

# COLLEGE OF ENGINEERING, ARCHITECTURE AND TECHNOLOGY

## College Administration

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## Campus Address and Phone

**Address:** 201 Advanced Technology Research Center, Stillwater, OK 74078

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The vision of the College of Engineering, Architecture and Technology (CEAT) is "To be the leading public university in engineering, architecture, and technology that engages diverse students, faculty and staff with industry and government to deliver excellence in advanced learning, leadership, relevant research, and benefits to society."

"Our mission is to provide a diverse student population with the highest quality education in engineering, architecture and technology. OSU develops ethical leaders with technical knowledge, innovation and communication skills to benefit the State of Oklahoma, the nation and the world."

The College of Engineering, Architecture and Technology is a community of scholars, innovators and leaders that is transforming our lives. The preparation of professionals that anticipate the needs of a changing world is at the nexus of society, economy, ethics, sustainability and humanity. The College is committed to educating professionals that innovate, design and build projects that provide solutions for both the developed and the developing world.

The College of Engineering, Architecture and Technology (CEAT) embraces students from diverse backgrounds to imagine and discover the challenges of engineering, architecture and technology, and to bring about innovation using their proficiency in science, mathematics, communications, ethics and humanity. This mission is built on the foundation of the University's mission and the expectations of a world class university.

As Oklahoma's land-grant university, CEAT fulfills the most fundamental premise that founded OSU; to promote economic and community viability through technical assistance, academic and professional education, training and communication in the areas of engineering, architecture and technology, and by connecting scientific research and scholarship to industry, communities, and individual citizens in Oklahoma, the region and the world.

As we progress into the future, professionals with a higher education will continue to be largely responsible for shaping our world. The power they exercise is an exciting prospect and presents a sobering responsibility.

Less complex problems have been solved and are now a part of history. Many difficult problems remain. The need for talented and highly educated professionals is obvious; one will be embarking on a lifetime of challenge as he or she prepares for a career in engineering, engineering technology or architecture at Oklahoma State University.

The College of Engineering, Architecture and Technology offers a complete spectrum of educational opportunities at both the undergraduate and graduate levels designed to give graduates the capability and flexibility to meet the ever-changing needs of a society that is committed to technological innovation. To make continuing contributions, engineers, architects and technologists must have many abilities at their command. The modern tools and processes of industry must be understood. The processes of design and analysis require a firm understanding of mathematics and the sciences. An effective engineer, architect or engineering technologist must develop sensitivity to human needs, ideas, institutions and cultures. These programs prepare graduates to be effective contributors within human organizations and provide an increased understanding of both the technical and non-technical factors that shape our human environment. With this firm foundation, and a commitment to lifelong learning, College of Engineering, Architecture and Technology graduates are fully prepared to make contributions to society throughout their professional careers.

The curriculum in each program provides the optimum combination of breadth in the enduring fundamentals and specialization in a discipline. Each curriculum sensitizes the student to ethical, social, cultural, and global issues that will shape their ideas and contributions. To equip the student to contribute to solutions at the cutting edge of technology, curricula are continuously evolving to include current applications of the principles. Through the combination of theory, practice and improved sensitivity to diverse issues, graduates will be prepared to support their diverse interests while positively contributing to the advancement of technology and the world.

ENDEAVOR was opened in the fall of 2019. This one of a kind, hands-on, 72,000-square-foot facility allows undergraduate students to explore and experiment with engineering principles, systems, and new technologies. ENDEAVOR is a platform for interdisciplinary and collaborative learning and solutions that lead to entrepreneurial enterprise.

## Academic Programs

Academic programs offered in the College of Engineering, Architecture and Technology culminate in the following degrees:

### Schools of Engineering

- Bachelor of Science in Aerospace Engineering, Biosystems Engineering with options in Bioprocessing and Food Processing, Environment and Natural Resources, Machine Systems and Agricultural Engineering, and Pre-medical; Chemical Engineering with options in Biomedical/Biochemical and Pre-medical; Civil Engineering with an option in Environmental; Computer Engineering; Electrical Engineering; Industrial Engineering and Management; and Mechanical Engineering with options in Premedical or Petroleum.
- Master of Science in Biosystems Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering with options in Control Systems and Optics and Photonics, Engineering and Technology Management, Industrial Engineering and Management, Materials Science and Engineering, Mechanical and Aerospace Engineering with an option of Unmanned Aerial Systems and Petroleum Engineering.

- Master of Engineering in Electrical Engineering and Mechanical Engineering.
- Doctor of Philosophy in Biosystems Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Industrial Engineering and Management, Materials Science and Engineering, Mechanical and Aerospace Engineering, and Petroleum Engineering.

## School of Architecture

- Bachelor of Architecture, Bachelor of Architectural Engineering.
- Graduate Certificate in Integrative Design of Building Envelope.

## Division of Engineering Technology

- Bachelor of Science in Engineering Technology in Construction Engineering Technology with options in Building and Heavy, Electrical Engineering Technology with a Computer option, Fire Protection and Safety Engineering Technology, and Mechanical Engineering Technology.
- Master of Science in Engineering Technology with an option in Fire Safety and Explosion Protection.
- Master of Science in Fire and Emergency Management Administration.
- Doctor of Philosophy in Fire and Emergency Management Administration.

## Accreditation

### UNDERGRADUATE ENGINEERING DEGREE PROGRAMS

The following OSU College of Engineering, Architecture and Technology programs are individually accredited by the Engineering Accreditation Commission of ABET, <https://www.abet.org> (<https://www.abet.org/>).

- Aerospace Engineering
- Architectural Engineering
- Biosystems Engineering
- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Electrical Engineering
- Industrial Engineering & Management
- Mechanical Engineering

### UNDERGRADUATE ENGINEERING TECHNOLOGY DEGREE PROGRAMS

The following OSU College of Engineering, Architecture and Technology programs are individually accredited by the Engineering Technology Accreditation Commission of ABET, <https://www.abet.org> (<https://www.abet.org/>).

- Construction Engineering Technology (BS in Engineering Technology)
- Electrical Engineering Technology (BS in Engineering Technology)
- Fire Protection and Safety Engineering Technology (BS in Engineering Technology)
- Mechanical Engineering Technology (BS in Engineering Technology)

### UNDERGRADUATE ARCHITECTURE DEGREE PROGRAM

"In the United States, most registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit professional degree programs in architecture offered by institutions with U.S. regional accreditation, recognizes three types of degrees: the Bachelor of Architecture, the Master of Architecture, and the Doctor of Architecture. A program

may be granted an eight-year term, an eight-year term with conditions, or a two-year term of continuing accreditation, or a three-year term of initial accreditation, depending on the extent of its conformance with established education standards. Doctor of Architecture and Master of Architecture degree programs may require a non-accredited undergraduate degree in architecture for admission. However, the non-accredited degree is not, by itself, recognized as an accredited degree."

The Oklahoma State University School of Architecture offers the following NAAB-accredited degree programs:

B. Arch. (154 undergraduate credits)

Next accreditation visit: 2025, <http://www.naab.org/>.

## High School Preparation

In addition to the curricular requirements for admission specified by OSU, the College of Engineering, Architecture and Technology strongly recommends that students have a fourth year of mathematics and an additional year of laboratory science.

Initial placement in OSU mathematics courses is by placement examination to ensure that each student will be challenged but has the preparation to be successful in the first mathematics course. Placement in science courses is based on prior preparation in the science and completion of or placement beyond prerequisite mathematics courses. When appropriate, a student with an exceptionally strong background can obtain academic credit by advanced standing examination or by College Level Examination Program (CLEP) tests or similar.

## Enrolling in the College of Engineering, Architecture, and Technology

A freshman student who has been admitted to OSU can be enrolled directly into a CEAT degree program if the student has both of the following performance requirements:

1. an ACT Composite score of 24 or higher, or a total SAT score of 1160 or higher, and
2. an ACT MATH score of 24 or higher, or a SAT Math score of 600 or higher, OR achieve a GPA of 3.5 or higher (on a 4.00 grading scale standard weighting to The College Board's Advanced Placement courses and the International Baccalaureate higher-level courses) in the required 15 core high school courses.

*SAT score is the combination of Critical Reading and Math sections only. SAT scores represent tests taken on or after the National March 2016 test.*

**Due to COVID-19, admission to OSU is test optional for the fall 2021 entering classes. If a student is admitted to CEAT following the test optional admission guidelines, they can be enrolled directly into a CEAT degree program if the student has a minimum 3.5 (15-unit core) GPA.**

Prospective engineering, architecture or technology students who do not meet these performance qualifications may enroll in any other college or may enroll in University College in the Pre-CEAT program and work with a CEAT-focused advisor to gain the academic background for enrollment in CEAT degree programs. Those students will be enrolled in a CEAT degree program when they have met the following performance requirements:

1. passed all prerequisite MATH courses needed to enroll in Calculus I or Calculus for Technology I, and
2. has an OSU Cumulative GPA of at least 2.0.

Transfer students can enroll directly into a CEAT degree program if they satisfy all OSU resident transfer student requirements, have a GPA of at least 2.0, and are qualified to enroll in Calculus I or higher in the MATH sequence. Other transfer students may enroll in University College in the Pre-CEAT program until they meet the qualifications for enrolling in a CEAT pre-professional program.

Students transferring to CEAT from another major at OSU must meet the same requirements for admission as a student transferring from another college or university.

## Special College Programs

**CEAT Living/ Learning Program (LLP).** CEAT residential floors have been established in CEAT Parker Hall for both male and female CEAT students. Parker Hall is reserved for CEAT Freshman and provides an immersive environment to help freshman succeed in CEAT and at OSU. Special programming is provided, and upper-class mentors live on each of the floors. The CEAT Parker In Residence program allows a CEAT representative to live on the ground floor of Parker Hall and provide inspiration and mentorship for students. The second floor of CEAT Parker Hall is referred to as Maude's Squad, and is our freshmen female LLP. All Living/ Learning Programs provide an atmosphere that is conducive to study. The students experience a community where they can work together, have access to tutoring and other services, and serve as role models for other students. Special activities are planned for the floors, including events with faculty and other leaders. They are highly recommended for student success in CEAT. <https://ceat.okstate.edu/student-services/living-learning-parker.html>

**CEAT Summer Bridge** is a three-week residential, on-campus, preparatory program for incoming freshmen students who have been accepted to Oklahoma State University and who plan to study a major in CEAT. This program is designed to guide students as they transition from high school to the academic rigors of CEAT coursework through academic review, mock exams, orientation seminars and engineering design projects. In addition, the students will build relationships with peers, faculty and staff, and start the process of building strong study habits with the assistance of CEAT upperclassmen as mentors. <https://ceat.okstate.edu/student-services/summer-bridge-program.html>

The **Discover Architecture Program** introduces high school students to Architecture, Architectural Engineering, Landscape Architecture, and Construction Engineering Technology. This week-long summer program has academic projects that are designed to stimulate creativity and be fun! Participants live in campus housing, and complete projects that include the application of sketching and designing in model, using computer presentation tools, and several hands-on building projects to help students understand if a career in the building arts might be right for them. The program is offered by Oklahoma State University faculty at the Stillwater campus for students who are at least 16 years of age. <https://ceat.okstate.edu/arch/discover-architecture.html>

The **Pre-CEAT Program** is housed within University College but physically located in CEAT. This program provides a focused advisor, tutoring and other activities to help students get academically ready for success in CEAT.

**CEAT Scholars Program** provides educational experiences for a select group of students to develop and enhance their technical competence, world view, professional and public responsibility, and leadership skills. Based on demonstrated academic and leadership potential, up to 100 scholars are selected each year, by application and interview, to enter this four-year program. Students participate in special lectures,

regional tours, cultural events, seminars, personal development activities, faculty mentoring, and international travel. [https://ceat.okstate.edu/scholarships/ceat\\_scholars\\_program.html](https://ceat.okstate.edu/scholarships/ceat_scholars_program.html)

**CEAT Freshman Research Scholars Program** provides opportunities for accelerated intellectual development of a select group of students. Each student is assigned a research faculty mentor and participates in a research program. The initial assignment is for one year and it may be extended based on student interest, research project continuation and mentor availability. <https://scholardevelopment.okstate.edu/freshman-research-scholars/prospective-freshman-researchers> (<https://scholardevelopment.okstate.edu/freshman-research-scholars/prospective-freshman-researchers/>)

**WW Allen Scholars Program** is designed for top academic students who also show significant promise in leadership and career ambition. The program is highlighted by the opportunity to pursue a master's degree at the University of Cambridge in the UK following graduation from OSU. <https://ceat.okstate.edu/scholarships/w-w-allen-scholars-program.html>

**Phillips 66 SHIELD Scholars Program** provides scholarships and professional and personal development through enrichment activities, seminars and community service. The program is for current students enrolled full-time in chemical engineering, civil engineering, computer engineering, electrical engineering, fire protection safety engineering technology, industrial engineering, mechanical engineering or materials engineering. <http://ceat.okstate.edu/scholarships> (<http://ceat.okstate.edu/scholarships/>)

**CEAT Grand Challenge Scholars Programs** focus on preparing students to be the generation that solves the grand challenges facing society in this century with emphasis on integrative research, interdisciplinary curriculums, entrepreneurship, global understanding and service learning. <https://ceat.okstate.edu/gcsp.html>

**CEAT Diversity and Inclusion Programs (CDP)** provide services to support, retain and graduate all CEAT students which includes underrepresented populations such as Native Americans, African Americans, Hispanic/Latino Americans, Women, First-Generation, Non-Traditional, Disabled, Veterans and LGBTQ. All students are welcome to participate, learn and celebrate the value of a diverse CEAT community. <https://ceat.okstate.edu/student-services/diversity-equity-inclusion/index.html> (<https://ceat.okstate.edu/student-services/diversity-equity-inclusion/>)

**CEAT Tutoring** provides free tutoring for most required Math, Physics, Chemistry, Computer Science and Engineering core courses. Services include advising, tutoring, career placement and more. <https://ceat.okstate.edu/student-services/tutoring.html>

**CEAT Career Services** is dedicated to helping students reach their career goals by providing individualized career assistance, specialized workshops, and resources on a variety of topics including career exploration, job search strategies, resume and job search correspondence preparation, interviewing skills, and salary negotiation. The office also supports the Cooperative Education Program (Co-op) and provides individual career assessments for undergraduate students. As part of the OSU Career Services system, CEAT Career Services works in close partnership with CEAT Student Academic Services to link academic and career success. <https://ceat.okstate.edu/student-services/career-services/index.html> (<https://ceat.okstate.edu/student-services/career-services/>)

**CEAT Cooperative Education Program (Co-op)** provides an avenue for undergraduate students to complete a year of full-time work experience

directly related to their academic studies. Co-op students alternate terms of major-related employment with terms of full-time coursework to achieve a quality education and industry experience. In addition to professional development, participation in the Co-op program earns academic credit and maintains full-time enrollment status for students during the work experience terms. <https://ceat.okstate.edu/student-services/career-services/coop-faq.html>

**CEAT Study Abroad Programs** offer students the opportunity to expand their education by traveling and studying outside the United States. Opportunities range from shorter faculty-led programs to semester exchange opportunities.

## Departmental Clubs and Honor Societies

Alpha Epsilon (Biosystems and Agricultural Engineering Honor Society)  
 Alpha Omega Epsilon (Professional and Social Sorority for Women in Engineering)  
 Alpha Pi Mu (Industrial Engineering and Management Honor Society)  
 Alpha Rho Chi (Architecture Honor Society)  
 The Almighty S(he)  
 Amateur Radio Club - W5YJ  
 American Association of Drilling Engineers  
 American Indian Science and Engineering Society  
 American Institute of Architecture Students  
 American Institute of Aeronautics & Astronautics  
 American Institute of Chemical Engineers  
 American Society for Quality  
 American Society of Agricultural and Biological Engineers  
 American Society of Civil Engineers  
 American Society of Heating, Refrigeration and Air Conditioning Engineers  
 American Society of Mechanical Engineers  
 American Society of Mechanical Engineers - Technology  
 American Society of Safety Engineers  
 APICS  
 Association for Supply Chain Management  
 Architectural Engineering Institute  
 Architecture Students Teaching Elementary Kids (ASTEK)  
 CEAT Student Council  
 CHEM Kidz  
 Chi Epsilon (Civil and Architectural Engineering Honor Society)  
 Concrete Canoe  
 Construction Management Society  
 Construction Specifications Institute  
 Cowboy Motorsports Quarter Scale Tractor Team  
 Cowboy Waterworks  
 Engineers Without Borders  
 Eta Kappa Nu (Electrical and Computer Engineering Honor Society)  
 Firefighter Combat Challenge  
 Fire Protection Society  
 Freedom by Design  
 Institute for Operations Research and the Management Sciences  
 Institute of Electrical and Electronics Engineers (IEEE)  
 Institute of Electrical and Electronics Engineers - Technology (IEEE-T)  
 Institute of Industrial and Systems Engineers  
 Institute of Transportation Engineers  
 International Fluid Power Society  
 International Society for Automation  
 Mercury Robotics  
 National Society of Black Engineers  
 National Organization of Minority Architecture Students

Omega Chi Epsilon (Chemical Engineering Honor Society)  
 Out in Science, Technology, Engineering, and Mathematics (oSTEM)  
 OSU Automation Society  
 Pi Tau Sigma (Honorary Mechanical Engineering Society)  
 Sigma Gamma Tau (Honorary Aerospace Engineering Society)  
 Sigma Lambda Chi (Construction Engineering Technology Honor Society)  
 Society of Asian Scientists and Engineers  
 Society of Automotive Engineers  
 Society of Automotive Engineers Formula Racing Team  
 Society of Automotive Engineers Mini-Baja Team  
 Society of Fire Protection Engineers  
 Society of Hispanic Professional Engineers  
 Society of Petroleum Engineers  
 Society of Manufacturing Engineers  
 Society of Women Engineers  
 Student Association of Fire Investigators  
 Student Firefighter Combat Challenge Team  
 Tau Alpha Pi (Technology Student's Honor Society)  
 Tau Beta Pi (Engineering Student's Honor Society)  
 Tau Sigma Delta (Architecture Student's Honor Society)  
 Theme Park Engineering Group  
 Theta Tau

## CEAT Honors Program

The OSU Honors College provides challenges for undergraduate students of unusually high ability, motivation and initiative. Honors classes, seminars and independent study courses are designed to align students and instructors in a manner that encourages discussion and provides a mature approach to learning.

Information regarding The Honors College at OSU, and Scholar Development/Leadership Programs can be found on the Honors College tab in the left menu.

## Scholarships

Numerous CEAT scholarships are funded through the generosity of alumni, private and corporate donations. Awards are available for undergraduate and graduate students at all levels and are granted based on academic achievement, campus involvement and leadership potential, as well as financial need. Freshmen and undergraduate transfer students are automatically considered for most CEAT scholarships, based off the student's eligibility through their OSU application and acceptance to OSU and CEAT, for priority scholarship consideration students should apply and be accepted to CEAT by November 1st. Student must be accepted by Feb. 1<sup>st</sup> for all other scholarship considerations. All CEAT scholarships are awarded on a competitive basis. Some scholarships require additional applications. Details can be found at <https://ceat.okstate.edu/scholarships/index.html> (<https://ceat.okstate.edu/scholarships/>).

Current undergraduate (continuing) students should submit applications for general CEAT scholarships online at <https://ceat.okstate.edu/scholarships/index.html> (<https://ceat.okstate.edu/scholarships/>).

## Computing Requirements

For students in Engineering, Architecture and Technology, the college requires that all students have several basic tools. Students in the College must have a scientific calculator and a laptop computer. The scientific calculator should be capable of computing trigonometric functions, logarithmic and natural logarithmic functions, basic statistical

analysis, and all algebraic functions. The laptop requirements are published at <https://ceat.okstate.edu/itservices/>.

## Academic Advising

The College's Office of Student Academic Services (<https://ceat.okstate.edu/studentservices/>) provides advisement for all CEAT freshman students except for those who are advised in their academic department. University College provides advisement through the Pre-CEAT program, for OSU students who do not meet the qualifications for enrollment in CEAT but wish to become qualified to enroll in a CEAT degree program in the future. Each student is personally advised in the planning and scheduling of his or her coursework, assisted with the selection of a major, and is counseled and advised individually on matters of career choice, activities at OSU and on other academic matters.

Each CEAT student, and his or her advisor, carefully selects general education, core engineering or architecture, and elective courses to meet the curriculum objectives and accreditation criteria. To assist students in planning and mapping their academic success, an electronic account is created for each student at the time of initial enrollment. Students have access to their personal account, via the STAR System, where they can review their advising materials, degree sheet, flowchart and other documents. The advisor assists the student with academic decisions and works to ensure accuracy and compliance; however, the ultimate responsibility for meeting degree requirements rests with the student.

## Academic Areas

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- Chemical Engineering (p. 2148)
- Civil and Environmental Engineering (p. 2166)
- Division of Engineering Technology (p. 2197)
  - Electrical Engineering Technology (p. 2224)
  - Mechanical Engineering Technology (p. 2300)
  - Construction Engineering Technology (p. 2189)
  - Fire and Emergency Management Program (p. 2237)
  - Fire Protection and Safety Engineering Technology (p. 2244)
- Electrical and Computer Engineering (p. 2202)
- Industrial Engineering and Management (p. 2252)
  - Engineering and Technology Management (p. 2232)
- Materials Science and Engineering (p. 2265)
- Mechanical and Aerospace Engineering (p. 2270)
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## Undergraduate Programs

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- Architectural Engineering: Construction Project Management, BEN (p. 2321)
- Architectural Engineering: Structures, BEN (p. 2323)
- Architecture, BAR (p. 2328)
- Biosystems Engineering: Bioprocessing & Food Processing, BSBE (p. 2463)
- Biosystems Engineering: Biosystems Engineering, BSBE (p. 2465)
- Biosystems Engineering: Environmental and Natural Resources, BSBE (p. 2467)
- Biosystems Engineering: Machine Systems & Agricultural Engineering, BSBE (p. 2469)

- Biosystems Engineering: Pre-Medical, BSBE (p. 2471)
- Chemical Engineering, BSCH (p. 2159)
- Chemical Engineering: Biomedical/Biochemical, BSCH (p. 2161)
- Chemical Engineering: Pre-Medical, BSCH (p. 2163)
- Civil Engineering, BSCV (p. 2185)
- Civil Engineering: Environmental, BSCV (p. 2187)
- Computer Engineering, BSCP (p. 2218)
- Computer Engineering: Software Engineering, BSCP (p. 2220)
- Construction Engineering Technology: Building, BSET (p. 2193)
- Construction Engineering Technology: Heavy, BSET (p. 2195)
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- Electrical Engineering Technology: Computer, BSET (p. 2230)
- Electrical Engineering, BSEE (p. 2222)
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- Mechanical Engineering, BSME (p. 2292)
- Mechanical Engineering: Fire Protection Systems, BSME (p. 2294)
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## Graduate Programs

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- Chemical Engineering, MS/PhD (p. 2157)
- Civil Engineering, MS/PhD (p. 2184)
- Electrical Engineering, MEN/MS/PhD (p. 2216)
- Engineering and Technology Management, Graduate Certificate/MS (p. 2232)
- Engineering Technology: Mechatronics & Robotics, MS (p. 3012)
- Fire and Emergency Management Administration, MS/PhD (p. 2241)
- Engineering Technology: (p. 3010)Fire Safety and Explosion Protection, MS (p. 2244)
- Industrial Engineering and Management, MS/PhD (p. 2260)
- Integrative Design of Building Envelope, Graduate Certificate (p. 2924)
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  - Unmanned Aerial Systems MS (p. 3080)
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- Supply Chain & Logistics, Graduate Certificate (p. 2942)

## Minors

### Undergraduate Minors

Contact the following individuals for additional information related to minors in their academic area.

**Professor Suzanne Bilbeisi**, [suzanne.bilbeisi@okstate.edu](mailto:suzanne.bilbeisi@okstate.edu), 101AK Donald W Reynolds Bldg, 405-744-9051

- Architectural Studies: Architecture and Entrepreneurship (ASAE), Minor (p. 2325)
- Architectural Studies: Design (ASDS), Minor (p. 2326)
- Architectural Studies: History and Theory (ASHT), Minor (p. 2327)

**Professor Heather Yates**, heather.yates@okstate.edu, Engineering North 517, 405-744-8710

- Construction (CNST), Minor (p. 2199)

**Professor Sunderesh Heragu**, sunderesh.heragu@okstate.edu, Engineering North 354, 405-744-6055

- Data Analytics for Engineers (DAEN), Minor (p. 2262)

**Professor Haley Murphy**, haley.c.murphy@okstate.edu, Engineering North 570B, 405-744-5638

- Emergency Management (EM), Minor (p. 2243)

**Professor Virginia Charter**, virginia.charter@okstate.edu, 545 Engineering North 405-744-5721

- Safety and Exposure Sciences (SAES), Minor (p. 2251)

**Professor Chulho Yang**, chulho.yang@okstate.edu (young.chang@okstate.edu), Engineering North Fifth Floor, 405-744-3033

- Mechatronic Engineering Technology for EET Students (EETM), Minor (p. 2200)

**Professor Avimanyu Sahoo**, avimanyu.sahoo@okstate.edu (young.chang@okstate.edu), Engineering North Fifth Floor, 405-744-8719

- Mechatronic Engineering Technology for MET Students (METM), Minor (p. 2201)

**Professor Randy Seitsinger**, randy.seitsinger@okstate.edu, 201 ATRC, 405-744-5140

- Nuclear Engineering (NENG), Minor (p. 2147)

**Professor Prem Bikkina**, prem.bikkina@okstate.edu (@okstate.edu), 420 Engineering North 405-744-5280

- Petroleum Engineering (PETE), Minor (p. 2165)

## Biosystems and Agricultural Engineering

The Department of Biosystems and Agricultural Engineering (BAE) is administered jointly by the Ferguson College of Agriculture and the College of Engineering, Architecture and Technology. Students interested in a degree in Biosystems Engineering can enroll through either college at which time they will be assigned an advisor in Biosystems Engineering. The degree is accredited by the Engineering Accreditation Commission of ABET (see [www.abet.org](http://www.abet.org) (<http://www.abet.org/>)) under criteria for biological engineering and similarly named programs.

Biosystems engineers are professionals who create and adapt engineering knowledge and technologies for the efficient and effective production, processing, storage, handling and distribution of food, feed, fiber and other biological products, while at the same time providing for a quality environment and preserving and protecting natural resources. Biosystems engineers directly address problems and opportunities related to food, water, energy and the environment—all of which are critical to the quality of life in our society. Subject-matter specialization is provided through the following five undergraduate option areas: general, bioprocessing and food processing, environment and natural resources, machine systems and pre-medical.

The Biosystems Engineering program is a comprehensive engineering program that includes math, physical and biological sciences, basic engineering sciences and specialty areas. The first two years focus on the underlying biological, physical, chemical and mathematical principles of engineering, supplemented by appropriate general education courses in English, social sciences and humanities. The next two years builds systematically upon the scientific knowledge acquired in the early courses and students have the opportunity to focus on the option areas listed above.

Biosystems engineering courses integrate engineering sciences, physical sciences, and biological sciences, and teach students to address real-world challenges. With the guidance of experienced faculty, students work both as individuals and in teams to design creative solutions to complex problems. The coursework is specifically sequenced and interrelated to provide design experience at each level, leading to progressively more complex, open-ended problems. The coursework incorporates the social and economic aspects of technical problems, and stresses the responsibilities of engineering professionals to behave ethically and promote occupational and public safety. The program culminates in senior year design courses in which students integrate the analysis, synthesis and other abilities they have developed throughout the earlier portions of their study into a capstone experience. At this point, students are able to design components, systems and processes that meet specific requirements, including such pertinent societal considerations as ethics, safety, environmental impact and aesthetics. The students have also developed and displayed the ability to conduct experiments essential to specific studies and to analyze the experimental results that lead to meaningful conclusions.

An integral part of this education continuum—from basic science through comprehensive engineering design—is learning experiences that facilitate the students' abilities to function effectively in both individual and team environments. Moreover, the program provides every graduate with adequate learning experiences to develop effective written and oral communication skills. State-of-the-art computational tools are introduced and used as a part of their problem-solving experiences. Finally, the students' experience in solving ever-more-challenging problems enables

them to continue to learn independently throughout their professional careers.

The Biosystems Engineering program verifies that our students possess core engineering knowledge and capability by requiring students to take the Fundamentals of Engineering exam, which is an important step toward becoming a professional engineer. All candidates for the BS degree in Biosystems Engineering must take the Fundamentals of Engineering exam prior to receiving their degree.

The overall objective of the undergraduate Biosystems Engineering degree program is to provide the comprehensive education necessary to prepare students for successful, productive and rewarding careers in engineering for agricultural, food and biological systems.

Within a few years of graduation, Biosystems Engineering program graduates will become top professionals, managers or leaders in a wide variety of industries and organizations involved with biosystems engineering, where they apply discovery, problem solving, and leadership skills for the benefit of their organization and the society at large.

A wide variety of employment opportunities are available for biosystems engineers in industry, public service and education. Some of these opportunities include positions in governmental agencies, consulting engineering firms, and agricultural and food equipment industries. Biosystems engineers are employed throughout the U.S. as well as internationally.

## Courses

### BAE 1012 Introduction to Biosystems Engineering

**Prerequisites:** Engineering major.

**Description:** Introduction to the Biosystems Engineering discipline; use of computers in solving engineering problems; and the application of computer software in engineering analysis and reporting.

**Credit hours:** 2

**Contact hours:** Lecture: 1 Lab: 2 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Biosystems & Ag Eng

### BAE 1022 Experimental Methods in Biosystems Engineering

**Prerequisites:** BAE 1012 or consent of instructor.

**Description:** An introduction to the basics of instrumentation, measurement techniques, and data analysis, with an emphasis on written communication skills. Lecture and laboratory exercises that address measurement principles, including accuracy, precision and error analysis.

**Credit hours:** 2

**Contact hours:** Lecture: 1 Lab: 2 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Biosystems & Ag Eng

**BAE 2013 Modeling in Biosystems Engineering****Prerequisites:** MATH 2144; BIOL 1114 or BOT 1404.**Description:** Introduction and modeling of various applications in biosystems and agricultural engineering. Case studies that emphasize the interface between engineering and biology in areas such as plant systems, industrial biological processes, sensor and control systems development, intelligent machine design, environmental remediation, water treatment systems and food processing. Use of a fourth generation programming language for solving engineering problems. Course previously offered as BAE 2012.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 3013 Heat and Mass Transfer in Biological Systems****Prerequisites:** ENSC 3233, MATH 2233.**Description:** Mechanisms of heat and mass transfer, with specific applications in transport processes of biological systems. Introduction to steady state and transient heat conduction and convection, radiation, diffusion, simultaneous heat and mass transfer.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 3023 Instruments and Controls****Prerequisites:** ENSC 2613, MATH 2233.**Description:** Design of control and instrumentation systems, including sensor and actuator principles, interface electronics, system identification, modeling, and performance specification. Applications in biological and agricultural systems. Design project required.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 3033 Advanced Biology and Material Science of Biomaterials****Prerequisites:** BAE 1022, BIOL 1114 or BOT 1404, PHYS 2014, MATH 2144.**Description:** Building on basic biology and engineering fundamentals to characterize properties of biological materials such as moisture content and water movement, rheology, electromagnetic response, thermal properties, conveyance requirements, psychometric interactions and heating/cooling response. Course previously offered as BAE 2022 and BAE 2023.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 3113 Biological Applications in Engineering****Prerequisites:** BAE 2012, BIOL 1114, ENSC 2213, 3233, MATH 2233 or concurrent enrollment.**Description:** Introduction to engineering applications of biological processes. Technologies covered include fermentation systems, enzyme kinetics, wastewater treatment and bioremediation.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 3213 Energy and Power in Biosystems Engineering****Prerequisites:** BAE 1022, completion or concurrent enrollment in ENSC 2213, ENSC 2613, ENSC 3233.**Description:** Analysis and design of energy generation, transmission, and utilization in the production and processing of biological materials.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 3223 Principles of Agriculture and Off-Road Machinery****Prerequisites:** Completion or concurrent enrollment in ENSC 3233, ENSC 2613 and SOIL 2124.**Description:** Principles of design, function, operation, testing and application of agricultural and off-road equipment and systems. Vehicle and implement system dynamics and hitching, and plant and soil interaction with machines. Machinery evaluation and standardized test procedures emphasizing safe and efficient performance of modern farm and off-road equipment.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 3313 Natural Resources Engineering****Prerequisites:** BAE 2023, STAT 2013, and ENSC 3233 or concurrent enrollment.**Description:** Principles and practices of engineering analysis and design applied to hydrology, water quality, erosion and sedimentation, air quality, irrigation and animal waste management. Course previously offered as BAE 3323.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 3 Contact: 5**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 4001 Professional Practice in Biosystems Engineering****Prerequisites:** Concurrent enrollment in BAE 4012.**Description:** Preparation for professional practice through case studies about ethics, legal liability, safety, and societal issues. Practical professional communications experience.**Credit hours:** 1**Contact hours:** Contact: 1 Other: 1**Levels:** Undergraduate**Schedule types:** Discussion**Department/School:** Biosystems & Ag Eng



**BAE 4010 Special Topics in Biosystems Engineering**

**Description:** New and emerging areas of study in Biosystems Engineering. Offered for variable credit, 1-4 credit hours, maximum of 8 credit hours.

**Credit hours:** 1-4

**Contact hours:** Lecture: 1-4 Contact: 1-4

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 4012 Senior Engineering Design Project I**

**Prerequisites:** Completion or concurrent enrollment in ENSC 2143, BAE 3013, BAE 3023, BAE 3213, BAE 4001.

**Description:** Team work on professional level design projects, using design procedures to develop specifications, propose alternative solutions, consider external constraints, develop drawings or plans, construct, test and evaluate designs.

**Credit hours:** 2

**Contact hours:** Lecture: 1 Lab: 2 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Biosystems & Ag Eng

**BAE 4023 Senior Engineering Design Project II**

**Prerequisites:** Completion or concurrent enrollment in BAE 4012, BAE 3013, BAE 3023.

**Description:** Second of two-semester sequence of senior design courses. Course previously offered as BAE 4022.

**Credit hours:** 3

**Contact hours:** Lecture: 1 Lab: 4 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Biosystems & Ag Eng

**BAE 4043 In-Vehicle Networking for Off-Road and Heavy Duty Systems**

**Prerequisites:** BAE 3023.

**Description:** Analysis of in-vehicle network systems and associated design issues. Introduction to CAN-based networking, serial and parallel communications, sensor interfacing, computer control of external devices, and comprehensive coverage of ISO 11783 and BAE J1939.

**Credit hours:** 3

**Contact hours:** Lecture: 1 Lab: 4 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Biosystems & Ag Eng

**BAE 4213 Precision Agriculture**

**Prerequisites:** MATH 1513, senior standing.

**Description:** Introduction to the concepts of precision agriculture including analysis of spatial variability, relationships of fertility and crop response, geographical information systems, variable rate technology, optical sensing, global positioning systems, and yield monitoring. Case studies included for detailed analyses. Same course as SOIL 4213. May not be used for Degree Credit with BAE 5223.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 4224 Machinery for Production and Processing**

**Prerequisites:** ENSC 2143.

**Description:** Analysis and design of machine components and machine systems for production and processing of biological materials. Component failure theory and analysis. Assembly and design of mechanical elements. Course previously offered as BAE 4223. May not be used for Degree Credit with BAE 5224.

