, space environment, attitude determination & control, telecommunications, space structures, rocket propulsion, and spacecraft systems.
Prerequisite(s): MATH 238 and AEM 311.

AEM 368. Flight Dynamics & Control I. 4 sem. hrs.
Fundamentals of airplane aerodynamics and performance, static trim, 6-DOF equations of motion, and flight dynamics, stability and control.
Prerequisite(s): AEM 313 and AEM 349.

AEM 402. Integrated Aerospace Design I. 3 sem. hrs.
Preliminary design techniques for an aerospace system.
Prerequisite(s): AEM 341 and AEM 368 and AEM 413
Prerequisite(s) with concurrency: AEM 408.

AEM 404. Integrated Aerospace Design II. 3 sem. hrs.
Preliminary and detailed design of aircraft and space vehicles, including weight and balance, power plant selection, exterior layout, performance, stability, and control. Involves group efforts on selected projects.
Prerequisite(s): AEM 402.

AEM 408. Propulsion Systems. 3 sem. hrs.
Basic propulsion dynamics, thermodynamics of fluid flow, combustion kinetics, airbreathing engines, rockets, design criteria, performance and advanced propulsion systems.
Prerequisite(s): AEM 413.

AEM 413. Compressible Flow. 3 sem. hrs.
Dynamics of compressible fluids: shock waves, one-dimensional flow, expansion waves in two-dimensional flow and compressible flow over aerodynamic bodies.
Prerequisite(s): AEM 311 and ME 215.

AEM 414. Experimental Aerodynamics. 3 sem. hrs.
This course provides a laboratory counterpart to concepts discussed in aerodynamics and fluid mechanics. Course topics include statistical and uncertainty analysis techniques, design of experiments, computer-based data-acquisition, sensors for fluid mechanic measurements, and aerodynamic measurement techniques and facilities.
Prerequisite(s): AEM 313.

AEM 416. Helicopter Theory. 3 sem. hrs.
Critical examination of the propulsive airscrew, including induced velocity relations, flow patterns, and similarity. Practical applications are approached through existing theory and practice.
Prerequisite(s): MATH 238 and AEM 264 and AEM 311.
AEM 420. Computational Fluid Dynamics. 3 sem. hrs.
Introduction to basic mathematical concepts and engineering problems associated with numerical modeling of fluid systems. Application of the state of the art numerical models to engineering problems. Fundamentals of Finite Difference and Finite Volume Methods and their applications in fluid dynamics and heat transfer problems will be covered. Prerequisite(s): AEM 311 and AEM 349 and MATH 238.

AEM 428. Space Propulsion. 3 sem. hrs.
This course introduces the student to descriptions and analyses of space and launch-vehicle propulsion. Topics covered include advanced schemes such as nuclear, solar and laser propulsion; power cycles; and tether systems. Prerequisite(s): AEM 408
Prerequisite(s) with concomitance: AEM 408.

AEM 448. Stochastic Mechanics. 3 sem. hrs.
This course develops, analyzes and discusses the application of uncertainty quantification in engineering systems and design methodologies to include uncertainties in the systems. Topics include: classification of uncertainties and methods of quantification, perturbation approaches, polynomial chaos, sampling techniques, random processes and Bayesian analysis. Prerequisite(s): GES 255.

Design of tension, compression bending, torsion, and stiffened panel members; experimental and analytical investigations involving static and dynamic structural behavior. Writing proficiency is required for a passing grade in this course. Prerequisite(s): AEM 341.

AEM 452. Composite Materials. 3 sem. hrs.
First exposure to composite materials. Focus on how heterogeneity/anisotropy in composites influence thermomechanical behavior. The behavior of both continuous and short fiber reinforced composites will be emphasized. Stress analysis for design, manufacturing processes and test methods of composite materials will be covered. Prerequisite(s): AEM 250 and AEM 341 or CE 331 or ME 350.

AEM 461. Computational Methods for Aerospace Structures. 3 sem. hrs.
Development of the fundamentals of the finite-element method from matrix and energy methods. Use of the finite-element method for detailed design of aerospace structures. Modeling techniques for static and dynamic analyses. Prerequisite(s): MATH 227 or MATH 247, AEM 341 and AEM 349.

AEM 468. Flight Dynamics & Control II. 4 sem. hrs.
Linear equations of motion, dynamic response, state-space methods and fundamentals of classical and modern control theory; flying and handling qualities design criteria; stability augmentation and control augmentation. Computing proficiency is required for a passing grade in this course. Prerequisite(s): AEM 368.

AEM 469. Orbital Mechanics. 3 sem. hrs.
Introduction to engineering application of celestial mechanics; high-speed, high-altitude aerodynamics; and other fields related to the contemporary problems of space vehicles. Fundamentals of applied dynamics, nomenclature of space flight, space environment and solar system, and two-body orbits. Kepler’s laws, coordinate transformations, and related studies. Prerequisite(s): MATH 238 and AEM 264.

AEM 470. Mechanical Vibrations. 3 sem. hrs.
Free and forced vibrations, both undamped and damped. Systems with many degrees of freedom are formulated and analyzed by matrix methods. Experimental techniques of vibration measurement are introduced. Prerequisite(s): AEM 264 and MATH 238 and AEM 250.

AEM 471. Fundamentals Of Acoustics. 3 sem. hrs.
Fundamental physical principles underlying wave propagation and resonance in mechanical systems. Introduces applications and provides experience in acoustic and audio measurements and the associated instrumentation. Prerequisite(s): MATH 238 and PH 106 and ECE 320.

AEM 474. Structural Dynamics. 3 sem. hrs.
Theoretical foundations of structural dynamics and application of methods to modeling, analysis, and design. Prerequisite(s): AEM 250 and AEM 264 and MATH 237 and MATH 238.

AEM 481. Complex Engineering Systems. 3 sem. hrs.
Introduction to the concepts and techniques associated with the analysis of complex systems, dynamic systems, chaos, lumped parameter modeling, feedback, networks, thermal/electrical circuit analogies, entropy. Prerequisite(s): AEM 349 or ME 349, ME 215, MATH 238.

AEM 484. Space Environment. 3 sem. hrs.
This course provides an introduction to the effects of the space environment on spacecraft. The harsh space environment introduces several unique challenges to the spacecraft designer. Focus on the impact of this environment and how best to mitigate these effects through early design choices will give the satellite designer better tools. Topics include: geomagnetic field, gravitational field of the Earth, Earth’s magnetosphere, vacuum, solar UV, atmospheric drag, atomic oxygen, free and trapped radiation particles, plasma, spacecraft charging, micrometeoroids.

AEM 491. Special Problems. 1-6 sem. hr.
Assigned problems are explored on an individual basis. Credit is based on the amount of work undertaken.

AEM 492. Special Problems. 3 sem. hrs.
Assigned problems are explored on an individual basis. Credit is based on the amount of work undertaken.

AEM 495. Senior Seminar. 2 sem. hrs.
Selected topics from recent developments in the aeronautical and space engineering fields. There are visiting lecturers and extensive student participation. Several nontechnical topics of immediate interest to seniors are explored. Each student must complete a personal resume. Writing proficiency within this discipline is required for a passing grade in this course. Prerequisite(s) with concomitance: AEM 402.

Chemical and Biological Engineering (CHE) Courses

CHE 125. Introduction To Chemical Engineering. 1 sem. hr.
An introduction to the chemical engineering profession, its history and its career-enabling potential. The course contains selected topics, plant visits and alumni seminars covering the full range of career opportunities from emerging areas (nanotechnology, biochemical, multifunctional materials) to those found in the more traditional positions within the chemical, petrochemical and petroleum industries. Offered primarily in the fall.

CHE 225. Chemical & Biological Engineering Honors Forum. 1 sem. hr.
Designed to expose students to the rich array of resources, ideas, and experiences of chemical engineering. Emphasis and content based on faculty member’s area of expertise.

CHE 254. Chemical Engineering Calculations. 4 sem. hrs.
Study of physical and chemical processes and chemical reactions; material and energy balance calculations for single-phase and multiphase systems; simultaneous energy and material balances. Offered fall and spring. Prerequisite(s): CH 101 or CH 117; and MATH 125 or MATH 145; and CHE 125 or AEM 121 or CHE 131 or ECE 121 or CHE 121 or ENGR 111 or ENGR 131 or ME 121 or MTE 121 or MTE 155 or EE 121 or CS 121.

CHE 255. Chemical Engineering Thermodynamics. 4 sem. hrs.
Chemical calculations using the first and second laws of thermodynamics, including chemical and phase equilibria, multiphase reacting systems, steady-state and non-steady-state material and energy balances. Computer proficiency is required for a passing grade in this course. Offered fall and spring. Prerequisite(s): CHE 254 and MATH 126 or MATH 146.

CHE 304. Fluid Flow Operations. 3 sem. hrs.
Equations of momentum and energy transport and their applications to the analysis of fluid process behavior, filtration, fluidization and metering of fluids. Offered primarily in the fall semester. Prerequisite(s): CHE 254 and MATH 126 or MATH 146
Prerequisite(s) with concurrency: CHE 254.

CHE 305. Separation Processes. 3 sem. hrs.
Unified approach to the basic calculations and fundamental concepts involved in the design of equilibrium-stage separations processes and continuous contacting equipment. Computer proficiency is required for a passing grade in this course. Prerequisite(s): CHE 255.

Study of heat transfer and its application in the design of specific processes and process equipment. Prerequisite(s): CHE 254 and CHE 304
Prerequisite(s) with concurrency: CHE 304.

CHE 320. Operations Laboratory. 4 sem. hrs.
Operations of chemical engineering. Course includes problems and reports based on performance tests. Writing proficiency within this discipline is required for a passing grade in this course. Offered summer semester only. Prerequisite(s): CHE 305 and CHE 306.