**Credit hours:** 4

**Contact hours:** Lecture: 4 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 4283 Bioprocess Engineering**

**Prerequisites:** BAE 3013, BAE 3113 or consent of instructor, ENSC 3233.

**Description:** Application of fundamental engineering principles to biochemical and biological processes. Introduction to cellular processes, fermentation technology, biological mass transfer and kinetics, bioreactor design and scale-up and downstream processing. Same course as CHE 4283. May not be used for Degree Credit with BAE 5283.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 4314 Design Hydrology**

**Prerequisites:** BAE 2023 and ENSC 3233, and STAT 4033 or STAT 4073, or concurrent.

**Description:** Basic principles of surface and groundwater hydrology and their application in engineering problems. The hydrologic cycle, weather and hydrology, precipitation, evaporation, transpiration, subsurface waters, stream flow hydrographs, hydrologic and hydraulic stream routing, probability of hydrologic events and application of hydrologic models. Laboratory component will emphasize the application of hydrologic and hydraulic models and the quantification of hydrologic and hydraulic parameters. Course previously offered as BAE 4313. May not be used for degree credit with BAE 5314.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Biosystems & Ag Eng

**BAE 4324 Water Quality Engineering**

**Prerequisites:** BAE 4314 or CIVE 3843.

**Description:** Point and nonpoint source pollution processes, including transport mechanisms, and contaminant fate, control and remediation. Other topics include principles of ecological engineering, water body assessment and integrated watershed management. May not be used for Degree Credit with BAE 5374.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Biosystems & Ag Eng

**BAE 4400 Special Problems**

**Description:** Investigations in specialized areas of biosystems engineering. Offered for variable credit, 1-4 credit hours, maximum of 8 credit hours.

**Credit hours:** 1-4

**Contact hours:** Contact: 1-4 Other: 1-4

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Biosystems & Ag Eng

**BAE 4413 Food Engineering**

**Prerequisites:** BAE 3013 and ENSC 3233, ENSC 2213.

**Description:** Analysis and design of various unit operations in food processing including thermal processing, drying, evaporation, freezing, processing non-Newtonian fluids and quality changes during processing. Course previously offered as BAE 4423. May not be used for Degree Credit with BAE 5443.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 5000 Master's Research and Thesis**

**Prerequisites:** Consent of major professor.

**Description:** Research and thesis writing. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Biosystems & Ag Eng

**BAE 5010 Advanced Topics in Biosystems Engineering**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** New and emerging areas of study in Biosystems Engineering. Offered for variable credit, 1-4 credit hours, maximum of 8 credit hours.

**Credit hours:** 1-4

**Contact hours:** Lecture: 1-4 Contact: 1-4

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 5030 Problems in Biosystems Engineering and Agricultural Technology**

**Prerequisites:** Consent of instructor.

**Description:** Problems associated with biosystems engineering and agricultural technology. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Biosystems & Ag Eng

**BAE 5213 Renewable Energy Engineering**

**Prerequisites:** ENSC 2213, ENSC 3233 or consent of instructor.

**Description:** Renewable technologies such as solar, wind, geothermal, hydroelectric, and biomass to generate energy for electricity, heating, transportation, and other uses.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 5223 Precision Agriculture**

**Prerequisites:** MATH 1513.

**Description:** Introduction to the concepts of precision agriculture including analysis of spatial variability, relationships of fertility and crop response, geographical information systems, variable rate technology, optical sensing, global positioning systems, and yield monitoring. Case studies included for detailed analyses. May not be used for degree credit with BAE 4213.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 5224 Machinery for Production and Processing**

**Prerequisites:** ENSC 2143.

**Description:** Analysis and design of machine components and machine systems for production and processing of biological materials. Component failure theory and analysis. Assembly and design of mechanical elements. May not be used for degree credit with BAE 4224.

**Credit hours:** 4

**Contact hours:** Lecture: 4 Contact: 4

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 5243 Biological Conversion for Advanced Biofuels**

**Prerequisites:** ENSC 2213.

**Description:** Fundamental principles and applications of converting biomass to advanced biofuels. Focus will be on biological processes, fermentor design and operation, product recovery and emerging fuels.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 5283 Advanced Bioprocess Engineering**

**Prerequisites:** Consent of instructor.

**Description:** Application of fundamental engineering principles to biochemical and biological processes. Introduction to cellular processes, fermentation technology, biological mass transfer and kinetics, bioreactor design and scale-up and downstream processing. Same course as CHE 5283.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Biosystems & Ag Eng

**BAE 5313 Watershed Modeling****Prerequisites:** BAE 4313 or equivalent.**Description:** A computer modeling course with an emphasis on chemical and physical processes governing nonpoint source pollution (nitrogen, phosphorus, sediment) at the basin scale. The laboratory use of state-of-the-art models applied to a variety of agricultural systems. "Hands on" use of comprehensive hydrologic water quality models that utilize spatial data in a geographic information system. Models and parameter uncertainty, digital data sources, parameter estimation and model testing, calibration and validation. For students with advanced personal computer skills.**Credit hours:** 3**Contact hours:** Lecture: 1 Lab: 6 Contact: 7**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 5314 Design Hydrology****Prerequisites:** BAE 2023 and ENSC 3233, and STAT 4033 or STAT 4073, or concurrent.**Description:** Basic principles of surface and groundwater hydrology and their application in engineering problems. The hydrologic cycle, weather and hydrology, precipitation, evaporation, transpiration, subsurface waters, stream flow hydrographs, hydrologic and hydraulic stream routing, probability of hydrologic events and application of hydrologic models. Laboratory component will emphasize the application of hydrologic and hydraulic models and the quantification of hydrologic and hydraulic parameters. Course previously offered as BAE 4313. May not be used for degree credit with BAE 4314.**Credit hours:** 4**Contact hours:** Lecture: 3 Lab: 2 Contact: 5**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 5324 Modeling and Design in Storm Water and Sediment Control****Prerequisites:** BAE 4313 or equivalent.**Description:** Analysis and design of storm water, sediment and water quality systems with a focus on application to urban areas and developments in the urban-rural fringe. Advanced concepts in hydrologic modeling with kinematics, diffusion and dynamic modeling of flow; soil erosion, sediment transport and sediment control; storm water quality modeling and the impact of best management practices. In laboratories, use of hydrologic, sediment, and water quality models in analysis and design for real-world problems.**Credit hours:** 4**Contact hours:** Lecture: 3 Lab: 3 Contact: 6**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 5333 Applied Water Resources Statistics****Prerequisites:** STAT 5013 or equivalent.**Description:** Applied statistical methods for hydrologists, engineers, and environmental scientists for analysis of environmental data. Parametric and nonparametric methods and exploratory data analysis applied to observed environmental data sets. Laboratory exercises emphasize hands-on application of statistical problems to reinforce concepts.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 3 Contact: 5**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 5343 Environmental Contaminant Transport****Prerequisites:** BAE 4313.**Description:** Conceptual and mathematical models for the transport of contaminants in natural systems with an emphasis on agricultural pollutants. Basic transport processes relevant to the three environmental media - air, water, and soil. Common features underlying pollutant transport.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 5353 Environmental and Ecological Risk Assessment****Prerequisites:** Graduate standing.**Description:** Process and methodologies associated with human, environmental and ecological risks. Will quantify uncertainty in human perturbation, management, and restoration of environmental and ecological processes. Course available online only through AG\*IDEA consortium.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 5374 Water Quality Engineering****Prerequisites:** BAE 4314 or CIVE 3843.**Description:** Point and nonpoint source pollution processes, including transport mechanisms, and contaminant fate, control and remediation. Other topics include principles of ecological engineering, water body assessment and integrated watershed management. May not be used for degree credit with BAE 4324.**Credit hours:** 4**Contact hours:** Lecture: 3 Lab: 3 Contact: 6**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 5413 Advanced Instrumentation and Control Systems for Biological Applications****Prerequisites:** BAE 3023 or equivalent.**Description:** Principles and operation of commercial instruments and data acquisition systems used in biological, environmental, and agricultural applications. Hands-on projects that will improve system design, development and programming skills. Introduction of advanced topics including machine vision, spectroscopy, and data communication networks.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng

**BAE 5423 Food Rheology****Prerequisites:** ENSC 3233.**Description:** Characterization and analysis of the rheological properties of food products. Focus on measurement techniques and equipment, including tube and rotational type instruments, with specific applications in food processing.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Biosystems & Ag Eng**BAE 5433 Biosensors****Prerequisites:** PHYS 2114 and CHEM 3053 or equivalent.**Description:** Principles and applications of biosensors in food analysis, disease diagnostics, and environmental monitoring. Emphasis on conceptual design and characterization of biosensors. Introduction to recent advances in biodetection using nanotechnology.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 5443 Food Engineering****Prerequisites:** BAE 3013 and ENSC 3233, ENSC 2213.**Description:** Analysis and design of various unit operations in food processing including thermal processing, drying, evaporation, freezing, processing non-Newtonian fluids and quality changes during processing. May not be used for degree credit with BAE 4413.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 5501 Seminar****Description:** Discussion of current literature with special emphasis on research and experimental techniques.**Credit hours:** 1**Contact hours:** Contact: 1 Other: 1**Levels:** Graduate**Schedule types:** Discussion**Department/School:** Biosystems & Ag Eng**BAE 6000 Doctoral Research and Dissertation****Prerequisites:** Approval by the student's advisory committee.**Description:** Research and doctoral dissertation preparation. Offered for variable credit, 1-10 credit hours, maximum of 42 credit hours.**Credit hours:** 1-10**Contact hours:** Contact: 1-10 Other: 1-10**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Biosystems & Ag Eng**BAE 6101 Teaching Practicum in Biosystems Engineering****Prerequisites:** One semester of doctoral study in Biosystems Engineering, or consent of instructor.**Description:** Philosophies and techniques of resident and non-resident teaching, including experiences in preparation, presentation, and evaluation of lectures, laboratories, extension or continuing education programs. Course previously offered as BAE 6100.**Credit hours:** 1**Contact hours:** Contact: 1 Other: 1**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Biosystems & Ag Eng**BAE 6213 Advanced Biomass Thermochemical Conversion****Prerequisites:** ENSC 2213.**Description:** Advanced study, evaluation, and application of thermochemical conversion pathways in biofuel production. Specific topics include biomass gasification, pyrolysis, liquefaction, and heterogeneous catalysis. Course available online only through AG\*IDEA consortium. Course previously offered as BAE 6100.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 6313 Stochastic Methods in Hydrology****Prerequisites:** CIVE 5843, STAT 4033.**Description:** Stochastic and statistical hydrologic analyses of surface water and groundwater systems. Analysis of urban and rural drainage and detention systems. Same course as CIVE 6843.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 6333 Fluvial Hydraulics****Prerequisites:** BAE 3013 or equivalent.**Description:** Principles of sediment detachment and transport in fluvial systems. Design of stable channels and flow resistance relationships for sediment-laden flows.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 6343 Ground Water Contaminant Transport****Prerequisites:** SOIL 5583 or CIVE 5913 or GEOL 5453.**Description:** Principles of solute and multiphase transport in soils and ground water. Effects of advection, diffusion, dispersion, degradation, volatilization and adsorption. Relationships between laboratory and field scale transport. Contamination by nonaqueous phase liquids.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng

**BAE 6503 Similitude in Research****Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Biosystems & Ag Eng**BAE 6520 Problems in Soil and Water Engineering****Prerequisites:** Consent of instructor.**Description:** Consent of instructor. Problems associated with erosion control, drainage, flood protection and irrigation. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 2-6**Contact hours:** Contact: 2-6 Other: 2-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Biosystems & Ag Eng**BAE 6540 Prob Farm Power & Mach****Prerequisites:** Consent of instructor.**Description:** Literature review and analytical studies of selected farm power and machinery problems. Written report required. Offered for variable credit, 2-6 credit hours, maximum of 6 credit hours.**Credit hours:** 2-6**Contact hours:** Contact: 2-6 Other: 2-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Biosystems & Ag Eng**BAE 6580 Problems in Transport Processes****Prerequisites:** Consent of instructor.**Description:** Literature review and analysis of heat and mass transport and interval diffusion in biological materials. Transport phenomena at interfaces, thermal and cryogenic processing, drying, packed and fluidized bed systems. Thermal and moisture control processing affecting quality of food products. Written report required. Offered for variable credit, 2-6 credit hours, maximum of 6 credit hours.**Credit hours:** 2-6**Contact hours:** Contact: 2-6 Other: 2-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Biosystems & Ag Eng**BAE 6610 Adv Research & Study****Prerequisites:** Approval by the student's advisory committee.**Description:** Research and study at the doctoral level on the topic related to the student's doctoral program and field of interest. Offered for variable credit, 1-10 credit hours, maximum of 20 credit hours.**Credit hours:** 1-10**Contact hours:** Contact: 1-10 Other: 1-10**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Biosystems & Ag Eng

## Undergraduate Programs

No results found.

## Graduate Programs

### BAE Graduate Programs

The Department of Biosystems and Agricultural Engineering (BAE) offers programs leading to the Master of Science and Doctor of Philosophy

degrees in Biosystems Engineering. These degrees emphasize research and development.

BAE provides excellent laboratory and computer facilities for students to explore research and design in such areas as bioprocessing and food engineering, machine vision, sensor and control technology, waste management and utilization, hydrology, water quality, porous media flow, and intelligent systems for agricultural machine design and production.

Graduate students design experiments and special equipment to conduct their work. They are expected to demonstrate, by supporting research or by design, the ability to identify a problem, define alternatives, propose a solution, organize a design or an experimental investigation, manage the project to completion, analyze and interpret data, and report the results through peer-reviewed papers and professional presentations.

Research projects are supported by the Oklahoma Agricultural Experiment Station and by state, federal and private grants and contracts. Well-trained faculty members, many of whom are registered professional engineers with research, consulting and design experience, guide the graduate students' activities and plan programs to meet students' needs.

### Graduate Admission Requirements

Admission to either the Master of Science (MS) or Doctor of Philosophy (PhD) degree program requires graduation from an engineering curriculum accredited by the ABET Engineering Accreditation Commission, <http://www.abet.org> (<http://www.abet.org/>). Students without accredited degrees may be admitted provisionally and may be required to take additional courses. A student must be accepted by an advisor in the department prior to official admission to the graduate program. Admission is competitive based on GPA(s) from previous degree(s), TOEFL/IELTS (for international students), statement of interests, experience, and recommendations. The GRE is not required, but often considered for graduate assistantship.

### Degree Requirements

Each graduate student follows an approved plan of study and is supervised by his/her advisory committee. The Plan of Study is designed to satisfy the individual goals of the student, while conforming to the general requirements of the BAE Department and the Graduate College. All BAE graduate students are required to enroll in one credit hour of BAE Graduate Seminar (BAE 5501).

### Master of Science Degree – Thesis Option

The Master of Science degree program with the thesis option requires a minimum of 24 credit hours of approved graduate-level coursework and six hours of research work. A written thesis and an oral thesis defense are required.

### Master of Science Degree – Non-Thesis Option

The Master of Science degree program with a non-thesis option requires a minimum of 32 credit hours of approved graduate-level coursework, six of which are creative components, e.g. approved internship and technical projects.

### PhD Degree

The Doctor of Philosophy degree requires a minimum of 60 credit hours beyond the master's degree, or 90 credit hours beyond a bachelor degree, including 30 research dissertation hours. A one-credit-hour Teaching Practicum (BAE6101) is required for all PhD students, in addition to Graduate College requirements.

## Faculty

Mari S. Chinn, PhD—Professor and Department Head

**Professor/Orville L. and Helen Buchanan Endowed Chair:** Danielle Bellmer, PhD

**Professor/Sarkey's Professor/Assistant Director and State Program Leader, Agricultural Natural Resources, Oklahoma Cooperative Extension**

**Service:** Randal K. Taylor, PhD, PE

**Director, Capital Projects for CASNR/Assistant Director, Oklahoma**

**Agricultural Experiment Station:** Randy L. Raper, PhD, PE

**Professors:** Hasan Atiyeh, PhD, PE; Danielle D. Bellmer, PhD; Timothy J. Bowser, PhD, PE; Nurhan Dunford, PhD, PE; Ajay Kumar, PhD, PE; Ning Wang, PhD, PE; Paul Weckler, PhD, PE

**Associate Professors:** Robert Scott Frazier, PhD, PE; Douglas W. Hamilton, PhD, PE; John Long, PhD, PE; Yu Mao, PhD; Saleh Taghvaeian, PhD

**Assistant Professors:** Ali Mirchi, PhD

**Research Associate Professor:** J.D. Carlson, PhD

**Assistant Extension Specialist:** Wesley Lee, MS

**Teaching Assistant Professor:** Sara Alian, PhD

**Adjunct Associate Professor:** Derek Whitelock, PhD

**Adjunct Assistant Professor:** Sherry L. Hunt, PhD

# Biosystems Engineering: Bioprocessing & Food Processing, BSBE

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (<http://catalog.okstate.edu/archive/2021-2022/university-academic-regulations/#matriculation>).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 124**

Code	Title	Hours
<b>General Education Requirements</b>		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 926)		
ENGL 1113 or ENGL 1313	Composition I Critical Analysis and Writing I	3
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
MATH 2163	Calculus III	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN)	4
BIOL 1114	Introductory Biology (LN)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Course designated (S)		3
<i>Additional General Education</i>		
Courses designated (A), (H), (N), or (S)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2014	University Physics I (LN)	4
PHYS 2114	University Physics II (LN)	4
<i>Mathematics</i>		
MATH 2233	Differential Equations	3

<i>Engineering &amp; Engineering Science</i>		
ENGR 1322 or ENGR 1332	Engineering Design with CAD Engineering Design with CAD for MAE	2
ENSC 2113	Statics	3
ENSC 2143	Strength of Materials	3
ENSC 2213	Thermodynamics	3
ENSC 2613	Introduction to Electrical Science	3
ENSC 3233	Fluid Mechanics	3
<i>Biosystems Engineering</i>		
BAE 1012	Introduction to Biosystems Engineering	2
BAE 1022	Experimental Methods in Biosystems Engineering	2
BAE 2013	Modeling in Biosystems Engineering	3
BAE 3033	Advanced Biology and Material Science of Biomaterials	3
<b>Hours Subtotal</b>		<b>38</b>
<b>Major Requirements</b>		
<i>Common Professional School</i>		
STAT 4033 or STAT 4073	Engineering Statistics Engineering Statistics with Design of Experiments	3
IEM 3503	Engineering Economic Analysis	3
BAE 3013	Heat and Mass Transfer in Biological Systems	3
BAE 3023	Instruments and Controls	3
BAE 3213	Energy and Power in Biosystems Engineering	3
BAE 4001	Professional Practice in Biosystems Engineering	1
BAE 4012	Senior Engineering Design Project I	2
BAE 4023	Senior Engineering Design Project II	3
<i>Specific Professional School</i>		
BAE 4283	Bioprocess Engineering	3
BAE 4413	Food Engineering	3
MICR 2123	Introduction to Microbiology	3
MICR 2132	Introduction to Microbiology Laboratory	2
BIOC 2344	Chemistry and Applications of Biomolecules	4
<b>Hours Subtotal</b>		<b>36</b>
<b>Electives</b>		
Select 8 hours of engineering and/or science electives to be selected from an approved list upon consultation with an advisor		8
<b>Hours Subtotal</b>		<b>8</b>
<b>Total Hours</b>		<b>124</b>

## Other Requirements

- A minimum 2.0 Technical GPA. The Technical GPA is calculated from all BAE prefixes or substitutions to BAE courses.
- A grade of "C" or better is required in following courses: BAE 2013, BAE 3013, BAE 3023, BAE 3033, BAE 3213, ENSC 2113, ENSC 2143, ENSC 2213, ENSC 2613, ENSC 3233.
- Students are required to complete the Fundamentals of Engineering (FE) exam prior to graduation.

- A minimum of 40 semester credit hours and 100 grade points must be earned in courses numbered 3000 or above.
- A 2.00 GPA or higher in upper-division hours.

## **Additional State/OSU Requirements**

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.



# Biosystems Engineering: Biosystems Engineering, BSBE

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (<http://catalog.okstate.edu/archive/2021-2022/university-academic-regulations/#matriculation>).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 121**

Code	Title	Hours
<b>General Education Requirements</b>		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 926)		
ENGL 1113	Composition I	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
MATH 2163	Calculus III	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN)	4
BIOL 1114	Introductory Biology (LN)	4
or PBIOL 1404	Plant Biology (LN)	
<i>Social &amp; Behavioral Sciences (S)</i>		
Any course designated (S)		3
<i>Additional General Education</i>		
Courses designated (A), (H), (N), or (S)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2014	University Physics I (LN)	4
PHYS 2114	University Physics II (LN)	4
<i>Mathematics</i>		
MATH 2233	Differential Equations	3

<i>Engineering &amp; Engineering Science</i>		
ENGR 1332	Engineering Design with CAD for MAE	2
ENSC 2113	Statics	3
ENSC 2143	Strength of Materials	3
ENSC 2213	Thermodynamics	3
ENSC 2613	Introduction to Electrical Science	3
ENSC 3233	Fluid Mechanics	3
<i>Biosystems Engineering</i>		
BAE 1012	Introduction to Biosystems Engineering	2
BAE 1022	Experimental Methods in Biosystems Engineering	2
BAE 2013	Modeling in Biosystems Engineering	3
BAE 3033	Advanced Biology and Material Science of Biomaterials	3
<b>Hours Subtotal</b>		<b>38</b>
<b>Major Requirements</b>		
<i>Common Professional School</i>		
STAT 4033	Engineering Statistics	3
or STAT 4073	Engineering Statistics with Design of Experiments	
IEM 3503	Engineering Economic Analysis	3
BAE 3013	Heat and Mass Transfer in Biological Systems	3
BAE 3023	Instruments and Controls	3
BAE 3213	Energy and Power in Biosystems Engineering	3
BAE 4001	Professional Practice in Biosystems Engineering	1
BAE 4012	Senior Engineering Design Project I	2
BAE 4023	Senior Engineering Design Project II	3
<i>Specific Professional School</i>		
BAE 3223	Principles of Agriculture and Off-Road Machinery	3
BAE 4224	Machinery for Production and Processing	4
ENSC 2123	Elementary Dynamics	3
BAE 4314	Design Hydrology	4
BAE 4283	Bioprocess Engineering	3
BAE 4413	Food Engineering	3
<b>Hours Subtotal</b>		<b>41</b>
<b>Total Hours</b>		<b>121</b>

## Other Requirements

- A minimum 2.0 Technical GPA. The Technical GPA is calculated from all BAE prefixes or substitutions to BAE courses.
- A grade of "C" or better is required in following courses: BAE 2013, BAE 3013, BAE 3023, BAE 3033, BAE 3213, ENSC 2113, ENSC 2143, ENSC 2213, ENSC 2613, ENSC 3233.
- Students are required to complete the Fundamentals of Engineering (FE) exam prior to graduation.
- A minimum of 40 semester credit hours and 100 grade points must be earned in courses numbered 3000 or above.
- A 2.00 GPA or higher in upper-division hours.

## **Additional State/OSU Requirements**

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

# Biosystems Engineering: Environmental and Natural Resources, BSBE

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (<http://catalog.okstate.edu/archive/2021-2022/university-academic-regulations/#matriculation>).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 123**

Code	Title	Hours
<b>General Education Requirements</b>		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 926)		
ENGL 1113	Composition I	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
MATH 2163	Calculus III	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN)	4
BIOL 1114	Introductory Biology (LN)	4
or P BIO 1404	Plant Biology (LN)	
<i>Social &amp; Behavioral Sciences (S)</i>		
Any course designated (S)		3
<i>Additional General Education</i>		
Courses designated (A), (H), (N), or (S)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2014	University Physics I (LN)	4
PHYS 2114	University Physics II (LN)	4
<i>Mathematics</i>		

MATH 2233	Differential Equations	3
<i>Engineering &amp; Engineering Science</i>		
ENGR 1322	Engineering Design with CAD	2
or ENGR 1332	Engineering Design with CAD for MAE	
ENSC 2113	Statics	3
ENSC 2143	Strength of Materials	3
ENSC 2213	Thermodynamics	3
ENSC 2613	Introduction to Electrical Science	3
ENSC 3233	Fluid Mechanics	3
<i>Biosystems Engineering</i>		
BAE 1012	Introduction to Biosystems Engineering	2
BAE 1022	Experimental Methods in Biosystems Engineering	2
BAE 2013	Modeling in Biosystems Engineering	3
BAE 3033	Advanced Biology and Material Science of Biomaterials	3
<b>Hours Subtotal</b>		<b>38</b>
<b>Major Requirements</b>		
<i>Common Professional School</i>		
STAT 4033	Engineering Statistics	3
or STAT 4073	Engineering Statistics with Design of Experiments	
IEM 3503	Engineering Economic Analysis	3
BAE 3013	Heat and Mass Transfer in Biological Systems	3
BAE 3023	Instruments and Controls	3
BAE 3213	Energy and Power in Biosystems Engineering	3
BAE 4001	Professional Practice in Biosystems Engineering	1
BAE 4012	Senior Engineering Design Project I	2
BAE 4023	Senior Engineering Design Project II	3
<i>Specific Professional School</i>		
BAE 4314	Design Hydrology	4
BAE 4324	Water Quality Engineering	4
CIVE 3833	Applied Hydraulics	3
GEOL 1114	Physical Geology (LN)	4
NREM 3013	Applied Ecology and Conservation	3
SOIL 2124	Fundamentals of Soil Science (N)	4
or CIVE 3714	Introduction to Geotechnical Engineering	
<b>Hours Subtotal</b>		<b>43</b>
<b>Total Hours</b>		<b>123</b>

## Other Requirements

- A minimum 2.0 Technical GPA. The Technical GPA is calculated from all BAE prefixes or substitutions to BAE courses.
- A grade of "C" or better is required in following courses: BAE 2013, BAE 3013, BAE 3023, BAE 3033, BAE 3213, ENSC 2113, ENSC 2143, ENSC 2213, ENSC 2613, ENSC 3233.
- Students are required to complete the Fundamentals of Engineering (FE) exam prior to graduation.
- A minimum of 40 semester credit hours and 100 grade points must be earned in courses numbered 3000 or above.
- A 2.00 GPA or higher in upper-division hours.

## **Additional State/OSU Requirements**

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

# Biosystems Engineering: Machine Systems & Agricultural Engineering, BSBE

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (<http://catalog.okstate.edu/archive/2021-2022/university-academic-regulations/#matriculation>).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 124**

Code	Title	Hours
<b>General Education Requirements</b>		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 926)		
ENGL 1113	Composition I	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
MATH 2163	Calculus III	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN)	4
BIOL 1114	Introductory Biology (LN)	4
or P BIO 1404	Plant Biology (LN)	
<i>Social &amp; Behavioral Sciences (S)</i>		
Any course designated (S)		3
<i>Additional General Education</i>		
Courses designated (A), (H), (N), or (S)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2014	University Physics I (LN)	4
PHYS 2114	University Physics II (LN)	4
<i>Mathematics</i>		

MATH 2233	Differential Equations	3
<i>Engineering &amp; Engineering Science</i>		
ENGR 1332	Engineering Design with CAD for MAE	2
ENSC 2113	Statics	3
ENSC 2143	Strength of Materials	3
ENSC 2213	Thermodynamics	3
ENSC 2613	Introduction to Electrical Science	3
ENSC 3233	Fluid Mechanics	3
<i>Biosystems Engineering</i>		
BAE 1012	Introduction to Biosystems Engineering	2
BAE 1022	Experimental Methods in Biosystems Engineering	2
BAE 2013	Modeling in Biosystems Engineering	3
BAE 3033	Advanced Biology and Material Science of Biomaterials	3
<b>Hours Subtotal</b>		<b>38</b>
<b>Major Requirements</b>		
<i>Common Professional School</i>		
STAT 4033	Engineering Statistics	3
or STAT 4073	Engineering Statistics with Design of Experiments	
IEM 3503	Engineering Economic Analysis	3
BAE 3013	Heat and Mass Transfer in Biological Systems	3
BAE 3023	Instruments and Controls	3
BAE 3213	Energy and Power in Biosystems Engineering	3
BAE 4001	Professional Practice in Biosystems Engineering	1
BAE 4012	Senior Engineering Design Project I	2
BAE 4023	Senior Engineering Design Project II	3
<i>Specific Professional School</i>		
BAE 3223	Principles of Agriculture and Off-Road Machinery	3
BAE 4224	Machinery for Production and Processing	4
ENSC 2123	Elementary Dynamics	3
ENSC 3313	Materials Science	3
SOIL 2124	Fundamentals of Soil Science (N)	4
<b>Hours Subtotal</b>		<b>38</b>
<b>Electives</b>		
Select 6 hours of engineering and/or science electives to be selected from an approved list upon consultation with an advisor		6
<b>Hours Subtotal</b>		<b>6</b>
<b>Total Hours</b>		<b>124</b>

## Other Requirements

- A minimum 2.0 Technical GPA. The Technical GPA is calculated from all BAE prefixes or substitutions to BAE courses.
- A grade of "C" or better is required in the following courses: BAE 2013, BAE 3013, BAE 3023, BAE 3033, BAE 3213, ENSC 2113, ENSC 2143, ENSC 2213, ENSC 2613, ENSC 3233.
- Students are required to complete the Fundamentals of Engineering (FE) exam prior to graduation.

- A minimum of 40 semester credit hours and 100 grade points must be earned in courses numbered 3000 or above.
- A 2.00 GPA or higher in upper-division hours.

## **Additional State/OSU Requirements**

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Biosystems Engineering: Pre-Medical, BSBE

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (<http://catalog.okstate.edu/archive/2021-2022/university-academic-regulations/#matriculation>).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 125**

Code	Title	Hours
<b>General Education Requirements</b>		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 926)		
ENGL 1113	Composition I	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
MATH 2163	Calculus III	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1515	Chemistry II (LN)	5
BIOL 1114	Introductory Biology (LN)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Any course designated (S)		3
<i>Additional General Education</i>		
Courses designated (A), (H), (N), or (S)		3
<b>Hours Subtotal</b>		<b>43</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2014	University Physics I (LN)	4
PHYS 2114	University Physics II (LN)	4
<i>Mathematics</i>		
MATH 2233	Differential Equations	3
<i>Engineering &amp; Engineering Science</i>		

ENGR 1322	Engineering Design with CAD	2
or ENGR 1332	Engineering Design with CAD for MAE	
ENSC 2113	Statics	3
ENSC 2143	Strength of Materials	3
ENSC 2213	Thermodynamics	3
ENSC 2613	Introduction to Electrical Science	3
ENSC 3233	Fluid Mechanics	3
<i>Biosystems Engineering</i>		
BAE 1012	Introduction to Biosystems Engineering	2
BAE 1022	Experimental Methods in Biosystems Engineering	2
BAE 2013	Modeling in Biosystems Engineering	3
BAE 3033	Advanced Biology and Material Science of Biomaterials	3
<b>Hours Subtotal</b>		<b>38</b>

### Major Requirements

#### *Common Professional School*

STAT 4033	Engineering Statistics	3
or STAT 4073	Engineering Statistics with Design of Experiments	
IEM 3503	Engineering Economic Analysis	3
BAE 3013	Heat and Mass Transfer in Biological Systems	3
BAE 3023	Instruments and Controls	3
BAE 3213	Energy and Power in Biosystems Engineering	3
BAE 4001	Professional Practice in Biosystems Engineering	1
BAE 4012	Senior Engineering Design Project I	2
BAE 4023	Senior Engineering Design Project II	3

#### *Specific Professional School*

Select BAE 4000 level (Any Upper Level BAE Classes, at least 5 hours total)		5
CHEM 3053	Organic Chemistry I	3
CHEM 3153	Organic Chemistry II	3
CHEM 3112	Organic Chemistry Laboratory	2
MICR 2123	Introduction to Microbiology	3
BIOL 1604	Animal Biology	4
BIOC 3653	Survey of Biochemistry	3
or MICR 3033	Cell and Molecular Biology	

**Hours Subtotal** **44**

**Total Hours** **125**

## Other Requirements

- A minimum 2.0 Technical GPA. The Technical GPA is calculated from all BAE prefixes or substitutions to BAE courses.
- A grade of "C" or better is required in following courses: BAE 2013, BAE 3013, BAE 3023, BAE 3033, BAE 3213, ENSC 2113, ENSC 2143, ENSC 2213, ENSC 2613, ENSC 3233.
- Students are required to complete the Fundamentals of Engineering (FE) exam prior to graduation.
- A minimum of 40 semester credit hours and 100 grade points must be earned in courses numbered 3000 or above.
- A 2.00 GPA or higher in upper-division hours.

## **Additional State/OSU Requirements**

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.



## CEAT Dean's Office and CEAT Online Learning

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### CEAT Online Learning

The CEAT Online Learning office provides administrative and technological support along with specialized recording classrooms and a studio to enable CEAT faculty to offer high quality online courses.

To learn more about CEAT Online Learning and see their contact information, please visit the CEAT Online Learning website (<https://ceatonline.okstate.edu>).

Courses are open to non-degree seeking students who meet the course prerequisites.

### Nuclear Engineering Minor

Oklahoma State University is part of the University Engineering Alliance (UEA). The UEA is a partnership of eight universities that offers online graduate and undergraduate coursework in nuclear engineering.

To learn more about the UEA, please visit their website (<http://www.universityengineeringalliance.org>).

To declare the OSU Nuclear Engineering minor or enroll in UEA nuclear engineering classes, contact the CEAT Online Learning office.

### Minors

- Nuclear Engineering (NENG), Minor (p. 2147)

## Nuclear Engineering (NENG), Minor

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Randy Seitsinger**, randy.seitsinger@okstate.edu, 201 ARTC, 405-744-5140

**Minimum Overall Grade Point Average:** 2.50 with a grade of "C" or better in each course submitted for the minor

**Total Hours:** 15 (not including math and science prerequisites)

Code	Title	Hours
<b>Minor Requirements</b>		
PHYS 4663	Radioactivity and Nuclear Physics	3
or ENGR 4213	Elements of Nuclear Engineering	
Select 12 hours from below:		12
(Other courses approved by college)		
PHYS 4010	Special Problems <sup>1</sup>	
PHYS 4663	Radioactivity and Nuclear Physics	
MAE 4263	Energy Conversion Systems	
ENGR 4213	Elements of Nuclear Engineering	
ENGR 4233	Energy Systems and Resources	
ENGR 4283	Science and Technology of Terrorism and Counterterrorism	
ENGR 4293	Nonproliferation: Issues for Weapons of Mass Destruction	
ENGR 4300	Nuclear Engineering Special Topics	
<b>Total Hours</b>		<b>15</b>

<sup>1</sup> PHYS 4010 must be Introduction to Health Physics, Nuclear Reactor Theory, or other approved PHYS 4010

## Additional OSU Requirements

### Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).

## Chemical Engineering

Chemical engineers use knowledge of how nature works (science) and the language of science (mathematics) to create value and solve difficult problems for the benefit of society. The key skill that differentiates chemical engineering from other disciplines is the ability to understand, design and operate transformation (physical or chemical) processes. Chemical engineers literally change (transform) the world. Many in the public assume chemical engineers work only in chemical plants and petroleum refineries. The reality is that chemical engineers work in a broad range of industries including pharmaceuticals, biochemicals, semiconductor materials, foods, plastics, paper, steel, consumer goods, automotive, specialty materials, oil & gas production, renewable energy, engineering services, and the list goes on. Key to providing a benefit to society, chemical engineers are responsible for resource conservation, minimizing pollution, minimizing costs, and maximizing quality and safety of processes that make the products.

The emphasis on the molecular or chemical nature of everything people use is what makes chemical engineers different from other engineers. The emphasis on the processes that make the products is what makes chemical engineers different from chemists.

Chemical engineers often find themselves defining a problem or product, developing a process to do what is needed, and then designing the equipment to carry out the process. After the installation, chemical engineers commonly manage operations, oversee equipment maintenance and supervise control of product quality. They troubleshoot problems that hinder smooth operations, and they plan for future expansions or improvements. Their training and knowledge make them well qualified to market products and processing equipment. The varied background and experience of chemical engineers make them ideally suited for advancement into top-level managerial and executive positions. An advanced degree in chemical engineering is not required.