CHE 321. Basic Chemical Engineering Laboratory. 2 sem. hrs.
Basic chemical engineering measurements are made, including temperature, pressure, concentration, and fluid flow. Fundamental and empirical equations are used to analyze mass, energy, and momentum transport. Writing proficiency within this discipline is required for a passing grade in this course. Prerequisite(s): CHE 255.
CHE 322. Unit Operations Laboratory. 2 sem. hrs.
Performance tests on chemical engineering unit operations, such as distillation and heat transfer, are designed, operated, and analyzed in a formal report. Writing proficiency within this discipline is required for a passing grade in this course. Offered fall and spring semesters. Successful completion of CHE 321 and CHE 322 satisfies the curriculum requirement of CHE 323.
Prerequisite(s): CHE 304, CHE 305, CHE 306, CHE 321.

CHE 322. Operations Laboratory. 4 sem. hrs.
Performance tests on chemical engineering unit operations, such as distillation and heat transfer, are designed, operated, and analyzed in a formal report. Writing proficiency within this discipline is required for a passing grade in this course. Offered summer only. Can be replaced by successful completion of CHE 321 and CHE 322.
Prerequisite(s): CHE 304, CHE 305, CHE 306.

CHE 324. Transport Phenomena. 3 sem. hrs.
Development of the conservation equations for mass, momentum and energy with application to steady-state and transient chemical processes. Computer proficiency is required for a passing grade in this course.
Prerequisite(s): CHE 255 CHE Eng Thermodynamics MATH 238 Applid Diff Equations I
Prerequisite(s) with concurrency: MATH 238 and CHE 255.

CHE 325. CHE Honors Forum. 1 sem. hr.
Designed to expose students to the rich array of resources, ideas and experiences of chemical engineering. Emphasis and content based on faculty member's area of expertise.

CHE 354. Chemical Reactor Design. 3 sem. hrs.
Reaction rate equations and comparisons with experimental data; use of rate information for the design of chemical reactors. Offered primarily in the spring semester.
Prerequisite(s): CHE 255, MATH 238.

CHE 412. Polymer Materials Engineering. 3 sem. hrs.
Introduction to the manufacture, processing and applications of organic polymeric materials. This course covers the chemistry of polymer manufacture, the molecular structures of polymers, and the structure-property relationships for thermoplastic and thermosetting polymers. Offered primarily in the spring semester.
Prerequisite(s): CH 102 or CH 118.

CHE 418. Tissue Engineering. 3 sem. hrs.
Tissue Engineering is an emerging dynamic, experimental science in which engineering and biological science principles are used to develop techniques for improving or restoring the structure and function of tissue. Offered primarily in the fall semester.

CHE 425. Chemical Engineering Honors Forum. 1 sem. hr.
Designed to expose students to the rich array of resources, ideas, and experiences of chemical engineering. Emphasis and content based on faculty member's area of expertise.

Health and safety in the chemical process industry that will introduce chemical engineering students to health and safety, regulations and the designs and procedures to meet them in the chemical process. Advanced topics will also be introduced, including current relevant topics such as recent accidents and ways and means of preventing a re-occurrence, advanced models of spills and advanced safety analysis.
Prerequisite(s): CH 102 General Chemistry I or CH 118 Honors General Chemistry CHE 255 Chem Engr Thermodynamics.

CHE 445. Introduction to Biochemical Engineering. 3 sem. hrs.
Study of biological processes; application of chemical engineering skills to areas including enzyme kinetics, fermentation, cell growth and metabolic processes. Offered primarily in the spring semester.
Prerequisite(s): CH 231.

Technical and economic design of chemical processes and plants. It is recommended that students complete at least two 300-level CHE classes before enrolling in 481.
Prerequisite(s): CHE 255.

CHE 482. Chemical Process Design II. 3 sem. hrs.
Optimal design of chemical processes and plants. Writing proficiency within this discipline is required for a passing grade in this course.
Prerequisite(s): CHE 481.

CHE 491. Special Problems. 1-3 sem. hr.
Research combined with practical application and testing. Credit is based on the amount of work undertaken. Students undertaking research project must obtain clearance from the supervising professor before registering.

CHE 492. Special Problems. 1-3 sem. hr.
New course development or research combined with practical application and testing. Credit is based on the amount of work undertaken. Students undertaking research project must obtain clearance from the supervising professor before registering.

CHE 493. Process Dynamics & Control. 3 sem. hrs.
Development of model equations that describe the unsteady-state behavior of chemical processes; automatic control design and analysis emphasizing time-domain methods; introduction to digital computer control.
Prerequisite(s): CHE 255 and MATH 238.

CHE 495. Undergrad Honors Seminar. 1 sem. hr.
Presentation of research/practical study results before a group of peers (graduate students, other honors students, faculty, and invited guests).

CHE 496. Undergrad Honors Seminar. 1 sem. hr.
Presentation of research/practical study results before a group of peers (graduate students, other honors students, faculty, and invited guests).

CHE 498. Honors Special Problems. 1-3 sem. hr.
Credit is based on the amount of work undertaken. Research or practical study in a chemical engineering area, the outcome of which is a definite result presented in a report, paper, or manuscript. Instructor permission required.

CHE 499. Honors Special Problems. 1-3 sem. hr.
Credit is based on the amount of work undertaken. Research, teaching assistantship, practical study, honors co-op or internship in a chemical engineering area, the outcome of which is a definite result presented in a report, paper, or manuscript. Instructor or Honors Chair permission required.

Civil, Construction and Environmental Engineering (CE) Courses

CE 121. Intro Civil Constrctn Envir Eg. 1 sem. hr.
Introduce the student to the areas of professional, civil and environmental engineering practices with exposure to faculty members specializing in each area, solving typical problems in each professional area, learning of the activities of service organizations, and the responsibilities of professional practice.

CE 220. Society Infrastructure & Enviromm. 3 sem. hrs.
Permitting, environmental impact statements and other environmental issues associated with human activities and engineering projects.

Precise measurement of lengths, angles, areas, and elevations in geodetic systems; computation of construction control, including highway alignment and land areas.
Prerequisite(s): (ENGR 161 or ENGR 171 or ART 131) and Math 115 or (Math 112 and Math 113) or ACT 30 or SAT 680 or PLMA 440 or PLAC 565.

CE 262. Civil & Constructn Engr Matls. 0-3 sem. hrs.
Introduction to the engineering properties of structural materials, including steel, wood, aggregate, concrete and asphalt, including experimental testing procedures and interpretation of results.
Prerequisite(s): AEM 201 or ESM 210; and
Prerequisite(s) with concurrency: AEM 250.

CE 270. Climate Changes: European Alps. 4 sem. hrs.
The course focuses on hydrology, climate, dendrohydrology (tree rings) and glaciers. The classroom lectures and in-class labs include the use of remote imagery to evaluate glacier recession, application of empirical equations to estimate glacier mass loss, evaluation of hydrologic (streamflow, snowpack) and climatic datasets, developing skeleton plots and cross dating tree-ring data, and seminars. The field labs consist of hand coring and analyzing tree ring data.

CE 271. Glaciology. 4 sem. hrs.
Glacier basics, physical properties, mass and energy balance, climate change impacts, streamflow impacts.

CE 320. Intro Environmental Engineering. 3 sem. hrs.
Introduction to the scientific and engineering principles needed to analyze and solve environmental engineering problems, and lab experience in the practice of environmental engineering related to air, water and waste water management. Writing proficiency within this discipline is required for a passing grade in this course.
Prerequisite(s): CH 101 OR CH 117 min grade of C-
Prerequisite(s) with concurrency: AEM 311 and CHE 304.

CE 331. Intro to Structural Eng.. 0-3 sem. hrs.
Introduction and principles of structural analysis of determinate and indeterminate structures. Computing proficiency is required for a passing grade in this course.
Prerequisite(s): AEM 250 and CE 262.

CE 340. Geotechnical Engineering. 4 sem. hrs.
Static and dynamic interaction of soil and water; theories of stress distribution, consolidation, strength and failures; stability of soil structures.
Prerequisite(s): CE 262 and AEM 250.
CE 350. Intro. to Transportation Eng. 3 sem. hrs.
An introduction to different modes of transportation with emphasis on roadway and traffic engineering. Topics include transportation economics and planning, highway geometric and pavement design, drainage, construction, traffic control devices, traffic operations, and management and highway capacity analysis. Prerequisite(s): CE 260 GES 255.

CE 366. Introduction to Construction Engineering. 3 sem. hrs.
Applying engineering economic principles to construction and engineering problems; construction management processes and methods in planning, scheduling, and monitoring engineering projects. Prerequisite(s): CE 262.

CE 378. Water Resources Engineering. 3 sem. hrs.
Mechanics of steady and unsteady flow in closed and open conduits, hydraulics; water supply and wastewater disposal. Computing proficiency is required for a passing grade in this course. Prerequisite(s): Dynamics (AEM 264) and Fluid Mechanics (AEM 311); or Fluid Flow Operations (ChE 304).

CE 401. Capstone Design: Site Development. 4 sem. hrs.
Students use software to design site projects in teams, prepare construction drawings and deliver engineering reports. This class is normally taken during the last term on campus. Writing proficiency within the discipline and computing proficiency are required for a passing grade in this course. Prerequisite(s): Student must satisfy one of the following sets of prerequisite(s): a) CE 320 with a minimum grade of C- And CE 350 with a minimum grade of C- And CE 378 with a minimum grade of C- And Six (6) credit hours of 400- or 500-level CE courses with a minimum grade of C-. Or b) CE 340 with a minimum grade of C- And CE 366 with a minimum grade of C- And CE 320 or CE 350 or CE 378 with a minimum grade of C- And Six (6) credit hours of 400- or 500-level CE courses with a minimum grade of C-. Or c) CE 424 or CE 524, CE 425 or CE 525, CE 427 or CE 527, CE 442 or CE 542, CE 451 or CE 551, CE 457 or CE 557, CE 459 or CE 559, CE 475 or CE 575, CE 485 or CE 585. b) CE 340 with a minimum grade of C- And CE 366 with a minimum grade of C- And Six (6) credit hours of 400- or 500-level CE courses with a minimum grade of C-. Or c) CE 320 with a minimum grade of C- And CE 340 with a minimum grade of C- And CE 378 with a minimum grade of C- And Six (6) credit hours of 400- or 500-level CE courses with a minimum grade of C-. Or d) CE 424 or CE 524, CE 425 or CE 525, CE 427 or CE 527, CE 442 or CE 542, CE 485 or CE 585.

Students use software to design building projects in teams, prepare construction drawings and deliver engineering reports. The course is normally taken during the last term on campus. Writing proficiency within the discipline and computing proficiency are required for a passing grade in this course. Prerequisite(s): Student must satisfy the following set of prerequisite(s): CE 331 with a minimum grade of C- And CE 340 with a minimum grade of C- And CE 366 with a minimum grade of C- And Six (6) credit hours of 400- or 500-level CE courses with a minimum grade of C- And CE 378 with a minimum grade of C- And Six (6) credit hours of 400- or 500-level CE courses with a minimum grade of C-. Or a) CE 424 or CE 524, CE 425 or CE 525, CE 427 or CE 527, CE 442 or CE 542, CE 485 or CE 585.

CE 414. Information Systems Design. 3 sem. hrs.
An overview of management information systems (MIS). The course will focus on the practical aspects, applications and methodology or MIS, particularly from the construction engineer's perspective. Information design methodology and building information modeling (BIM) will be covered in detail. Prerequisite(s): CE 366.

CE 417. Advanced Project Management. 3 sem. hrs.
This is an engineering management course designed to introduce students to the functions of project engineering and managers. It details the processes of planning and controlling project scope time and cost. Prerequisite(s): CE 366 or IE 203 Prerequisite(s) with concurrency: GES 255.

CE 418. Engineering Management. 3 sem. hrs.
An introduction to management principles and the management functions of planning, organizing, motivating and controlling. Management of engineers in research, design, manufacturing/construction and quality will be studied. Prerequisite(s): CE 366.

CE 420. Environmental Measurements. 3 sem. hrs.
Environmental Engineering phenomena are explored through conducting laboratory experiments, selecting analytical protocols to achieve an objective, evaluating collected data sets, and discussing the results in well written reports. The course is composed of classroom lectures/discussions and weekly laboratory activities. Prerequisite(s): CE320 and CE378 and GES 255 Prerequisite(s) with concurrency: CE 424.

CE 422. Solid And Hazardous Waste Mgt. 3 sem. hrs.
Engineering design and regulatory requirements for the collection, storage, recycling, treatment and disposal of solid wastes. Prerequisite(s): CE 320.

CE 424. Water And Wastewater Treatment. 3 sem. hrs.
Physical, chemical and biological principles and design of municipal water and wastewater treatment units. Prerequisite(s): CE 320.

CE 425. Air Quality Engineering. 3 sem. hrs.
This is an introductory course in Air Quality Engineering. We have to major foci. The first is to understand and evaluate our air resources and air quality (as related to human and environmental health) in terms of fundamental principles and design processes. The second is to introduce the student to a variety of air pollution issues and engineered treatment processes. Prerequisite(s): AEM 311 or CHE 304; and CE 320.

CE 427. Storm Water Management. 3 sem. hrs.
Quality and quantity of urban storm water. Receiving water problems and sources of pollutants. Runoff quality and quantity characteristics, Selection and design of controls; regulations. Prerequisite(s): CE 378 and CE 475.

CE 432. Matrix Analysis of Structures. 3 sem. hrs.
Introduction to the matrix-displacement method of analysis for framed structures, including computer implementation of analysis. An introduction to finite-element analysis is also included. Prerequisite(s): CE 331.

CE 433. Reinf Concrete Struct I. 3 sem. hrs.
Concrete materials; placement of concrete and theory and design of reinforced beams, girders, slabs, columns and footings. Prerequisite(s): CE 331.

CE 434. Structural Steel Design I. 3 sem. hrs.
Theory and design of structural steel members and their connections. Prerequisite(s): CE 331.

CE 435. Concrete Materials. 3 sem. hrs.
Portland cement and supplementary cementitious materials, aggregates, properties of fresh and hardened concrete, concrete durability issues, mixture proportioning, concrete construction methods, special concrete materials, test methods. Prerequisite(s): CE 331 or CE 340.

CE 437. Reinforced Concrete Struct II. 3 sem. hrs.
Design of reinforced concrete building components including two-way slabs, slender columns, prestressed beams, slap-on-grade and retaining walls. Prerequisite(s): CE 433.

CE 438. Struct Steel Design II. 3 sem. hrs.
Basic and elementary design procedures for steel structures such as plate girders, mill buildings, multitstory buildings, highway bridges and light-gauge steel structures. Prerequisite(s): CE 434.

CE 439. Design of Wood and Masonry Structures. 3 sem. hrs.
Design of wood and masonry components and subassemblies for low-rise residential and commercial buildings according to current design specifications. Prerequisite(s): CE 331.

CE 442. Waste Containmmt Facility. 3 sem. hrs.
Introduction to the fundamentals of soil behavior as they relate to environmental engineering. Topics include soil behavior, soil compaction, conduction phenomena, geosynthetic and aspects of landfill design. Prerequisite(s): CE 340 and CE 320.

CE 444. Foundation Engineering. 3 sem. hrs.
Analysis and design of soil foundation systems. Prerequisite(s): CE 340.

Application of the principles of geometric design and traffic signal layout: vertical and horizontal alignment, intersections, traffic control, and traffic signal layout. Design projects will be prepared to illustrate standard techniques. Prerequisite(s): CE 350.

CE 454. Urban Transportation Planning. 3 sem. hrs.
The course will provide a foundation in urban transportation planning, including an introduction to the planning process, software associated with transportation modeling and conducting transportation planning and traffic impact studies. Prerequisite(s): CE 350.

CE 458. Traffic Engineering. 3 sem. hrs.
Vehicle operating characteristics, traffic flow, geometric design of road and intersections, and methods of traffic control. Prerequisite(s): CE 350.
CE 459. Pavement Design and Rehabilitation. 3 sem. hrs.
This course covers two major areas of asphalt and concrete pavements: pavement thickness design and pavement maintenance. Topics include pavement design by the Asphalt Institute and AASHTO methods. Major maintenance will cover overlay design and slab repair, while routine maintenance will cover distress surveys, pothole repair, and crack and joint sealing. Prerequisite(s): CE 350 or CE 366.

CE 460. Front End Planning. 3 sem. hrs.
Principles and applications for effective, early planning of capital facilities including: finance, economics decision-making, risk management, team alignment and front end planning processes and tools. Prerequisite(s): CE 366.

CE 461. Horizontal Construction Methods. 3 sem. hrs.
Introduction to horizontal construction equipment and methods, design of horizontal construction systems and construction operation analysis and simulation. Prerequisite(s): CE 366 Prerequisite(s) with concurrency: CE 340.

CE 462. Vertical Construction Methods. 3 sem. hrs.
Introduction to vertical construction equipment and methods, design of vertical construction systems and construction operation analysis and management processes. Prerequisite(s): CE 366 Prerequisite(s) with concurrency: CE 331.

Addresses the estimating and cost control function from conceptual planning through project execution. Topics include productivity analysis, organization of estimates, cost forecasting, estimating tools and techniques, contingency planning, and relationship to contract types and project execution strategies. Prerequisite(s): CE 366.

CE 464. Safety Engineering. 3 sem. hrs.
An introduction to safety management and accident prevention, including state and federal laws related to general and construction projects. Topics include accident theories, safety regulations, Construction Safety act, hazards and their control, human behavior and safety and safety management. Prerequisite(s): CE 366GES 255 and CE 366.

CE 467. Constr. Accounting & Finance. 3 sem. hrs.
Financial management of construction projects. Topics include alternative selection, life-cycle analysis, applied financial management techniques, insurance/ indemnification, risk management and tax implications. Prerequisite(s): CE 366.

CE 468. Construction Scheduling. 3 sem. hrs.
The management structure of construction companies and the laws, regulations, practices, tools and processes used in planning, scheduling and monitoring construction projects. Writing proficiency within this discipline is required for a passing grade in this course. Prerequisite(s): CE 366.

The course focuses on statistical hydrology, climate, dendrohydrology (tree rings) and glaciers. The classroom lectures and in-class labs include the use of statistical software to analyze hydrologic datasets, the use of remote imagery to evaluate glacier recession, application of empirical equations to estimate glacier mass loss, evaluation of hydrologic (streamflow, snowpack) and climatic datasets, developing skeleton plots and cross dating tree-ring data, and seminars. The field labs consist of hand coring and analyzing tree ring data. Prerequisite(s): Sophomore status, 2.5 GPA.

CE 475. Hydrology. 3 sem. hrs.
Hydrologic cycle, rainfall-runoff relations, unit hydrograph, statistical hydrology and hydrologic simulation. Includes a class project with application to flood control, water supply and multipurpose projects. Prerequisite(s): CE 378.

CE 480. Forensic Engineering. 3 sem. hrs.
When failures in the built environment occur, whether during design, construction or in-service, a thorough examination of the causes is essential to both the evolution sound engineering practices and to dispute resolution through the legal system. The role of the engineer in this process is examined. Prerequisite(s): AEM 250.

CE 481. Legal Aspects of Engineering and Construction. 3 sem. hrs.
Legal aspects of engineering and construction contracts and specifications; contract formation, interpretation, rights and duties, and changes; legal liabilities and professional ethics of architects, engineers and contractors. Writing proficiency within this discipline is required for a passing grade in this course. This is a three hour survey course covering, primarily, the organization of the federal and state courts, construction contracting, potential tort liability and professionalism for engineers in Alabama. Prerequisite(s): CE 320, CE 331, CE 340, CE 350, CE 366 or CE 378, and one HU elective (3 credits).