Many who aspire to careers in medicine or law first obtain BS degrees in chemical engineering. The rigor of the program and the emphasis on critical thinking and analytical reasoning are highly valued by professional school admission committees. A career as a research scientist or academic typically requires a PhD degree.

### Vision

1. Sustain a nationally competitive undergraduate program recognized for quality, fundamental-practice balance, and educational leadership.
2. Attain widespread recognition for contributions to professional knowledge and tools, which are useful, widely accepted, and practiced by others.
3. Sustain and create infrastructures that facilitate synergism, creativity, personal and professional growth, and productivity by students and professional personnel both within OSU and the outside world.

### Mission

The mission of the School of Chemical Engineering at Oklahoma State University is to develop human resources, professional knowledge, and the infrastructure through which chemical engineering can contribute to human welfare. We expect to maintain national recognition for our contributions. This mission statement can be found in the <https://che.okstate.edu/content/mission.html>

## Program Educational Objectives

The goal of the BS degree program is to produce graduates who possess broad-based knowledge, skills and judgment that prepares them to succeed in the profession of engineering or in further studies at the graduate level, including medical school. To achieve this goal, the program is designed to progressively develop both technical and human skills. The School has three broad objectives. Within the first few years after graduation, our BS graduates will have demonstrated:

Competencies – skill in tools and techniques that are fundamental to the job and the ability and drive to be life-long learners.

Professionalism – applying technical skills in combination with business acumen, teamwork, and communication skills to advance the mission of the enterprise with ethics and integrity.

Balance – a holistic, integrated understanding of self and society to empower self-direction, wise life choices, and deployment of skills in a global context.

## Student Learning Outcomes

Graduating students possess an understanding of fundamental chemical engineering concepts, methodologies and technologies as demonstrated by:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The curriculum consists of three primary parts:

1. general education,
2. core engineering, and
3. professional school topics.

In the first two years of study of in the chemical engineering program, the focus is on the underlying scientific and mathematical principles of engineering, supplemented by appropriate general education courses in English, social sciences, history and humanities. Students who demonstrate proficiency in this portion of the program enter the professional school.

The curriculum in the professional school (typically the last two years) of study builds systematically upon the scientific knowledge acquired in the pre-professional, primary curriculum. The students have the opportunity to focus in one of three options:

1. the regular course prepares a graduate for a wide range of employment opportunities;
2. the pre-medical option is for those who wish preparation for medical school; and
3. the biomedical/biochemical option is for those who seek employment in bio-related professions.

Each option prepares a student for success in both employment and graduate study at OSU or other universities. A detailed description of degree requirements for the bachelor's-level curricula is given in the publication Undergraduate Programs and Requirements.

Each option builds upon the preceding chemical engineering courses to develop the ability to identify and solve meaningful engineering problems. The coursework is specifically sequenced and interrelated to provide design experience at each level, leading to progressively more complex, open-ended problems. The coursework includes sensitizing students to socially-related technical problems and their responsibilities as engineering professionals to behave ethically and protect occupational and public safety. The program culminates in the senior-year design courses in which the students integrate the analysis, synthesis and other abilities they have developed throughout the earlier portions of their study into a capstone experience. At this point, students will be able to design components, systems and processes that meet specific requirements, including such pertinent societal considerations as ethics, safety, environmental impact and aesthetics. The students will have developed and displayed the ability to design and conduct experiments essential to specific studies, and to analyze the experimental results and draw meaningful conclusions within an enterprise context.

Integral parts of this educational continuum from basic science through comprehensive engineering design are learning experiences that facilitate the students' abilities to function effectively in both individual and collaborative environments. To achieve this, the program provides every student with adequate learning experiences to develop effective written and oral communication skills. State-of-the-art computational tools are introduced and utilized as a part of their problem-solving experiences. Finally, the students' experience in solving ever-more-challenging problems gives them the ability to continue to learn independently throughout their professional careers.

Students are offered opportunities to enhance their classroom and laboratory experiences through student organizations such as the student chapter of American Institute of Chemical Engineers. Outstanding scholars are recognized by Omega Chi Epsilon, the national honor society for chemical engineering students. Additionally, opportunities for internship and co-op experiences are offered to chemical engineering students so that they can gain professional experience during their collegiate program. Please visit our Internet site <http://che.okstate.edu> (<http://che.okstate.edu/>) for more information.

Chemical Engineering Program is accredited under the Engineering Accreditation Commission of ABET, <https://www.abet.org> (<https://www.abet.org/>) criteria for chemical, biochemical, biomolecular and similarly named engineering programs.

## Courses

### CHE 1112 Introduction to the Engineering of Coffee (LN)

**Description:** A non-mathematical introduction to the engineering aspects of roasting and brewing coffee. Simple engineering concepts are used to study methods for roasting and processing of coffee. The course will investigate techniques for brewing coffee such as a drip coffee, pour-over, French press, AeroPress, and espresso. Laboratory experiences focus on roasting and brewing coffee to teach introductory engineering concepts to both engineers and non-engineers.

**Credit hours:** 2

**Contact hours:** Lecture: 1 Lab: 2 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Chemical Engineering

**General Education and other Course Attributes:** Scientific Investigation, Natural Sciences

### CHE 2033 Introduction to Chemical Process Engineering

**Prerequisites:** CHEM 1515, ENSC 2213, and ENGR 1412 with grades of "C" or better and concurrent enrollment in MATH 2233 or MATH 3263.

**Description:** Application of mathematics and scientific principles to solving chemical engineering problems. Simple material and energy balances applied to process design. The nature and application of unit operations and unit processes to the development of chemical processes.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3 Other: 0

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Chemical Engineering

### CHE 2581 Chemical Engineering Seminar I

**Prerequisites:** CHE majors.

**Description:** Through guest lectures and home assignments, preparation and planning for a CHE career and success in the CHE curriculum. Professional growth topics oriented to students in the sophomore-level courses.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

### CHE 3013 Rate Operations I

**Prerequisites:** CHE 2033 and ENSC 3233 with grades of "C" or better.

**Description:** Development and application of phenomenological and empirical models to the design and analysis of fluid processing and heat transfer unit operations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 3113 Rate Operations II**

**Prerequisites:** CHE 3013, CHE 3333, and CHE 3473 with grades of "C" or better.

**Description:** Development and application of phenomenological and empirical models to the design and analysis of mass transfer and separations unit operations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 3123 Chemical Reaction Engineering**

**Prerequisites:** CHE 3013, CHE 3333, and CHE 3473 with grades of "C" or better.

**Description:** Principles of chemical kinetics rate concepts and data treatment. Elements of reactor design principles for homogeneous systems; introduction to heterogeneous systems. Course previously offered as CHE 4473.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 3202 Interdisciplinary Design and Build for Chemical Systems I**

**Prerequisites:** CEAT major or consent of instructor.

**Description:** Interdisciplinary design course that provides independent work experience, professional development, and assigned design-build problems.

**Credit hours:** 2

**Contact hours:** Lecture: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 3211 Interdisciplinary Design and Build for Chemical Systems II**

**Prerequisites:** CEAT major and CHE 3202 or consent of instructor.

**Description:** Continuation of CHE 3202. Interdisciplinary design course that provides independent work experience, professional development, and assigned design-build problems.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 3333 Introduction to Transport Phenomena**

**Prerequisites:** CHE 2033, MATH 2163, and (MATH 2233 or MATH 3263) with grades of "C" or better.

**Description:** Molecular concepts of mass, momentum, and thermal energy diffusion. Theories and correlations for transport properties of viscosity, thermal conductivity, and diffusivity. Shell balance techniques to derive differential equations of change. Application of ODEs to simple transport phenomena problems. Turbulent flow analysis. Use of CFD software for analysis. Course previously offered as CHE 4333.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 3473 Chemical Engineering Thermodynamics**

**Prerequisites:** CHE 2033, CHEM 3153, and CHEM 3112 with grades of "C" or better.

**Description:** Application of thermodynamics to chemical process calculations. Behavior of fluids, including estimation of properties by generalized methods. Study of chemical thermodynamics, including heats of reaction, chemical reaction, and phase equilibria.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 3581 Chemical Engineering Seminar II**

**Prerequisites:** Junior standing in the department.

**Description:** Through guest lectures and home assignments, preparation and planning for a CHE career and success in the CHE curriculum. Professional growth topics oriented to students in the junior-level CHE courses.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4002 Chemical Engineering Laboratory I**

**Prerequisites:** CHE 3013, CHE 3333, CHE 3473, ENGL 1113, ENGR 1111, AND STAT 4033 with grades of "C" or better.

**Description:** Application of CHE fundamentals and unit operation principles to the analysis of bench and pilot-scale equipment. Primarily fluid processing and heat exchange. Design of experiments on non-ideal units to generate credible data useful for validation of principles and for engineering decisions. Interpretation of experimental data and presentation of results.

**Credit hours:** 2

**Contact hours:** Lab: 4 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Chemical Engineering

**CHE 4073 Introduction to Tissue Engineering**

**Prerequisites:** Senior standing or higher and ENSC 3233 and ENSC 3313 and MATH 2153; or by consent of instructor.

**Description:** An overview of the principles of tissue engineering and regenerative medicine, including a general understanding of tissue growth and development, and an investigation of the engineering principles needed to design tissues and organs. May not be used for degree credit with CHE 5073.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4112 Chemical Engineering Laboratory II**

**Prerequisites:** CHE 3113, CHE 3123, CHE 4002 with grades of "C" or better.

**Description:** A continuation of CHE 4002. Primary reaction and mass transfer processes.

**Credit hours:** 2

**Contact hours:** Lab: 4 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Chemical Engineering

**CHE 4124 Chemical Engineering Design I**

**Prerequisites:** CHE 3113, CHE 3123, CHE 4002 with grades of "C" or better.

**Description:** Economic analysis of process plants and systems of equipment; methods for estimating plant investment requirements and operating costs; economic evaluation and optimal design of chemical process systems; basic equipment and process design calculations.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Chemical Engineering

**CHE 4133 Introduction to Catalysis and Photocatalysis**

**Prerequisites:** Senior standing or higher and CHE 3123 or consent of instructor.

**Description:** Molecular level insight into catalysis and photocatalysis from the basics of chemistry and chemical engineering. Topics covered include homogeneous catalysis, heterogeneous catalysis, molecular photocatalysis, and photocatalysis on metals and metal oxides. The rational design of catalysts using first-principle (e.g., density functional theory) calculations is covered. Advancements made in the experimental and computational catalysis fields to convert renewable natural resources such as solar light and cellulosic biomass into electricity, fuels, valuable chemicals and pharmaceuticals. May not be used for degree credit with CHE 5133.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4224 Chemical Engineering Design II**

**Prerequisites:** CHE 4124 with grades of "C" or better.

**Description:** A continuation of CHE 4124. Economic analysis of process plants and equipment. Design of chemical processing equipment and chemical plants. Application of computer techniques to chemical engineering design.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Chemical Engineering

**CHE 4283 Bioprocess Engineering**

**Prerequisites:** CHE 3123 (or instructor consent).

**Description:** Application of fundamental engineering principles to biochemical and biological processes. Introduction to cellular processes, fermentation technology, biological mass transfer and kinetics, bioreactor design and scale-up and downstream processing. Same course as BAE 4283.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4293 Biomedical Engineering**

**Prerequisites:** ENSC 2213, ENSC 3233, MATH 2155.

**Description:** Introduction to engineering principles applied to biomedical applications. Biomaterials, drug delivery, artificial organs, transport in biological systems, tissue engineering and modeling of biological systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4302 Introduction to Science and Engineering Research**

**Prerequisites:** Senior level or by consent of instructor.

**Description:** This course is designed to expose senior level undergraduate students to principles and practice common to research in science and engineering, and accelerate student development towards independent and creative research prowess upon entering a graduate program. May not be used for degree credit with CHE 5302.

**Credit hours:** 2

**Contact hours:** Lecture: 1 Lab: 2 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Chemical Engineering

**CHE 4323 Electrochemical Engineering**

**Prerequisites:** ENSC 2213 and ENSC 3233, or Permission of Instructor.

**Description:** An introduction to the fundamental principles of electrochemistry and its applications in different engineering systems for energy, chemical, biomedical, and electronics industries. May not be used for degree credit with CHE 5323.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4343 Environmental Engineering**

**Prerequisites:** CHE 4123.

**Description:** Application of science and engineering principles to minimize the adverse effects of human activities on the environment. National and state environmental regulations. Predictive movement and fate of chemicals in the geospheres. Multi-media pollution assessment, analysis and control. Consideration of safety, health and environmental issues from a process standpoint.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4493 Introduction to Molecular Modeling and Simulation**

**Prerequisites:** Senior standing or higher and any one of the following courses – CHE 3473, CHEM 3433, CHEM 3553, MAE 3223, MAE 5683, MAE 5693, BIOC 3223 or consent of instructor.

**Description:** Theory of statistical mechanics and its application to computing thermodynamic, transport and phase equilibria properties of fluids. Modeling of matter at molecular level and atomistic simulation methods such as Monte Carlo and molecular dynamics. Quantum calculation of thermodynamics for industrially relevant reactions. Software used: Cassandra, Gromacs, LAMMPS, and Gaussian. May not be used for degree credit with CHE 5493.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4523 Introduction to Colloid Processing**

**Prerequisites:** MATH 2153 and CHEM 1515.

**Description:** The physics and chemistry governing the behavior of microscopic particles in dilute and concentrated suspensions. Interparticle interaction influence on viscosity, viscoelasticity, yield stress, and shear thinning. Practical applications of colloids principles in industrial practice. No credit for students with credit in CHE 5523. Same course as MSE 4523.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4581 Chemical Engineering Seminar III**

**Prerequisites:** Senior standing in the department.

**Description:** Through guest lectures and home assignments, preparation and planning for a ChE career and success in the ChE curriculum. Professional growth topics oriented to students in the senior-level ChE courses.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4603 Introduction to Membrane Separations**

**Prerequisites:** Senior standing or higher and CHE 3113 or consent of instructor.

**Description:** Basic principles of membrane technology: membrane synthesis processes and molecular separation mechanisms for different types of membranes. General overview of many different membrane processes. Basic transport equations and fundamental concepts with examples and industrial applications. Includes a project/discussion for a membrane reactor model. May not be used for degree credit with CHE 5603.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4753 Introduction to Applied Numerical Computing for Scientists and Engineers**

**Prerequisites:** Senior standing or higher, and MATH 2233 or MATH 3263, and knowledge of programming, or consent of instructor.

**Description:** Practical software tools for computational problem solving in science and engineering: version control (e.g., Git), mathematical typesetting (e.g., LaTeX), graphical user interfaces, and high level program languages with libraries of solvers and visualization tools (e.g., Python and MATLAB). Application of numerical computing methods to solve systems of differential and algebraic equations and to estimate model parameters using optimization. May not be used for degree credit with CHE 5753.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4773 Introduction to Computational Fluid-Particle Dynamics**

**Prerequisites:** Senior standing or higher and CHE 3333 or consent of instructor.

**Description:** Computational fluid-particle dynamics (CFPD) modeling strategies and simulation of multiphase flow transport phenomena such as particle tracking, deposition, reaction, and erosion. Detailed flow visualization using multiphase flow models on ANSYS CFX and Fluent platforms. Application of numerical techniques to simulate processes defined by first-principles. Application of CFPD for drug formulation optimization, lung aerosol dynamics, separation processes, reactions in stirred tanks and plug flow reactors. May not be used for degree credit with CHE 5773.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4783 Nanomaterial Synthesis and Characterization**

**Description:** Exposing students to the principles and concepts of nanoscience and nanotechnology with focus on nanomaterial synthesis and characterization, and accelerating student development towards an effective literature review on a selected topic. May not be used for degree credit with CHE 5783.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4843 Chemical Process Instrumentation and Control**

**Prerequisites:** CHE 4124.

**Description:** Process instrumentation for measurement and control. Process dynamics and modeling. Linearization. Classical control system analysis and design. Tuning. Communication through block diagrams and P&IDs.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 4990 Special Problems****Prerequisites:** Senior standing.**Description:** Training in independent work, study of relevant literature, and experimental investigation of an assigned problem. Offered for variable credit, 1-5 credit hours, maximum of 5 credit hours.**Credit hours:** 1-5**Contact hours:** Contact: 1-5 Other: 1-5**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Chemical Engineering**CHE 5000 Master's Thesis****Prerequisites:** Approval of major professor.**Description:** Methods used in research and thesis writing. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Chemical Engineering**CHE 5030 Professional Practice****Prerequisites:** Senior standing and consent of instructor.**Description:** Application of chemical engineering principles to the solution of real-life engineering problems in an actual or simulated industrial environment. Includes application of design and testing procedures, economic evaluation and reporting on one or more assigned projects. Offered for variable credit, 2-6 credit hours, maximum of 8 credit hours.**Credit hours:** 2-6**Contact hours:** Contact: 2-6 Other: 2-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Chemical Engineering**CHE 5073 Tissue Engineering****Prerequisites:** Graduate standing and permission of instructor.**Description:** Tissue engineering (TE) and the material strategy for different tissue constructs in bone TE, liver TE, neural TE, intestine TE, etc. will be discussed in this course. Same as MSE 5073. May not be used for degree credit with CHE 4703.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 5110 Special Topics in Chemical Engineering****Prerequisites:** Consent of instructor.**Description:** Small group and individual projects in unit operations, unit procedures, chemical kinetics, computer applications, process modeling, or any of a wide range of chemical engineering topics. May be repeated for credit if subject matter varies. Offered for variable credit, 2-3 credit hours, maximum of 6 credit hours.**Credit hours:** 2-3**Contact hours:** Contact: 2-3 Other: 2-3**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Chemical Engineering**CHE 5123 Advanced Chemical Reaction Engineering****Prerequisites:** CHE 4473.**Description:** Advanced principles and applications of chemical kinetics in catalysis, heterogeneous systems, non-ideal reactions, polymerization, and biological reactions.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 5133 Catalysis and Photocatalysis****Prerequisites:** Graduate standing or CHE 3123 or consent of instructor.**Description:** Molecular level insight into catalysis and photocatalysis from the basics of chemistry and chemical engineering. Topics covered include homogeneous catalysis, heterogeneous catalysis, molecular photocatalysis, and photocatalysis on metals and metal oxides. The rational design of catalysts using first-principle (e.g., density functional theory) calculations is covered. Advancements made in the experimental and computational catalysis fields to convert renewable natural resources such as solar light and cellulosic biomass into electricity, fuels, valuable chemicals and pharmaceuticals. May not be used for degree credit with CHE 4133.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 5213 Advanced Transport Phenomena****Prerequisites:** CHE 3333 (or equivalent), or graduate student standing in the School of Chemical Engineering, or a closely related, calculus-based STEM discipline, or consent of instructor.**Description:** Mechanisms and modeling of mass, momentum and heat transport with an emphasis on chemical, petroleum, and biomedical engineering applications.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 5233 Bioseparations****Prerequisites:** BAE 3013 or CHE 3013.**Description:** Study of separations important in food and biochemical engineering such as leaching, extraction, expression, absorption, ion exchange, filtration, centrifugation, membrane separation, and chromatographic separations. Course available online only through AG\*IDEA consortium.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering



**CHE 5263 Advanced Biomaterials Science and Engineering****Prerequisites:** Graduate standing or consent of instructor.**Description:** Engineering issues that are implicit in understanding the interactions of living tissue and processed materials will be introduced. Emphasis is on identifying the processes in which cells interact with surfaces and particulate matter and the outcome of these interactions. Highlighted biological responses will include inflammation and coagulation. Also, biomaterial issues related to drug delivery and tissue engineering will be discussed. Same course as MAE 5003.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 5273 Basic Physiology and Physiological System Analysis for Engineers****Prerequisites:** Graduate standing or consent of instructor.**Description:** The goals of this class are: 1) to introduce the basic physiology concepts used widely in biomedical engineering research; 2) to introduce and develop engineering concepts and approaches for quantitative analysis of physiological systems. Engineering principles will be applied to study mechanical properties of various tissue and organ systems under normal and diseased conditions. Knowledge obtained from this class can help engineers to apply engineering principles to the design and development of medical devices for disease treatments. Same course as MAE 5013.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 5283 Advanced Bioprocess Engineering****Prerequisites:** Consent of instructor.**Description:** Application of fundamental engineering principles to biochemical and biological processes. Introduction to cellular processes, fermentation technology, biological mass transfer and kinetics, bioreactor design and scale-up, and downstream processing. Same course as BAE 5283.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 5293 Advanced Biomedical Engineering****Prerequisites:** Consent of instructor.**Description:** Principles and engineering analysis of biomedical processes. Artificial organs, biomaterials, tissue engineering, transport in biological systems, biomedical imaging and drug delivery systems. Same course as MAE 5033.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 5302 Introduction to Science and Engineering Research****Prerequisites:** Graduate level or by consent of instructor.**Description:** This course is designed to expose new graduate students to principles and practice common to research in science and engineering, and accelerate student development towards independent and creative research prowess. May not be used for degree credit with CHE 4302.**Credit hours:** 2**Contact hours:** Lecture: 1 Lab: 2 Contact: 3**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Chemical Engineering**CHE 5323 Electrochemical Engineering****Prerequisites:** Graduate standing.**Description:** An introduction to the fundamental principles of electrochemistry and its applications in different engineering systems for energy, chemical, biomedical, and electronics industries. May not be used for degree credit with CHE 4323.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 5343 Advanced Environmental Engineering****Prerequisites:** Consent of instructor.**Description:** Science and engineering principles to minimize the adverse effects of human activities on the environment. National and state regulations. Predictive movement and fate of chemicals in the geospheres. Multi-media pollution assessment, analysis, and control. Consideration of safety, health, and environment issues from a process standpoint. Special project required. Credit not allowed if CHE 4343 was taken.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 5373 Process Simulation****Prerequisites:** CHE 5843 or concurrent enrollment or with professor's consent.**Description:** Computer-aided process synthesis, simulation, analysis and optimization. Systematic tools for developing and screening potential chemical process flow sheets. Use of commercial process simulators to aid in evaluating process designs. Practical problems will be used as examples and case studies.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering

**CHE 5493 Molecular Modeling and Simulation**

**Prerequisites:** Graduate standing and any one of the following courses: CHE 3473, CHEM 3433, CHEM 3553, MAE 3223, MAE 5683, MAE 5693, BIOC 3224 or consent of instructor.

**Description:** Theory of statistical mechanics and its application to computing thermodynamic, transport and phase equilibria properties of fluids. Modeling of matter at molecular level and atomistic simulation methods such as Monte Carlo and molecular dynamics. Quantum calculation of thermodynamics for industrially relevant reactions. Software used: Cassandra, Gromacs, LAMMPS, and Gaussian. May not be used for degree credit with CHE 4493.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5523 Colloid Processing**

**Prerequisites:** Graduate standing in engineering, physics, or chemistry or consent of instructor.

**Description:** The physics and chemistry governing the behavior of microscopic particles in dilute and concentrated suspensions. Interparticle interaction influence on viscosity, viscoelasticity, yield stress, and shear thinning. Practical application of colloids principles in industrial practice.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5603 Membrane Separations**

**Prerequisites:** Graduate standing and CHE 3113 or consent of instructor.

**Description:** Basic principles of membrane technology: membrane synthesis processes and molecular separation mechanisms for different types of membranes. General overview of many different membrane processes. Basic transport equations and fundamental concepts with examples and industrial applications. Includes a project/discussion for a membrane reactor model. May not be used for degree credit with CHE 4603.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5633 Stagewise Operations**

**Description:** Stagewise separation in binary and multicomponent systems. Development of theoretical techniques with application to typical situations in vapor-liquid, liquid-liquid and solid-liquid systems. Use of digital and analog techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5703 Optimization Applications**

**Prerequisites:** Graduate standing.

**Description:** A survey of various methods of unconstrained and constrained linear and non-linear optimization. Applications of these methodologies using hand-worked examples and available software packages. Intended for engineering and science students. Same course as ECEN 5703, IEM 5023 & MAE 5703.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5723 Plasmonic Photocatalysis**

**Prerequisites:** CHE 5123; or by consent of instructor.

**Description:** The field of plasmonic photocatalysis grew tremendously in the last decade. In this course, the current state of the art plasmonic photocatalysis are reviewed through the rigorous collection of literature. The advantages of the visible-light-driven plasmonic photocatalysis over the conventional thermal energy-driven heterogeneous catalysis will be discussed. The fundamental insight into photocatalytic mechanisms by which the charge carriers (electrons and holes) are formed and transferred to adsorbates to drive chemical transformations on the surface of plasmonic nanocatalysts will also be discussed. The computational methods used to predict and understand the photocatalytic activity and selectivity in plasmonic photocatalysis will also be reviewed. Finally, the current challenges, new opportunities, and future outlook for plasmonic photocatalysis will be presented.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5733 Neural Networks**

**Prerequisites:** Graduate standing.

**Description:** Introduction to mathematical analysis of networks and learning rules and on the application of neural networks to certain engineering problems, image and signal processing and control systems. Same course as ECEN 5733 & MAE 5733.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5743 Chemical Engineering Process Modeling**

**Description:** Chemical engineering systems and process models.

Analytical and numerical methods of solution of resulting equations with computer methods in a chemical engineering context.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5753 Applied Numerical Computing for Scientists and Engineers**

**Prerequisites:** Graduate standing, and MATH 2233 or MATH 3263, and knowledge of programming, or consent of instructor.

**Description:** Practical software tools for computational problem solving in science and engineering: version control (e.g., Git), mathematical typesetting (e.g., LaTeX), graphical user interfaces, and high level program languages with libraries of solvers and visualization tools (e.g., Python and MATLAB). Application of numerical computing methods to solve systems of differential and algebraic equations and to estimate model parameters using optimization. May not be used for degree credit with CHE 4753.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5773 Computational Fluid-Particle Dynamics**

**Prerequisites:** Graduate standing and CHE 3333 or consent of instructor.

**Description:** Computational fluid-particle dynamics (CFPD) modeling strategies and simulation of multiphase flow transport phenomena such as particle tracking, deposition, reaction, and erosion. Detailed flow visualization using multiphase flow models on ANSYS CFX and Fluent platforms. Application of numerical techniques to simulate processes defined by first-principles. Application of CFPD for drug formulation optimization, lung aerosol dynamics, separation processes, reactions in stirred tanks and plug flow reactors. May not be used for degree credit with CHE 4773.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5783 Nanomaterial Synthesis and Characterization**

**Description:** Exposing students to the principles and concepts of nanoscience and nanotechnology with focus on nanomaterial synthesis and characterization, and accelerating student development towards an effective literature review to come up with novel idea on a selected topic. May not be used for degree credit with CHE 4783.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5843 Principles of Chemical Engineering Thermodynamics**

**Description:** Principles of thermodynamics. Properties of fluids and prediction of thermodynamic properties. Phase and chemical equilibrium. Thermodynamics in unit operations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5850 Advanced Process Control Laboratory**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Instrumentation systems and control strategies on pilot-scale chemical processes. Calibration, filtering, dynamic modeling, tuning, advanced control, and method evaluation. Students will learn industrial practices and cope with many non-idealities. Offered for variable credit, 2-3 credit hours, maximum of 6 credit hours.

**Credit hours:** 2-3

**Contact hours:** Lecture: 1 Lab: 2-4 Contact: 3-5

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Chemical Engineering

**CHE 5853 Advanced Chemical Process Control**

**Prerequisites:** CHE 4843 or equivalent.

**Description:** General concepts and approaches of model-based control. Studies in the application of process-model-based control and model-predictive control on multivariable, nonlinear, nonstationary, noisy processes.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5873 Air Pollution Control Engineering**

**Description:** Causes, effects and control of atmosphere pollution. Same course as CIVE 5873.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Chemical Engineering

**CHE 5990 Special Problems**

**Prerequisites:** Consent of instructor.

**Description:** Individual report topics in chemical engineering involving operations, processes, equipment, experiments, literature search, theory, computer use or combinations of these. Offered for variable credit, 1-4 credit hours, maximum of 9 credit hours.

**Credit hours:** 1-4

**Contact hours:** Contact: 1-4 Other: 1-4

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Chemical Engineering

**CHE 6000 Doctoral Thesis**

**Prerequisites:** Consent of major professor.

**Description:** The doctoral candidate registers for a minimum of 1 semester credit hour to a maximum of 15 semester credit hours in each semester during which dissertation work is in process. Methods used in research and thesis writing. An original investigation of a problem in chemical engineering and its report in a dissertation. Offered for variable credit, 1-15 credit hours, maximum of 54 credit hours.

**Credit hours:** 1-15

**Contact hours:** Contact: 1-15 Other: 1-15

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Chemical Engineering

**CHE 6010 Chemical Engineering Seminar****Prerequisites:** Consent of major professor.**Description:** Advanced research and development topics. Offered for variable credit, 1 credit hour, maximum of 10 credit hours.**Credit hours:** 1**Contact hours:** Contact: 1 Other: 1**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Chemical Engineering**CHE 6223 Advanced Chemical Engineering Thermodynamics****Prerequisites:** CHE 5843.**Description:** Phase equilibrium in multicomponent systems. Irreversible processes. Properties of fluids and the prediction of properties by statistical methods. Application of thermodynamics to unit operations.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering**CHE 6440 Advanced Topics in Chemical Engineering****Description:** Topics in chemical engineering unit operations in design. Advanced mathematical techniques in chemical engineering problems. May be repeated for credit if subject matter varies. Offered for variable credit, 3-6 credit hours, maximum of 9 credit hours.**Credit hours:** 3-6**Contact hours:** Contact: 3-6 Other: 3-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Chemical Engineering**CHE 6703 Research Methods in Chemical Engineering****Prerequisites:** MS or PhD candidacy in chemical engineering or consent of instructor.**Description:** Methods and skills required to successfully conduct chemical engineering research projects. Maintaining research records, experiment design, data validation, results presentation and research ethics.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Chemical Engineering

## Undergraduate Programs

- Chemical Engineering, BSCH (p. 2159)
- Chemical Engineering: Biomedical/Biochemical, BSCH (p. 2161)
- Chemical Engineering: Pre-Medical, BSCH (p. 2163)

## Graduate Programs

The School of Chemical Engineering offers programs leading to the Master of Science and Doctor of Philosophy. A program of independent study and research on a project under the direction of a member of the Graduate Faculty will be satisfactorily completed by all graduate students. For the Master of Science candidate, the project will result in a thesis. For the Doctor of Philosophy candidate, the project will result in a dissertation.

## Admission Requirements

Admission to either the Master of Science or Doctor of Philosophy degree program requires graduation from a chemical engineering curriculum

approved by the ABET or a recognized equivalent from any international program.

Students with undergraduate degrees in other engineering disciplines or closely-related fields, such as chemistry, physics, mathematics, or biological sciences, are evaluated on an individual basis and a specific plan of study is developed for each student. This plan may include an additional 10 – 15 semester credit hours of undergraduate courses in Chemical Engineering. Admission is competitive based on undergraduate GPA, GRE and TOEFL (for international students), statement of background and goals, research experience and interests, and recommendations.

## The Master of Science Degree

The general credit requirement is 30 credit hours beyond the BS degree, including 24 credit hours of classwork and six credit hours of thesis research. Students must be enrolled in CHE 6010 Chemical Engineering Seminar during the fall and spring semesters. The courses taken must include:

Code	Title	Hours
CHE 5123	Advanced Chemical Reaction Engineering	3
CHE 5213	Advanced Transport Phenomena	3
CHE 5743	Chemical Engineering Process Modeling	3
CHE 5843	Principles of Chemical Engineering Thermodynamics	3
CHE 5302	Introduction to Science and Engineering Research	2

## The Doctor of Philosophy Degree

The general credit requirement is 60 credit hours beyond the BS degree, including 24 credit hours of research and 36 credit hours of classwork. Students must be enrolled in CHE 6010 Chemical Engineering Seminar during the fall and spring semesters. The courses must include:

Code	Title	Hours
CHE 5123	Advanced Chemical Reaction Engineering	3
CHE 5213	Advanced Transport Phenomena	3
CHE 5743	Chemical Engineering Process Modeling	3
CHE 5843	Principles of Chemical Engineering Thermodynamics	3
CHE 5302	Introduction to Science and Engineering Research	2

Each student is responsible for consultation with his or her advisory committee in preparing the plan of study.

## Minors

- Petroleum Engineering (PETE), Minor (p. 2165)

## Faculty

Geir Hareland, PhD, PEng—Professor and Head  
**Professor and Continental Resources Chair:** Geir Hareland, PhD, PEng  
**Professor and Anadarko Chair:** Heather D.N. Fahlenkamp, PhD  
**Professor and BP Chair:** Jeffery L. White, PhD  
**Professor and Robert N. Maddox Professor:** Joshua D. Ramsey, PhD, PE  
**Professors:** D. Alan Tree, PhD; Sundar V. Madihally, PhD  
**Associate Professor and Ward Fellow:** Clint P. Aichele, PhD

**Associate Professor and Samson Chair in Petroleum Engineering:** Mileva Radonjic, PhD

**Associate Professor and Courson Chair in Petroleum Engineering:** Prem Bikkina, PhD

**Associate Professor:** Jindal Shah, PhD

**Assistant Professor and Ward Fellow:** Mohammed Al Dushaishi, PhD

**Assistant Professors:** Marimuthu Andiappan, PhD; PhD; Ömer Özgür Çapraz, PhD; Yu Feng, PhD; Shohreh Hemmati, PhD; Seok-Jhin Kim, PhD; Hunjoo Lee, PhD

**Clinical Assistant Professor (ENDEAVOR):** Brad Rowland, PhD

## Chemical Engineering, BSCH

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 130**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
MATH 2163	Calculus III	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1515	Chemistry II (LN)	5
PHYS 2014	University Physics I (LN)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Any course designated (S)		6
<b>Hours Subtotal</b>		<b>43</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2114	University Physics II (LN)	4
<i>Engineering</i>		
ENGR 1111	Introduction to Engineering	1
ENGR 1412	Introductory Engineering Computer Programming	2
<i>Engineering Science</i>		
ENSC 2113	Statics	3
ENSC 2143	Strength of Materials	3

ENSC 2613	Introduction to Electrical Science	3
ENSC 2213	Thermodynamics	3
ENSC 3233	Fluid Mechanics	3
ENSC 3313	Materials Science	3

### Mathematics

Select one of the following:		3
STAT 2013	Elementary Statistics (A)	
STAT 2023	Elementary Statistics for Business and Economics (A)	
STAT 2053	Elementary Statistics for the Social Sciences (A)	
STAT 4013	Statistical Methods I (A)	
STAT 4033	Engineering Statistics	
STAT 4053	Statistical Methods I for the Social Sciences (A)	
STAT 4073	Engineering Statistics with Design of Experiments	

### Chemistry

CHEM 3053	Organic Chemistry I	3
Select one of the following:		5
CHEM 3153 & CHEM 3112	Organic Chemistry II and Organic Chemistry Laboratory	
BIOC 3653 & BIOC 3723	Survey of Biochemistry and Biochemistry and Molecular Biology Laboratory	

**Hours Subtotal 36**

### Major Requirements

#### Mathematics

MATH 2233	Differential Equations	3
or MATH 3263	Linear Algebra and Differential Equations	

#### Chemistry

CHEM 3433	Physical Chemistry I	3
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#### Chemical Engineering

CHE 2033	Introduction to Chemical Process Engineering	3
CHE 2581	Chemical Engineering Seminar I	1
CHE 3013	Rate Operations I	3
CHE 3113	Rate Operations II	3
CHE 3123	Chemical Reaction Engineering	3
CHE 3333	Introduction to Transport Phenomena	3
CHE 3473	Chemical Engineering Thermodynamics	3
CHE 3581	Chemical Engineering Seminar II	1
CHE 4002	Chemical Engineering Laboratory I	2
CHE 4112	Chemical Engineering Laboratory II	2
CHE 4124	Chemical Engineering Design I	4
CHE 4224	Chemical Engineering Design II	4
CHE 4581	Chemical Engineering Seminar III	1
CHE 4843	Chemical Process Instrumentation and Control	3

**Hours Subtotal 42**

### Controlled Electives

#### Advanced Chemical Science

Select 3 hours of the following: 3

ANSI 3423	Animal Genetics <sup>1</sup>	
BIOC 3223	Physical Chemistry for Biologists	
BIOC 3653	Survey of Biochemistry <sup>1</sup>	
BIOC 3713	Biochemistry I <sup>1</sup>	
BIOC 3723	Biochemistry and Molecular Biology Laboratory	
BIOC 4113	Molecular Biology	
BIOL 3023	General Genetics <sup>1</sup>	
CHEM 3153	Organic Chemistry II	
CHEM 3353	Descriptive Inorganic Chemistry	
CHEM 3553	Physical Chemistry II	
CHEM 4023	Modern Methods of Chemical Analysis	
FDSC 3373	Food Chemistry I	
FDSC 4373	Food Chemistry II	
GEOL 4403	Geochemistry	
MICR 3033	Cell and Molecular Biology	
<i>Restricted Electives</i>		
Select 6 hours of upper-level course credit meeting School objectives <sup>1,2</sup>		6
<b>Hours Subtotal</b>		<b>9</b>
<b>Total Hours</b>		<b>130</b>

<sup>1</sup> Cannot use both ANSI 3423 Animal Genetics & BIOL 3023 General Genetics or BIOC 3653 Survey of Biochemistry & BIOC 3713 Biochemistry I.