CE 484. Exp. Design & Field Sampling. 3 sem. hrs.
Experimental design, sensitivity analyses, water sampling and flow monitoring. Receiving water chemical reactions. Field investigations. Prerequisite(s): CE 320 and GES 255.

CE 485. Const. Site Erosion Control. 3 sem. hrs.

CE 486. GIS for Civil Engineers. 3 sem. hrs.
Introduction to geographic information system design and use for civil engineering problem solving. Prerequisite(s): CE 260 and any CE 300 Level Course.

CE 491. Special Problems. 1-3 sem. hr.
Credit is based on the amount of work undertaken. Analysis and/or design in any phase of civil engineering. The course is intended to take care of needs not covered by regularly offered courses.

CE 498. Undergraduate Research Experience. 1-6 sem. hr.
Conduct research under the guidance of a faculty member. Analyze data. Produce and present, submit or publish related scholarly work. Prerequisite(s): CE 320 or CE 331 or CE 340 or CE 350 or CE 366 or CE 378, and Permission of a department faculty member (research advisor).

Computer Science (CS) Courses
CS 100. CS I for Majors. 4 sem. hrs.
A first course in programming for students majoring in computer science. Language concepts include primitives, variables, sequences, function, selection, iteration and recursion. Software engineering concepts include testing and debugging. System concepts include directories, paths, files, and text editing. Prerequisite(s): (Math 112 and Math 113) or Math 115 or UA ACT Subject Math Placement 565 or UA Placement Mathematics 440. Prerequisite(s) with concurrency: Math 125 or Math 126 or Math 145 or Math 146.

CS 101. CS II for Majors. 4 sem. hrs.
A second course in programming for students majoring in computer science. Using a high-level language, student use object-oriented practices to study fundamental data structures and algorithms. Issues such as computability, problem complexity and algorithm analysis, efficient searching and sorting, data structures, and the object-oriented programming paradigm are introduced and explained.
Prerequisite(s): (CS 100 or CSB 102 or (CS 150 and ECE 285)) and (Math 125 or Math 145).

CS 102. Microcomputer Applications. 3 sem. hrs.
Familiarization with Windows, fundamental and intermediate word processing commands, spreadsheet applications, and database management. (Credit for this course will not be applied to the requirements for a computer science degree).

CS 104. Computer Science Principles. 3 sem. hrs.
An introductory course that overviews the core principles of computer science from a broad spectrum of topics. The course content is focused on computing and its relation to creativity, abstraction, algorithms, programming, Big Data, Internet/ networking, and societal impact. Students will work on team-based projects that explore topics in Big Data, investigate the impact of the internet, and create their own games and/or smartphone applications. This course is restricted to Math and Math Education majors only.
Prerequisite(s) with concurrency: MATH 112 or MATH 115 or MATH 125 or MATH 126 or MATH 145 or MATH 146.

CS 120. Business Programming I. 3 sem. hrs.
An introduction to programming. The topics include procedural information enabled problem formulation, design and development of business computer solutions. This course concentrates on the construction and testing of individual programs. Prerequisite(s): MATH 112 or MATH 115 or MATH 121 or MATH 125.

CS 121. The Discipline of Computing. 1 sem. hr.
An introduction to the discipline of computing designed for students who are considering a major or minor in computer science. Prerequisite(s): MATH 112 OR higher OR UA Math Placement Test Score of 380. Prerequisite(s) with concurrency: MATH 112.
CS 150. Programming I. 2 sem. hrs.  
An introductory course that teaches programming and program development. The emphasis of the course is the rapid acquisition of programming, testing, debugging and system skills. Topics include sequence, selection, iteration, arrays, functions and recursion.  
Prerequisite(s): (Math 112 and Math 113) or Math 115 or UA Subject Math Placement Test Score (PLAC) of 565 or UA Math Placement Test Score (PLMA) of 440  
Prerequisite(s) with concurrency: MATH 125 and MATH 126 and MATH 145 and MATH 146.  

CS 160. Computer Science Concepts. 1 sem. hr.  
Introductory programming laboratory that focuses on basic problem solving concepts.  
Prerequisite(s): Credit for MATH 112 or placement into MATH 115 or above.  

CS 200. Software Design and Engineering. 4 sem. hrs.  
Introduction to software engineering: the software crisis, program life cycle, software systems analysis techniques, software modeling, theory and practice of design, program testing methodologies, programmer team organization, and program verification and synthesis.  
Prerequisite(s): CS 101.  

CS 201. Data Structures and Algorithms. 4 sem. hrs.  
Data structures including balanced search trees, heaps, hash tables, and graphs. Algorithm design techniques including divide-and-conquer, greedy method, and dynamic programming. Emphasis on problem solving, design, analysis, and reasoning about data structures and algorithms.  
Prerequisite(s): CS 101 and Math 301.  
Prerequisite(s) with concurrency: Math 302.  

CS 202. Intro to the Internet. 3 sem. hrs.  
Introduces the student to the fundamentals of the internet and web page design and development. Students will be shown how to use the internet, text editors, and build basic web pages using HTML coding. This will include, but not be limited to hyperlinks, tables, basic CSS styling, frames and forms. The student will also be given demonstrations and assignments using a WYSIWYG editor.  
Prerequisite(s): CS 102 or CS 150 or CBH 101 or CS 100 or PLCS of 380.  

CS 205. Web Site Design. 3 sem. hrs.  
A course designed to teach website design principles and implementation techniques. This class is not cross-listed as a graduate course. Computing proficiency is required for a passing grade in this course.  
Prerequisite(s): CS 202.  

This course builds on the concepts and expertise gained in data driven problem solving and computer programming. It explores problem formulation, solution designing and object-oriented construction of business applications. This course concentrates on problem decomposition, design, construction and testing of individual programs. Computing proficiency is required for a passing grade in this course.  
Prerequisite(s): CS 120 or CBH 101.  

CS 250. Programming II. 2 sem. hrs.  
A second course in programming that builds upon the concepts covered in CS 150. The emphasis is to improve and solidify program development skills as well as to introduce students to multimedia programming. Computing proficiency is required for a passing grade in this course.  
Prerequisite(s): CS 150 or CS 100.  

CS 260. Foundations of Comp Science. 3 sem. hrs.  
An introduction to the science of Computer Science. Topics include: introduction to complexity, O(n), searching, sorting, design strategies, problem solving, arrays, linked lists, stacks, queues, and binary search trees.  
Prerequisite(s): CS 150 or CS 100 or CBH 101 and (CS 160 or ECE 285).  

CS 285. Microcomputer Appl II. 3 sem. hrs.  
Use of spreadsheets and other environments to build business and scientific applications. Course includes development of problem-solving skills and an introduction to the object-oriented paradigm. Computing proficiency is required for a passing grade in this course.  
Prerequisite(s): CS 102 or CS 150 or CBH 101 or CS 100 or PLCS of 380.  

CS 302. Computerized Database Systems. 3 sem. hrs.  
An introduction to commercial database packages. Students will gain familiarity with both creating and using standard database software packages to solve real-world problems. Computing proficiency is required for a passing grade in this course.  
Prerequisite(s): CS 102 or CS 150 or CBH 101 or CS 100 or PLCS of 380.  

CS 305. Advanced Computerized Database Systems. 3 sem. hrs.  
This course is designed for non-majors wishing to learn more about the use of database systems in a wide variety of applications. Coverage includes advanced database topics such as advanced queries, custom forms and custom reports.  
Prerequisite(s): CS 302.  

CS 315. Software Engineering. 3 sem. hrs.  
Introduction to software engineering: the software crisis, program life cycle, software systems analysis techniques, software modeling, theory and practice of design, program testing methodologies, programmer team organization, and program verification and synthesis.  
Prerequisite(s): CS 290 and (CS 250 or ECE 285).  

CS 340. Legal & Ethical Issues in Comp. 3 sem. hrs.  
By way of case study, the course finds and frames issues related to legal and ethical issues in computing. Topics include privacy, free speech, intellectual property, security, and software reliability and liability issues. Computing proficiency is required for a passing grade in this course.  
Prerequisite(s): CS 102 or CS 150 or CBH 101 or CS 100 or PLCS of 380.  

CS 345. Advanced Legal and Ethical Issues in Computing. 3 sem. hrs.  
Using case study and fact pattern analysis, students will find and frame legal and ethical issues presented by past, contemporary and emerging technology. Students will engage in service learning to enhance their sense of civic responsibility.  
Prerequisite(s): CS 340.  

CS 350. Programming III: Java. 2 sem. hrs.  
The third course in programming that builds upon the concepts covered in CS 250 and transitions to the Java programming language. The emphasis is on building larger projects using production languages and development environments. Computing proficiency is required for a passing grade in this course.  
Prerequisite(s): CS 250 or ECE 285.  

CS 351. Programming III: C++. 2 sem. hrs.  
The third course in programming that builds upon the concepts covered in CS 250 and transitions to the C++ programming language. The emphasis is on building larger projects using production languages and development environments. Computing proficiency is required for a passing grade in this course.  
Prerequisite(s): CS 250 or ECE 285.  

CS 360. Data Structures & Algorithms. 4 sem. hrs.  
Basic concepts of data, linear lists, strings, arrays, trees, graphs, and the related storage of representations and structures. Applications include expression conversion, sorting, searching and dynamic storage allocation. Computing proficiency is required for a passing grade in this course.  
Prerequisite(s): MATH 301; and CS 250 or ECE 285; and CS 260;  
Prerequisite(s) with concurrency: MATH 302 and CS 350 and CS 351 and CS 352.  

CS 385. Prototyping In Visual Environm. 3 sem. hrs.  
Design and construction of standard user interfaces using a visual programming environment. Course includes the prototyping of several standard user interface mechanisms. Computing proficiency is required for a passing grade in this course.  
Prerequisite(s): CS 250 or ECE 285.  

CS 391. Special Topics. 3 sem. hrs.  
Special topics in computing.  

CS 395. Competitive Programming I. 1 sem. hr.  
A study of techniques and practices that promote success in competitive programming contests.  

CS 396. Competitive Programming II. 1 sem. hr.  
Advanced study of techniques and practices that promote success in competitive programming contests. Must have 3 hours of credit in CS 395.  
Prerequisite(s): CS 395.  

CS 403. Programming Languages. 3 sem. hrs.  
Formal study of programming language specification, analysis, implementation, and run-time support structures; organization of programming languages with emphasis on language constructs and mechanisms; and study of non-procedural programming paradigms.  
Prerequisite(s): CS 315; and CS 350 or CS 351 or CS 352; and CS 360; and ECE 383.  

CS 407. Software Interface Desgn. 3 sem. hrs.  
Basic concepts of human-computer interaction, including guidelines for interface design, evaluation of interface designs, virtual environments, menus, forms, natural language interactions, novel interaction devices, information search and information visualization.  
Prerequisite(s): CS 315, CS 360, and ECE 383; and CS 350 or CS 351 or CS 352.  

CS 415. Software Design & Development. 3 sem. hrs.  
Object-oriented design and development using UML and Java, design patterns, and architectural paradigms.  
Prerequisite(s): CS 315; and CS 350 or CS 351 or CS 352; and CS 360; and ECE 383.  

CS 416. Testing and Quality Assurance. 3 sem. hrs.  
Study of verification & validation and related processes. Topics include techniques and tools for software analysis, testing, and quality assurance.  
Prerequisite(s): CS 315, (CS 350 or CS 351), CS 360, and ECE 383.  

The University of Alabama
CS 417. Requirements Engineering. 3 sem. hrs.
Study of requirements engineering and its phases. Topics include formal, semi-
formal, and informal paradigms for elicitation, documentation, and management of
software system requirements.
Prerequisite(s): CS 315, (CS 350 or CS 351), CS 360, and ECE 383.

CS 420. Software Mainten. & Evolution. 3 sem. hrs.
Study of software and its phases. Topics include techniques and tools for concept
location, impact analysis, actualization, refactoring, and validation.
Prerequisite(s): CS 315 and CS 350 or CS 351; and CS 360 and ECE 383.

CS 426. Intro Operating Systems. 3 sem. hrs.
Study of basic operating system concepts with an emphasis on memory, processor,
device, and information management.
Prerequisite(s): CS 315 and CS 350 or CS 351 or CS 352; and CS 360 and ECE
383.

An examination of computer security concepts, such as cryptographic tools, user
authentication, access control, database security, intrusion detection, malicious
software, denial of service, firewalls and intrusion prevention systems, trusted
computing and multilevel security, buffer overflow, software security, physical and
infrastructure security, human factors, and security auditing.
Prerequisite(s): CS 315 and ECE 383; and CS 350 or CS 351 or CS 352; and CS
360.

CS 434. Compiler Construction. 3 sem. hrs.
Syntax and semantics of procedure-oriented languages and translation techniques
used in their compilation; includes computer implementation.
Prerequisite(s): CS 315; and CS 350 or CS 351 or CS 352; and CS 360 and ECE
383.

Fundamentals of interactive 3-D computer graphics, including modeling and
transformations, viewing, lighting and shading, mapping methods, graphics pipeline,
shading languages, and interaction techniques. Programming projects are required.
Prerequisite(s): CS 315; and CS 350 or CS 351 or CS 352; and CS 360; and ECE
383.

CS 438. Comptr Commun Networks. 3 sem. hrs.
The study of the issues related to computer communications. Topics include physical
topologies, switching, error detection and correction, routing, congestion control,
and connection management for global networks (such as the Internet) and local area
networks (such as Ethernet). In addition, network programming and applications will
be considered.
Prerequisite(s): CS 315; and CS 350 or CS 351 or CS 352; and CS 360; and ECE
383.

CS 440. Computers, Ethics and Society. 3 sem. hrs.
Social, legal, and ethical aspects of computing: privacy, free speech, intellectual
property, crimes, the work place, risks, and professional ethics and responsibilities.
Prerequisite(s): CS 315 and CS 360 and ECE 383 and CS 350 or CS 351 or CS 352.

CS 448. Network Security. 3 sem. hrs.
Concepts concerning network security, including an examination of network security
concepts, algorithms, and protocols.
Prerequisite(s): CS 200, CS 201 and ECE 383.

CS 457. Database Management Systems. 3 sem. hrs.
Constituent parts of database management (design, creation, and manipulation of
databases), including the conceptual and relational data models, SQL, normalization
and security. Writing proficiency within this discipline is required for a passing grade
in this course.
Prerequisite(s): CS 315; and CS 350 or CS 351 or CS 352; and CS 360; and ECE
383.

CS 460. Intro to Autonomous Robotics. 3 sem. hrs.
Issues involved with the implementation of robot control software including motion,
kinematics, simulation testing, sensor incorporation and unmodeled factors.
Prerequisite(s): CS 426.

CS 465. Artificial Intelligence. 3 sem. hrs.
The advanced study of topics under the umbrella of artificial intelligence including
problem solving, knowledge representation, planning and machine learning.
Prerequisite(s): CS 315; and CS 350 or CS 351 or CS 352; and CS 360; and ECE
383.

CS 470. Computer Algorithms. 3 sem. hrs.
Construction of efficient algorithms for computer implementation.
Prerequisite(s): CS 315; and CS 350 or CS 351 or CS 352; and CS 360; and ECE
383.

CS 475. Formal Languages & Machines. 3 sem. hrs.
Regular expressions and finite automata. Context free grammars and pushdown
automata. Recursively enumerable languages and the Turing machine. The
Chomsky hierarchy.
Prerequisite(s): CS 315, CS 360, and ECE 383; and CS 350 or CS 351 or CS 352.

CS 480. Computer Simulation. 3 sem. hrs.
Introduction to simulation and use of computer simulation models; simulation
methodology, including generation of random numbers and variants, model design,
and analysis of data generated by simulation experiments.
Prerequisite(s): CS 360; and CS 315 and CS 350 or CS 351 or CS 352; and ECE
383.

CS 491. Special Topics. 3 sem. hrs.
Formal courses that cover new and innovative topics in computer science and do
not yet have their own course numbers. Specific course titles will be announced from
time to time.
Prerequisite(s): CS 315; and CS 350 or CS 351 or CS 352; and CS 360; and ECE
383.

CS 492. Special Prob (Area). 1-3 sem. hr.
Reading and research course designed to meet the needs of individual students.
This course cannot be used as a required 400-level computer science elective.

CS 495. Capstone Computing. 3 sem. hrs.
A culminating capstone project course that integrates the skills and abilities
throughout the curriculum into a comprehensive design and development experience
for computer science majors. Writing proficiency within this discipline is required for
a passing grade in this course, and ethical issues are applied to the students' future
professions.
Prerequisite(s): CS 350 or CS 351 or CS 352; and CS 315 and CS 360 and ECE
383.

CS 497. . 1 sem. hr.
Provides a unique opportunity to explore new problem solving techniques in a way
that is not covered traditionally in the curriculum, helping students improve their
software development skills.
Prerequisite(s): CS 360.

CS 499. Undergraduate Thesis Research. 3 sem. hrs.
Independent research and participation within a faculty member's research group.
Writing proficiency within this discipline is required for a passing grade in this course.
Permission of the supervising faculty member is required.
Prerequisite(s): CS 315; and CS 350 or CS 351; and CS 360 and ECE 383.

General Engineering Studies (ENGR) Courses
ENGR 103. Engineering Foundations. 3 sem. hrs.
Introductory course for students in all engineering disciplines that provides the basic
skills required for engineering with an emphasis on problem solving, sketching,
teamwork, oral and written technical communication, and the design process.
Prerequisite(s): [(MATH 112 AND MATH 113) OR MATH 115]OR MATH 125 or
higher with concurrency
Prerequisite(s) with concurrency: MATH 125 or MATH 126 or MATH 145 or MATH
146.

ENGR 111. Engineering for the Future. 1 sem. hr.
An introduction to the discipline of engineering and what the future of the field will
involve. Focus on developing and understanding of the discipline, the contributions
that the discipline will make to society in the future and career opportunities for
students in the field.
Prerequisite(s): UA Math Placement Test Score (PLMA) of 310 OR Higher, UA Subject Math Placement Test Score (PLAC) of 467 OR Higher, ACT Math Subscore 24 OR Higher, SAT Math Subscore 560 OR Higher OR Passed MATH 110 with C- or
higher.
Prerequisite(s) with concurrency: MATH 112 and MATH 113 and MATH 125 and MATH 126 and MATH 145 and MATH 146.

Introductory course for students in all engineering disciplines that provides the basic
skills required for engineering with an emphasis on problem solving, teaming and the
design process.
Prerequisite(s): (MATH 112 AND MATH 113)OR MATH 115 OR UA Math Placement Test Score (PLMA) of 440 or higher OR UA Subject Math Placement Test Score (PLCA) of 565 or higher OR ACT Math Subscore of 30 or higher OR SAT Math Subscore of 680 or higher.
Prerequisite(s) with concurrency: MATH 125 and MATH 126 and MATH 145 and MATH 146 and ENGR 161 and ENGR 171.

A second course for students that reinforces the basic skills required for engineering
with an emphasis on design, problem solving, teaming and technical communication.
Prerequisite(s): ENGR 131.
An accelerated course for students in all engineering disciplines that is open to students with AP Physics credit or initial placement into Calculus II or higher. With the completion of ENGR 142 with a grade of "C-" or higher, placement credit is also awarded for ENGR 131. The course reinforces the basic skills required for engineering with an emphasis on design, problem solving, teaming, and technical communication.
Prerequisite(s): AP Physics credit OR MATH 125.