<sup>2</sup> Must be 3000 level or higher. Must meet requirements for professional development, technical knowledge, or life balance. May be fulfilled by upper-division coursework as part of the pursuit of a minor at OSU.

## Graduation Requirements

1. A minimum GPA of 2.00 is required in all CHE coursework.
2. Must Receive a "C" or better in the following CHE courses: CHE 2033, CHE 3013, CHE 3113, CHE 3123, CHE 3333, CHE 3473, and CHE 4002.
3. The major engineering design experience, capstone course, is satisfied by CHE 4124 Chemical Engineering Design I and CHE 4224 Chemical Engineering Design II.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Chemical Engineering: Biomedical/ Biochemical, BSCH

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average:** 2.00

**Total Hours:** 134

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I	3
	or ENGL 1313	Critical Analysis and Writing I
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
MATH 2163	Calculus III	3
<i>Humanities (H)</i>		
PHIL 3833	Biomedical Ethics (H) (or equivalent with Chemical Engineering Advisor approval)	3
Select 3 hour course designated (H)		3
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1515	Chemistry II (LN)	5
BIOL 1114	Introductory Biology (LN)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Any course designated (S)		6
<b>Hours Subtotal</b>		<b>43</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2014	University Physics I (LN)	4
PHYS 2114	University Physics II (LN)	4
<i>Engineering</i>		
ENGR 1111	Introduction to Engineering	1

ENGR 1412	Introductory Engineering Computer Programming	2
<i>Engineering Science</i>		
ENSC 2113	Statics	3
ENSC 2143	Strength of Materials	3
ENSC 2613	Introduction to Electrical Science	3
ENSC 2213	Thermodynamics	3
ENSC 3233	Fluid Mechanics	3
ENSC 3313	Materials Science	3
<i>Mathematics</i>		
Select one of the following:		3
STAT 2013	Elementary Statistics (A)	
STAT 2023	Elementary Statistics for Business and Economics (A)	
STAT 2053	Elementary Statistics for the Social Sciences (A)	
STAT 4013	Statistical Methods I (A)	
STAT 4033	Engineering Statistics	
STAT 4053	Statistical Methods I for the Social Sciences (A)	
STAT 4073	Engineering Statistics with Design of Experiments	
<i>Chemistry</i>		
CHEM 3053	Organic Chemistry I	3
Select one of the following:		5
CHEM 3153 & CHEM 3112	Organic Chemistry II and Organic Chemistry Laboratory	
BIOC 3653 & BIOC 3723	Survey of Biochemistry and Biochemistry and Molecular Biology Laboratory	
<b>Hours Subtotal</b>		<b>40</b>
<b>Major Requirements</b>		
<i>Mathematics</i>		
MATH 2233	Differential Equations	3
	or MATH 3263	Linear Algebra and Differential Equations
<i>Chemistry</i>		
CHEM 3433	Physical Chemistry I	3
<i>Chemical Engineering</i>		
CHE 2033	Introduction to Chemical Process Engineering	3
CHE 2581	Chemical Engineering Seminar I	1
CHE 3013	Rate Operations I	3
CHE 3113	Rate Operations II	3
CHE 3123	Chemical Reaction Engineering	3
CHE 3333	Introduction to Transport Phenomena	3
CHE 3473	Chemical Engineering Thermodynamics	3
CHE 3581	Chemical Engineering Seminar II	1
CHE 4002	Chemical Engineering Laboratory I	2
CHE 4112	Chemical Engineering Laboratory II	2
CHE 4124	Chemical Engineering Design I	4
CHE 4224	Chemical Engineering Design II	4
CHE 4581	Chemical Engineering Seminar III	1
CHE 4843	Chemical Process Instrumentation and Control	3



<b>Hours Subtotal</b>	<b>42</b>
<b>Controlled Electives</b>	
<i>Advanced Chemical Science</i>	
Select 3 hours	3
ANSI 3423	Animal Genetics <sup>1</sup>
BIOC 3223	Physical Chemistry for Biologists
BIOC 3653	Survey of Biochemistry <sup>1</sup>
BIOC 3713	Biochemistry I <sup>1</sup>
BIOC 3723	Biochemistry and Molecular Biology Laboratory
BIOC 4113	Molecular Biology
BIOL 3023	General Genetics <sup>1</sup>
CHEM 3153	Organic Chemistry II
CHEM 3353	Descriptive Inorganic Chemistry
CHEM 3553	Physical Chemistry II
CHEM 4023	Modern Methods of Chemical Analysis
FDSC 3373	Food Chemistry I
FDSC 4373	Food Chemistry II
GEOL 4403	Geochemistry
MICR 3033	Cell and Molecular Biology
<i>Bioengineering/Bioscience Electives</i>	
Select 6 hours of the following:	6
BAE 3113	Biological Applications in Engineering
BAE 4413	Food Engineering
BIOC 3223	Physical Chemistry for Biologists
BIOC 3653	Survey of Biochemistry <sup>1</sup>
BIOC 3713	Biochemistry I <sup>1</sup>
BIOC 3723	Biochemistry and Molecular Biology Laboratory
BIOC 4113	Molecular Biology
BIOC 5824	Biochemical Laboratory Methods
BIOL 1604	Animal Biology
BIOL 3023	General Genetics
CHE 4283	Bioprocess Engineering
CHE 4293	Biomedical Engineering
CHE 5283	Advanced Bioprocess Engineering
CHE 5293	Advanced Biomedical Engineering
MICR 2123 & MICR 2132	Introduction to Microbiology and Introduction to Microbiology Laboratory
MICR 3033	Cell and Molecular Biology
<b>Hours Subtotal</b>	<b>9</b>
<b>Total Hours</b>	<b>134</b>

<sup>1</sup> Cannot use both ANSI 3423 Animal Genetics & BIOL 3023 General Genetics or BIOC 3653 Survey of Biochemistry & BIOC 3713 Biochemistry I.

## Graduation Requirements

1. A minimum GPA of 2.00 is required in all CHE coursework.
2. Must Receive a "C" or better in the following CHE courses: CHE 2033, CHE 3013, CHE 3113, CHE 3123, CHE 3333, CHE 3473, and CHE 4002.

3. The major engineering design experience, capstone course, is satisfied by CHE 4124 Chemical Engineering Design I and CHE 4224 Chemical Engineering Design II.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Chemical Engineering: Pre-Medical, BSCH

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average:** 2.00

**Total Hours:** 135

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
MATH 2163	Calculus III	3
<i>Humanities (H)</i>		
Any course designated (H) <sup>1</sup>		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1515	Chemistry II (LN)	5
BIOL 1114	Introductory Biology (LN)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Any course designated (S) <sup>2</sup>		6
<b>Hours Subtotal</b>		<b>43</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2014	University Physics I (LN)	4
PHYS 2114	University Physics II (LN)	4
BIOL 1604	Animal Biology	4
<i>Engineering</i>		
ENGR 1111	Introduction to Engineering	1

ENGR 1412	Introductory Engineering Computer Programming	2
<i>Engineering Science</i>		
ENSC 2113	Statics	3
ENSC 2143	Strength of Materials	3
ENSC 2613	Introduction to Electrical Science	3
ENSC 2213	Thermodynamics	3
ENSC 3233	Fluid Mechanics	3
ENSC 3313	Materials Science	3
<i>Chemistry</i>		
CHEM 3053	Organic Chemistry I	3
CHEM 3112	Organic Chemistry Laboratory	2
CHEM 3153	Organic Chemistry II	3
<b>Hours Subtotal</b>		<b>41</b>
<b>Major Requirements</b>		
<i>Mathematics</i>		
MATH 2233	Differential Equations	3
or MATH 3263	Linear Algebra and Differential Equations	
Select one of the following:		3
STAT 2013	Elementary Statistics (A)	
STAT 2023	Elementary Statistics for Business and Economics (A)	
STAT 2053	Elementary Statistics for the Social Sciences (A)	
STAT 4013	Statistical Methods I (A)	
STAT 4033	Engineering Statistics	
STAT 4053	Statistical Methods I for the Social Sciences (A)	
STAT 4073	Engineering Statistics with Design of Experiments	
<i>Chemistry</i>		
CHEM 3433	Physical Chemistry I	3
<i>Chemical Engineering</i>		
CHE 2033	Introduction to Chemical Process Engineering	3
CHE 2581	Chemical Engineering Seminar I	1
CHE 3013	Rate Operations I	3
CHE 3113	Rate Operations II	3
CHE 3123	Chemical Reaction Engineering	3
CHE 3333	Introduction to Transport Phenomena	3
CHE 3473	Chemical Engineering Thermodynamics	3
CHE 3581	Chemical Engineering Seminar II	1
CHE 4002	Chemical Engineering Laboratory I	2
CHE 4112	Chemical Engineering Laboratory II	2
CHE 4124	Chemical Engineering Design I	4
CHE 4224	Chemical Engineering Design II	4
CHE 4581	Chemical Engineering Seminar III	1
CHE 4843	Chemical Process Instrumentation and Control	3
<b>Hours Subtotal</b>		<b>45</b>
<b>Controlled Electives</b>		
<i>Advanced Chemical Science</i>		
BIOL 3023	General Genetics	3

or MICR 3033	Cell and Molecular Biology	
<i>Bioengineering/Bioscience Electives</i>		
Select 3 hours of the following:		3
BAE 3113	Biological Applications in Engineering	
BAE 4413	Food Engineering	
BIOC 3223	Physical Chemistry for Biologists	
BIOC 3713	Biochemistry I	
BIOC 3653	Survey of Biochemistry	
BIOC 4113	Molecular Biology	
BIOL 3023	General Genetics	
BIOL 3214	Human Anatomy	
CHE 4283	Bioprocess Engineering	
CHE 4293	Biomedical Engineering	
CHE 5283	Advanced Bioprocess Engineering	
CHE 5293	Advanced Biomedical Engineering	
<b>Hours Subtotal</b>		<b>6</b>
<b>Total Hours</b>		<b>135</b>

<sup>1</sup> Humanities courses - should select one from ENGL and one ART, ENGL, FLL, MUSI, PHIL or TH to also meet medical school requirements.

<sup>2</sup> Social & Behavioral Sciences courses – should select from ANTH, PSYC, or SOC to also meet medical school requirements.

## Graduation Requirements

1. A minimum GPA of 2.00 is required in all CHE coursework.
2. Must Receive a "C" or better in the following CHE courses: CHE 2033, CHE 3013, CHE 3113, CHE 3123, CHE 3333, CHE 3473, and CHE 4002.
3. The major engineering design experience, capstone course, is satisfied by CHE 4124 Chemical Engineering Design I and CHE 4224 Chemical Engineering Design II.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Petroleum Engineering (PETE), Minor

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Professor Prem Bikkina**, prem.bikkina@okstate.edu, 420 Engineering North 405-744-5280

**Minimum Overall Grade Point Average: 2.50**

**Total Hours: 18**

Code	Title	Hours
<b>Minor Requirements</b>		
GEOL 3413	Petroleum Geology for Engineers	3
GEOL 4323	Applied Well Log Analysis for Engineers	3
PETE 4303	Petroleum Rocks and Fluids	3
PETE 4313	Drilling and Well Completions	3
PETE 4333	Production Engineering	3
PETE 4343	Reservoir Engineering and Well Testing	3
<b>Total Hours</b>		<b>18</b>

- GEOL 3413 Petroleum Geology for Engineers is a prerequisite for all other courses
- PETE 4303 Petroleum Rocks and Fluids is a prerequisite for PETE 4313 Drilling and Well Completions, PETE 4333 Production Engineering and PETE 4343 Reservoir Engineering and Well Testing.

## Additional OSU Requirements

### Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).

## Civil and Environmental Engineering

Civil engineers build the future. The exceptional diversity of professional practice in civil and environmental engineering presents many career opportunities for students.

The concern of civil engineers is infrastructure - the design, construction, management, alteration and utilization, which allows society to function. Civil engineers plan, design and construct, highways, waterway and railway systems, harbors and shipping facilities, systems for the treatment and distribution of water and for the collection and treatment of municipal and industrial waste, dams and hydroelectric works, airports and terminals, structures of every kind including buildings, bridges, towers, industrial plants, tunnels and subway systems, processes for the control of water and air pollution, and many other works of general benefit to society.

The curriculum in civil engineering is based on courses in mathematics, physical sciences and engineering sciences. On this foundation, required courses equip the student with the basic skills needed for the professional practice of civil engineering and provide the tools for more advanced study. Engineering theory and principles are developed in a way that will encourage their application to the practical solution of problems.

### Program Educational Objectives

The Bachelor of Science in Civil Engineering degree program educates and prepares engineers who a few years after graduation will be:

- Contributing to society through the practice of civil engineering in a variety of contexts, including the protection of public health, safety, and welfare and the development of sustainable engineering solutions;
- Effectively applying and adapting the technical knowledge, engineering principles, communication skills and personal attributes necessary to be successful in the civil engineering profession;
- Advancing within their profession, including attaining professional licensure and positions of leadership;
- Exhibiting life-long learning, including the pursuit of advanced degrees; and
- Engaging with and advocating for the civil engineering profession.

The curriculum is designed to enable students to satisfy the program educational objectives in conjunction with the student outcomes. These outcomes state that graduates of the program will have:

- (1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- (2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- (3) an ability to communicate effectively with a range of audiences
- (4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

The School provides a curriculum that is effective and balanced among the major areas of civil engineering practice. Design capabilities are developed throughout the curriculum, culminating in a comprehensive senior design experience, incorporating much of the previous coursework. Some degree of specialization is provided through the choice of elective courses in structures, engineering mechanics, transportation engineering, soil mechanics and foundations, construction engineering and management, environmental engineering and water resources. There is a designated option for those students wishing to concentrate more heavily in the environmental area of practice. Program curricula requirements are outlined in the publication Undergraduate Program and Requirements. The Bachelor of Science in Civil Engineering degree is accredited by the Engineering Accreditation Commission of ABET, <https://www.abet.org/>.

### Courses

#### CIVE 2041 Civil and Environmental Engineering Seminar

**Prerequisites:** Sophomore standing or department permission required.

**Description:** An introduction to the importance of communication, professional ethics, knowledge of contemporary issues, and the role these play in developing a broad education. Emphasis will be placed on understanding the impact of engineering solutions in a global and societal context. The various sub-disciplines within the fields of Civil and Environmental Engineering will also be presented.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

#### CIVE 2081 Environmental Chemistry for Engineers

**Prerequisites:** CHEM 1414 with minimum grade of "C."

**Description:** This course applies the material covered in a general chemistry course for engineers to the skills needed for environmental engineering. In achieving these objectives, this course also supports Outcome 1 of the BSCE degree program accreditation requirements. (1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 3413 Structural Analysis**

**Prerequisites:** Minimum grade of "C" in ENSC 2143.

**Description:** Analysis of internal forces and deflections of structures subjected to static loading. Beams, trusses, and framed structures analyzed by appropriate classical methods. Classical methods and modern computer procedures for the analysis of statically indeterminate structures.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 3513 Structural Steel Design**

**Prerequisites:** CIVE 3413 with minimum grade of C.

**Description:** Introduction to the design of structural steel members and connections in accordance with AISC specifications. May not be used for degree credit with ARCH 3323. May not be used for degree credit with CIVE 5473 and ARCH 3323.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 3523 Reinforced Concrete Design**

**Prerequisites:** CIVE 3413 with minimum grade of C.

**Description:** Introduction to the design of reinforced concrete elements in accordance with the strength design requirements of the ACI Building code. May not be used for degree credit with ARCH 4123.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 3614 Engineering Surveying**

**Prerequisites:** Minimum grade of "C" required in MATH 2123 or MATH 2144.

**Description:** Principles and techniques of vertical and horizontal measurements related to engineering and construction projects. Linear and angular measurements, differential leveling, traverses, topographic surveys, construction surveying, horizontal and vertical curves, earthwork quantities and design of route systems.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 3623 Engineering Materials Laboratory**

**Prerequisites:** ENSC 2143 with minimum grade of "C."

**Description:** Introduction on material properties and related design criteria for common construction materials: structural steel, wood and timber, aggregates, portland cement and concrete, asphalt binder and concrete. Discussion on material specific topics on fabrication methods; mechanical and non-mechanical properties; use and applications; standards, testing and quality control measures; selection and design criteria. Laboratory exercises supplement lecture theory and provide "hands-on" experience in performing standard tests.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 3633 Transportation Engineering**

**Prerequisites:** CIVE 3614 with minimum grade of "C", and minimum grade of "C" in STAT 4073 or STAT 4033 or concurrent enrollment.

**Description:** Planning, design and operations of transportation facilities. Vehicle characteristics and human factors in design. Traffic stream variables and their measurement techniques. Basic traffic flow models. Highway and street intersection capacity and level of service. Traffic control concepts. Transportation systems management. Application of statistical analysis and operations research to analyze transportation problems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 3714 Introduction to Geotechnical Engineering**

**Prerequisites:** Minimum grade of "C" in ENSC 2143, or department permission required.

**Description:** Physical and mechanical properties of soils, including grain size analysis, plasticity, permeability, consolidation, and shear strength. Use of physical and mechanical properties to calculate stresses in a soil mass, lateral earth pressures and bearing capacity. Laboratory tests conducted to determine the physical and mechanical soil properties needed for application in geotechnical design. Course previously offered as CIVE 3713.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 3813 Environmental Engineering Science**

**Prerequisites:** Minimum grade of "C" in (CHEM 1414 or CHEM 1515) and ENSC 3233.

**Description:** Engineering aspects of the life support system; the carbon-oxygen cycle; cycling of nitrogen, sulfur and phosphorus; and the hydrologic cycle. Concepts of environmental pollution and degradation. Techniques for mitigation; water and wastewater treatment, solid and hazardous waste management, and air pollution abatement. Calculation of pollution potential and treatment system parameters.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 3833 Applied Hydraulics**

**Prerequisites:** Minimum grade of "C" in ENSC 3233, and (CHEM 1414 or CHEM 1515).

**Description:** Basic hydraulic principles and their application in civil engineering problems. Analyses of water distribution networks, open channels, storm-water management and wastewater collection systems, water pumps, hydraulic models, hydraulic measurements, treatment plant hydraulics and hydraulic structures.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 3843 Hydrology I**

**Prerequisites:** Minimum grade of "C" in ENSC 3233 and (CHEM 1414 or CHEM 1515), and minimum grade of "C" in STAT 4033 or STAT 4073.

**Description:** Basic principles of surface groundwater hydrology and their application in engineering problems. The hydrologic cycle, weather and hydrology, precipitation, evaporation, transpiration, subsurface waters, stream flow hydrographs, hydrologic and hydraulic stream routing, probability of hydrologic events, application of hydrologic models. May not be used for degree credit with BAE 4314.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 3853 Environmental Engineering Laboratory**

**Prerequisites:** CIVE 3813 with minimum grade of "C".

**Description:** Performance of experiments with benchscale environmental engineering unit operations, review of chemical principles and analyses important to the evaluation of these and other environmental engineering applications. Emphasis on the development of experimental results that can be used in the design of full-scale units. May not be used for degree credit with CIVE 5813.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4010 Civil Engineering Research**

**Prerequisites:** Senior standing or consent of instructor.

**Description:** Research and investigation of civil engineering problems. Offered for variable credit, 1-4 credit hours, maximum of 12 credit hours.

**Credit hours:** 1-4

**Contact hours:** Contact: 1-4 Other: 1-4

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 4013 Aquatic Chemistry**

**Prerequisites:** Senior standing and minimum grade of "C" in CHEM 1414 or CHEM 1515, and minimum grade of "C" in CIVE 3813.

**Description:** Application of chemical principles to environmental problems. Chemical kinetics, chemical equilibrium, acid-base chemistry, development of pc-pH diagrams, and coordination chemistry. Precipitation and dissolution reactions and oxidation-reduction reactions. Course is a senior elective. May not be used for degree credit with CIVE 5013.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4033 GIS Applications for Water Resources**

**Prerequisites:** Senior standing.

**Description:** Application of theoretical and practical components of geographic information system for engineers. Digital mapping of water resources information, spatial coordinate systems and digital terrain analysis using digital elevation models. Analysis of a variety of spatial data in efficient and effective manner. Introduction of geospatial analytical algorithms to solve civil and environmental problems. Course is a senior elective. May not be used for degree credit with CIVE 5033.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4041 Engineering Practice**

**Prerequisites:** Senior standing.

**Description:** Topics relevant to the professional practice of civil and environmental engineering will be introduced, to include management principles, project management, and the laws that impact the practice of engineering, such as OSHA and ADA. Emphasis will be placed on written communication skills to include resumes, letters of introduction, and job interviews. The advantages of professional registration and technical/ professional society membership will be presented as well as discussions of professional ethics, income taxes and investments. Course previously offered as CIVE 4042.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4043 Senior Design**

**Prerequisites:** Minimum grades of "C" in each: CIVE 3623 and CIVE 3633 and CIVE 3714 and CIVE 3833; and within last two semesters of program completion. Minimum grade of "C" in CIVE 3513 or CIVE 3523.

**Description:** Major comprehensive design experience using the team approach. Industry practitioners provide design projects and analyze and critique results. Extends the undergraduate experience and provides the student with opportunities to analyze and design complex structures. Capstone course. May not be used for degree credit with CIVE 4143.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4050 Special Topics in Civil & Environmental Engineering**

**Prerequisites:** Senior standing and within last 2 semesters of program completion.

**Description:** New courses offered in CIVE that have yet to be assigned a permanent number.

**Credit hours:** 1-4

**Contact hours:** Contact: 1-4 Other: 1-4

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 4083 Applied Statistics for Civil Engineers**

**Prerequisites:** Senior standing, and CIVE 3633 with minimum grade of "C," and STAT 4033 or STAT 4073 with minimum grade of "C."

**Description:** This course covers subjects including statistical fundamentals; continuous, count, discrete dependent variable models, random parameter models, and Bayesian modeling that are widely used in civil, particularly transportation engineering. Course is a senior elective. May not be used for degree credit with CIVE 5083.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4103 Construction Simulation**

**Prerequisites:** Senior standing and CIVE 4273 with minimum grade of "C."

**Description:** This course introduces students to effective ways of modeling construction processes and technologies. It provides an investigation of quantitative methods used for the design and analysis of construction operations to maximize productivity and minimize resource idleness. It includes discussions on queueing theory, line-of-balance techniques, linear programming and simulation. Comprehensive group projects that involve modeling and analyzing actual construction operations will be integral parts of this course. Course is a senior elective. May not be used for degree credit with CIVE 5103.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4113 Construction Business Management**

**Prerequisites:** Senior standing.

**Description:** Fundamental theories and applied methods of financial management of construction companies. The spectrum of the present and future practice of business management at the construction company level. Basic construction business operations in the context of construction accounting, financial management, cash flow analysis, financial planning, and risk analysis. May not be used for degree credit with CIVE 5113.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4123 The Legal & Regulatory Environment of Civil Engineering**

**Prerequisites:** Professional School.

**Description:** The U.S. and Oklahoma court systems. Tort law and labor law having an impact on engineering and construction. Union organization and activities. Government contracting and the laws governing it. Discussions of the Occupation Safety and Health Act and Americans with Disabilities Act. In-Depth look at environmental policy, laws, and regulations affecting engineering, including NEPA, CWA, SDWA, RCRA, CERCLA and CAA Water law. May not be used for degree credit with CIVE 5123.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4133 Construction Contracts and Specifications**

**Prerequisites:** Senior standing.

**Description:** The nature of contracts. Contract documents. Master format. Principles of specification writing. Contract types. Bonds and insurance. Bidding. Subcontracting. Disputes and disputes resolution. Course is a senior elective. May not be used for degree credit with CIVE 5133.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4143 Environmental Engineering Design**

**Prerequisites:** Minimum grade of "C" in each; CIVE 3714 and CIVE 3833 and CIVE 3853 and CIVE 4833, and within last semester of program completion.

**Description:** Actors involved in the design of engineered environmental systems. Solving "real world" environmental engineering problems. Design experience using decision-making techniques, integrating and expanding upon current knowledge, and defending decisions made. Economic, environmental, social, and regulatory aspects of environmental engineering design. Capstone course. May not be used for degree credit with CIVE 4043.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4153 Contract Administration**

**Prerequisites:** Senior standing.

**Description:** Methods and techniques of tracking and control of construction projects. Evaluation of current research findings to contract implementation. Course is a senior elective. May not be used for degree credit with CIVE 5153.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng



**CIVE 4163 Construction Equipment Management****Prerequisites:** Senior standing.**Description:** Analysis of construction equipment. Performance under various operating conditions. Application of engineering fundamentals to construction methods. Selection and costs of equipment, prediction of equipment production rates, and unit costs of work in place. Course is a senior elective. May not be used for degree credit with CIVE 5163.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4183 Construction Estimating****Prerequisites:** Senior standing, and concurrent prerequisite CIVE 4273 with minimum grade of "C."**Description:** The construction industry, its makeup, operation, estimating, and bidding procedures. Theory and practice of estimating materials, labor, equipment, and overhead costs for various types of construction. Emphasis on preliminary cost estimates during the conceptual design phase of a construction project. May not be used for degree credit with CIVE 5183.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4193 BIM for Construction****Prerequisites:** Senior standing, and concurrent prerequisite CIVE 4273 with minimum grade of "C."**Description:** The course focuses on advanced information systems used to control and predict project performance (cost and schedule) in construction. Building information Modeling is examined as a systems approach of integrating design and construction for the benefit of developing construction work packages, 4D simulations, clash detection, and the process of implementing BIM on an enterprise to project level. May not be used for degree credit with CIVE 5193.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4243 Use and Design of Geosynthetics****Prerequisites:** Senior standing and CIVE 3714 with minimum grade of "C."**Description:** Description of types of geosynthetics available for engineering uses. Pertinent engineering properties required to design for various functions, basic design methodology for geosynthetics for various functions, and construction and performance considerations. May not be used for degree credit with CIVE 5243.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4273 Construction Engineering and Project Management****Prerequisites:** Senior standing and ENGR 1412 with minimum grade of "C."**Description:** Principles and practice of construction engineering and project management. Project planning, development of cost estimates and project schedules, construction methods and fundamental terminology used in the engineering and construction industry. May not be used for degree credit with CIVE 5073.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Civil & Environ. Eng**CIVE 4283 Numerical Methods in Geotechnical Engineering****Prerequisites:** CIVE Professional School and CIVE 3714 with minimum grade of C.**Description:** The course covers a brief review of some fundamental principles of finite element method and its application to problems in geotechnical engineering. Students will use computer programs to perform analysis of geotechnical earth structures including flow through porous media, unsaturated and expansive soils. May not be used for degree credit with CIVE 5283.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4293 Design and Analysis of Earth Retaining Structures****Prerequisites:** CIVE professional school and CIVE 3714 minimum grade of C.**Description:** Lateral earth pressure theories. Use of earth retaining structures in civil engineering construction. Design and analysis of gravity, sheet pile, soil nail, and MSE walls by hand calculation and with a computer program. May not be used for degree credit with CIVE 5293.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4303 Systems Analysis for Civil Engineers****Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.**Description:** Synthesis of systems modeling and simulation techniques, mathematical optimization procedures, and evaluation tools of multi-attributed systems including utility theory and decision analysis. Mathematical optimization techniques in the areas of resource allocation, transportation and water resources systems planning, structural design, construction management, and environmental and ecological problems. Course is a senior elective. May not be used for degree credit with CIVE 5303.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng

**CIVE 4313 Highway Traffic Operations**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Level of service, capacity and service volume concepts. Operational characteristics of uninterrupted-flow and interrupted-flow of traffic facilities. The 1985 HCM procedures for analyzing the capacity of freeways, multi-lane and two-lane rural highways, urban arterials, signalized and unsignalized street intersections, and transit and pedestrian facilities. Administrative and planning actions for congestion management. Design alternatives and improvement strategies for effective use of urban arterial street width. Course is a senior elective. May not be used for degree credit with CIVE 5313.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4323 Civil Infrastructure Systems**

**Prerequisites:** Senior standing and CIVE 3633 with minimum grade of "C".

**Description:** The course presents a unified approach to the management of civil infrastructure systems. Topics of discussion include various aspects of asset management analytical methods, data collection technologies, life cycle cost, prioritization and optimization, climate change and sustainability. Types of infrastructure considered in the course include pavements (roads and airports), bridges, drainage and sewer systems, water supply systems, and power supply facilities. May not be used for degree credit with CIVE 5323.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4343 Urban Transportation Planning**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Determinants of demand for transportation and models for demand forecasting. Performance characteristics of transportation systems and models for performance. Quantitative analysis of multimodal transportation networks including prediction of flow patterns and service quality. Evaluation of social, environmental, and political impacts of transportation decisions. Application of systems analysis techniques to the generation, evaluation, and selection of alternative transportation systems. Course is a senior elective. May not be used for degree credit with CIVE 5343.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4363 Design and Planning of Airports**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Nature of civil aviation. Aircraft characteristics and performance related to airport planning and design. Air traffic control and navigation systems. Basics of airport planning and airport demand forecasting. Analysis of airport capacity and delays. Runway length requirements. Configuration and geometric design of runways, taxiways, holding aprons, and landing areas. Airport lighting, marking, and signing. Drainage and noise control. Course is a senior elective. May not be used for degree credit with CIVE 5363.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4373 Design of Traffic Control Systems**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Traffic control systems design, available technological options, and range of agency needs. Design of vehicle detectors, controllers, communications links, signal display hardware, and wiring. Development of timing plans using computer simulation models. Freeway surveillance and control: ramp metering, incident detection, and motorist information systems. Preparation of contractual documents and construction supervision. Course is a senior elective. May not be used for degree credit with CIVE 5373.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4383 Geometric Design of Highways**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Geometric, functional, and aesthetic aspects of roadway design. Alignment, sight distance, at-grade intersections, interchanges, and freeway systems. Design tools and techniques. Course is a senior elective. May not be used for degree credit with CIVE 5383.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4403 Advanced Strength of Materials**

**Prerequisites:** Senior standing and CIVE 3413 with minimum grade of "C".

**Description:** General states of stress and strain, theories of failure, energy principles, beam bending, shear center, torsion of prismatic shafts, beams on elastic foundations, plates and shells, elastic stability. May not be used for degree credit with CIVE 5403.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4413 Classical and Matrix Methods of Structural Analysis**

**Prerequisites:** Senior standing and CIVE 3413 with minimum grade of "C".

**Description:** Advanced analysis of indeterminate frames, trusses and arches by classical, numerical, energy, and stiffness methods with emphasis on methods for hand computations and development of matrix analysis. May not be used for degree credit with CIVE 5413.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4483 Concrete Testing and Monitoring Methods**

**Prerequisites:** Senior standing and CIVE 3623 with minimum grade of "C," or CIVE 3523 with minimum grade of "C."

**Description:** Standard and advanced concrete testing and monitoring methods used for strength assessment of concrete, along with other various material properties and integrity issues in the laboratory and in the field. Principles, applications and limitations, procedures, equipment operation and result interpretation are discussed for each destructive and non-destructive evaluation technique reviewed: mechanical, chemical, electrical, ultrasonic and acoustics, thermography, radiography. This course includes a laboratory session to develop manipulation skills and review concepts presented in lectures. Course is a senior elective. May not be used for degree credit with CIVE 5483.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4493 Infrastructure Condition Assessment and Repair**

**Prerequisites:** Senior standing and CIVE 3623 with minimum grade of "C," and CIVE 3523 with minimum grade of "C."

**Description:** The course provides guidelines on how to conduct a practical condition assessment of reinforced concrete infrastructure, which includes discussions on performing condition surveys, preliminary and detailed investigations; along with concrete properties, distress features and associated causes, diagnostics testing; reporting findings and recommendation. It also includes a discussion in basic repair methods and materials. Course is a senior elective. May not be used for degree credit with CIVE 5493.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4513 Advanced Reinforced Concrete Design**

**Prerequisites:** Senior standing and CIVE 3523 with minimum grade of "C".

**Description:** Advanced topics in reinforced concrete design with emphasis on frames, slabs and earthquake resistant structures. May not be used for degree credit with CIVE 5513.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4523 Advanced Steel Structure Design**

**Prerequisites:** Senior standing and CIVE 3513 with minimum grade of "C".

**Description:** Advanced topics in steel design such as plastic design, plate girders, composite design, fatigue and fracture, stability and bracing design. May not be used for degree credit with CIVE 5523.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4533 Prestressed Concrete**

**Prerequisites:** Senior standing and CIVE 3523 with minimum grade of "C".

**Description:** Design of simple and continuous prestressed concrete beams. Behavior under overload. Calculation of prestress losses and deflections. May not be used for degree credit with CIVE 5533.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4563 Structural Dynamics**

**Prerequisites:** Senior standing and minimum grade of "C" in CIVE 3413 and ENSC 2123.

**Description:** Analysis of linear, elastic damped and undamped systems with single and multiple degrees of freedom undergoing free forced vibration. Lumped and distributed mass systems. Computational techniques to numerically integrate the equations of motion. May not be used for degree credit with CIVE 5563.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4573 Timber Design**

**Prerequisites:** Senior standing and CIVE 3513 or CIVE 3523 with minimum grade of "C."

**Description:** Design of structural timber members, assemblies, and connections in accordance with ANSA/AF&PA, NDS specifications. Design, build, and test timber structure. Course is a senior elective. May not be used for degree credit with CIVE 5573.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4583 Advanced Construction Materials**

**Prerequisites:** CIVE Professional School and CIVE 3623 with minimum grade of "C."

**Description:** Undergraduate elective course addresses advanced topics on fundamental material properties and related design criteria for products commonly used in civil construction: timber and engineered wood products, metals and alloys, polymers and fiber reinforced composites; and glass. Lectures will include material specific topics on: physical, chemical and mechanical properties; fabrication methods; use and applications; standards, testing and quality control measures; selection and design criteria. May not be used for degree credit for CIVE 5583.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4653 Asphalt Materials and Mix Design**

**Prerequisites:** Senior standing and CIVE 3623 with minimum grade of "C".

**Description:** Principles of asphalt concrete mix design including material characteristics and performance. Evaluation of Superpave mix design methods. Asphalt cements, rubberized asphalt polymer asphalts, emulsions, cutbacks, and aggregates. Laboratory sessions focused on the engineering properties of the materials discussed. May not be used for degree credit with CIVE 5653.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4673 Concrete Materials and Mix Design**

**Prerequisites:** Senior standing and CIVE 3623 with minimum grade of "C."

**Description:** Principles of concrete mix design, including material characteristics, strength and durability requirements, environmental effects and forensic analysis. ACI and PCA mix design procedures. Laboratory on theoretical and practical aspects of concrete technology. Course is a senior elective. May not be used for degree credit with CIVE 5673.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4693 Pavement Design and Analysis**

**Prerequisites:** Senior standing and minimum grade of "C" in CIVE 3633 and CIVE 3623.

**Description:** Principles of pavement design, including stress analyses, load and environmental effects, and material characteristics. AASHTO, PCA and AI methods of pavement design. Computer methods practical aspects of life cycle cost analyses and construction methods. May not be used for degree credit with CIVE 5693.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4711 Basic Soils Testing Laboratory**

**Prerequisites:** Non CIVE majors only, ARCH 4143 for ARCH students.

**Description:** Laboratory measurements of the physical and mechanical properties of soils; grain size distribution, plasticity, permeability, compaction, compressibility, and shear strength.