Focus is on the ability to use sketching as an effective communication tool within the field of engineering.
Prerequisite(s): MATH 112
Prerequisite(s) with concurrency: MATH 113 and MATH 115 and MATH 121 and MATH 125 and MATH 126 and MATH 145 and MATH 146.

ENGR 161. Small-Scale Eng. Graphics. 1 sem. hr.
Two-dimensional representations of multiviews, sections, and auxiliaries will be generated.
Prerequisite(s): ENGR 151
Prerequisite(s) with concurrency: ENGR 103.

ENGR 171. Large-Scale Eng. Graphics. 1 sem. hr.
Use of a commercial software package to produce engineering drawings such as multiviews, sections and auxiliaries, isometric and oblique pictorials, dimensional drawings as well as simple topographical and property drawings, with an emphasis on large-scale applications.
Prerequisite(s): ENGR 151
Prerequisite(s) with concurrency: ENGR 103.

ENGR 191. Freshman Engineering Special Topics. 1-3 sem. hr.
To enrich UA’s undergraduate education in the area of nanotechnology. The course is a low level freshman course that will cover simple introductory material on nanotechnology and its concepts, its environmental, economical, ethical and societal impacts on it. It consists of 7 modules: Introduction to nanotechnology & biotechnology, engineering applications of nanotechnology and biomedicine, seeing is believing and micro/nanofabrications, economics of nanotechnology and biotechnology, philosophy, ethics, science and engineering; nanotechnology, biotechnology and society; nanotechnology, biotechnology and environment.
Prerequisite(s): None.

Electrical and Computer Engineering (ECE) Courses

ECE 121. Introduction to Electrical and Computer Engineering. 1 sem. hr.
Introduction to electrical and computer engineering disciplines, specializations, the engineering design process, mathematics required for these disciplines, computer-based modeling and simulation tools, and professional responsibilities.
Prerequisite(s): MATH 110.

ECE 225. Electric Circuits. 4 sem. hrs.
Physical concepts and mathematical techniques of circuit analysis; DC, transient, and sinusoidal steady-state analysis of circuits; Includes laboratory experiments.
Prerequisite(s): PH 106 and PH 126, MATH 227 and MATH 238.

Algorithm design, programming, test and debugging skills using the C programming language. Applications to engineering problem solving in electrical and computer engineering.
Prerequisite(s): MATH 125 or MATH 145
Prerequisite(s) with concurrency: CS 150.

ECE 320. Fundmntl Electrical Engr. 3 sem. hrs.
Introduction to circuit analysis, methods, resistive circuits, AC circuits, first-order transients, AC power, operational amplifiers and machines. Not open to electrical engineering majors or to students who have earned credit for ECE 225.
Prerequisite(s): PH 106; and MATH 238 or MATH 247
Prerequisite(s) with concurrency: MATH 238 or MATH 247.

ECE 326. Electric Networks. 3 sem. hrs.
Prerequisite(s): ECE 225 and MATH 238 and MATH 355.

ECE 330. Intro. to Semiconductor Device. 3 sem. hrs.
Semiconductor device physics, PN junction, Schottky diodes, BJF, MOS capacitor, MOSFET, and optoelectronic devices. Brief introduction of microelectronic fabrication.
Prerequisite(s): PH 253 and ECE 225
Prerequisite(s) with concurrency: ECE 225.

ECE 332. Electronics I. 0-4 sem. hrs.
Semiconductor materials and properties, fundamentals of p-n junctions, diodes, diode circuits and operation, signal generators, rectifier and wave-shaping circuits, bipolar and field effect transistors, MOSFET, transistor DC circuit analysis, basic transistor amplifiers. Writing proficiency is required for a passing grade in this course.
Prerequisite(s): ECE 225 or ECE 320; and EN 102.

ECE 333. Electronics II. 4 sem. hrs.
Operational amplifiers, BJTs, MOSFETs, integrated current biasing and active loads, differential and multistage amplifiers, frequency response, feedback and stability, power amplifiers, and introduction to digital circuits. The lab deals with experiments illustrating concepts in electronics. Writing proficiency within this discipline is required for a passing grade in this course.
Prerequisite(s): ECE 322.

ECE 340. Electromagnetics. 4 sem. hrs.
Electrostatics, magnetostatics, Maxwell’s equations, plane waves, guided waves, and radiation.
Prerequisite(s): PH 106 and MATH 227 and MATH 238
Prerequisite(s) with concurrency: MATH 238.

ECE 350. Electric Power & Machines. 3 sem. hrs.
Single- and three-phase power system analysis. Theory and operation of electromechanical devices, including magnetic circuits, transformers, as well as DC and AC rotating machines, Fundamentals of power electronics.
Prerequisite(s): ECE 225 or ECE 320.

ECE 350. Digital Logic. 4 sem. hrs.
Number systems, Boolean algebra, logic functions and gates, design of combinational logic systems, flip-flops, design of synchronous sequential systems, and iterative networks. Includes laboratory experiments.
Prerequisite(s): ECE 225 and ECE 285.

ECE 380. Digital Logic. 4 sem. hrs.
Microprocessors, microcontroller, assembly-language programming, interrupts, polling and hardware interfaces. Computing proficiency is required for a passing grade in this course.
Prerequisite(s): (ECE 285 or CS 250 or CBH 101) and ECE 380.

ECE 404. Sensor Networks. 3 sem. hrs.
Basic architecture and applications of wireless sensor networks (WSN). Hardware components of WSN, WSN operating systems, transport layer, routing layer, MAC layer and data link layer of WSN.
Prerequisite(s): ECE 383.

ECE 408. Communications. 3 sem. hrs.
Analog and digital communication systems, random signals, sampling, filtering, analog-to-digital encoding, advanced digital modulation/demodulation, source encoding/decoding, channel encoding/decoding, multiplexing, system performance analysis.
Prerequisite(s): MATH 355 and ECE 370.

ECE 409. Communications Lab. 1 sem. hr.
Modeling and design of communication systems. Familiarization with specialized communications equipment and techniques. Proper use of laboratory instruments.
Prerequisite(s): ECE 370 and ECE 408
Prerequisite(s) with concurrency: ECE 408.

ECE 430. Solid State Devices. 3 sem. hrs.
Solid state physics for semiconductor devices, p-n junction, metal-semiconductor junction, JFET/MESFET, MODFET, BJF and non-ideal behaviors of solid state devices. Organic thin film devices including organic solar cells, thin film transistors, light emitting diodes and their application for flexible displays.
Prerequisite(s): ECE 330.

ECE 432. VLSI Design. 3 sem. hrs.
Digital design issues in the context of VLSI systems. Introduction to CMOS digital design methodology, layout techniques, behavior models, circuit simulation and testing of complex systems.
Prerequisite(s): ECE 332.

ECE 434. Mixed Signal Circuits. 3 sem. hrs.
Design and testing issues in the context of mixed-signal embedded systems. Introduction to CMOS mixed-signal design methodology, layout techniques, analog to digital converters, digital to analog converters, circuit simulation, and testing and packaging of complex mixed-signal systems.
Prerequisite(s): ECE 332.
ECE 438. Integr Circuit Fabr Prin. 3 sem. hrs.
Study of the processing tools used in semiconductor device fabrication. Topics include semiconductor fundamentals, semiconductor device fabrication processes, interconnections and contacts, integrated circuit packaging, and chip yield. Prerequisite(s): ECE 333 or MTE 271.

ECE 439. Thin Film Technology. 3 sem. hrs.
Crystal structure and defects, film nucleation and growth models, growth of polycrystalline and epitaxial films, vacuum science technology, physical and chemical vapor deposition, solution based methods and thin film characterization techniques. Prerequisite(s): ECE 225 or PH 253.

ECE 440. Electromagnetic Waves. 3 sem. hrs.
Mathematics and physics of the radiation, propagation and scattering of electromagnetic waves. Boundary value problems involving finite and infinite structures, waveguides, antennas and media. Prerequisite(s): ECE 340.

ECE 451. Power Electronics. 3 sem. hrs.
Detailed study on the theory and operation of power electronics converters and systems. Overview of enabling power semiconductors switching devices. Introduction to feedback control of converters. Machine drive fundamentals. Prerequisite(s): ECE 332 and ECE 350.

ECE 452. Power Electronics Laboratory. 1 sem. hr.
Laboratory experience in three phase power systems and electric machinery. Laboratory experience on the theory and operation of power electronic converters, systems and machine drives. Prerequisite(s): ECE 332 and ECE 350 Prerequisite(s) with concurrency: ECE 451.

ECE 453. Power Systems. 3 sem. hrs.
Basic power systems concepts and per unit quantities; transmissions lines, transformer and rotating machine modeling; power flow; symmetrical component of power systems; faulted power system analysis. Prerequisite(s): ECE 350.

ECE 454. . 1 sem. hr.
Test and analysis of power systems and machine devices and the design of systems using devices. Prerequisite(s): ECE 350 and ECE 453 Prerequisite(s) with concurrency: ECE 453.

ECE 455. Electromechanical Systems. 3 sem. hrs.
Static and dynamic modeling, analysis, and simulation of mechanical, electrical, hydraulic and mixed systems. MATLAB and SIMULINK model development and simulation. Prerequisite(s): ECE 225 and MATH 238.

ECE 461. Quantum Well Elec & Devices. 3 sem. hrs.
Energy levels and wave functions of semiconductor microstructures; envelope function approximation; quantum wells, superlattices; excitons; optical and electrical properties; selection rules; quantum confined Stark Effect; Wannier-Stark localization; field-effect transistors, tunneling devices, quantum well lasers, electro-optic modulators and quantum-well intersubband photodetectors. Prerequisite(s): ECE 330 or PH 253.

ECE 462. Semiconductor Optoelectronics. 3 sem. hrs.
Elemental and compound semiconductors; fundamentals of semiconductor physical properties; solid state physics; optical recombination and absorption; light emitting diodes; quantum well lasers; quantum dot lasers; blue lasers; semiconductor modulators; photodetectors; semiconductor solar cells; semiconductor nanostructure devices. Prerequisite(s): PH 253.