**Credit hours:** 1

**Contact hours:** Lab: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Civil & Environ. Eng

**CIVE 4723 Foundation Engineering**

**Prerequisites:** Senior standing and CIVE 3714 with minimum grade of "C."

**Description:** Types of structural foundations including footings, mats, rafts, piles and drilled shafts. Site characteristics, exploration programs, field data, test results, construction materials and methods as basis for selection of type of foundation and design. Geotechnical design procedures and considerations. Course is a senior elective. May not be used for degree credit with CIVE 5723.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4733 Soil Mechanics**

**Prerequisites:** Senior standing and CIVE 3714 with minimum grade of "C."

**Description:** Application of soil mechanics principles and concepts in geotechnical areas of permeability and seepage, settlement analysis, bearing capacity, lateral earth pressures and retaining walls, slope stability, and metastable soils. Course is a senior elective. May not be used for degree credit with CIVE 5713.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4743 Project Engineering and Management**

**Prerequisites:** Senior standing and concurrent prerequisite CIVE 4273 with minimum grade of "C".

**Description:** Management of the design and construction of civil engineering projects. Topics include owner's study, formation of project teams, design coordination, construction, and project closeout. Course is a senior elective. May not be used for degree credit with CIVE 5143.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4753 Engineering Soil Stabilization**

**Prerequisites:** Senior standing and CIVE 3714 with minimum grade of "C."

**Description:** Theoretical and practical aspects of engineering soil stabilization as a method for improving and upgrading low quality and unstable soils for engineering purposes. Use of lime, fly ash, portland cement, asphalt, and other physical and chemical admixtures. Application of deep foundation stabilization methods such as preloading, deep compaction, injection and reinforcement. Course is a senior elective. May not be used for degree credit with CIVE 5753.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4773 Soil-Structure Interaction**

**Prerequisites:** Senior standing and CIVE 3714 with minimum grade of "C."

**Description:** The mechanical interaction effects between soils and structures using suitable engineering procedures such as finite differences and finite element methods. Civil engineering problems where interaction effects are most dominant including grade beams (beams on elastic foundation), axially- and laterally-loaded piles, cantilever, and anchored sheet pile walls. Course is a senior elective. May not be used for degree credit with CIVE 5743.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4833 Unit Operations in Environmental Engineering**

**Prerequisites:** Senior standing and minimum grade of "C" in CIVE 3813.

**Description:** Fundamental principles of water and wastewater treatment, including basic theory and development of design parameters. Application of these to the design of unit operations and processes in various treatment plants. May not be used for degree credit with CIVE 5843.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4863 Advanced Unit Operations in Environmental Engineering**

**Prerequisites:** Senior standing and CIVE 4833 with minimum grade of "C."

**Description:** Theory and design of advanced physical-chemical water and wastewater treatment processes applied to municipal, industrial, and hazardous waste situations. Course is a senior elective. May not be used for degree credit with CIVE 5863.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4873 Air Pollution Control Engineering**

**Prerequisites:** Senior standing and CIVE 4833 with minimum grade of "C."

**Description:** Causes, effects, and control of atmospheric pollution. Course is a senior elective. May not be used for degree credit with CIVE 5873.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4883 Introduction to Environmental Modeling**

**Prerequisites:** CIVE Professional School and minimum grade of C in ENSC 3233 and CIVE 3813 and CIVE 3833.

**Description:** Intended as an introductory course for senior undergraduate students to the fundamentals of environmental modeling. Develops material necessary to construct models capable of identifying contaminant distributions at future times and space for water and air pollution applications. Advanced topics such as stochastic modeling, ecological risk assessment, neural modeling and spatial statistical analysis among others will be presented according to the backgrounds and interests of the enrolled students. May not be used for degree credit with CIVE 5833 and BAE 5343.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4903 Microbiology for Engineers**

**Prerequisites:** Senior standing.

**Description:** Microbiology relates to many aspects of engineering, primarily environmental engineering. The class will cover the roles of bacteria in water and wastewater treatment, the bioremediation of hazardous substances, the mechanisms of antibiotic resistance, the molecular tools for studying and tracking bacteria, and special topics with regards to bacteria in common engineered environments. Basic microbiology and biochemistry will be covered throughout the course providing necessary background. May not be used for degree credit with CIVE 5903.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4913 Groundwater Hydrology**

**Prerequisites:** CIVE Professional School and CIVE 3843 with minimum grade C.

**Description:** Theory of groundwater movement, storage, exploration and pumping tests. Design of groundwater recovery and recharge systems. May not be used for degree credit with CIVE 5913.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4923 Environ Risk Assessment**

**Prerequisites:** Professional School and minimum grade of "C" in CIVE 3813 and STAT 4033 or STAT 4073 with minimum grade of "C".

**Description:** Environmental risk assessment and management. Applies elements of statistics, probability and environmental simulation to determine the public health and ecological risks from activities of humans. May not be used for degree credit with CIVE 5823.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4933 Water Treatment**

**Prerequisites:** Senior standing and CIVE 4833 with minimum grade of "C".

**Description:** Theory, design, and operation of water treatment plants.

Sizing of various unit processes. Water treatment plant control procedures. May not be used for degree credit with CIVE 5933.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4943 Risk and Failure Analysis of Dams**

**Prerequisites:** CIVE Professional School.

**Description:** Analyzing, evaluating and managing risks to Dams and providing a rigorous, systematic, and thorough approach to sustain and support of safety aspects. Evaluating CUASI Data to support aspects of the environment near and around Dams. Using new technologies such as ArcInfo to provide solutions to problems. May not be used for degree credit with CIVE 5043.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4953 Biological Waste**

**Prerequisites:** Senior standing and CIVE 4833 with minimum grade of C.

**Description:** Fundamentals of microbial systems applied to waste treatment processes. Standard suspended-growth and fixed biofilm wastewater and sludge suspensions and treatment system design calculations. May not be used for degree credit with CIVE 5953.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4963 Open Channel Flow**

**Prerequisites:** CIVE Professional School and CIVE 3833 with minimum grade of C.

**Description:** Open channel hydraulics, energy and momentum concepts, resistance, channel controls and transitions, flow routing and sediment transport. May not be used for degree credit with CIVE 5963.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4973 Concrete Durability**

**Prerequisites:** Senior standing and CIVE 3623 with minimum grade of "C."

**Description:** This course investigates the mechanisms, test methods, and evaluation procedures for the primary mechanisms for durability issues in concrete. Emphasis is placed on providing a practical and theoretical overview of the topics. Special topics may be covered with the interest of the students. Course is a senior elective. May not be used for degree credit with CIVE 5273.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4983 Residuals & Solid Waste Management**

**Prerequisites:** Professional School and CIVE 4833 with minimum grade of "C".

**Description:** Theory, design and operation of systems for handling, treatment, and disposal of process sludge (water treatment, wastewater treatment, industrial) and solid wastes. Potential material reclamation options. May not be used for degree credit with CIVE 5883.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5000 Master's Thesis**

**Description:** A student studying for a master's degree will enroll in this course for a total of 6 credits if a thesis is to be written. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 5010 Civil Engineering Seminar**

**Description:** Review of literature of major fields of civil engineering.

Offered for variable credit, 1-3 credit hours, maximum of 15 credit hours.

**Credit hours:** 1-3

**Contact hours:** Contact: 1-3 Other: 1-3

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 5013 Aquatic Chemistry**

**Description:** Application of chemical principles to environmental problems. Chemical kinetics, chemical equilibrium, acid-base chemistry, development of pc-pH diagrams, and coordination chemistry. Precipitation and dissolution reactions and oxidation-reduction reactions. CHEM 1515 or equivalent background required. May not be used for degree credit with CIVE 4013.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5020 Civil Engineering Research**

**Prerequisites:** Graduate standing and approval of major professor.

**Description:** Research and investigations other than thesis studies.

Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 5030 Engineering Practice****Prerequisites:** Approval of adviser.**Description:** Professional supervised civil engineering practice involving authentic projects for which the student assumes a degree of professional responsibility. Activities must be approved in advance by the student's adviser and may consist of engineering experience on-campus or off-campus, or both. Periodic reports, both oral and written, are required as specified by the adviser. Offered for variable credit, 1-6 credit hours, maximum of 9 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Civil & Environ. Eng**CIVE 5033 GIS Applications for Water Resources****Prerequisites:** Graduate standing or professional school.**Description:** Application of theoretical and practical components of geographic information system for engineers. Digital mapping of water resources information, spatial coordinate systems and digital terrain analysis using digital elevation models. Analysis of a variety of spatial data in efficient and effective manner. Introduction of geospatial analytical algorithms to solve civil and environmental problems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 5043 Risk and Failure Analysis of Dams****Prerequisites:** Graduate standing or professional school.**Description:** Analyzing, evaluating and managing risks to Dams and providing a rigorous, systematic, and thorough approach to sustain and support of safety aspects. Evaluating CUASI Data to support aspects of the environment near and around Dams. Using new technologies such as ArcInfo to provide solutions to problems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 5073 Constr Equip and Proj Mngmnt****Description:** Principles and practice of construction engineering and project management. Project planning, development of cost estimates and project schedules, construction methods and fundamental terminology used in the engineering and construction industry. May not be used for degree credit with CIVE 4273.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Civil & Environ. Eng**CIVE 5080 Engineering Problems****Prerequisites:** Permission of instructor.**Description:** Problems of particular interest to graduate students in the field of civil engineering. This course meets the criteria for a creative component. Not to be included on thesis plans. Offered for variable credit, 1-3 credit hours, maximum of 3 credit hours.**Credit hours:** 1-3**Contact hours:** Contact: 1-3 Other: 1-3**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Civil & Environ. Eng**CIVE 5083 Applied Statistics for Civil Engineers****Description:** This course covers subjects including statistical fundamentals; continuous, count, discrete dependent variable models, random parameter models, and Bayesian modeling that are widely used in civil, particularly transportation engineering. Course is a senior elective. May not be used for degree credit with CIVE 4083.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 5103 Construction Simulation****Description:** This course introduces students to effective ways of modeling construction processes and technologies. It provides an investigation of quantitative methods used for the design and analysis of construction operations to maximize productivity and minimize resource idleness. It includes discussions on queueing theory, line-of-balance techniques, linear programming and simulation. Comprehensive group projects that involve modeling and analyzing actual construction operations will be integral parts of this course. May not be used for degree credit with CIVE 4103.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 5113 Construction Business Management****Description:** Fundamental theories and applied methods of financial management of construction companies. The spectrum of the present and future practice of business management at the construction company level. Basic construction business operations in the context of construction accounting, financial management, cash flow analysis, financial planning, and risk analysis. May not be used for degree credit with CIVE 4113.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng

**CIVE 5123 The Legal and Regulatory Environment of Engineering**

**Prerequisites:** Graduate standing or admission to CIVE professional school required.

**Description:** The U.S. and Oklahoma court systems. Tort law and labor law having an impact on engineering and construction. Union organization and activities. Government contracting and the laws governing it. Discussions of the Occupation Safety and Health Act and Americans with Disabilities Act. In-Depth look at environmental policy, laws, and regulations affecting engineering, including NEPA, CWA, SDWA, RCRA, CERCLA and CAA Water law.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate, Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5133 Construction Contracts and Specifications**

**Description:** The nature of contracts. Contract documents. Master format. Principles of specification writing. Contract types. Bonds and insurance. Bidding. Subcontracting. Disputes and disputes resolution. May not be used for degree credit with CIVE 4133.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5143 Project Engineering and Management**

**Description:** Management of the design and construction of civil engineering projects. Topics include owner's study, formation of project teams, design coordination, construction, and project closeout. May not be used for degree credit with CIVE 4743.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5153 Contract Administration**

**Description:** Methods and techniques of tracking and control of construction projects. Evaluation of current research findings to contract implementation. May not be used for degree credit with CIVE 4153.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5163 Construction Equipment Management**

**Description:** Analysis of construction equipment. Performance under various operating conditions. Application of engineering fundamentals to construction methods. Selection and costs of equipment, prediction of equipment production rates, and unit costs of work in place. May not be used for degree credit with CIVE 4163.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5183 Construction Estimating**

**Prerequisites:** Graduate standing and CIVE major.

**Description:** The construction industry, its makeup, operation, estimating, and bidding procedures. Theory and practice of estimating, materials, labor, equipment, and overhead costs for various types of construction. Emphasis on preliminary cost estimates during the conceptual design phase of a construction project. May not be used for degree credit with CIVE 4183.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5193 BIM for Constructions**

**Prerequisites:** CIVE major and graduate standing.

**Description:** The course focuses on advanced information systems used to control and predict project performance (cost and schedule) in construction. Building information modeling is examined as a systems approach of integrating design and construction for the benefit of developing construction work packages, 4D simulations, clash detection, and the process of implementing BIM on an enterprise to project level. May not be used for degree credit with CIVE 4193.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5203 Pavement Rehabilitation, Management and Safety**

**Prerequisites:** Graduate standing or senior standing with instructor approval.

**Description:** Understand and perform pavement evaluations of function, structure, surface condition, and surface safety and learn various types of equipment for evaluating pavement function, structure, and surface condition and safety. Describe techniques for rehabilitation of flexible and rigid pavements, and overall objectives and major components of a pavement management system. Understand and explain the basic techniques of safety analysis based on pavement surface data.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5243 Use and Design of Geosynthetics**

**Prerequisites:** Graduate student.

**Description:** Description of types of geosynthetics available for engineering uses. Pertinent engineering properties required to design for various functions, basic design methodology for geosynthetics for various functions, and construction and performance considerations. May not be used for degree credit with CIVE 4243.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng



**CIVE 5253 Sensors and their Applications for Pavement**

**Prerequisites:** Graduate standing or senior standing with instructor approval.

**Description:** Sensor Principles of Falling Weight Deflectometer (FWD), Rolling Weight Deflectometer (RWD) and Traffic Speed Deflectometer (TSD); 2D and 3D laser imaging as used in pavement surface condition survey; Laser rangefinders and accelerometers for pavement longitudinal profile; Friction and texture measurement of pavement surface; New software and mobile tools for presenting sensor data with HTML5; 3D visualization and database management with pavement sensor data; Inertial navigation system and high-precision gyro for pavement data positioning; LIDAR and its usage for infrastructure management.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5273 Concrete Durability**

**Prerequisites:** CIVE 5673 Concrete Mixture Design and graduate standing or permission of instructor.

**Description:** This course investigates the mechanisms, test methods, and evaluation procedures for the primary mechanisms for durability issues in concrete. Emphasis is placed on providing a practical and theoretical overview of the topics. Special topics may be covered with the interest of the students.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5283 Numerical Methods in Geotechnical Engineering**

**Prerequisites:** Graduate standing, or professional school and CIVE 3714 for undergraduates.

**Description:** The course covers a brief review of some fundamental principles of finite element method and its application to problems in geotechnical engineering. Students will use computer programs to perform analysis of geotechnical earth structures including flow through porous media, unsaturated and expansive soils.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5293 Design and Analysis of Earth Retaining Structures**

**Prerequisites:** CIVE major and graduate standing.

**Description:** Lateral earth pressure theories. Use of earth retaining structures in civil engineering construction. Design and analysis of gravity, sheet pile, soil nail, and MSE walls by hand calculation and with a computer program. May not be used for degree credit with CIVE 4293.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5303 Systems Analysis for Civil Engineers**

**Description:** Synthesis of systems modeling and simulation techniques, mathematical optimization procedures, and evaluation tools of multi-attributed systems including utility theory and decision analysis. Mathematical optimization techniques in the areas of resource allocation, transportation and water resources systems planning, structural design, construction management, and environmental and ecological problems. May not be used for degree credit with CIVE 4303.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5313 Highway Traffic Operations**

**Description:** Level of service, capacity and service volume concepts. Operational characteristics of uninterrupted-flow and interrupted-flow traffic facilities. The 1985 HCM procedures for analyzing the capacity of freeways, multilane and two-lane rural highways, urban arterials, signalized and unsignalized street intersections, and transit and pedestrian facilities. Administrative and planning actions for congestion management. Design alternatives and improvement strategies for effective use of urban arterial street width. May not be used for degree credit with CIVE 4313.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5323 Civil Infrastructure Systems**

**Prerequisites:** Graduate student.

**Description:** The course presents a unified approach to the management of civil infrastructure systems. Topics of discussion include various aspects of asset management: analytical methods, data collection technologies, life cycle cost, prioritization and optimization, climate change and sustainability. Types of infrastructure considered in the course include pavements (roads and airports), bridges, drainage and sewer systems, water supply systems, and power supply facilities. May not be used for degree credit with CIVE 4323.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5333 Reliability and Risk of Components and Systems**

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5343 Urban Transportation Planning**

**Description:** Determinants of demand for transportation and models for demand forecasting. Performance characteristics of transportation systems and models for performance. Quantitative analysis of multimodal transportation networks including prediction of flow patterns and service quality. Evaluation of social, environmental, and political impacts of transportation decisions. Application of systems analysis techniques to the generation, evaluation, and selection of alternative transportation systems. May not be used for degree credit with CIVE 4343.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5363 Design and Planning of Airports**

**Description:** Nature of civil aviation. Aircraft characteristics and performance related to airport planning and design. Air traffic control and navigation systems. Basics of airport planning and airport demand forecasting. Analysis of airport capacity and delays. Runway length requirements. Configuration and geometric design of runways, taxiways, holding aprons, and landing areas. Airport lighting, marking, and signing. Drainage and noise control. May not be used for degree credit with CIVE 4363.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5373 Design of Traffic Control Systems**

**Description:** Traffic control systems design, available technological options, and range of agency needs. Design of vehicle detectors, controllers, communications links, signal display hardware, and wiring. Development of timing plans using computer simulation models. Freeway surveillance and control: ramp metering, incident detection, and motorist information systems. Preparation of contractual documents and construction supervision. May not be used for degree credit with CIVE 4373.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5383 Geometric Design of Highways**

**Description:** Geometric, functional, and aesthetic aspects of roadway design. Alignment, sight distance, at-grade intersections, interchanges, and freeway systems. Design tools and techniques. May not be used for degree credit with CIVE 4383.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5403 Advanced Strength of Materials**

**Description:** General states of stress and strain, theories of failure, energy principles, beam bending, shear center, torsion of prismatic shafts, beams on elastic foundations, plates and shells, elastic stability. May not be used for degree credit with CIVE 4403.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5413 Classical and Matrix Methods of Structural Analysis**

**Prerequisites:** Graduate standing or admission to CIVE professional school, and CIVE 3413.

**Description:** Advanced analysis of indeterminate frames, trusses and arches by classical, numerical, energy, and stiffness methods with emphasis on methods for hand computations and development of matrix analysis.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5423 Matrix Analysis of Structures**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3413.

**Description:** Matrix analysis of two- and three-dimensional trusses and frames. Development of member stiffness matrices. Assemblage of structure matrices by direct stiffness method. Computer programs for structural analysis.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5433 Energy Methods in Applied Mechanics**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3413 and MATH 2233 or MAE 3323.

**Description:** Advanced structural mechanics from the standpoint of virtual work; energy principles and variational calculus applied to the analysis of structures, mechanisms, dynamics, and vibrations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5453 Engineering Analysis**

**Description:** Advanced, classical mathematical skills for engineers. Dimensional Analysis, General Tensor Analysis, Curvilinear Coordinates, Partial Differential Equations, Perturbation Theory, Integral Equations, Special Functions, Eigen Function Analysis, Integral Transform Methods, Variational Methods.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5473 Steel Plastic Design**

**Prerequisites:** Graduate standing or CIVE 3413 Structural Analysis and instructor approval.

**Description:** This course is for incoming graduate students that are not familiar with LRFD AISC based steel design. Topics typically covered in the undergraduate course are covered with additional topics.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5483 Concrete Testing and Monitoring Method**

**Prerequisites:** Graduate student.

**Description:** Standard and advanced concrete testing and monitoring methods used for strength assessment of concrete, along with other various material properties and integrity issues in the laboratory and in the field. Principles, applications and limitations, procedures, equipment operation and result interpretation are discussed for each destructive and non-destructive evaluation technique reviewed: mechanical, chemical, electrical, ultrasonic and acoustics, thermography, radiography. This course includes a laboratory session to develop manipulation skills and review concepts presented in lectures. May not be used for degree credit with CIVE 4483.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5493 Infrastructure Condition Assessment and Repair**

**Prerequisites:** Graduate student.

**Description:** The course provides guidelines on how to conduct a practical condition assessment of reinforced concrete infrastructure, which includes discussions on performing condition surveys, preliminary and detailed investigations; along with concrete properties, distress features and associated causes, diagnostics testing; reporting findings and recommendation. It also includes a discussion in basic repair methods and materials. May not be used for degree credit with CIVE 4493.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5503 Computer-Aided Structural Analysis and Design**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3413, CIVE 3513, CIVE 3523 (or concurrent enrollment); or permission of instructor.

**Description:** Major comprehensive design experience. Promotion of a design office atmosphere in using a team approach. Industry practitioners provide design projects and critique results. Analysis and design of complex structures and preparation of contract documents and drawings. Emphasis on modern computer-based computation and presentation tools.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5513 Advanced Reinforced Concrete Design**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3523.

**Description:** Advanced topics in reinforced concrete design with emphasis on frames, slabs, and earthquake-resistant structures.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5523 Advanced Steel Structure Design**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3513.

**Description:** Advanced topics in steel design such as plastic design, plate girders, composite design, fatigue and fracture, stability, and bracing design.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5533 Prestressed Concrete**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3523.

**Description:** Design of simple and continuous prestressed concrete beams. Behavior under overload. Calculation of prestress losses and deflections. May not be used for degree credit with CIVE 4533.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5543 Bridge Design**

**Prerequisites:** CIVE 3513 AND CIVE 3523.

**Description:** Structural design of steel and concrete highway bridges, including bridge types, parts of a bridge, loads and load distribution, analysis, design, and bridge rating. Emphasis on topics of special interest to students.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5563 Structural Dynamics**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and ENSC 2123 and CIVE 3413.

**Description:** Analysis of linear, elastic damped and undamped systems with single and multiple degrees of freedom undergoing free and forced vibration. Lumped and distributed mass systems. Computational techniques to numerically integrate the equations of motion. Course previously offered as CIVE 6433.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5573 Timber Design**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3523 or CIVE 3513.

**Description:** Design of structural timber members, assemblies, and connections in accordance with ANSA/AF&PA, NDS specifications. Design, build, and test timber structure.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5583 Advanced Construction Materials**

**Prerequisites:** Graduate student.

**Description:** The course addresses advanced topics on fundamental material properties and related design criteria for products commonly used in civil construction: timber and engineered wood products, metals and alloys, polymers and fiber reinforced composites; and glass. The lectures will include material specific topics on: physical, chemical and mechanical properties; fabrication methods; use and applications; standards, testing and quality control measures; selection and design criteria. May not be used for degree credit with CIVE 4583.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5653 Asphalt Materials and Mix Design**

**Prerequisites:** CIVE 3623 or consent of instructor.

**Description:** Principles of asphalt concrete mix design including material characteristics and performance. Evaluation of Hveem and Marshall mix design methods. Asphalt cements, rubberized asphalt polymer asphalts, emulsions, cutbacks, and aggregates. Laboratory sessions focused on the engineering properties of the materials discussed.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5673 Concrete Materials and Mix Design**

**Prerequisites:** Senior or graduate standing.

**Description:** Principles of concrete mix design, including material characteristics, strength and durability requirements, environmental effects and forensic analysis. ACI and PCA mix design procedures. Laboratory on theoretical and practical aspects of concrete technology.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5693 Pavement Design and Analysis**

**Prerequisites:** CIVE 3633 or consent of instructor.

**Description:** Principles of pavement design, including stress analyses, load and environmental effects, and material characteristics. AASHTO, PCA and AI methods of pavement design. Computer methods. Practical aspects of life cycle cost analyses and construction methods.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5713 Soil Mechanics**

**Prerequisites:** CIVE 3713 and CIVE 4711.

**Description:** Application of soil mechanics principles and concepts in geotechnical areas of permeability and seepage, settlement analysis, bearing capacity, lateral earth pressures and retaining walls, slope stability, and metastable soils. May not be used for degree credit with CIVE 4733.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5723 Foundation Engineering**

**Description:** Types of structural foundations including footings, mats, rafts, piles and drilled shafts. Site characteristics, exploration programs, field data, test results and construction materials and methods as basis for selection of type of foundation and design. Geotechnical design procedures and considerations. May not be used for degree credit with CIVE 4723.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5733 Rock Mechanics in Engineering Design and Construction**

**Prerequisites:** Undergraduate courses in soils and geology.

**Description:** Stresses, strength variations, and deformational behavior of rock. Engineering classification of rock. Methods of field and laboratory measurement of the engineering properties of rock. Rock mechanics consideration in the design and construction of engineering works.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5743 Soil-Struc Interaction**

**Description:** The mechanical interaction effects between soils and structures using suitable engineering procedures such as finite differences and finite element methods. Civil engineering problems where interaction effects are most dominant including grade beams (beams on elastic foundation), axially- and laterally-loaded piles, cantilever, and anchored sheet pile walls. May not be used for degree credit with CIVE 4773.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5753 Engineering Soil Stabilization**

**Description:** Theoretical and practical aspects of engineering soil stabilization as a method for improving and upgrading low quality and unstable soils for engineering purposes. Use of lime, fly ash, portland cement, asphalt, and other physical and chemical admixtures. Application of deep foundation stabilization methods such as preloading, deep compaction, injection and reinforcement. May not be used for degree credit with CIVE 4753.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5813 Environmental Laboratory Analysis**

**Prerequisites:** Graduate standing or permission of instructor.

**Description:** Analytical procedures for water and waste water contaminants. Emphasis on the chemical theory of procedures, analytical work and an understanding of the significance or need for such laboratory data for surface and groundwater management and water and wastewater treatment processes and design. May not be used for degree credit with CIVE 3853.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5823 Environmental Risk Assessment and Management**

**Prerequisites:** Graduate standing or permission of instructor.

**Description:** Environmental risk assessment and management. Applies elements of statistics, probability and environmental simulation to determine the public health and ecological risks from activities of humans. May not be used for degree credit with CIVE 4923.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5833 Introduction to Environmental Modeling**

**Description:** Intended as an introductory course for graduate and senior undergraduate students to the fundamentals of environmental modeling. Develops material necessary to construct models capable of identifying contaminant distributions at future times and space for water and air pollution applications. Advanced topics such as stochastic modeling, ecological risk assessment, neural modeling and spatial statistical analysis among others will be presented according to the backgrounds and interests of the enrolled students. In part, the course is designed as the "Physical Science" component for MS students in the Environmental Sciences program. May not be used for degree credit with CIVE 4883.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5843 Unit Operations in Environmental Engineering**

**Description:** Fundamental principles of water and wastewater treatment, including basic theory and development of design parameters. Application of these to the design of unit operations and processes in various treatment plans. May not be used for degree credit with CIVE 4833. CIVE 5843 was used to denote Hydrology II prior to 2004.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5853 Bioremediation**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and 3813, or permission of instructor.

**Description:** Process selection and design of bioremediation systems for renovation of contaminated hazardous and industrial waste sites, soils, sludge. Site analysis emphasizing contaminant and environmental characteristics. Engineering factors to promote successful bioremediation. Design project required.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate, Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5863 Advanced Unit Operations in Environmental Engineering**

**Description:** Theory and design of advanced physical-chemical water and wastewater treatment processes applied to municipal, industrial, and hazardous waste situations. May not be used for degree credit with CIVE 4863.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5873 Air Pollution Control Engineering**

**Description:** Causes, effects, and control of atmospheric pollution. Same course as CHE 5873. May not be used for degree credit with CIVE 4873.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5883 Residuals and Solid Waste Management**

**Prerequisites:** Graduate standing or admission to CIVE professional school required, or permission of instructor.

**Description:** Theory, design and operation of systems for handling, treatment, and disposal of process sludge (water treatment, wastewater treatment, industrial) and solid wastes. Potential material reclamation options. May not be used for degree credit with CIVE 4983.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5903 Microbiology for Engineers**

**Description:** Microbiology relates to many aspects of engineering, primarily environmental engineering. The class will cover the roles of bacteria in water and wastewater treatment, the bioremediation of hazardous substances, the mechanisms of antibiotic resistance, the molecular tools for studying and tracking bacteria, and special topics with regards to bacteria in common engineered environments. Basic microbiology and biochemistry will be covered throughout the course providing necessary background. May not be used for degree credit with CIVE 4903.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5913 Groundwater Hydrology**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and 3843, or permission of instructor.

**Description:** Theory of groundwater movement, storage, exploration and pumping tests. Design of groundwater recovery and recharge systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5933 Water Treatment**

**Description:** Theory, design, and operation of water treatment plants. Sizing of various unit processes. Water treatment plant control procedures. May not be used for degree credit with CIVE 4933.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5953 Biological Waste Treatment**

**Description:** Fundamentals of microbial systems applied to waste treatment processes. Standard suspended-growth and fixed biofilm wastewater and sludge suspensions and treatment system design calculations. May not be used for degree credit with CIVE 4953.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5963 Open Channel Flow**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3833, or permission of instructor.

**Description:** Open channel hydraulics, energy and momentum concepts, resistance, channel controls and transitions, flow routing, and sediment transport.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 6000 PhD Research Dissertation**

**Description:** Independent research under the direction of a member of the graduate faculty by students working beyond the level of Master of Science degree. Offered for variable credit, 1-16 credit hours, maximum of 30 credit hours.

**Credit hours:** 1-16

**Contact hours:** Contact: 1-16 Other: 1-16

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 6010 Seminar**

**Prerequisites:** Consent of instructor and approval of the student's advisory committee.

**Description:** Analytical studies with suitable reports on problems in one or more of the subfields in civil engineering by students working beyond the level of Master of Science degree. Offered for variable credit, 1-6 credit hours, maximum of 12 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 6403 Theory of Elasticity**

**Prerequisites:** Graduate standing or admission to CIVE professional school required, or permission of instructor.

**Description:** Stress, strain, and deformation analysis of two- and three-dimensional elastic continua. Propagation of stress waves through elastic continua.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 6413 Plate and Shell Structures**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 5403, or permission of instructor.

**Description:** Bending of thin plate structures to include rectangular and circular plates. Analysis of orthotropic plates by classical and numerical methods. Introduction to shell bending theory.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 6434 Finite Element Analysis**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Finite elements: formulation techniques, weighted residuals, variational techniques, shape functions and element types, isoparametric elements, convergence criteria, error analysis, and programming techniques. Applications to solid mechanics, structures, fluid mechanics, and heat transfer are discussed.

**Credit hours:** 4

**Contact hours:** Lecture: 4 Contact: 4

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 6553 Natural Hazards Engineering****Prerequisites:** Graduate standing and CIVE 5563.**Description:** Performance of structural systems exposed to extreme loadings from natural hazard events. The response, analysis, and design of structures exposed to earthquakes, wind, flood, and fire loadings are considered. Advanced analytical, computational, and experimental techniques. Current building code specifications.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 6843 Stochastic Methods in Hydrology****Prerequisites:** Graduate standing and STAT 4073 or STAT 4033.**Description:** Stochastic and statistical hydrologic analyses of surface water and ground water systems. Analyses of urban and rural drainage and detention systems. Same course as BAE 6313.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 6923 Industrial Wastes Engineering****Prerequisites:** Graduate standing or permission of instructor.**Description:** Theory and methods of waste minimization, waste product reduction or reuse; process changes and treatment of residuals to reduce volume and toxicity of industrial wastes.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng

## Undergraduate Programs

- Civil Engineering, BSCV (p. 2185)
- Civil Engineering: Environmental, BSCV (p. 2187)

## Graduate Programs

The School of Civil and Environmental Engineering offers two programs leading to post-baccalaureate degrees—the Master of Science degree in civil engineering, and the Doctor of Philosophy degree. The Master of Science degree is characterized by a technical specialization in a particular area of study. The Doctor of Philosophy degree is designed to prepare students for research and for the teaching profession in engineering.

Major areas of study in the School are applied mechanics, structural analysis, design, transportation, materials, construction engineering and management, geotechnical engineering, water resources and environmental engineering. Research is possible in all major fields. Master of Science in Civil Engineering candidates may choose either to specialize or to engage in a broadly based program of study, in accordance with an approved and purposeful plan of study.

## Admission Requirements

Candidates for the Master of Science or Doctor of Philosophy degree should have graduated from a civil engineering curriculum accredited by ABET. Graduates from other curricula and schools should submit

transcripts to the head of the School of Civil and Environmental Engineering for evaluation.

## Degree Requirements

All degree programs follow an approved plan of study that must be submitted at a designated time. All programs are characterized by the flexibility available in a study plan that is designed to satisfy the particular needs of the student, while conforming to the general requirements implied by the title of the degree and specified by the University.

The Master of Science degree in civil engineering requires the completion of at least 30 credit hours beyond the bachelor's degree, including a research thesis for which no more than six credit hours may be granted. The non-thesis option (32 credit hours) described in the Graduate College section may be permitted at the discretion of the student's advisory committee.

The Doctor of Philosophy degree requires the completion of at least 90 credit hours of coursework beyond the bachelor's degree, including not more than 30 credit hours for the research thesis. In addition, the candidate must meet the equivalency of the language requirement (six hours) in selected areas at the discretion of his or her committee to facilitate his or her research. Generally, official admission as a candidate for the Doctor of Philosophy degree in any program offered by the School will not be granted until a member of the Graduate Faculty in the School agrees to serve as major (or thesis) advisor for the prospective candidate.