ECE 463. Magnetic Materials & Devices. 3 sem. hrs.
Diamagnetism and Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, magnetic anisotropy, domains and the magnetization process, fine particles and thin films and magnetization dynamics. Prerequisite(s): ECE 340.

ECE 466. Fund of Nanotechnology. 3 sem. hrs.
Nanofabrication with electron beam lithography, focused ion beam, lithography, and nanoimprint; microscopies for nanostructures, including SEM, EDX, TEM, AFM, STM; nanoscale devices based on nanostructured materials (carbon nanotubes and metal oxide nanomaterials). Prerequisite(s): ECE 330 or PH 253.

ECE 475. Control Systems Analysis. 3 sem. hrs.
Classical and modern feedback control system methods; stability; Bode, root locus, state variables, and computer analysis. Prerequisite(s): ECE 326.

ECE 476. Control Systems Lab. 1 sem. hr.
Practical analysis and design of feedback control systems and components; electrical, mechanical, and electromechanical systems. Prerequisite(s): ECE 326 Prerequisite(s) with concurrency: ECE 475.

ECE 479. Digital Control Systems. 3 sem. hrs.
Frequency and time methods in discrete time control systems; sampling of continuous-time signals, stability, transform design techniques, and state variable analysis and design techniques. Prerequisite(s): MATH 237 and ECE 370 and ECE 475.

ECE 480. Digital Systems Design. 3 sem. hrs.
Digital systems design with hardware description languages, programmable implementation technologies, electronic design automation design flows, design considerations and constraints, design for test, system-on-a-chip designs, IP cores, reconfigurable computing and digital system design examples and applications. Prerequisite(s): ECE 383 Prerequisite(s) with concurrency: ECE 481.

ECE 481. Digital Systems Design Lab. 1 sem. hr.
Logic design and simulation via hardware description languages, use of electronic design automation tools, and CPU design. Prerequisite(s) with concurrency: ECE 480.

ECE 482. Comp Visn Dig Image Proc. 3 sem. hrs.
Introduction to computer vision and digital image processing with an emphasis on image representation, transforms, filtering, compression, boundary detection, and pattern matching. Prerequisite(s): MATH 355 and ECE 285.

ECE 484. Computer Architecture. 3 sem. hrs.
Basic computer organization, computer arithmetic, assembly language, machine language, simple and pipelined central-processor organization, memory system hierarchy, and measuring computer performance. Prerequisite(s): ECE 383.

ECE 485. Programmable Logic Controllers. 3 sem. hrs.
Programmable Logic Controllers, fundamentals of ladder logic programming and PLC systems, advanced PLC operation, and related topics, including networking, control applications and human-machine interface design. Prerequisite(s): ECE 383.

ECE 486. Embedded Systems. 3 sem. hrs.
Integration of microprocessors into digital systems. Includes hardware interfacing, bus protocols and peripheral systems, embedded and real-time operating systems, real-time constraints, networking, and memory system performance. Prerequisite(s): ECE 386 Prerequisite(s) with concurrency: ECE 487.

ECE 487. Embedded Systems Laboratory. 1 sem. hr.
Projects provide hands-on experience in hardware interfacing, system-level design, real-time concepts and memory system performance. Prerequisite(s): ECE 383 Prerequisite(s) with concurrency: ECE 486.

ECE 491. Special Problems. 1-8 sem. hr.
Investigation of a problem or problems, usually involving research with a faculty member. Credit is based on the individual assignment.

ECE 492. Capstone Design I 2 sem. hrs.
First of a two-course sequence to provide design experience through capstone design, a team-based two-semester-long design project. Also, the first-semester course will include instruction in design methodology, engineering ethics, societal impacts, project economics, and management tools. Prerequisite(s) with concurrency: ECE 333.

ECE 493. Selected Topics. 1-8 sem. hr.
Special courses in all areas of electrical or computer engineering, offered as the need arises. Credit is based on the course requirements.

ECE 494. Capstone Design II 2 sem. hrs.
Second of a two-course sequence to provide design experience through capstone design, a team-based two-semester-long design project. Prerequisite(s): ECE 492.

ECE 496. . 1-3 sem. hr.
Investigation of an electrical or computer engineering research or design problem. ECE 499. . 1-3 sem. hr.
Investigation of an electrical or computer engineering research or design problem.

Engineering Graphics (DR) Courses

DR 100. Technical Sketching Engineers. 1 sem. hr.
Prerequisite(s): MATH 112 or MATH 113 or MATH 115 or MATH 117 or MATH 121 or MATH 125 or MATH 126 or MATH 131 or MATH 132 or MATH 145 or MATH 146.
### Mechanical Engineering (ME) Courses

**ME 121. INTRODUCTION TO MECHANICAL ENGINEERING. 1 sem. hr.**
An introduction to the discipline of mechanical engineering and the role of the mechanical engineer, including both mechanical and thermal/fluid stems. Focus is on learning about the discipline through a series of student hands-on activities. Credit will not be given for this course for students who have passed ME 215.
Prerequisite(s): Math 112 or Math 113 or Math 115 or Math 125 or Math 126 or Math 145 or Math 146 or Math 227 or Math 238.
Prerequisite(s) with concurrency: Math 112 or Math 113 or Math 115 or Math 125 or Math 126 or Math 145 or Math 146 or Math 227 or Math 238.

**ME 215. Thermodynamics I. 3 sem. hrs.**
Thermodynamic cycle analysis; thermodynamics of non-reacting and reacting mixtures; and chemical equilibrium.
Prerequisite(s): ME 215, Math 227 or Math 247.

**ME 305. Thermodynamics II. 3 sem. hrs.**
Basic propulsion dynamics, thermodynamics of fluid flow, combustion kinetics, air-breathing engines, rockets, design criteria, performance and advanced propulsion systems.
Prerequisite(s): ME 305.

**ME 309. Heat Transfer. 3 sem. hrs.**
Steady and unsteady conduction, convection and radiation heat transfer.
Prerequisite(s): Math 238 and ME 215 and AEM 311.

**ME 349. Engineering Analysis. 3 sem. hrs.**
Elements of statistics, matrix algebra, numerical analysis, and partial differential equations applied to engineering problems; includes extensive computer applications. Computing proficiency is required for a passing grade in this course.
Prerequisite(s): Math 238 and GES 132 or ENGR 141 or ENGR 193.

**ME 350. Static Machine Components. 4 sem. hrs.**
The analysis of stresses of machine elements and the topics of fatigue strength, wear and failure criteria. Also includes the design of fasteners covering both bolted and welded joints, as well as an introduction to finite element analysis.
Prerequisite(s): AEM 250 and AEM 251 and DR 125 or ART 131 or ENGR 161.

**ME 360. Control Instrument Components. 3 sem. hrs.**
Introduction to selection and use of electrical, pneumatic, and other components of mechanical system instrumentation and control. Specific components include modern electrical measurement devices, signal conditioning, force and torque measurement, proximity sensors, AC and DC motors, etc. Writing proficiency is required for a passing grade in this course.
Prerequisite(s): AEM 250; and ECE 320 or ECE 225.

**ME 364. Vehicle Dynamics. 3 sem. hrs.**
Dynamics of four-wheeled vehicles, including acceleration and braking performance, road loads, ride comfort, steady-state cornering, suspensions, steering systems, and rollover. Vehicle dynamics system modeling programs are introduced and used for detailed investigations of the effect of system design parameters on performance.
Prerequisite(s): AEM 264.

**ME 372. Dynamic Systems. 3 sem. hrs.**
An introduction to the modeling, analysis and control of dynamic systems. The course takes the student from initial modeling through analysis of the system response and finally into the control of the system. Specific systems include mechanical devices, electrical circuits, and electromechanical systems. Computing proficiency is required for a passing grade in this course.
Prerequisite(s): Math 238 and AEM 264 and ME 349; and ECE 320 or ECE 225.

**ME 377. Noise Control. 3 sem. hrs.**
Physical properties of noise; hearing and noise criteria measurement techniques; and noise-control fundamentals applied to practical problems.
Prerequisite(s): Math 238 and PH 106.

**ME 383. Modern Manufacturing Processes. 3 sem. hrs.**
A survey of classical and modern manufacturing processes. Emphasis is on technical fundamentals and practical applications. Components include geometric and service attributes of manufactured products, metal casting processes, forming processes, machine processes and joining processes. Practical project experience included.
Prerequisite(s): AEM 250 and AEM 251 and DR 125 or ART 131 or ENGR 161.
ME 406. Thermal Power Systems. 3 sem. hrs.
Study of thermal systems emphasizing large power generation systems. Topics include Rankine and gas turbine cycles, fossil fuels combustion, boiler characteristics, cogeneration, combined cycle plants, environmental effects of power generation, and alternative energy concepts. Prerequisite(s): ME 305.

Fundamentals and practice associated with heating, ventilating and air-conditioning; study of heat and moisture flow in structures, energy consumption, human comfort and health; and design of practical systems. Prerequisite(s): ME 309 and ME 305.

ME 416. Energy Conservtn & Manaq. 3 sem. hrs.
Analysis of energy systems, including fossil fuels, steam, cogeneration, waste heat recovery, heating, ventilation, air-conditioning, control and energy-management systems. Topics include conservation in electrical load, lighting, building envelope, and insulation; alternative energy sources; economic analysis; energy auditing; and fuel sources and supplies. Prerequisite(s): ME 309 and ME 305 and ECE 320 or ECE 225.

ME 417. Sustainable Energy. 3 sem. hrs.
Contemporary issues surrounding the challenge of providing energy for societal and economic development are examined. Depletion of fossil fuel resources and the impact of fossil fuel use on the environment and climate are considered. Alternative sustainable sources of energy production are explored. Prerequisite(s): ME 215.