## Faculty

Professor and M. R. Lohmann Chair—Norbert (Norb) Delatte, PhD, PE, F.ASCE, F.ACI

**Dean, College of Engineering, Architecture and Technology, Professor and Donald & Cathey Humphreys Chair:** Paul J. Tikalsky, PhD, PE, F.ASCE, F.ACI

**Professor and Gilbert, Cooper, W&W Steel Chair:** Tyler Ley, PhD, PE, F.ACI  
**Regents Professor and Decker Dawson Chair:** C. (Kelvin) Wang, PhD, PE

**Professors:** S.A. Ahmed, PhD, PE; Rifat Bulut, PhD

**Associate Professors:** Robert Emerson, PhD, PE; Mark Krzmarzick, PhD, PE; Qiang (Joshua) Li, PhD, PE; Debakanta (Deb) Mishra, Ph.D., P.E.; Bruce Russell, PhD, PE; Gregory G. Wilber, PhD, PE; Yong Wei Shan, PhD, PE; Mohamad Soliman, PhD

**Assistant Professors:** Mohamed Elkashef, PhD, PE; Mary Foltz, PhD; Jorge Gonzalez Estrella, PhD

**Adjunct Professors:** Garry Gregory, PhD, PE; Boris Dan Hernandez, PhD; Enos Stover, PhD, PE; Brian Wintle, PhD, PE

**Lecturer:** Matt Mitchell, PE

## Civil Engineering, BSCV

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 128**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I	3
or ENGL 1313	Critical Analysis and Writing I	
ENGL 3323	Technical Writing	3
or ENGL 1213	Composition II	
or ENGL 1413	Critical Analysis and Writing II	
<i>American History &amp; Government</i>		
Select one of the following:		
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
<i>Humanities (H)</i>		
Courses designated (H)		
6		
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course.		
CHEM 1414	General Chemistry for Engineers (LN) <sup>1</sup>	4
or CHEM 1515	Chemistry II (LN)	
BIOL 1114	Introductory Biology (LN)	4
or GEOL 1114	Physical Geology (LN)	
PHYS 2014	University Physics I (LN)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
SPCH 2713	Introduction to Speech Communication (S)	3
<b>Hours Subtotal</b>		<b>40</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan.		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Mathematics</i>		
MATH 2163	Calculus III	3
<i>Basic Science</i>		
CIVE 2081	Environmental Chemistry for Engineers <sup>1</sup>	1
PHYS 2114	University Physics II (LN)	4
<i>Engineering</i>		
ENGR 1111	Introduction to Engineering	1
ENGR 1322	Engineering Design with CAD	2

ENGR 1412	Introductory Engineering Computer Programming	2
<i>Engineering Science</i>		
ENSC 2113	Statics	3
ENSC 2123	Elementary Dynamics	3
ENSC 2143	Strength of Materials	3
ENSC 2141	Strength of Materials Lab	1
<i>Civil Engineering</i>		
CIVE 2041	Civil and Environmental Engineering Seminar	1
CIVE 3614	Engineering Surveying	4
CIVE 3813	Environmental Engineering Science	3
<b>Hours Subtotal</b>		<b>31</b>
<b>Major Requirements</b>		
<i>Mathematics</i>		
MATH 2233	Differential Equations	3
STAT 4033	Engineering Statistics	3
or STAT 4073	Engineering Statistics with Design of Experiments	
<i>Engineering Science</i>		
ENSC 3233	Fluid Mechanics	3
ENSC 3231	Fluids and Hydraulics Lab	1
<i>Civil Engineering</i>		
CIVE 3413	Structural Analysis	3
CIVE 3513	Structural Steel Design	3
CIVE 3523	Reinforced Concrete Design	3
CIVE 3623	Engineering Materials Laboratory	3
CIVE 3633	Transportation Engineering	3
CIVE 3714	Introduction to Geotechnical Engineering	4
CIVE 3833	Applied Hydraulics	3
CIVE 3843	Hydrology I	3
CIVE 4041	Engineering Practice	1
CIVE 4043	Senior Design	3
CIVE 4273	Construction Engineering and Project Management	3
CIVE 4833	Unit Operations in Environmental Engineering	3
<i>Industrial Engineering &amp; Management</i>		
IEM 3503	Engineering Economic Analysis	3
<b>Hours Subtotal</b>		<b>48</b>
<b>Electives</b>		
Select 9 hours of the following:		
9		
CIVE 4010	Civil Engineering Research	
CIVE 4013	Aquatic Chemistry	
CIVE 4033	GIS Applications for Water Resources	
CIVE 4050	Special Topics in Civil & Environmental Engineering	
CIVE 4103	Construction Simulation	
CIVE 4113	Construction Business Management	
CIVE 4123	The Legal & Regulatory Environment of Civil Engineering	
CIVE 4133	Construction Contracts and Specifications	
CIVE 4153	Contract Administration	
CIVE 4163	Construction Equipment Management	



CIVE 4183	Construction Estimating
CIVE 4193	BIM for Construction
CIVE 4243	Use and Design of Geosynthetics
CIVE 4283	Numerical Methods in Geotechnical Engineering
CIVE 4293	Design and Analysis of Earth Retaining Structures
CIVE 4303	Systems Analysis for Civil Engineers
CIVE 4313	Highway Traffic Operations
CIVE 4323	Civil Infrastructure Systems
CIVE 4343	Urban Transportation Planning
CIVE 4363	Design and Planning of Airports
CIVE 4373	Design of Traffic Control Systems
CIVE 4383	Geometric Design of Highways
CIVE 4403	Advanced Strength of Materials
CIVE 4413	Classical and Matrix Methods of Structural Analysis
CIVE 4513	Advanced Reinforced Concrete Design
CIVE 4523	Advanced Steel Structure Design
CIVE 4533	Prestressed Concrete
CIVE 4563	Structural Dynamics
CIVE 4573	Timber Design
CIVE 4653	Asphalt Materials and Mix Design
CIVE 4673	Concrete Materials and Mix Design
CIVE 4693	Pavement Design and Analysis
CIVE 4723	Foundation Engineering
CIVE 4733	Soil Mechanics
CIVE 4773	Soil-Structure Interaction
CIVE 4743	Project Engineering and Management
CIVE 4753	Engineering Soil Stabilization
CIVE 4873	Air Pollution Control Engineering
CIVE 4863	Advanced Unit Operations in Environmental Engineering
CIVE 4913	Groundwater Hydrology
CIVE 4923	Environ Risk Assessment
CIVE 4933	Water Treatment
CIVE 4943	Risk and Failure Analysis of Dams
CIVE 4983	Residuals & Solid Waste Management
CIVE 4963	Open Channel Flow
CIVE 4973	Concrete Durability

ENGR 4043 or ENGR 4060 may be used as one of the CIVE electives.

<b>Hours Subtotal</b>	<b>9</b>
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<b>Total Hours</b>	<b>128</b>
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<sup>1</sup> Chem 1515 fulfills the requirements for both CHEM 1414 and CIVE 2081.

## Other Requirements

### Graduation Requirements

1. A minimum 2.00 Technical GPA. The technical GPA is calculated from all courses counting in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.

2. A 'C' or better is required in all CIVE, ENSC, and Math prefixed courses required in the degree.
3. If "B" or higher is not earned in ENGL 1113 Composition I, then ENGL 1213 Composition II must be completed.
4. The major engineering design experience, capstone course, is satisfied by CIVE 4043 Senior Design.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Civil Engineering: Environmental, BSCV

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 128**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I	3
	or ENGL 1313	Critical Analysis and Writing I
ENGL 3323	Technical Writing	3
	or ENGL 1213	Composition II
	or ENGL 1413	Critical Analysis and Writing II
<i>American History &amp; Government</i>		
Select one of the following:		
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
<i>Humanities (H)</i>		
Courses designated (H)		
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course.		
CHEM 1414	General Chemistry for Engineers (LN) <sup>1</sup>	4
	or CHEM 1515	Chemistry II (LN)
BIOC 2344	Chemistry and Applications of Biomolecules	4
	or BIOL 1114	Introductory Biology (LN)
PHYS 2014	University Physics I (LN)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
SPCH 2713	Introduction to Speech Communication (S)	3
<b>Hours Subtotal</b>		<b>40</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan.		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Mathematics</i>		
MATH 2163	Calculus III	3
<i>Basic Science</i>		
PHYS 2114	University Physics II (LN)	4
CIVE 2081	Environmental Chemistry for Engineers <sup>1</sup>	1

<i>Engineering</i>		
ENGR 1111	Introduction to Engineering	1
ENGR 1322	Engineering Design with CAD	2
ENGR 1412	Introductory Engineering Computer Programming	2
<i>Engineering Science</i>		
ENSC 2113	Statics	3
ENSC 2123	Elementary Dynamics	3
ENSC 2143	Strength of Materials	3
ENSC 2141	Strength of Materials Lab	1
<i>Civil Engineering</i>		
CIVE 2041	Civil and Environmental Engineering Seminar	1
CIVE 3614	Engineering Surveying	4
CIVE 3813	Environmental Engineering Science	3
<b>Hours Subtotal</b>		<b>31</b>
<b>Major Requirements</b>		
<i>Mathematics</i>		
MATH 2233	Differential Equations	3
STAT 4033	Engineering Statistics	3
	or STAT 4073	Engineering Statistics with Design of Experiments
<i>Engineering Science</i>		
ENSC 3233	Fluid Mechanics	3
ENSC 3231	Fluids and Hydraulics Lab	1
<i>Civil Engineering</i>		
CIVE 3413	Structural Analysis	3
CIVE 3523	Reinforced Concrete Design	3
CIVE 3853	Environmental Engineering Laboratory	3
CIVE 3623	Engineering Materials Laboratory	3
CIVE 3633	Transportation Engineering	3
CIVE 3714	Introduction to Geotechnical Engineering	4
CIVE 3833	Applied Hydraulics	3
CIVE 3843	Hydrology I	3
CIVE 4041	Engineering Practice	1
CIVE 4143	Environmental Engineering Design	3
CIVE 4273	Construction Engineering and Project Management	3
CIVE 4833	Unit Operations in Environmental Engineering	3
<i>Industrial Engineering &amp; Management</i>		
IEM 3503	Engineering Economic Analysis	3
<b>Hours Subtotal</b>		<b>48</b>
<b>Electives</b>		
Select 9 hours of the following:		
CIVE 4010	Civil Engineering Research	
CIVE 4013	Aquatic Chemistry	
CIVE 4033	GIS Applications for Water Resources	
CIVE 4050	Special Topics in Civil & Environmental Engineering	
CIVE 4123	The Legal & Regulatory Environment of Civil Engineering	
CIVE 4243	Use and Design of Geosynthetics	

CIVE 4863	Advanced Unit Operations in Environmental Engineering	
CIVE 4873	Air Pollution Control Engineering	
CIVE 4883	Introduction to Environmental Modeling	
CIVE 4913	Groundwater Hydrology	
CIVE 4923	Environ Risk Assessment	
CIVE 4933	Water Treatment	
CIVE 4943	Risk and Failure Analysis of Dams	
CIVE 4963	Open Channel Flow	
CIVE 4983	Residuals & Solid Waste Management	
ENGR 4043 or ENGR 4060 may be used for one CIVE elective.		
<b>Hours Subtotal</b>		<b>9</b>
<b>Total Hours</b>		<b>128</b>

<sup>1</sup> CHEM 1515 fulfills the requirements for both CHEM 1414 and CIVE 2081.

## Graduation Requirements

1. A minimum 2.00 Technical GPA. The technical GPA is calculated from all courses counting in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A 'C' or better is required in all CIVE, ENSC, and Math prefixed courses required in the degree.
3. If "B" or higher is not earned in ENGL 1113 Composition I, then ENGL 1213 Composition II must be completed.
4. The major engineering design experience, capstone course, is satisfied by CIVE 4143 Environmental Engineering Design.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Construction Engineering Technology

The construction industry is the largest industry in the world. Leadership in this field requires a broad knowledge of labor, materials and equipment, capital and construction procedures. The interdisciplinary approach of the construction engineering technology program offers the student specialized coursework in all phases of construction, designed to prepare him or her for responsible positions in industry.

The primary goal of the Construction Engineering Technology (CET) program is to enhance the quality of the instructional program through effective management of the curriculum, teaching assignments and fiscal and physical resources. This goal includes providing instructional facilities, equipment and support services for faculty and students which maintain an excellent learning environment.

### Program Educational Objectives

OSU Construction Engineering Technology graduates a few years after graduation will:

1. Solve problems typically found in the construction industry in construction engineering design, estimating, planning, scheduling and project management using mathematical, analytical and scientific skills of engineering technology.
2. Successfully work in teams and communicate effectively in written, oral and graphical forms.
3. Continue life-long career and professional growth by actively interacting with local industries and participating in appropriate professional societies.
4. Continue life-long personal growth in sensitivity to ethical responsibilities, global environments and associated social issues.

Construction Engineering Technology graduates can expect to obtain these student outcomes upon graduation:

- (1) an ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve broadly-defined engineering problems appropriate to the discipline;
- (2) an ability to design systems, components, or processes meeting specified needs for broadly-defined engineering problems appropriate to the discipline;
- (3) an ability to apply written, oral, and graphical communication in broadly-defined technical and non-technical environments; and an ability to identify and use appropriate technical literature;
- (4) an ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes; and
- (5) an ability to function effectively as a member as well as a leader on technical teams.

Faculty with excellent credentials, including a balance of formal education, teaching ability and appropriate industry experience, are recruited nationwide and are provided opportunities for individual professional development and regular contact with the industry. Faculty members are encouraged to become involved in extension and research programs relating to the department's areas of strength or growth and to serve the needs for continuing education within the industry, particularly in the regional construction community.

These needs and opportunities for service are assessed regularly through close cooperation with local and regional construction professionals and industry associations. An active Advisory Board, representing a broad cross-section of the industry, meets regularly to offer support and guidance necessary to preserve uncompromising excellence.

The Construction Engineering Technology program is accredited by the Engineering Technology Accreditation Commission of ABET, <http://www.abet.org> (<http://www.abet.org/>). The educational objectives of the Construction Engineering Technology program are consistent with those required by ETAC of ABET and are listed under "Division of Engineering Technology" in the Catalog.

The modern constructor must have a great deal of technical knowledge to keep abreast of rapidly changing equipment, materials and methods of construction. Specialized courses in estimating, surveying, structures, construction planning and scheduling, construction law and insurance, field and office management and construction procedures provide students with the background necessary for today's construction industry. These specialized courses, in addition to a blend of the basic sciences, business and general studies, produce a well-balanced curriculum for students in construction engineering technology. Special attention is given to computer applications in construction estimating, and the development of graphic, written and oral communication skills is emphasized throughout the curriculum.

Students with an interest in building structures may select courses in the "building" option of the construction engineering technology curriculum, which provides them with knowledge of working drawings, mechanical and electrical equipment of buildings, and other coursework for a career in building construction.

Students with an interest in civil engineering structures may select courses in the "heavy" option of the construction engineering technology curriculum, which provides them with knowledge of highways, soils, foundations and other coursework for a career in the heavy and industrial construction industry.

The program attempts to identify and recruit highly qualified students who will benefit from the instructional platform, and faculty members promote retention and ultimate graduation of construction engineering technology students through effective instruction and advisement. A schedule of outcome assessment among graduates and their employers assures that the program continues to provide the academic training required for success.

Graduates of construction engineering technology have shown the curriculum to be successful in their development as productive members of the construction industry, holding responsible positions as company executives, project managers, estimators, material and equipment salespersons, and construction managers at all levels.

## Courses

### CET 1213 Introduction to Construction

**Description:** Overview of the entire construction industry with emphasis on construction materials, methods and systems. Both building and heavy highway construction drawings and their interpretation. Previously offered as CMT 1213 and CMT 1214.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### CET 2203 Construction Drawings (for Non-Majors)

**Description:** Principles of graphic communication are applied to reading and drawing construction plans, with emphasis to fire protection systems. Does not meet CMT degree requirements. (Online course for non-CMT majors). Previously offered as CMT 2203.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### CET 2253 Printreading & BIM

**Prerequisites:** Grade of "C" or better in MATH 1513 or ALEKS score greater or equal to 60 or permission of instructor.

**Description:** Principles of 2D and 3D graphic communication are applied to reading and drawing construction plans. Techniques for measuring items of construction work from plans and specifications are also covered. Previously offered as CMT 2253.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### CET 2263 Estimating I

**Prerequisites:** Grade of "C" or better in (CMT 1213 and CET 2253) and (CET 2253 or CMT 2253) and (MATH 1613 or MATH 1715 or MATH 1813 or ALEKS score greater or equal to 65) or permission of instructor.

**Description:** Quantity take-off with emphasis on excavation, formwork and concrete, masonry, rough carpentry and miscellaneous specialty items. Previously offered as CMT 2263.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### CET 2343 Concrete Technology

**Prerequisites:** Grade of "C" or better in (CET 1213 and CMT 1213) and (CMT 2353 or CET 2253) or permission of department.

**Description:** Fundamentals and practical application of concrete and concrete making materials including admixtures. Proportioning concrete mixtures. Batching, mixing, conveying, placing, finishing, and curing concrete. Hot and cold weather concreting, jointing, volume change and crack control. Previously offered as CMT 2343 and CMT 2351 and CMT 2352.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

### CET 3213 Soft Skills for Effective Interpersonal Communication (S)

**Description:** A study of personal one-on-one communication skills to improve effective intrapersonal communication. The course also relates intrapersonal skills to successful teamwork and teambuilding and becoming and presenting the best version of yourself.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**General Education and other Course Attributes:** Social & Behavioral Sciences

### CET 3273 Scheduling Construction Projects

**Prerequisites:** Grade of "C" or better in CMT 2263, or CET 2263 or permission of department.

**Description:** Scheduling basics, including bar charts and critical-path methods; manual and computer techniques using current software; emphasis on using schedules for construction project management. Previously offered as CMT 3273.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### CET 3322 Construction Practicum I

**Prerequisites:** Grade of "C" or better in (CMT 1213 and CET 1213) and (CMT 2253 or CET 2253), or permission of department.

**Description:** Supervised field experience in construction; 400 hours minimum documented time required. Previously offered as CMT 3331 and CMT 3322.

**Credit hours:** 2

**Contact hours:** Lecture: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### CET 3323 Theory of Built Structures

**Prerequisites:** A grade of "C" or better in (MATH 2123 or MATH 2144) and (GENT 2323 or ENSC 2113) or permission of the department.

**Description:** The study of equilibrium of structural systems and stresses and strains that occur in structural members of the built environment. Previously offered as CMT 3323.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### CET 3332 Construction Practicum II

**Prerequisites:** Grade of "C" or better in (CMT 2263 or CET 2263), (CMT 3322 or CET 3322) and CIVE 3614 or permission of department.

**Description:** Supervised temporary, full-time employment in construction, emphasizing field and office engineering and a variety of project management functions; 400 hours minimum documented time required. Previously offered as CMT 3332 and CMT 3333.

**Credit hours:** 2

**Contact hours:** Lecture: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**CET 3364 Structures I**

**Prerequisites:** Grade of "C" or better in (CMT 2343, CET 2343, or CMT 2351) and (CMT 3323, CET 3323 or GENT 3323 or ENSC 2143) and (MATH 2133 or MATH 2153) and (PHYS 1214 or PHYS 2114) and (CMT 3322 or CET 3322) and (CMT 3273 or CET 3273).

**Description:** Methods of structural analysis applicable to construction; design of timber structures and forms for concrete structures. Previously offered as CMT 3363 and CMT 3364.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**CET 3433 Principles of Site Development**

**Prerequisites:** Grade of "C" or better in (CET 2343 or CMT 2343 or CMT 2352), CIVE 3614 and CMT 3323, CMT 3323 or GENT 3323 or ENSC 2143.

**Description:** Site layout, vertical and horizontal control, surveying instrument adjustments, site investigations, excavations, site drainage and geotechnical considerations. Previously offered as CMT 3433 and CMT 2333.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**CET 3443 Environmental Building Systems (Non-Majors)**

**Prerequisites:** Grade of "C" or better in ENGR 1322 or CMT 2253 or ARCH 3263 and grade of "C" or better in (PHYS 1114 or PHYS 2014), or permission of department.

**Description:** An introductory level knowledge of plumbing, heating, air-conditioning, electrical and lighting systems as applied to construction and construction-related projects. May not be used for degree credit with CET 3463.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**CET 3463 Environmental Building Systems**

**Prerequisites:** Grade of "C" or better in CET 2253 or CMT 2253 and (PHYS 1214 or PHYS 2114) or permission of department.

**Description:** Plumbing, heating, air-conditioning, electrical and lighting systems as applied to residences and commercial buildings. Previously offered as CMT 3463.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**CET 3554 Structures II**

**Prerequisites:** Grade of "C" or better in (CET 3364 or CMT 3364).

**Description:** Analysis and design of elements in steel and reinforced concrete structures; review of shop drawings for both types of construction. Previously offered as CMT 3553 and CMT 3554.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**CET 3633 CAD and BIM for Construction Managers**

**Prerequisites:** Grade of "C" or better in (CMT 1213 or CET 1213) and (CMT 2253 or CET 2253).

**Description:** Interpretation and production of construction drawings using computer aided drafting. Theory and use of Building Information Modeling software builds upon computer aided drafting skills. Previously offered as CMT 3633.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**CET 4050 Advanced Construction Management Problems**

**Description:** Special problems in construction management. Previously offered as as CMT 4050. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Engineering Technology

**CET 4263 Estimating II**

**Prerequisites:** Grade of "C" or better in EET 1003, (CMT 2263 or CET 2263) and concurrent enrollment or grade of "C" or better in GENT 2323 or ENSC 2113; or permission of department.

**Description:** Extensive use of actual contract documents for quantity take-off, pricing and assembling the bid for several projects. Use of computers in estimating. Previously offered as CMT 4263.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**CET 4273 Technology in Construction**

**Prerequisites:** Grade of "C" or better in (CMT 3273 or CET 3273) and (CMT 4263 or CET 4263).

**Description:** Applications of various technologies including software for construction. Previously offered as CMT 4273.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**CET 4283 Business Practices for Construction**

**Prerequisites:** Grade of "C" or better in ACCT 2003, ACCT 2103, (CMT 3273 or CET 3273) and (CMT 4563 or CET 4563) or permission of department.

**Description:** Principles of management applied to construction contracting; organizing office and field staff; bonding, liens, financial management practices; introduction to the construction manager concept; schedule of values; construction billings. Previously offered as CMT 4283.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### **CET 4293 Construction Manager Concepts**

**Prerequisites:** Grade of "C" or better in (CMT 3332 or CET 3332) and (CMT 4283 or CET 4283) and (CMT 3364 or CET 3364) and ENGL 3323 or permission of department.

**Description:** Capstone course utilizing skills and knowledge of estimating, scheduling, bidding, construction management, CAD, TQM, partnering and safety; includes topics in leadership, motivation and the use of current project management software. Previously offered as CMT 4293.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### **CET 4333 Equipment Management for Constructors**

**Prerequisites:** Grade of "C" or higher in (CMT 2263 or CET 2263), (CMT 2343 or CET 2343) and (ACCT 2003 or ACCT 2103) or permission of department.

**Description:** Selection and use of equipment, estimating equipment costs, estimating equipment production rates for all types of equipment used in building construction and heavy/highway construction. Previously offered as CMT 4333.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### **CET 4443 Construction Safety and Loss Control**

**Prerequisites:** Grade of "C" or better in (CMT 2253 or CET 2253) and (CMT 4263 or CET 4263) or permission of department.

**Description:** A detailed study of OSHA Part 1926 - Construction Safety and Health Compliance and related safety topics including topics related to the OSHA 30-hour training program; concepts and methods of loss control. Previously offered as CMT 4443.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### **CET 4533 Heavy Civil Construction and Estimating**

**Prerequisites:** Grade of "C" or better in (CMT 2263 or CET 2263) and (CMT 2343 or CET 2343 or CMT 2351) or permission of department.

**Description:** Theory and application of contractor estimating and bidding procedures used in heavy and highway construction projects. Previously offered as CMT 4533.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### **CET 4563 Construction Law and Insurance**

**Prerequisites:** A grade of "C" or better in (CMT 2263 or CET 2263) and SPCH 2713 and acceptance to the CMT Upper Division or permission of the department.

**Description:** Legal and insurance problems as they pertain to the construction industry. Previously offered as CMT 4563.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

## **Undergraduate Programs**

- Construction Engineering Technology: Building, BSET (p. 2193)
- Construction Engineering Technology: Heavy, BSET (p. 2195)

## **Faculty**

Heather Yates, EdD, CPC—**Professor and Program Coordinator**

**Associate Professor:** Rachel Mosier, PhD, PE

**Assistant Professors:** Amy Lewis, PdD; Soojin Yoon, PhD

**Assistant Professor of Practice:** Dr. Marllon "Dan" Cook, PhD

# Construction Engineering Technology: Building, BSET

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 124**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
	or ENGL 1313	Critical Analysis and Writing I
ENGL 1213	Composition II	3
	or ENGL 1413	Critical Analysis and Writing II
ENGL 3323	Technical Writing	3
<i>American History &amp; Government</i>		
Select one of the following:		
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2123	Calculus for Technology Programs I (A) (With a grade of "C" or better in MATH 2123 or MATH 2144) <sup>1</sup>	3
	or MATH 2144	Calculus I (A)
MATH 2133	Calculus for Technology Programs II (A) (With a grade of "C" or better in MATH 2133 or 2153) <sup>1</sup>	3
	or MATH 2153	Calculus II (A)
<i>Humanities (H)</i>		
Courses designated (H)		
6		
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course.		
PHYS 1114	College Physics I (LN) (With a grade of "C" or better in PHYS 1114 or PHYS 2014) <sup>1</sup>	4
	or PHYS 2014	University Physics I (LN)
PHYS 1214	College Physics II (LN) (With a grade of "C" or better in PHYS 1214 or PHYS 2114) <sup>1</sup>	4
	or PHYS 2114	University Physics II (LN)
Select an additional 4 hours of Natural Science with N and L designations		
4		
<i>Social &amp; Behavioral Sciences (S)</i>		
Courses designated (S)		
6		
<b>Hours Subtotal</b>		<b>45</b>

## Diversity (D) & International Dimension (I)

May be completed in any part of the degree plan.

Select at least one Diversity (D) course

Select at least one International Dimension (I) course

## College/Departmental Requirements

<i>Specialty</i>		
CET 1213	Introduction to Construction (With a grade of "C" or better) <sup>1</sup>	3
CET 2253	Printreading & BIM (With a grade of "C" or better) <sup>1</sup>	3
CET 2263	Estimating I (With a grade of "C" or better) <sup>1</sup>	3
CET 2343	Concrete Technology (With a grade of "C" or better) <sup>1</sup>	3

## *Related Specialty*

ACCT 2103	Financial Accounting (With a grade of "C" or better in ACCT 2103 or ACCT 2003) <sup>1</sup>	3
	or ACCT 2003	Survey of Accounting
EET 1003	Introduction to Microcomputer Programming (With a grade of "C" or better) <sup>1</sup>	3
ENSC 2113	Statics (With a grade of "C" or better) <sup>1</sup>	3

**Hours Subtotal 21**

## *Communications*

SPCH 2713	Introduction to Speech Communication (S) (With a grade of "C" or better) <sup>1</sup>	3
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## Major Requirements

<i>Specialty</i>		
CET 3273	Scheduling Construction Projects (With a grade of "C" or better)	3
CET 3322	Construction Practicum I (With a grade of "C" or better)	2
CET 3332	Construction Practicum II (With a grade of "C" or better)	2
CET 3364	Structures I (With a grade of "C" or better)	4
CET 3433	Principles of Site Development (With a grade of "C" or better)	3
CET 3463	Environmental Building Systems (With a grade of "C" or better)	3
CET 3554	Structures II	4
CET 4263	Estimating II (With a grade of "C" or better)	3
CET 4273	Technology in Construction (With a grade of "C" or better)	3
CET 4283	Business Practices for Construction (With a grade of "C" or better)	3
CET 4293	Construction Manager Concepts (With a grade of "C" or better)	3
CET 4443	Construction Safety and Loss Control	3
CET 4563	Construction Law and Insurance (With a grade of "C" or better)	3

## *Related Specialty*

CIVE 3614	Engineering Surveying (With a grade of "C" or better)	4
ENSC 2143	Strength of Materials (With a grade of "C" or better in ENSC 2143, CET 3323, or GENT 3323)	3
	or CET 3323	Theory of Built Structures
	or GENT 3323	Strength of Materials
IEM 3513	Economic Decision Analysis	3



<b>Hours Subtotal</b>	<b>52</b>
<b>Electives</b>	
Select 6 hours of the following:	6
CET 3213	Soft Skills for Effective Interpersonal Communication (S) (With a grade of "C" or better)
CET 3633	CAD and BIM for Construction Managers
CET 4333	Equipment Management for Constructors (With a grade of "C" or better)
CET 4533	Heavy Civil Construction and Estimating (With a grade of "C" or better)
CET 4050	Advanced Construction Management Problems
EEE 3023	Introduction to Entrepreneurial Thinking and Behavior
EEE 4223	Entrepreneurial Marketing
EEE 4533	Growing Small and Family Ventures
FEMP 3103	Introduction to Emergency Management (S)
FEMP 3733	Emergency Management: Preparedness and Response
FEMP 3763	Emergency Management: Recovery and Mitigation
FPST 3013	Safety Management (S)
MGMT 3013	Fundamentals of Management (S)
MKTG 3213	Marketing (S)
<b>Hours Subtotal</b>	<b>6</b>
<b>Total Hours</b>	<b>124</b>

<sup>1</sup> Complete all required courses prior to admission to Upper Division. (These courses are also listed on the *Calculation Work Sheet of the CET Application to Upper Division form*.)

## Other Requirements

### Admission to Upper Division (required)

1. Refer to the OSU Catalog corresponding to your matriculation date and the *Policy for Admission to the Upper Division of the Curriculum for CET* for detailed admissions requirements.
2. Complete a minimum of 60 credit hours (from the degree plan) prior to admission to Upper Division.
3. Achieve a minimum Selection GPA (SGPA) of 3.05 (from the *Calculation Work Sheet of the CET Application to Upper Division form*).

### Graduation Requirements

1. A minimum technical GPA of 2.00 is required. The technical GPA is calculated from all courses counting in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A grade of 'C' or better is required in each course that is a prerequisite to a required course that has an engineering or engineering technology prefix. A grade of 'C' or better is also required in CET 3213, CET 3463, CET 3433, CET 4273, CET 4293, CET 4333 and CET 4533.
3. Each student is required to sit for the American Institute of Constructors Level 1 – Associate Constructors Certification Exam or the Fundamentals of Engineering Exam.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

# Construction Engineering Technology: Heavy, BSET

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 124**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
	or ENGL 1313	Critical Analysis and Writing I
ENGL 1213	Composition II	3
	or ENGL 1413	Critical Analysis and Writing II
ENGL 3323	Technical Writing	3
<i>American History &amp; Government</i>		
Select one of the following:		
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2123	Calculus for Technology Programs I (A) (With a grade of "C" or better in MATH 2123 or 2144) <sup>1</sup>	3
	or MATH 2144	Calculus I (A)
MATH 2133	Calculus for Technology Programs II (A) (With a grade of "C" or better in MATH 2133 or MATH 2153) <sup>1</sup>	3
	or MATH 2153	Calculus II (A)
<i>Humanities (H)</i>		
Courses designated (H)		
6		
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course.		
PHYS 1114	College Physics I (LN) (With a grade of "C" or better in PHYS 1114 or PHYS 2014) <sup>1</sup>	4
	or PHYS 2014	University Physics I (LN)
PHYS 1214	College Physics II (LN) (With a grade of "C" or better in PHYS 1214 or PHYS 2114) <sup>1</sup>	4
	or PHYS 2114	University Physics II (LN)
Select an additional 4 hours of Natural Science with N and L designations		
4		
<i>Social &amp; Behavioral Sciences (S)</i>		
Courses designated (S)		
6		
<b>Hours Subtotal</b>		<b>45</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan.		
Select at least one Diversity (D) course		

Select at least one International Dimension (I) course

## College/Departmental Requirements

<i>Specialty</i>		
CET 1213	Introduction to Construction (With a grade of "C" or better) <sup>1</sup>	3
CET 2253	Printreading & BIM (With a grade of "C" or better) <sup>1</sup>	3
CET 2263	Estimating I (With a grade of "C" or better) <sup>1</sup>	3
CET 2343	Concrete Technology (With a grade of "C" or better) <sup>1</sup>	3
<i>Related Specialty</i>		
ACCT 2103	Financial Accounting (With a grade of "C" or better in ACCT 2103 or ACCT 2003) <sup>1</sup>	3
	or ACCT 2003	Survey of Accounting
EET 1003	Introduction to Microcomputer Programming (With a grade of "C" or better) <sup>1</sup>	3
ENSC 2113	Statics (With a grade of "C" or better) <sup>1</sup>	3
<b>Hours Subtotal</b>		<b>21</b>
<b>Major Requirements</b>		
<i>Communications</i>		
SPCH 2713	Introduction to Speech Communication (S) (With a Grade of "C" or Better) <sup>1</sup>	3
<i>Specialty</i>		
CET 3273	Scheduling Construction Projects (With a grade of "C" or better)	3
CET 3322	Construction Practicum I (With a grade of "C" or better)	2
CET 3332	Construction Practicum II (With a grade of "C" or better)	2
CET 3364	Structures I (With a grade of "C" or better)	4
CET 3433	Principles of Site Development (With a grade of "C" or better)	3
CET 3554	Structures II	4
CET 4263	Estimating II (With a grade of "C" or better)	3
CET 4283	Business Practices for Construction (With a grade of "C" or better)	3
CET 4293	Construction Manager Concepts (With a grade of "C" or better)	3
CET 4333	Equipment Management for Constructors (With a grade of "C" or better)	3
CET 4443	Construction Safety and Loss Control	3
CET 4533	Heavy Civil Construction and Estimating (With a grade of "C" or better)	3
CET 4563	Construction Law and Insurance (With a grade of "C" or better)	3
<i>Related Specialty</i>		
CIVE 3614	Engineering Surveying (With a grade of "C" or better)	4
ENSC 2143	Strength of Materials (With a grade of "C" or better in ENSC 2143, CET 3323, or GENT 3323)	3
	or CET 3323	Theory of Built Structures
	or GENT 3323	Strength of Materials
IEM 3513	Economic Decision Analysis	3

<b>Hours Subtotal</b>	<b>52</b>
<b>Electives</b>	
Select 6 hours of the following:	6
CET 3463	Environmental Building Systems (With a grade of "C" or better)
CET 3213	Soft Skills for Effective Interpersonal Communication (S)
CET 3633	CAD and BIM for Construction Managers
CET 4050	Advanced Construction Management Problems
CET 4273	Technology in Construction (With a grade of "C" or better)
EEE 3023	Introduction to Entrepreneurial Thinking and Behavior
EEE 4223	Entrepreneurial Marketing
EEE 4533	Growing Small and Family Ventures
FEMP 3103	Introduction to Emergency Management (S)
FEMP 3733	Emergency Management: Preparedness and Response
FEMP 3763	Emergency Management: Recovery and Mitigation
FPST 3013	Safety Management (S)
MGMT 3013	Fundamentals of Management (S)
MKTG 3213	Marketing (S)
<b>Hours Subtotal</b>	<b>6</b>
<b>Total Hours</b>	<b>124</b>

<sup>1</sup> Complete all courses prior to admission to Upper Division (these courses are also listed on the *Calculation Work Sheet of the CET Application to Upper Division* form).

## Other Requirements

### Admission to Upper Division (required)

1. Refer to the OSU Catalog corresponding to your matriculation date and the *Policy for Admission to the Upper Division of the Curriculum for CET* for detailed admissions requirements.
2. Complete a minimum of 60 credit hours (from the degree plan) prior to admission to Upper Division.
3. Achieve a minimum Selection GPA (SGPA) of 3.05 (from the *Calculation Work Sheet of the CET Application to Upper Division* form).

### Graduation Requirements

1. A minimum technical GPA of 2.0 is required. The technical GPA is calculated from all courses counting in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A grade of 'C' or better is required in each course that is a prerequisite to a required course that has an engineering or engineering technology prefix. A grade of 'C' or better is also required in CET 3213, CET 3463, CET 3433, CET 4273, CET 4293, CET 4333 and CET 4533.
3. Each student is required to sit for the American Institute of Constructors Level 1 – Associate Constructors Certification Exam or Fundamentals of Engineering Exam.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Division of Engineering Technology

The Division of Engineering Technology is comprised of multiple undergraduate and graduate degree programs with a wide range of major areas. Five programs are housed within the Division: Construction Engineering Technology, Electrical Engineering Technology, Fire and Emergency Management, Fire Protection and Safety Engineering Technology, and Mechanical Engineering Technology. We offer four ABET-accredited baccalaureate degrees, four undergraduate minors, three masters degrees and one doctor of philosophy degree.