ME 418. Combustion Engines. 3 sem. hrs.
Theory, design, and performance of combustion engines; fuels, oxidants, and propellants; and combustion, dissociation, ionization, and engine emissions. Prerequisite(s): ME 305.

ME 421. Reliability Maint & TPM. 3 sem. hrs.
Measures and methods of reliability engineering, maintainability engineering and total productive maintenance, as used in the system design process. Prerequisite(s): GES 255 or GES 500.

ME 430. Fuzzy Set Theory & Application. 3 sem. hrs.
This course introduces fuzzy set theory and its engineering applications to upper-class undergraduate students. Prerequisite(s): GES 400 or GES 500.

ME 450. Dynamic Machine Components. 3 sem. hrs.
This course covers the selection and application of machine elements in dynamic systems. Specific components covered include transmission elements (gears and pulleys), mechanisms (linkages and cams), shafting, bearing systems and prime movers. Prerequisite(s): AEM 264 and ME 350.

Selection and use of basic thermal systems measurement instrumentation. Techniques of analysis and design of thermal systems, including piping networks, heat exchangers, and pumping systems. Hands on experience with these systems. Statistical design of experiments. Writing proficiency is required for a passing grade in this course. Prerequisite(s): ME 305, ME 309 & ME 360 - each must have a minimum grade of C-.

ME 470. Mechanical Vibrations. 3 sem. hrs.
Free and forced vibrations, both undamped and damped, and systems with many degrees of freedom formulated and analyzed by matrix methods. Experimental techniques of vibration measurement are introduced. Prerequisite(s): ME 372 and AEM 250.

ME 471. Fundmntl Of Acoustics. 3 sem. hrs.
Fundamental physical principles underlying wave propagation and resonance in mechanical systems. Introduces applications and provides experience in acoustic and audio measurements, and the associated instrumentation. Prerequisite(s): MATH 238 and PHY 106 and ECE 225 or ECE 320.

ME 475. Control Systems Analysis. 3 sem. hrs.
Classical and modern feedback-control system analysis; block diagrams, state variables, stability, root locus and computerized analysis. Includes an introduction to modern control techniques. Prerequisite(s): ME 349 and ME 372.

ME 483. Computer-Aided Manufacturing. 3 sem. hrs.
Introduction and application of several technologies used in computer-aided design/manufacturing: computer-aided design, solid modeling, rapid prototyping, geometric dimensioning and tolerancing, machining process optimization, NC programming CNC machines, software-based product, and process design in machining. Prerequisite(s): ME 383.

ME 485. Intro to Computer-Aided Design. 3 sem. hrs.
Basics of computer-aided design, including solid modeling, model assembly, structural and thermal analysis, mechanism simulation and parametric/optimization study. Interactive computer programs are used to design and analyze mechanical components/devices. Prerequisite(s): ENGR 161, AEM 250 and ME 309.

ME 489. Mechanical Engg Design I. 3 sem. hrs.
Introduction to concepts and techniques of engineering design with supporting mathematical material. Quest lecturers present professional aspects of engineering. The Capstone Design Project is begun and carried on through ME 490 (ME 489 and ME 490 are taken in consecutive semesters). Prerequisite(s): ME 350 and ME 309.

ME 490. Mechancli Engr Design II. 3 sem. hrs.
In this semester-long internship experience, three-student teams serve as consultants to an industrial client. Emphasis is on conducting a professional design study and preparing written and oral presentations of the project. Prerequisite(s): ME 489.

ME 491. Special Problems. 1-6 sem. hr.
This is a special topics lecture class or an assigned problem class. Credit is based on the amount of work undertaken. ME 497. Mech Engineer Project. 1-3 sem. hr.
An individual analytical, experimental or design project. Research on an assigned problem culminates in a required report.

Metallurgical and Materials Engineering (MTE) Courses

MTE 121. Introduction to Materials . 1 sem. hr.
An introduction to the materials science and engineering profession and history. The course includes selected topics useful in the study of metallurgical and materials engineering.

This course will provide the science background today’s citizens need to understand the problems and limitations society faces with respect to energy resources and the environment. Science concepts will be introduced as needed and within the context of energy, the environment, or materials. Students will be encouraged to critically analyze timely examples of energy usage or environmental problems from the news media. Students will gain an understanding of how engineering and technology, especially the development of new materials, can translate science to practical and beneficial outcomes.

MTE 252. Metallurgical Process Calculations. 3 sem. hrs.
Mathematical quantitative relations of chemical reactions and physicochemical processes; principles of overall mass and energy balances and the application of these principles to metallurgical systems. Prerequisite(s): CH 102 and MATH 125.

Basic structure of ceramics, alloys, composites, metals, and polymers. Relationships between the structure of materials and their mechanical, electrical, magnetic, thermal, and chemical properties. Prerequisite(s): CH 101 or CH 117; MATH 125 or MATH 145.

MTE 275. Engineering Materials Laboratory. 3 sem. hrs.
Alloy preparation and processing of materials. Materials testing and evaluation, laboratory procedures and techniques, metallography, heat treatment, phase diagrams, hardenability, and mechanical testing. Introduction to technical report writing and application to written laboratory reports. Prerequisite(s): EN 101

MTE 353. Transport. 3 sem. hrs.
Definition of viscosity, elements of laminar and turbulent flow, and overall mechanical energy balance. Thermal conductivity, steady and transient conduction problems, forced and natural convection, heat transfer, and radiative heat transfer. Definition of binary diffusivity, convection mass transfer, and mass transfer coefficient. The application of the principles covered in the design of specific metallurgical systems. Prerequisite(s): MATH 238 and MTE 252

MTE 362. Thermodynamics Of Materials. 4 sem. hrs.
The fundamentals of thermodynamics applied to typical metallurgical processes and reactions, heterogeneous equilibrium, behavior of solutions, standard states, phase diagrams. Emphasis is placed on the use of basic thermodynamic data, graphical representations of thermodynamic data and equilibrium, and the application of using computational tools to solve problems. Computing proficiency is required for a passing grade in this course. Prerequisite(s): MTE 252.
MTE 373. Physical Metallurgy. 4 sem. hrs.
Introduction to the principles of physical metallurgy. Topics include crystal structure, deformation, dislocations, point defects, diffusion, phase diagrams, interfaces, nucleation theory, transformations, and growth. Writing proficiency is required for a passing grade in this course.
Prerequisite(s): MTE 271 and MTE 362.

Detailed study of principal alloy, ceramic, and polymer systems. Evaluation of the effects or processing on selected physical and mechanical material properties.
Overview of design fundamentals and examination of selected material/design case studies for manufacturing.
Prerequisite(s): MTE 271.

MTE 412. Polymer Materials Engineering. 3 sem. hrs.
Introduction to the manufacture, processing and applications of organic polymeric materials. The chemistry of polymer manufacture, the molecular structure of polymers, and the structure-property relationships for thermoplastic and thermosetting polymers are covered.
Prerequisite(s): CH 102.

Metal casting principles including pattern design, molding materials, conventional and digital molding methods, sand testing, solidification, risering and gating of castings, casting and mold design, microstructure and casting defects and their influence on mechanical properties. Computing proficiency is required for a passing grade in this course.
Prerequisite(s): MTE 380 or permission of instructor.

MTE 439. Metallurgy Of Welding. 3 sem. hrs.
Thermal, chemical, and mechanical aspects of welding using fusion welding processes. The metallurgical aspects of welding, including microstructure and properties of the weld, are also included.
Prerequisite(s): MTE 380 or permission of instructor.

MTE 441. Chemical Metallurgy. 4 sem. hrs.
Application of thermodynamics, fluid flow, and heat and mass transfer to the design and operation of chemical metallurgical processes; roasting, agglomerating, oxidation and reduction reactions, smelting, converting, and refining.
Prerequisite(s): MTE 353 and MTE 362.
Prerequisite(s) with concurrency: MTE 443.

Principles of engineering design. Problem formulation, concept design, configuration design, parametric design, detail design, materials selection, manufacturing process selection, prototyping, project planning and cost analysis, application of computer-based design tools, concepts of shared responsibility, teamwork and communication. Analysis of problems, design and development solutions. Oral presentations and written reports. A project will be assigned. Final project presentations will be evaluated by the MTE faculty.
Prerequisite(s): EC 110, MTE 362, 373, 380.
Prerequisite(s) with concurrency: MTE 441 and MTE 481.

Capstone design course. Students work in teams on design projects which involve evaluation of industrial based metallurgical or materials problems and emphasize societal impact. Implementation of design principles and the research plan developed in MTE 443. Interim and final design reviews with oral presentations and written reports. Final project presentation will be evaluated by the MTE faculty.
Writing proficiency is required for a passing grade in this course.
Prerequisite(s): MTE 416, 441, 443, 455, and 481.

MTE 449. Powder Metallurgy. 3 sem. hrs.
The course will cover the topic of powder metallurgy, describing the various types of powder processing and how these affect properties of the component(s) made. Current issues in the subject area, from high production to nanomaterials will be discussed.
Prerequisite(s): MTE 373 and MTE 380.

MTE 450. Plasma Processing of Thin Films. 3 sem. hrs.
This course will cover fundamental technology involved in thin film processing. Plasma deposition and etch technology will be discussed. The basics of plasma processing equipment will be detailed, with special emphasis on sputtering tools. A range of thin film applications will be explored, with examples of magnetic, semiconductor, optical, and medical applications. The fundamentals of process optimization using a Design of Experiments will be taught with a test case of process optimization for the final exam.
Prerequisite(s): PH 106 and CH 102 or permission of instructor.

MTE 455. Mechanical Behavior Of Materials. 4 sem. hrs.
Flow and fracture of solids; uniaxial stress-strain as a reference behavior; theories of terminal stability under impact; monotonic, sustained (creep), and repeated (fatigue) loadings of solids under various states of stress.
Prerequisite(s): AEM 201 or permission of instructor.