### Curricula

Our undergraduate curricula focus on hands-on learning and real-world applications. Most Engineering Technology faculty members have extensive industrial experiences, and our graduates are ready to be productive with little or no additional training. Our graduates' typical job titles are design engineer, application engineer, manufacturing engineer, field engineer, fire protection engineer, safety engineer, industrial hygienist, plant manager, project manager, estimator, and superintendent.

The Construction Engineering Technology (CET) program produces graduates with either a building or a heavy/highway focus. Students experience two internships providing them the opportunity to connect the classroom knowledge with field experiences. CET graduates are highly sought after by the construction industry, and the job placement rate is 100%. The Fire Protection and Safety Engineering Technology (FPSET) program has a long and rich history serving as the first baccalaureate ABET accredited FPSET program and still one of only a few in the nation. FPSET graduates are widely sought after by varied industries looking to reduce fire and safety losses. Students have a variety of career choices and flexibility due to the diversity of education the program provides.

The Electrical Engineering Technology (EET) curriculum is based on rigorous math and science courses, and its major courses are taught to be applicable to solve 21st-century challenges in electronics and computer technology. The EET program is laboratory-oriented in applied electrical engineering using current application information and practices to solve specific technical problems. The Mechanical Engineering Technology (MET) curriculum is nearly identical to the Mechanical Engineering (ME) curriculum for the first two years, but our upper-level major courses are taught with more emphasis on applications. Multiple MET major courses are popular among engineering undergraduate and graduate students who find their values for job search and thesis/dissertation research.

Minor degree choices are available in four areas. The Construction Minor, the Emergency Management Minor, and the Safety and Exposure Sciences Minor are open to students from all majors in the university. The Mechatronics Minor is mainly for those whose major is electrical engineering, mechanical engineering, EET, or MET.

We offer graduate degree options including Ph.D. and M.S. in Fire and Emergency Management Administration, MSET with an option in Fire Safety and Explosion Protection, and MSET with an option in Mechatronics and Robotics.

The MS in Fire and Emergency Management Administration is a specialized degree designed to provide an educational foundation for those who are currently serving or aspire to serve as managers or administrators in the fire service, emergency management, emergency medical services, law enforcement, or homeland security in the public, private, or nonprofit sectors. The PhD in Fire and Emergency

Management Administration is designed to produce proficient and active research scholars. It emphasizes preparing talented individuals for faculty careers at major research-oriented institutions, but we also welcome applicants whose career interests may lean toward non-academic settings or academic institutions that stress teaching.

The MS in Engineering Technology with an emphasis on Fire Safety and Explosion Protection is intended for individuals pursuing a career in engineering or the science underlying fire protection and safety. The courses are set up for both the needs of on campus students as well as working professionals with all classes being available both in-person and online.

The MS in Engineering Technology with an emphasis on Mechatronics and Robotics is a specialized degree developed in response to the increasing demand for mechatronics professionals. It is designed in combination of Electrical Engineering Technology and Mechanical Engineering Technology programs. The courses are offered both in-person on campus and online.

### Bachelor of Science in Engineering Technology Degree Programs

Construction Engineering Technology, 124 hours  
Electrical Engineering Technology, 125 hours  
Fire Protection and Safety Engineering Technology, 125 hours  
Mechanical Engineering Technology, 120 hours

### Master of Science in Engineering Technology Degree Programs

Fire Safety and Explosion Protection, 30 or 32 hours

Mechatronics and Robotics 30 hours

### Master of Science Degree Programs

Fire and Emergency Management Administration, 33 hours

### Doctorate of Philosophy Degree Programs

Fire and Emergency Management Administration, 60 hours beyond the master's degree.

### Accreditation

Each undergraduate Engineering Technology program is accredited by the Engineering Technology Accreditation Commission of ABET, <http://www.abet.org>.

### Transfer Students

We provide students from 2-year degree institutions excellent opportunities to obtain a bachelor's degree within four or a little more than four semesters at OSU. Transfer maps are available for students at community colleges and also engineering schools.

### Academic Areas

- Construction Engineering Technology (p. 2189)
- Electrical Engineering Technology (p. 2224)
- Fire Emergency Management Program (p. 2237)
- Fire Protection and Safety Engineering Technology (p. 2244)
- Mechanical Engineering Technology (p. 2300)

## Minors

- Construction (CNST), Minor (p. 2199)
- Mechatronic Engineering Technology for EET Students (EETM), Minor (p. 2200)
- Mechatronic Engineering Technology for MET Students (METM), Minor (p. 2201)

## Faculty

Young Chang, PhD, PE, CFPS—Professor and Head

**Associate Professor and FPSET Program Coordinator:** Virginia Charter, PhD, PE

**Associate Professor and FEMP Program Coordinator:** Haley Murphy, PhD

**Assistant Professor and EET Program Coordinator:** Avimanyu Sahoo, PhD

**Professor and MET Program Coordinator:** Chulho Yang, PhD, PE

**Professor and CET Program Coordinator:** Heather Yates, EdD, CPC

**Associate Professor and FSEP Graduate Advisor:** Bryan Hoskins, PhD, PE

**Associate Professors:** Imad Abouzahr, PhD, PE; Robert Agnew, PhD, CSP, CIH; Aaron Alexander, PhD; Warren L. Lewis, MS; Rachel Mosier, PhD, PE; Brian Norton, MS, PE

**Assistant Professors:** Amy Lewis, PhD; Xiangyu (Dale) Li, PhD; Tony McAleavy, PhD; Ellis Nuckolls, MS, PE; Haejun Park, PhD; Ilchung Park, PhD; Diana Rodriguez Coca, PhD; Hitesh Vora, PhD; Huaxia Wang, PhD; Soojin Yoon, PhD

**Assistant Professors of Professional Practice:** Marllon "Dan" Cook, PhD; Leslie Stockel, MS, CSP

**Assistant Dean of Engineering Extension and Adjunct Assistant**

**Professor:** Ed Kirtley, MS

**Teaching Assistant Professor:** Timothy Wilson, MS, CSP

**Teaching Associate:** Laura Emerson, MS

## Construction (CNST), Minor

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Total Hours:** 17

Code	Title	Hours
Required Courses		
CET 1213	Introduction to Construction	3
CET 2253	Printreading & BIM	3
CET 2263	Estimating I	3
CET 3273	Scheduling Construction Projects	3
Choose 2 of the following: <sup>1</sup>		5
CET 3322	Construction Practicum I <sup>1</sup>	
CET 3213	Soft Skills for Effective Interpersonal Communication (S)	
CET 3443	Environmental Building Systems (Non-Majors)	
CET 3633	CAD and BIM for Construction Managers	
CET 4263	Estimating II	
CET 4443	Construction Safety and Loss Control	
CET 4563	Construction Law and Insurance	
<b>Total Hours</b>		<b>17</b>

<sup>1</sup> If CET 3322 is not selected, the total hours required for the minor will be increased by one.

## Minimum Grade Requirements

- 2.0 minimum grade requirement for minors to be awarded.
- "C" or better in CET 1213, CET 2253, CET 2263, and CET 3273.

## Additional OSU Requirements

### Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).

## Mechatronic Engineering Technology for EET Students (EETM), Minor

**Total Hours:** 18

Code	Title	Hours
MET 1123	Technical Drawing and Basic CAD	3
ENSC 2113 or GENT 2323	Statics	3
ENSC 2143 or GENT 3323	Strength of Materials	3
MET 3003 or ENSC 2123	Dynamics	3
EET 3803	Fundamentals of Mechatronics <sup>1</sup>	3
EET 4803	Mechatronics System Design <sup>1</sup>	3
<b>Total Hours</b>		<b>18</b>

<sup>1</sup> These courses are the same as MET 3803 and MET 4803, respectively.

### Additional Requirements

- 2.2 overall GPA in courses submitted for the minor
- Grade of C or better in each course submitted for the minor

### Additional OSU Requirements

#### Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).

## Mechatronic Engineering Technology for MET Students (METM), Minor

**Total Hours:** 21

Code	Title	Hours
EET 2303	Technical Programming	3
EET 2544	Pulse and Digital Techniques	4
EET 2635	Solid State Devices and Circuits	5
EET 3423	Applied Analysis for Technology	3
MET 3803	Fundamentals of Mechatronics <sup>1</sup>	3
MET 4803	Mechatronics System Design <sup>1</sup>	3
<b>Total Hours</b>		<b>21</b>

<sup>1</sup> These courses are the same as EET 3803 and EET 4803, respectively.

### Additional Requirements

- 2.2 overall GPA in courses submitted for the minor
- Grade of C or better in each course submitted for the minor

### Additional OSU Requirements

#### Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).



## Electrical and Computer Engineering

The School of Electrical and Computer Engineering is highly recognized throughout the nation for its student-centered, laboratory intensive curriculum. It is a partner of choice for employers seeking well-educated, highly-motivated and uniquely creative college graduates dedicated to life-long learning. The School has devoted professors who serve, instruct and mentor undergraduate and graduate students pursuing Bachelor of Science (BS), Master of Engineering (MEng), Master of Science (MS), or Doctorate (PhD) degrees in electrical engineering (EE) or a BS degree in computer engineering (CpE). The Bachelor of Science in Electrical Engineering degree program (BSEE) and the Bachelor of Science in Computer Engineering degree program (BSCpE) are accredited by the Engineering Accreditation Commission of ABET, [www.abet.org/](http://www.abet.org/) (<https://www.abet.org/>).

Electrical engineers and computer engineers have been at the center of the technological revolution that has occurred over the past 100 years. Marvels such as the transistor, radio, telephone, television, internet, microprocessor, computer, tablet, radar system, motor, wind generator, GPS, smart phone, laser, microwave oven, electric car, pacemaker, antenna, and the flat panel display, to name only a handful, have resulted from the hard work and creative talents of electrical engineers and computer engineers. And since electricity and computers are essential in a modern society, the electrical engineer and the computer engineer will always be in high demand.

Electrical engineering encompasses many exciting subdisciplines including energy systems, machines, power electronics, analog electronics, digital electronics, mixed-signal electronics, VLSI chips, instrumentation, sensors, signal processing, machine vision, artificial intelligence, communications, control systems, robotics, wireless devices, electromagnetic fields, photonics, embedded controllers, networking, software development, biomedical devices and computer architecture. The School encompasses all of these subdisciplines in its curriculum or research activities.

Computer Engineering is a relatively young engineering discipline that combines a strong foundation of electrical engineering with elements of computer science, including hardware and software integration, and design. Computer engineering includes digital logic design, computer architecture, digital data communications, computer and sensor interfacing, microprocessors, digital control, VLSI circuits and systems, operating and software systems, and computer arithmetic.

Beyond creating technology, electrical engineers and computer engineers of tomorrow must be aware of the social, economic, ethical and environmental impact of their respective technologies. They must also communicate effectively, possess excellent teamwork skills, and understand, perform and complete the process of engineering design. The undergraduate programs in electrical engineering and computer engineering at Oklahoma State University equip graduates with these critical skills.

### Undergraduate Program Educational Objectives

The BSEE and BSCpE Educational Objectives reflect the aspirational expectations for our electrical engineering and computer engineering graduates after they enter their professional careers. Specifically:

- Our Graduates will be widely employed across the range of subdisciplines within electrical engineering and computer

engineering, and will be highly sought after by industrial, academic, non-profit and governmental organizations.

- Our Graduates will compete in a technologically changing world, collaborate in a diverse workforce, and communicate effectively their knowledge and ideas to colleagues, employers, customers and stakeholders.
- Our Graduates will be recognized leaders, team players, problem solvers, innovators and entrepreneurs in their profession.
- Our Graduates will identify and contribute to solving grand-challenge problems that improve the lives of people in Oklahoma, the United States, and around the world, serving their communities and their profession to produce a lasting, significant and positive impact.
- Our Graduates will abide by the highest ethical standards of professional practice in a technologically changing, professional environment.
- Our Graduates will continue to develop professionally throughout their lives by being adaptive learners with a never ending desire to assimilate new knowledge and embrace new technologies.
- Our Graduates will have the knowledge to earn professional registration or certification in their field or earn an advanced post-graduate or professional degree should they choose.
- Our Graduates will make a positive difference in the world.

### Undergraduate Program and Student Learning Outcomes

To support the aforementioned Program Educational Objectives, the School has established Student Learning Outcomes that are regularly assessed and expected of all students upon completion of their chosen program in Electrical Engineering or Computer Engineering. Attainment of the following outcomes prepares graduates to enter the professional practice of engineering:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science and mathematics;
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors;
3. an ability to communicate effectively with a range of audiences;
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts;
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives;
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions;
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The undergraduate electrical engineering and computer engineering programs at Oklahoma State University prepare each graduate for a life-long professional career. During the first two years of study, students complete a carefully designed set of lower-division courses in the areas of electrical engineering, computer engineering, computer science,

mathematics, physics, chemistry, humanities, and social sciences. After successfully completing these courses, students enroll in both required and elective upper-division courses in electrical engineering and computer engineering.

Electrical engineering and computer engineering students obtain fundamental knowledge and technical skills needed by tomorrow's professionals. Students pursuing a degree in Electrical Engineering are required prior to graduation to have taken a set of area courses in a single area in ECEN. These areas include a) control systems, digital signal processing, and communication systems, b) energy and power, c) computer systems and digital electronics, d) analog electronics, and e) microwaves and photonics. Students pursuing a degree in Computer Engineering are required to take specialized computer engineering courses dealing with microcontrollers, embedded controllers, robotics, computer architecture, discrete mathematics, digital logic design, networking, programming, coding, computing and digital electronics.

Instructional laboratories are a central part of the undergraduate curriculum to provide opportunities for hands-on experience in areas such as microcomputers, digital logic design, electronics, networks, instrumentation, optics, real-time digital signal processing, communications and electromagnetics. These laboratories are located in the College of Engineering, Architecture and Technology's new 70,000 ft<sup>2</sup> teaching facility, Endeavor, and are equipped with state-of-the-art, industrial-grade equipment.

Engineering design laboratories require students to solve open-ended, practical problems in a manner that demonstrate the students' ability to apply fundamental concepts, creativity and imagination. These problems have several possible outcomes; students must choose an acceptable approach and demonstrate that the optimal outcome has been met.

All electrical engineering and computer engineering students receive multiple engineering design experiences. The capstone design experience is a two-course sequence typically taken during the students' last two semesters of the BS program. The capstone experience gives students an opportunity to apply and demonstrate the skills that they have developed throughout the program. These design courses integrate theory, analysis, simulation, design and experimental skills to achieve a specific design outcome. Teamwork, communication skills, and the complete engineering design process—from problem definition to prototype that includes both presentation and documentation—are emphasized.

Student design teams receive individual project mentoring from an appropriate faculty member who provides project management advice and supervision. The capstone experience concludes with a formal public design demonstration, oral presentation and written report.

## Degree Programs and Options

The School of Electrical and Computer Engineering (ECEN) offers a full range of undergraduate and graduate program choices that allow students to excel in their careers. Specifically, the School of Electrical and Computer Engineering offers five degrees:

- Bachelor of Science in Electrical Engineering (BSEE)
- Bachelor of Science in Computer Engineering (BSCpE)
- Master of Engineering in Electrical Engineering (MEngEE, non-thesis)
- Master of Science in Electrical Engineering (MSEE, thesis)
- Doctor of Philosophy in Electrical Engineering (PhDEE)

### Bachelor of Science:

- This degree program is designed to provide fundamental scientific and mathematical knowledge needed for an engineering education and an entry-level engineering career.
- Broad-based and in-depth technical courses are provided to teach the fundamentals of the electrical engineering and computer engineering professions.
- The degree focuses on analysis and design methods, laboratory and simulation experiences, and theoretical and practical problems.
- Requirements: 124 credits hours (BSEE) and 125 credit hours (BSCpE).

### Master of Engineering:

- This degree program is tailored to students who wish to gain advanced knowledge and expertise in subject areas associated with their professional pursuits.
- This non-research, non-thesis instructional program is ideal for Distance Education students or for baccalaureate graduates interested in professional development.
- This program is available online.
- Requirements: 33 credit hours of coursework. Specific requirements for the MEngEE program are available on the web in the document entitled "Memorandum to Graduate Students"; see <https://ece.okstate.edu/>.

### Master of Science:

- This degree program is tailored to students who wish to gain advanced knowledge in subject areas associated with their professional pursuits.
- The program emphasizes research as part of the learning experience and culminates with the defense of a thesis.
- This program is ideal for students who wish to pursue a PhD.
- This program is available online.
- Requirements: 24 credit hours of coursework and 6 credit hours of thesis research. Specific requirements for the MSEE program are available on the web in the document entitled "Memorandum to Graduate Students;" see <https://ece.okstate.edu/>.

### Doctor of Philosophy:

- This degree program is tailored to students who desire to have a teaching and research career in academia or a research career in industry or government laboratories.
- This program is ideal for those students who have a passion to acquire in-depth knowledge.
- The program emphasizes the creation of new knowledge during the research process, the publication of that knowledge, and the defense of a dissertation.
- Requirements: 73 total credit hours beyond the BSEE/BSCpE degree. Specific requirements for the PhD program are available on the web in the document entitled "Memorandum to Graduate Students;" see <https://ece.okstate.edu/>.

Options: Students are also given the option to combine degrees to take advantage of common courses between various degrees, thereby reducing the total number of credit hours relative to non-combining options. These combining options are highly attractive from a financial and career point of view. That is, these options are less expensive and take less time. Knowledge gained in these degree programs adds value to

what the student can do once or while employed. The current combining options are:

- Dual BSEE and BSCpE degrees (137 credit hours)
- Joint "4+1" BSEE/BSCpE plus MEngEE degrees (148/149 credit hours)

With effective planning, the dual BSEE and BSCpE program can be completed in four years by taking approximately 17 credit hours of courses each semester. It may take less time if students have Advanced Placement credit hours. This dual degree program allows a student to have a true comprehensive education across the electrical and computer engineering spectrum, thus preparing the student for just about any entry-level career in electrical engineering or computer engineering. The program effectively requires the completion of the BSCpE degree plus 12 additional credit hours in non-computer, electrical engineering courses. An advising sheet for the dual program is posted on the School's web page; <https://ece.okstate.edu/>. This sheet has been devised to assure that the degree requirements for both the BSCpE and BSEE degrees are satisfied in the most expeditious manner.

The "4+1" program—available only to OSU baccalaureate students—is a five-year accelerated program that combines the BSEE or BSCpE degree with the M.Eng.EE degree. It is designed to give students a broad-based undergraduate education in electrical engineering or computer engineering along with a highly in-depth graduate education in a few key areas. This program is ideal for those students who want advanced knowledge to enhance their competitiveness in the work force and to satisfy their longing for in-depth knowledge that cannot be obtained in the baccalaureate degrees. Specific requirements for the "4+1" program are available on the web in the document entitled "Memorandum to Graduate Students;" see <https://ece.okstate.edu/>.

ECEN has submitted a new Option in Software Engineering as part of the Computer Engineering degree for approval in fall 2021. As the title suggests the option emphasizes software solutions in the context of computer engineering applications with a focus on the software-hardware interface. A total of 128 credit hours (i.e., 3 credit hours beyond the CpE degree) is required to complete this option. Of those 128 credit hours, 12 credit hours of software specific courses, as approved and listed by the School, must be completed.

A degree in electrical engineering or computer engineering is an excellent foundation for other professional fields such as medicine and law. Many graduates also pursue advanced programs in business and management after earning a degree in engineering.

## Courses

### ECEN 2011 Experimental Methods I

**Prerequisites:** PHYS 2114 with a "C" or better or concurrent enrollment advisor permission required.

**Description:** Laboratory associated with ECEN 2714 taken mostly by transfer students who have completed a similar course as ECEN 2714 without the accompanying laboratory. Previously offered as ECEN 3013.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Elec & Computer Engr

### ECEN 2714 Fundamentals of Electric Circuits

**Prerequisites:** MATH 2153 with a "C" or better and (PHYS 2114 and MATH 2233 with a "C" or better or concurrent enrollment).

**Description:** Circuit analysis techniques including equivalent networks and mesh/node formulation of network equations; operational amplifiers; RL, RC and RLC transient and steady-state circuit analysis; energy and power; electrical measurements and instrumentation.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

### ECEN 3020 Supervised Research Project

**Prerequisites:** Consent of instructor and ECEN department head.

**Description:** Supervised research project for qualified students. May be repeated no more than three times for a total of three credit hours. Offered for variable credit, 1-3 credit hours, maximum of 3 credit hours.

**Credit hours:** 1

**Contact hours:** Contact: 1 Other: 1

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Elec & Computer Engr

### ECEN 3113 Energy, Environment and Economics

**Prerequisites:** ECEN 3714 with a "C" or better.

**Description:** Topics relevant to understanding the close relationship between energy use, its impact on the environment, and overall economic implications. Green energy technologies (wind, solar, hydro) will be considered along with conventional techniques. Both conventional and non-conventional energy technologies will be discussed.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

### ECEN 3213 Computer Based Systems in Engineering

**Prerequisites:** CS 2433 with a "C" or better.

**Description:** A comprehensive introduction to technology and applications of microprocessors. Topics include computer hardware, software, programming, computation, interfacing, I/O, communication, data acquisition, data representation, and numerical analysis.

Applications of general-purpose and application-specific processors in various disciplines of engineering and engineering problem solving. Previously offered as ENSC 3213.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

### ECEN 3233 Digital Logic Design

**Description:** Boolean algebra, optimization of logic networks. Design using SSI, and MSI, LSI components. ROM and PLA applications.

Analysis and design of clock sequential logic networks. Flip-flops, counters, registers. Asynchronous circuit design and analysis. Laboratory experience in implementing combinational and sequential logic devices.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

**ECEN 3314 Electronic Devices and Applications**

**Prerequisites:** ECEN 3714 and ENSC 2611 with a "C" or better and (PHYS 3313 or ECEN 3903 with a "C" or better).

**Description:** Semiconductor electronic components including MOSFETs, BJTs, JFETs, and OpAmps. Emphasis on device models and use of solid state electronic devices to analyze, synthesize and design amplifiers and switching circuits. SPICE simulations are extensively utilized. Basic building blocks for analog and digital applications. Theoretical concepts and methods are demonstrated and reinforced through laboratory exercises. Course previously offered as ECEN 3313.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

**ECEN 3513 Signal Analysis**

**Prerequisites:** ECEN 3714 with a "C" or better.

**Description:** Deterministic signals. Fourier series and Fourier transforms. Impulse response, convolution and correlation. Sampling theorem. Analog modulation techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 3613 Applied Fields and Waves I**

**Prerequisites:** MATH 2163 and ECEN 3714 with a "C" or better.

**Description:** Circuit model of transmission lines, wave propagation, energy transfer, impedance mismatch, and transients. Field analysis of voltage, current, resistance, capacitance, and inductance. Coupled circuits.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 3623 Applied Fields and Waves II**

**Prerequisites:** ECEN 3613.

**Description:** Continuation of ECEN 3613. Plane-wave propagation in free space, power flow, reflection and transmission. Guided waves and resonators. Radiation and introduction to antenna systems. Boundary value problem analysis.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 3714 Network Analysis**

**Prerequisites:** MATH 2233 and ECEN 2714 and PHYS 2114 with a grade of "C" or better.

**Description:** Advanced mathematical analysis techniques used in circuit analysis including Laplace transforms, Fourier transforms, and Fourier series. Circuit frequency response, Bode plots, and filters, including passive, active, low-pass, high-pass, and band-pass filters. Theory of linear circuits; two-port circuit models and parameters. Course previously offered as ECEN 3713.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

**ECEN 3723 Systems I**

**Prerequisites:** ENSC 3714 and ENSC 2113 with a "C" or better and (MATH 3013 with a "C" or better or concurrent enrollment).

**Description:** Physical and mathematical modeling of electrical and mechanical dynamic systems. Transient response of first and second order systems. Laplace transform techniques for solving differential equations, transfer functions, frequency response and resonance. Course previously offered as ECEN 3413.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 3903 Introduction to Semiconductor Devices**

**Prerequisites:** PHYS 2114 with a "C" or better.

**Description:** Crystal structure, the quantum theory of solids. The physics of semiconductor materials and the p-n junction, with an emphasis on applications to semiconductor devices. Same course as PHYS 3313.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 3913 Solid State Electronic Devices**

**Prerequisites:** ECEN 3714 with a "C" or better and (PHYS 3313 or ECEN 3903 with a "C" or better).

**Description:** Solid state physics basis of modern electronic devices. Introductory quantum mechanics. Energy bands in solids. Electronic properties of semiconductors. Junction diodes. Bipolar transistors. Field effect transistor.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4010 Special Topics**

**Prerequisites:** ECEN 3233, and (ECEN 3213 or ENSC 3213) and ECEN 3714 with a "C" or better or advisor permission.

**Description:** Engineering topics not normally included in existing courses. Repeat credit may be earned with different course subtitles assigned. Offered for variable credit, 1-12 credit hours, maximum of 12 credit hours.

**Credit hours:** 1-12

**Contact hours:** Contact: 1-12 Other: 1-12

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Elec & Computer Engr

**ECEN 4013 Design of Engineering Systems**

**Prerequisites:** (ECEN 3213 or ENSC 3213), ECEN 3233, and ECEN 3714 with a grade of "C" or better and ECEN 3613, ECEN 3513, ECEN 3314 and (ENGL 3323 with a grade of "C" or better or concurrent enrollment).

**Description:** Complete design cycle for several small design projects, each including establishing objectives, synthesis, analysis, construction, testing and evaluation. Use of modern lab equipment and fabrication techniques. Development of communication skills.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

**ECEN 4024 Capstone Design**

**Prerequisites:** ECEN 4013.

**Description:** Continuation of ECEN 4013. Student project teams design, build, test and present results for realistic projects from university and industrial sponsors. Formulation of specifications, consideration of alternative solutions, feasibility considerations, detailed system descriptions, economic factors, safety, reliability, aesthetics, ethics and social impact. Course previously offered as ECEN 4023.

**Credit hours:** 4

**Contact hours:** Lab: 8 Contact: 8

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Elec & Computer Engr

**ECEN 4030 Undergraduate Professional Practice**

**Prerequisites:** Approval of ECEN department head.

**Description:** Experience in application of electrical engineering principles to typical problems encountered in industry. Solutions to the problems by student participation in the role of engineer or engineering intern. Offered for variable credit, 1-8 credit hours, maximum of 8 credit hours.

**Credit hours:** 1-8

**Contact hours:** Contact: 1-8 Other: 1-8

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Elec & Computer Engr

**ECEN 4133 Power Electronics**

**Prerequisites:** ECEN 3714 with a grade of "C" or better.

**Description:** Power electronic devices, components, and their characteristics; DC to AC conversion; fundamentals of inverters and waveshaping devices; application aspects; control aspects; characteristics and state-of-the-art of advanced power inverter and power conditioning topologies.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4153 Power System Analysis and Design**

**Prerequisites:** ECEN 3714, "C" or better.

**Description:** Power system component models from circuit theory. Formulation and design of the load flow model and the optimum economic generator allocation problem utilizing computer methods.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4213 Embedded Computer Systems Design**

**Prerequisites:** (ECEN 3213 or ENSC 3213), ECEN 3233 and ECEN 3714 with a "C" or better.

**Description:** Design of microprocessor-based systems through proper integration of hardware and software. Serial and parallel communications, sensor interfacing, computer control of external devices, and color graphics hardware. Design of PASCAL and assembly language modules for optimum real-time system performance.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

**ECEN 4233 High Speed Computer Arithmetic**

**Prerequisites:** ECEN 3233, (ECEN 3213 or ENSC 3213) and ECEN 3714 with a "C" or better.

**Description:** Course covers computer arithmetic as applied to general purpose and application-specific processors. Focus is on developing high-speed arithmetic algorithms and understanding their implementation in VLSI technology at the gate level.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4243 Computer Architecture**

**Prerequisites:** (ECEN 3213 or ENSC 3213), ECEN 3233, and ECEN 3714 with a "C" or better.

**Description:** Functional organization and hardware design of digital computer systems with emphasis on microprocessor-based systems. CPU organization, features of microprocessors including advanced 32-bit CPU's, memory system design including cache, virtual memory, error detection and correction, I/O operations, including direct memory access and peripheral interface design.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

**ECEN 4273 Software Engineering**

**Prerequisites:** (ECEN 3213 or ENSC 3213), ECEN 3233, CS 3653, and ECEN 3714 with a "C" or better.

**Description:** Functional organization and hardware design of digital computer systems with emphasis on microprocessor-based systems. CPU organization, features of microprocessors including advanced 32-bit CPU's memory system design including cache, virtual memory, error detection and correction, I/O operations, including direct memory access and peripheral interface design. Same course as CS 4273.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4283 Computer Networks**

**Prerequisites:** (ECEN 3213 or ENSC 3213), ECEN 3233 and ECEN 3714 with a "C" or better.

**Description:** Computer networks, distributed systems and their systematic design. Introduction to the use, structure, and architecture of computer networks. Networking experiments to describe network topology. ISO reference model. Same course as CS 4283.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4303 Digital Integrated Circuit Design**

**Prerequisites:** ECEN 3314 and (ECEN 3233 with a "C" or better).

**Description:** Theory of digital and electronics circuits. Digital logic families TTL, IIL, ECL, NMOS, CMOS, GaAs. Large signal models for transistors. Implementation at RAM and ROM. Circuit design for LSI and VLSI.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4313 Linear Electronics Circuit Design**

**Prerequisites:** ECEN 3314.

**Description:** Overview of semiconductor device physics (MOSFETs and BJTs) and integrated-circuit design environment. Building blocks for analog systems (differential amplifiers, operational amplifiers, output stages, and voltage references). Understanding of frequency response (Bode plot, transfer function, pole-zero analysis, feedback, and stability). Extensive SPICE-based design for performance optimization and design tradeoffs.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4353 Communication Electronics**

**Prerequisites:** ECEN 3314.

**Description:** Introduction to radio-frequency (RF) communication systems with a primary focus on transistor- and circuit-level analysis. Investigations of RF system properties (noise, linearity, and matching) modulation schemes, and transceiver architectures. Operation principles and basic design of low-noise amplifiers, mixers, power amplifiers, and oscillators.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4413 Automatic Control Systems**

**Prerequisites:** ECEN 3723 or (MAE 3723 or MAE 3724).

**Description:** Properties of feedback control systems, mathematical models of basic components, state-variable models of feedback systems, time-domain analysis, stability, transform analysis, frequency domain techniques, root-locus design of single input single output systems and simple compensation techniques. Same course as MAE 4053.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4503 Random Signals and Noise**

**Prerequisites:** ECEN 3513.

**Description:** Elementary concepts of probability, random variables. Random distributions and density functions. Operations on random variables such as expectation, variance and moments. Pairs of random variables. Introduction to random process. Applications on probability theory to practical problems and analysis of electrical systems using elementary concepts of probability.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4523 Communication Theory**

**Prerequisites:** ECEN 4503.

**Description:** Noise in modulation systems. Digital data transmission. Design of optimal receivers. Introduction to information theory.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4533 Data Communications**

**Prerequisites:** ECEN 4503 prerequisite or concurrent enrollment.

**Description:** Signal detection in noise. Tradeoffs between bandwidth signal-to-noise ratio and rate of information transfer. Transmission multiplexing and error handling. Elements of computer network design. Data link protocols.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4613 Microwave Engineering**

**Prerequisites:** ECEN 3613.

**Description:** Review of EM and transmission line theory. Microwave network theory: Impedance and admittance matrices, scattering matrix and S-parameters, ABCD and transfer matrices. Signal-flow diagrams. Matching circuits and microwave filters. Passive microwave devices: power dividers, hybrids, couplers, resonators, isolators, and circulators. Class projects such as radar, communication, imaging, or sensing systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4743 Introduction to Biomedical Engineering Modeling and Systems****Prerequisites:** ECEN 4763.**Description:** An overview of the field of biomedical engineering and an introduction of the modeling approaches implemented in biomedical engineering. Topics include bio-electronics, biomechanics, compartmental modeling, bio-signal processing, biomedical optics, etc. The course will demonstrate a few of major fields of activity in which biomedical engineers are engaged and modeling approaches are implemented.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4763 Introduction to Digital Signal Processing****Prerequisites:** ECEN 3513.**Description:** Introduction to discrete linear systems using difference equations and z-transforms. Discrete Fourier analysis. Design of digital filters. Sampling theorem. Applications of digital signal processing.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4773 Real Time Digital Signal Processing****Prerequisites:** ECEN 4763.**Description:** DSP Processor architectures and programming. A/D, D/A, polled and interrupt-driven I/O. Realtime implementation of FIR/IIR filters, the FFT, and other DSP algorithms on special purpose DSP hardware from Motorola, Texas Instruments and others. Link between DSP theory and practical implementation.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4823 Design of Optical Systems****Prerequisites:** ECEN 3714 with a "C" or better.**Description:** Introduction to optics through the design, construction, and characterization of optical systems. Emphasis on geometrical optics and spectroscopy. Course previously offered as ECEN 3813.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Elec & Computer Engr**ECEN 4843 Design of Lasers and Systems****Prerequisites:** ECEN 3613.**Description:** Introduction of the design of lasers and optical systems based on lasers including the design, construction, and characterization of lasers. Gaussian beams and optics, laser gain materials, laser cavities, advanced topics. Course previously offered as ECEN 4813.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Elec & Computer Engr**ECEN 5000 Thesis****Description:** A student studying for the master's degree will enroll in this course for a maximum of six credit hours. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 5030 Professional Practice****Description:** Experience in application of electrical engineering principles to typical problems encountered in industry and government engineering design and development projects. Solutions to the problems require participation by the student in the role of junior engineer or engineer-intern. Problem solutions involve economics and ecological considerations as well as technology and must be adequately documented. Offered for variable credit, 1-8 credit hours, maximum of 8 credit hours.**Credit hours:** 1-8**Contact hours:** Contact: 1-8 Other: 1-8**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 5060 Special Topics****Prerequisites:** Advisor permission.**Description:** Engineering topics not normally included in existing courses. Repeat credit may be earned with different course subtitles assigned.

Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 5070 Directed Studies****Prerequisites:** Consent of instructor.**Description:** Investigation outside of the classroom of topics not normally covered in lecture courses. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 5080 Fundamental Topics****Prerequisites:** Advisor permission.**Description:** Fundamental topics that are typically introduced in the senior year curriculum with additional depth and breadth commensurate with the graduate program. Repeat credit may be earned with difference course subtitles assigned. Offered for variable credit, 1-6 credit hours, maximum of 9 credit hours.**Credit hours:** 1-6**Contact hours:** Lecture: 1-6 Contact: 1-6**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr

**ECEN 5113 Power Systems Analysis by Computer Methods**

**Description:** Quasi-static control of power systems and analysis of power systems under abnormal operating conditions. Transient stability studies. Models formulated and solutions outlined for implementation on the computer.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5123 Engineering Systems Reliability Evaluation**

**Description:** Techniques and concepts needed for evaluating the long-term and short-term reliability of a system. Topics include static and spinning generation capacity; transmission, composite, interconnected, and dc system reliability evaluations; and power system security. Applications to systems other than power systems included. For students with little or no background in probability or statistics.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5133 Power Electronics and Renewables**

**Description:** Modeling and control aspects of power electronics for integrating renewable energy systems. Topics covered here will focus on power converter dynamics, indirect converter topologies, PWM technique, sliding mode control of converters, game theory based control, Maximum power point tracking, control of generators for different renewable energy systems. Simulation tools will be discussed as appropriate.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5153 Direct Energy Conversion**

**Description:** Energy conversion techniques and applications; thermo-electrics, thermionics, fuel cells, MHD and other processes involving electrical, mechanical and thermal energies. State-of-the-art developments in direct energy conversion using selected papers from journals and other publications. Gives the student a proper perspective of the possibilities and problems associated with satisfying future energy requirements.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5163 Cyber Physical Systems and Smart Grid**

**Prerequisites:** ECEN 4503.

**Description:** A comprehensive overview of advanced cyber-physical technologies and ideas that make the power grid smart. Topics covered include: basics of electric power systems; fundamentals of smart grids; the role of measurement, communications and monitoring technologies in smart grids; integrated applications of control and information advancements in a smart grid; Distributed Energy Resources (DERs) including renewable energy resources, energy storage systems, electric vehicles, and demand response; various functions and tools for managing smart grids; and interoperability, standards, and cyber security in smart grids.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5193 Power Economics and Regulation**

**Prerequisites:** Vector calculus, familiarity with complex numbers.

**Description:** Natural monopoly, regulated mono-polities. Power pricing. Deregulation and the Energy Policy Act of 1992. Bulk power markets, transmission access and wheeling. Economic dispatch and system operations. Security and reliability. Environmental externalities and Clean Air Act compliance. Procurement of new capacity and integrated resource planning. Co-generators and independent power producers.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5223 Digital Systems Testing**

**Prerequisites:** ECEN 3233.

**Description:** Testing of combinational and sequential circuits. Test generation techniques. Design of reliable and testable circuits and systems. Testing for LSI and VLSI.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5233 Embedded Sensor Networks**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Analysis and design of wireless networks, including the integration of sensing, computation, and wireless communication within an embedded system. Mobile sensor networks and body sensor networks. Real world application and new innovations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr



**ECEN 5253 Digital Computer Design**

**Prerequisites:** ECEN 4243 or graduate standing.

**Description:** Arithmetic algorithms and the design of the arithmetic/logic unit (ALU). Serial and parallel data processing; control and timing systems; microprogramming; memory organization alternatives; input/output interfaces. Same course as CS 5253.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5263 VLSI Digital Systems Design**

**Prerequisites:** ECEN 4303; ECEN 5253 recommended or graduate standing.

**Description:** Design of very large-scale digital systems on a single chip. Review of MOS technology. Design rules imposed by fabrication techniques. Systematic structures for control and data flow; system timing; highly concurrent systems. Experimental opportunities available.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5283 Computer Vision**

**Prerequisites:** ECEN 4763.

**Description:** Fundamental concepts and tools in computer vision. Image formation and camera calibration. Early vision: edge detection, feature extraction, texture analysis. Mid-level vision: clustering, segmentation and object detection. High-level vision: object recognition using principal component analysis (PCA) and video analysis by hidden Markov models (HMMs).

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5313 Analog Integrated Circuits**

**Description:** Advanced studies of analog CMOS IC design with an emphasis on EDA. Topics include bandgap reference, oscillators, PLL, linear regulators, DC-DC converters, low voltage, low power, and energy harvesting techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5333 Semiconductor Devices**

**Prerequisites:** ECEN 3314 and PHYS 3313 or equivalent.

**Description:** Semiconductor crystal structure and device fabrication, carrier distribution and transport, pn junction and diode, metal-semiconductor heterojunction, MOSFET, BJT and optoelectronic devices.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5363 Mixed-Signal Integrated Circuits**

**Description:** Analysis and design of CMOS mixed-signal IC for VLSI systems. Topics include comparators, switched-capacitor circuits, sample-and-hold, Nyquist and oversampling ADC/DAC, delta-sigma modulation, and digital calibration techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5373 RF Microwave Circuit Design**

**Prerequisites:** ECEN 3314 and ECEN 4613.

**Description:** Smith chart, single- and multi-port network, filter design, RF/microwave components and modeling, matching and biasing network, amplifier, oscillators and mixers.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5413 Optimal Control**

**Prerequisites:** ECEN 4413 or MAE 4053, ECEN 5713 or MAE 5713.

**Description:** Optimal control theory for modern systems design. Specification of optimum performance indices. Dynamic programming, calculus of variations and Pontryagin's minimum principle. Iterative numerical techniques for trajectory optimization. Same course as MAE 5413.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5433 Robotics Kinematics, Dynamics and Control**

**Prerequisites:** ECEN 4413 or MAE 4053 or consent of instructor.

**Description:** Kinematic and dynamic analysis of robot manipulators. Inverse kinematics, motion planning and trajectory generation. Industrial practice in robot servo control. Dynamics and control in the presence of constraints. Actuators and sensors. Force sensors and vision systems. Robotic force control and its applications in industry. Passivity-based control algorithms. Advanced control techniques for motion and force control. Same course as MAE 5433.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5463 Nonlinear System Analysis and Control**

**Prerequisites:** ECEN 4413 or MAE 4053, ECEN 5713 or MAE 5713.

**Description:** Failure of superposition of effects; phase-plane analysis; limit-cycles; Lyapunov stability; hyperstability and input-output stability; controllability and observability of nonlinear systems; feedback linearization; robust nonlinear control system design. Same course as MAE 5463. Course previously offered as ECEN 5723.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5473 Digital Control Systems****Prerequisites:** ECEN 4413 or MAE 4053.**Description:** Input-output and state-space representation of linear discrete-time systems. Approximate methods in discrete-time representation. Stability methods. Controllability, observability, state estimation, and parameter identification. Design and analysis of feedback control system using frequency-domain and state-space methods. Introduction to optimal control. Same course as MAE 5473. Course previously offered as ECEN 6413.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5483 Advanced Mechatronics Design****Prerequisites:** MAE 4733.**Description:** Optimizing C programming code for microcontrollers using the assembly language instruction set. RS-232 microcontroller communication protocol. Controller Area Network (CAN) communication protocol plus hands-on CAN bus development boards, advanced topics which could include but are not limited to sensor design, real time operating systems, and advanced communication protocols. Same course as MAE 5483.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5513 Stochastic Systems****Prerequisites:** ECEN 4503 or STAT 4033.**Description:** Theory and applications involving probability, random variables, functions of random variables, and stochastic processes, including Gaussian and Markov processes. Operations on random variables, transformation of random variables, single and multiple random variables, correlation, power spectral density, and stationary and non-stationary random processes. Random sums and sequences. Response of linear systems to stochastic processes. State-space formulation and covariance analysis. Same course as MAE 5513.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5533 Modern Communication Theory****Prerequisites:** ECEN 5513.**Description:** Noise as a random process, analog and digital signal detection in the presence of noise, optimum receiver design using signal space concepts and introduction to information theory. Trade-offs between bandwidth, signal-to-noise ratio and the rate of information transfer. Example system designs include earth satellite, deep space and terrestrial communication systems and computer communication networks.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5543 Data Transportation and Protection****Description:** Data and its representation; finite field matrices, pseudorandom sequences; information protection; space division networks; synchronization; and channel and error control.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5553 Telecommunications Systems****Prerequisites:** Graduate standing or consent of instructor.**Description:** Surveys the ways and means that voice, data and video are moved long distances. Covers computer networks (Ethernet LAN's, Internet WAN's); telephone systems (PSTN, VoIP and cellular telephony); video (MPEG, H.323, and IPTV); and last mile delivery systems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5573 Wireless Communication****Prerequisites:** ECEN 4503 or STAT 4033.**Description:** Wireless channel characterization: large-scale and small scale fading. Techniques to combat fading; diversity techniques, coding techniques, CDMA, OFDM, MIMO. Advanced communication systems such as 5G and Beyond cellular systems, mmWave and Terahertz communications, massive MIMO, and UAV-assisted communications.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5613 Electromagnetic Theory****Prerequisites:** ECEN 3613.**Description:** First graduate level treatment of classical electromagnetic theory. Wave equation, potential theory, boundary conditions. Rectangular, cylindrical and spherical wave functions. Conducting and dielectric guiding structures. Scattering and radiation. Introduction to numerical techniques.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5623 Antenna Theory****Prerequisites:** ECEN 3613.**Description:** Fundamental antenna parameters, including directivity, efficiency, radiation resistance, and pattern. Analysis of dipole, loop, aperture, broad-band, and traveling wave antennas. Array theory. Introduction to numerical techniques used in modern antenna design.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr

**ECEN 5633 Radar Theory**

**Prerequisites:** ECEN 3613; ECEN 4503 or ECEN 5513.

**Description:** Theoretical treatment of radar principles. Overview of radar systems and techniques, radar equation, integration of signals. Radar cross-section of single and multiple targets. Waveform design, resolution, ambiguities and accuracy. Range, speed and angular measurements. Detection of targets in noise. Statistical description of clutter. Signal processing techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5643 Antennas and Propagation for Wireless Communications**

**Prerequisites:** ECEN 3613, ECEN 4503.

**Description:** Aspects of radiowave propagation for fixed and mobile communication systems. Review of Maxwell's equations and plane wave propagation, antenna principles. Reflection, refraction, diffraction, fading and scintillation, attenuation, ducting, diversity. Propagation in a cellular environment. Satellite communications.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5683 Biomedical Optics**

**Description:** Biomedical optics, also often termed as biophotonics, is highly interdisciplinary subject on applying light for diagnostic detection and manipulation of biological tissue. This course introduces fundamental concepts and principal technologies of biomedical optics or biophotonics to graduate students and upper-level undergraduate students. The course includes three parts: The first part discusses light-tissue interaction. The second part introduces approaches to modeling photon propagation in tissue. The third part details several representative light-based sensing and imaging technologies for probing biological tissues at different spatial, spectral, and temporal scales for either morphological or functional diagnosis. Topics of therapeutic use of light will also be discussed.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5713 Linear Systems**

**Prerequisites:** ECEN 4413 or MAE 4053.

**Description:** Introduction to the fundamental theory of finite-dimensional linear systems with emphasis on the state-space representation. Mathematical representations of systems; linear dynamic solutions; controllability, observability, and stability; linearization and realization theory; and state feedback and state observer. Same course as MAE 5713.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5733 Neural Networks**

**Prerequisites:** ECEN 5713 or MAE 5713.

**Description:** Introduction to mathematical analysis of networks and learning rules, and on the application of neural networks to certain engineering problems in image and signal processing and control systems. Same course as CHE 5733 and MAE 5733.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5763 Digital Signal Processing**

**Prerequisites:** ECEN 4763.

**Description:** Discrete-time signals and systems; transform analysis of linear systems; design and implementation of digital filters; analog to digital conversion, quantization effects, and oversampling; discrete Fourier transform and the FFT; Fourier analysis using the DFT; introduction to parametric signal modeling; and practical applications of digital signal processing.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5773 Intelligent Systems**

**Prerequisites:** ECEN 5713 or MAE 5713.

**Description:** Introduction to the state-of-the-art intelligent control and system successfully deployed to industrial and defense applications. Emerging intelligent algorithms (e.g., NN, FS, GA, EP, DES); intelligent control architecture (e.g., bottom-up, top-down, semiotics); reinforcement learning and hybrid systems; and case studies and design projects. Same course as MAE 5773.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5783 Medical Imaging**

**Prerequisites:** ECEN 4743.

**Description:** A comprehensive introduction to the physics and engineering foundations of the standard medical imaging modalities used today. Topics include radiation, radiation-interaction with matter, X-ray radiography, ultrasonography, X-ray computed tomography, image reconstruction and analysis, magnetic resonance imaging, nuclear radiation based imaging, and image monitoring aspects of radiation therapy. The fundamental mathematics underlying each imaging modality is reviewed and the hardware needed to implement each system is examined.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5793 Digital Image Processing****Prerequisites:** ECEN 4763.**Description:** Digital image processing including image acquisition, enhancement, restoration, color image processing, morphological processing, segmentation, representation and description.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5803 Geometrical Optics****Prerequisites:** PHYS 3213 or consent of instructor.**Description:** Foundations of geometrical optics, geometrical theory of optical imaging, geometrical theory aberrations, image forming instruments. Same course as PHYS 5123.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5823 Physical Optics****Prerequisites:** PHYS 3213 or consent of instructor.**Description:** Multiple beam interference, diffractions, imaging, near field optical probes of matter, surface plasmons, light scattering from random media, optical coherence tomography- biomedical applications, negative materials, perfect lenses and super resolution. Same course as PHYS 5303.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5833 Fiber-Optic Communication Systems****Prerequisites:** ECEN 3613 or ECEN 4533.**Description:** The fundamentals of fiber-optic communication systems are described in detail. Fiber electromagnetic behaviors, laser and LED transmitters, photodetectors and semiconductor receivers and other hardware components are covered. System level design and integration concepts are covered including modulation schemes, multiplexing, dispersion and power budget, sampling, incoherent and coherent detection, error control, and network distribution. A historical framework shows how technical capabilities and growing communication needs forced fiber systems evolution.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5843 Microelectronic Fabrication****Prerequisites:** ECEN 3314.**Description:** Contamination control and clean-room, vacuum systems, wafer manufacturing. Photolithography and alternative lithographic techniques. Physical and chemical vapor deposition, oxidation, etching, doping, packaging, formation of semiconductor devices and circuits. A series of Fabrication lab projects is conducted starting from bare silicon wafers to fabricate Optoelectronic circuits.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**Additional Fees:** ECEN Consummable Materials fee of \$120 applies.**ECEN 5853 Ultrafast Optoelectronics****Prerequisites:** ECEN 5833.**Description:** Principles in ultrafast lasers and terahertz radiation are discussed. Topics include generation, propagation, amplification, and measurement of femtosecond optical pulses. Generation, detection, and manipulation of terahertz waves as fundamentals to understand how time-domain spectroscopy and imaging work will be described. Selected advanced topics in ultrafast metamaterials and plasmonics will also be discussed.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5923 Introduction to MEMS****Prerequisites:** ECEN 5843 or consent of instructor.**Description:** Fundamentals of Microsystems. Topics include: energy transduction mechanisms, energy dissipation modeling, energy methods, mechanics of small scale, fabrication process design, micromachining, electronic interface.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6000 Dissertation****Prerequisites:** Consent of major professor.**Description:** Independent research for students continuing graduate study beyond the level of the MS degree. Offered for variable credit, 1-12 credit hours, maximum of 36 credit hours.**Credit hours:** 1-12**Contact hours:** Contact: 1-12 Other: 1-12**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 6001 PhD Seminar Series****Prerequisites:** Approval of ECEN department head.**Description:** Seminar series for PhD studies and research.**Credit hours:** 1**Contact hours:** Lecture: 1 Contact: 1**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr

**ECEN 6050 Preliminary PhD Research and Proposal****Prerequisites:** Consent of adviser.**Description:** Independent research and report of an advanced electrical engineering problem. Work performed serves as foundation of the oral PhD preliminary exam.**Credit hours:** 3**Contact hours:** Contact: 3 Other: 3**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 6060 Special Topics****Prerequisites:** Advisor permission.**Description:** Advanced engineering topics not normally included in existing courses. Repeat credit may be earned with different course subtitles assigned. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 6070 Advanced Directed Studies****Prerequisites:** Admission into PhD program and consent of instructor.**Description:** Investigation outside of the classroom of topics not normally covered in lecture courses. Offered for variable credit, 1-6 credit hours, maximum of 12 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 6123 Special Topics in Power Systems****Prerequisites:** ECEN 5113.**Description:** Selected relevant current topics related to power system operation and planning.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6253 Advanced Topics in Computer Architecture****Prerequisites:** ECEN 5253 or CS 5253.**Description:** Innovations in the architecture and organization of computers, with an emphasis on parallelism. Topics may include pipelining, multiprocessors, data flow, and reduction machines. Same course as CS 6253.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6263 Advanced VLSI Design and Applications****Prerequisites:** ECEN 5223 and ECEN 5263.**Description:** System timing. Designing testable integrated circuits. Specialized parallel processing architectures. Application examples.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6453 Adaptive Control****Prerequisites:** ECEN 5473 or ECEN 5713 or MAE 5473 or MAE 5713.**Description:** Analysis and design of control techniques that modify their performance to adapt to changes in system operation. Review of systems analysis techniques, including state variable representations, linearization, discretization, covariance analysis, stability, and linear quadratic Gaussian design. On-line parameter estimation, model reference adaptive systems, self-tuning regulators, stable adaptive systems. Same course as MAE 6453. Course previously offered as ECEN 6450.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6483 Robust Multivariate Control Systems****Prerequisites:** ECEN 5713 or MAE 5713.**Description:** Introduction to multivariable systems: SISO robustness vs. MIMO robustness; multivariable system poles and zeros; MIMO transfer functions; multivariable frequency response analysis; multivariable Nyquist theorem; performance specifications; stability of feedback systems; linear fractional transformations (LFT's); parameterization of all stabilizing controllers; structured singular value; algebraic ricatti equations; H2 optimal control; H-infinity controller design. Same course as MAE 6483.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6523 Information Theory****Prerequisites:** ECEN 5513 or consent of instructor.**Description:** Mathematical theory of information (Shannon theory) including information measure and transmission rates and capacities. Source coding theory including algebraic and error-correcting codes. Design of waiver-forms for noise immunity. Information transfer in learning systems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6803 Photonics I: Advanced Optics****Prerequisites:** ECEN 3813 or PHYS 3213 or consent of instructor.**Description:** Advanced optics including spectral and time characteristics of detectors, characteristics of lasers, time, spectral and spatial parameters of laser emission, interferometric techniques, and nonlinear effects such as two-photon absorption and second and third harmonic generations. Emphasis on ultrashort laser pulses. Same course as CHEM 6803 & PHYS 6803.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr

**ECEN 6810 Photonics II: THz Photonics and THz-TD****Prerequisites:** ECEN 6803.**Description:** Concepts and techniques of driving electronic circuitry with ultra short laser pulses to generate and detect freely propagating pulses of THz electromagnetic radiation using several operational research systems. Same course as CHEM 6810 & PHYS 6810. Course previously offered as ECEN 6811. Offered for fixed credit, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6820 Photonics II: Spectroscopy II****Prerequisites:** ECEN 6803.**Description:** Operating principles and applications of laser spectroscopy of atoms, molecules, solids and complex fluids. Absorption, emission, photon correlation, coherence, time resolved Fourier transform. Raman spectroscopy and non-linear optical. Same course as CHEM 6820 & PHYS 6820. Course previously offered as ECEN 6821. Offered for fixed credit, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6823 Advanced Optical Techniques****Prerequisites:** ECEN 5853.**Description:** State-of-the-art optical devices and research methodologies. Investigation and discussion of contemporary developments in non-linear optical devices and laser applications. Includes both analytical and experimental techniques.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6830 Photonics II: Spectroscopy III****Prerequisites:** ECEN 6803.**Description:** Advanced spectroscopic instruments and methods used for investigation of semi-conductors and solid state material. Stimulated emission characterized both in wavelength and in time. Time-resolved fluorescence measurements. Multiphotonic excitations. Fast measuring techniques, including subnanosecond detectors, picosecond streak cameras, and ultra fast four-wave mixing and correlation techniques. Time-dependent photoconductivity measurements. Same course as CHEM 6830 & PHYS 6830. Course previously offered as ECEN 6831. Offered for 1 fixed credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6840 Photonics III: Microscopy I****Prerequisites:** CHEM 3553 or consent of instructor.**Description:** The structure and imaging of solid surfaces. Basics of scanning probe microscopy (SPM). Contact and non-contact atomic force microscopy (AFM). Scanning tunneling microscopy (STM) in air. Same course as CHEM 6840 & PHYS 6840. Course previously offered as ECEN 6841. Offered for fixed credit hours, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6843 Advanced Microelectronic Fabrication****Prerequisites:** ECEN 5843.**Description:** Photolithography, wet and dry etching, thermal and electron beam evaporation, photomask design using L-Edit, silicon devices processing, quartz devices processing, silicon-on-sapphire devices processing. GaAs devices processing and MEMS devices processing.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6850 Photonics III: Microscopy II****Prerequisites:** CHEM 3553 or consent of instructor.**Description:** Advanced techniques of scanning probe microscopy (SPM). Magnetic force microscopy, Kelvin force microscopy, scanning probe microscopy (STM) in vacuum. Characterization of materials with SPM. Nanolithography with SPM. Device manufacturing and analysis. Same course as CHEM 6850 & PHYS 6850. Course previously offered as ECEN 6851. Offered for 1 fixed credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6860 Photonics III: Microscopy III and Image Processing****Prerequisites:** ECEN 5793.**Description:** Digital image processing, including projects. Image acquisition and display, image enhancement, geometric operations, linear and nonlinear filtering, image restoration, edge detection, image analysis, morphology, segmentation, recognition, and coding/compression. Same course as CHEM 6860 & PHYS 6860. Offered for fixed credit hours, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr

**ECEN 6870 Photonics IV: Synthesis and Devices I****Prerequisites:** ECEN 6803 and ECEN 6840.**Description:** Preparation of functional nanostructures and related optical/electronic devices. Physical and chemical methods of thin film deposition. Engineering of prototypes of light emitting diodes, sensors, optical limiting coatings, lithographic patterns. Same course as CHEM 6870 & PHYS 6870. Course previously offered as ECEN 6871. Offered for 1 fixed credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6880 Photonics IV: Semiconductor Devices, Testing and Characterization****Prerequisites:** ECEN 6803 and ECEN 6840.**Description:** Test and characterization of semiconductor and optoelectronic devices. Hall effect, four point probe, CV and IV measurements, optical pump-probe, photoluminescence and electro-optics sampling. Same course as CHEM 6880 & PHYS 6880. Course previously offered as ECEN 6881. Offered for 1 fixed credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6890 Photonics IV: Semiconductor Synthesis and Devices III****Prerequisites:** ECEN 6803.**Description:** Processing, fabrication and characterization of semiconductor optoelectronic devices in class 100/10000 cleanrooms. Cleanroom operation including general procedure for material processing and device fabrication. Device processing using a variety of processing such as mask aligner, vacuum evaporators and rapid thermal annealer. Testing using optical and electrical testing apparatus such as I-V, C-V, Hall, and optical spectral measurement systems. Same course as CHEM 6890 & PHYS 6890. Course previously offered as ECEN 6891. Offered for fixed 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr

## Undergraduate Programs

- Computer Engineering, BSCP (p. 2218)
- Computer Engineering: Software Engineering, BSCP (p. 2220)
- Electrical Engineering, BSEE (p. 2222)

## Graduate Programs

The School of Electrical and Computer Engineering offers three graduate degrees, all in electrical engineering: Master of Engineering (MEngEE), Master of Science (MSEE) and Doctor of Philosophy (PhDEE).

These graduate degree programs are flexible in course selection and emphasis. Both the Master of Engineering and the Master of Science programs are available online.

The Master of Engineering degree program is tailored to students who wish to gain advanced knowledge and expertise in subject areas

associated with their professional pursuits. This non-research, non-thesis, instructional program is ideal for Distance Education students or for baccalaureate graduates interested in professional development to enhance their competitiveness in the workplace. It is well-suited for students who have little interest in a research-centric education.

The Master of Science degree emphasizes advanced mathematics, theory, design and research. It is intended for students interested in cutting-edge careers or who want to prepare for advanced research associated with the PhD program. This degree combines coursework with research that allows students to expand their knowledge in an in-depth area of electrical engineering or computer engineering. The MSEE program culminates with the defense of a thesis.

The Doctor of Philosophy degree is designed to prepare students for positions in academia, industry and government. This degree emphasizes the creation of new knowledge through the in-depth research process, as documented in the doctoral dissertation.

The School of Electrical and Computer Engineering also offers a “4+1” degree program that combines the BSEE/BScPE degree programs with the MEngEE degree program. The “4+1” program is only available to OSU baccalaureate students. It is designed to be completed in five years and to give students a broad-based undergraduate education in electrical engineering or computer engineering along with a highly in-depth graduate education in a few key areas. This program is ideal for those students who want advanced knowledge to enhance their competitiveness in the workforce and to satisfy their longing for in-depth knowledge that cannot be obtained in the baccalaureate degrees. Specific requirements for the “4+1” program are available on the web in the document entitled “Memorandum to Graduate Students;” see <https://ece.okstate.edu/>.

Students typically select coursework and participate in research and design projects in the following areas:

- Communication systems, cybersecurity and networks
- Control systems, robotics and mechatronics
- Analog, mixed-signal and RF electronics
- Computer architecture, VLSI digital circuits and arithmetic
- Electromagnetics and THz sciences
- Microcontrollers and embedded control
- Photonics and electro-optics
- Digital signal, image and video processing
- Energy and power
- Bioengineering

## Admission Requirements

Admission to the Graduate College, as described under “General Regulations” in the “Graduate College” section of the University Catalog is required. Graduation from an electrical engineering or computer engineering program accredited by the ABET is required for admission to the School of Electrical and Computer Engineering. In addition, sufficient GRE scores are required for admission to the doctoral program in the School of Electrical and Computer Engineering.

Graduates from non-engineering fields such as mathematics, physics and computer science are also admitted to the School of Electrical and Computer Engineering graduate programs if an evaluation of the applicant’s official transcript indicates that the applicant is prepared to succeed in graduate-level course work in electrical and computer

engineering, or can be expected to do so after a reasonable amount of remedial coursework has been completed. This condition also applies to graduates of unaccredited engineering programs and engineering technology programs.

## Degree Requirements

The Master of Engineering degree in Electrical Engineering (MEngEE) is awarded to those students who successfully complete an approved plan of study. The degree requires 33 credit hours of coursework; a thesis is not required. The plan of study requires, at a minimum, 24 hours of 5000-level courses, covering four areas in electrical and computer engineering (designated by second digit of the course number). Most plans of study include additional 5000-level courses, depending upon the background and particular educational goals of the student. Additional remedial work in undergraduate electrical and computer engineering courses may be required for students who do not have a sufficient background in electrical engineering. Specific requirements for the MEngEE program are available on the web in the document entitled "Memorandum to Graduate Students;" see <https://ece.okstate.edu/> (<https://ceat.okstate.edu/ece/>).

The Master of Science degree in Electrical Engineering (MSEE) is awarded to those students who successfully complete an approved plan of study. The degree requires 24 credit hours of coursework plus 6 credit hours for the thesis. In addition to the thesis requirement, the plan of study requires, at a minimum, 21 hours of 5000-level courses in at least two areas in electrical and computer engineering (designated by second digit of the course number). Most plans of study include additional 5000-level courses, depending upon the background and particular educational goals of the student. Each student is encouraged to include courses in supporting disciplines such as mathematics, physics, computer science or other engineering fields. Additional remedial work in undergraduate electrical and computer engineering courses may be required for students who do not have a sufficient background in electrical engineering. Specific requirements for the MSEE program are available on the web in the document entitled "Memorandum to Graduate Students;" see <https://ece.okstate.edu/> (<https://ceat.okstate.edu/ece/>).

The Doctor of Philosophy (PhDEE) degree is granted to recognize high achievement in coursework selected from the broad field of electrical and computer engineering. The degree is conferred on those who demonstrate the ability to perform independent research in a chosen field of specialization that generates new knowledge, as presented in a dissertation. For this degree the Graduate College requires a minimum of 73 credit hours of acceptable academic work beyond the bachelor's degree, including credit for the dissertation. Specific requirements for the PhD program are available on the web in the document entitled "Memorandum to Graduate Students;" see <https://ece.okstate.edu/> (<https://ceat.okstate.edu/ece/>).

The School of Electrical and Computer Engineering also participates in several interdisciplinary degree programs (See "Graduate Programs" under "Industrial Engineering and Management," and "Telecommunications Management" the "Graduate College" section of the Catalog.).

## Faculty

Jeffrey L. Young, PhD, PE—Professor and Head

**Professor and OSURF Endowed Chair:** Jeffrey L. Young, PhD, PE

**Regents Professor:** Gary Yen, PhD

**Associate Dean for CEAT Research, Professor and Henry Bellmon**

**Chair:** Charles F. Bunting, PhD

**Cal and Marilyn Vogt Professor:** Guoliang Fan, PhD

**Edward Joulain Endowed Chair and Professor in Engineering:** James Stine, PhD

**Professors:** H. Jack Allison, PhD, PE (emeritus); Charles M. Bacon, PhD (emeritus); James E. Baker, PhD (emeritus); Richard L. Cummins, PhD (emeritus); Daniel R. Grischkowsky, PhD (emeritus); Martin T. Hagan, PhD, PE (emeritus); Louis Johnson, PhD (emeritus); Subhash Kak, PhD (emeritus); Jerzy S. Krasinski, PhD (emeritus); Daqing Piao, PhD; Rama Ramakumar, PhD, PE (emeritus); Ronald P. Rhoten, PhD, PE (emeritus); Weihua Sheng, PhD; Keith A. Teague, PhD, PE (emeritus); James C. West, PhD; Rao Yarlagadda, PhD (emeritus); Weili Zhang, PhD

**Associate Professors:** Qi Cheng, PhD; Chriswell G. Hutchens, PhD, PE (emeritus); Carl D. Latino, PhD (emeritus); George Scheets, PhD (emeritus)

**Assistant Professors:** Wooyeol Choi, PhD; Hantao Cui, PhD; Sabit Ekin, PhD; John Hu, PhD; Bingzhe Li, PhD; Hamidreza Nazari Pouya, PhD; John O'Hara, PhD; Ickhyun Song, PhD



## Computer Engineering, BSCP

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 125**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
ENGL 1113 or ENGL 1313	Composition I <sup>1</sup> Critical Analysis and Writing I	3
ENGL 3323	Technical Writing	3
<i>American History &amp; Government</i>		
Select one of the following:		
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) (With a grade of "C" or better)	4
MATH 2153	Calculus II (A) (With a grade of "C" or better)	3
MATH 2163	Calculus III (With a grade of "C" or better)	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414 or CHEM 1515	General Chemistry for Engineers (LN) Chemistry II (LN)	4
PHYS 2014	University Physics I (LN) (With a grade of "C" or better)	4
PHYS 2114	University Physics II (LN) (With a grade of "C" or better)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Course designated (S)		3
<b>Hours Subtotal</b>		<b>43</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Mathematics</i>		
MATH 2233	Differential Equations (With a grade of "C" or better)	3
<i>Engineering</i>		
ENGR 1111	Introduction to Engineering	1
<i>Engineering Science</i>		
ECEN 3213	Computer Based Systems in Engineering (With a grade of "C" or better)	3

ENSC 2611	Electrical Fabrication Lab (With a grade of "C" or better)	1
<i>Computer Science</i>		
CS 1113	Computer Science I (A) (With a grade of "C" or better)	3
CS 2351	Unix Programming	1
CS 2433	C/C++ Programming (With a grade of "C" or better)	3
CS 3653	Discrete Mathematics for Computer Science (With a grade of "C" or better)	3
<i>Electrical &amp; Computer Engineering</i>		
ECEN 2714	Fundamentals of Electric Circuits (With a grade of "C" or better)	4
ECEN 3233	Digital Logic Design (With a grade of "C" or better)	3
<b>Hours Subtotal</b>		<b>25</b>
<b>Major Requirements</b>		
<i>Mathematics</i>		
MATH 3013	Linear Algebra (A) (With a grade of "C" or better)	3
<i>Electrical &amp; Computer Engineering</i>		
ECEN 3314	Electronic Devices and Applications	4
ECEN 3513	Signal Analysis	3
ECEN 3613	Applied Fields and Waves I	3
ECEN 3714	Network Analysis (With a grade of "C" or better)	4
ECEN 3903	Introduction to Semiconductor Devices (With a grade of "C" or better in ECEN 3903 or PHYS 3313)	3
or PHYS 3313	Introduction to Semiconductor Device Physics	
ECEN 4013	Design of Engineering Systems	3
ECEN 4024	Capstone Design	4
ECEN 4213	Embedded Computer Systems Design	3
ECEN 4243	Computer Architecture	3
ECEN 4303	Digital Integrated Circuit Design	3
ECEN 4503	Random Signals and Noise	3
<i>Computer Science</i>		
CS 4323	Design and Implementation of Operating Systems I	3
or ECEN 4283	Computer Networks	
CS 3353	Data Structures and Algorithm Analysis I (With a grade of "C" or better)	3
<i>Industrial Engineering &amp; Management</i>		
IEM 3503	Engineering Economic Analysis	3
<i>Electives</i>		
Select six hours selected from combinations on the departmentally approved list and approved by advisor		6
<b>Hours Subtotal</b>		<b>54</b>
<b>Controlled Electives</b>		
Select 3 hours of the following controlled electives:		3
ENSC 2113	Statics	
ENSC 2123	Elementary Dynamics	
ENSC 2143	Strength of Materials	
ENSC 2213	Thermodynamics	

Engineering courses 3000 level and above

Other courses such as MATH, CS, STAT, etc., may be approved by advisor

<b>Hours Subtotal</b>	<b>3</b>
<b>Total Hours</b>	<b>125</b>

- <sup>1</sup> If a "B" or higher is not earned in ENGL 1113 Composition I or ENGL 1313 Critical Analysis and Writing I, then ENGL 1213 Composition II or ENGL 1413 Critical Analysis and Writing II is also required (per Academic Regulation 3.5 (p. 920)).

## Graduation Requirements

1. A minimum GPA of 2.00 Technical GPA. The Technical GPA is calculated from all courses in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A "C" or better in courses listed above as requiring a "C" or better.
3. The major engineering design experience, capstone course, is satisfied by ECEN 4013 Design of Engineering Systems and ECEN 4024 Capstone Design.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

# Computer Engineering: Software Engineering, BSCP

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 128**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
ENGL 1113	Composition I <sup>1</sup>	3
or ENGL 1313	Critical Analysis and Writing I	
ENGL 3323	Technical Writing	3
<i>American History &amp; Government</i>		
Select one of the following:		
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) (With a grade of "C" or better)	4
MATH 2153	Calculus II (A) (With a grade of "C" or better)	3
MATH 2163	Calculus III (With a grade of "C" or better)	3
<i>Humanities (H)</i>		
Courses designated (H)		
6		
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN)	4
or CHEM 1515	Chemistry II (LN)	
PHYS 2014	University Physics I (LN) (With a grade of "C" or better)	4
PHYS 2114	University Physics II (LN) (With a grade of "C" or better)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Course designated (S)		
3		
<b>Hours Subtotal</b>		<b>43</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Mathematics</i>		
MATH 2233	Differential Equations (With a grade of "C" or better)	3
<i>Engineering</i>		
ENGR 1111	Introduction to Engineering	1
<i>Engineering Science</i>		
ECEN 3213	Computer Based Systems in Engineering (With a grade of "C" or better)	3

ENSC 2611	Electrical Fabrication Lab (With a grade of "C" or better)	1
<i>Computer Science</i>		
CS 1113	Computer Science I (A) (With a grade of "C" or better)	3
CS 2351	Unix Programming	1
CS 2433	C/C++ Programming (With a grade of "C" or better)	3
CS 3653	Discrete Mathematics for Computer Science (With a grade of "C" or better)	3
<i>Electrical &amp; Computer Engineering</i>		
ECEN 2714	Fundamentals of Electric Circuits (With a grade of "C" or better)	4
ECEN 3233	Digital Logic Design (With a grade of "C" or better)	3
<b>Hours Subtotal</b>		<b>25</b>
<b>Major Requirements</b>		
<i>Mathematics</i>		
MATH 3013	Linear Algebra (A) (With a grade of "C" or better)	3
<i>Electrical &amp; Computer Engineering</i>		
ECEN 3314	Electronic Devices and Applications	4
ECEN 3513	Signal Analysis	3
ECEN 3613	Applied Fields and Waves I	3
ECEN 3714	Network Analysis (With a grade of "C" or better)	4
ECEN 3903	Introduction to Semiconductor Devices (With a grade of "C" or better in ECEN 3903 or PHYS 3313)	3
or PHYS 3313	Introduction to Semiconductor Device Physics	
ECEN 4013	Design of Engineering Systems	3
ECEN 4024	Capstone Design	4
ECEN 4213	Embedded Computer Systems Design	3
ECEN 4243	Computer Architecture	3
ECEN 4303	Digital Integrated Circuit Design	3
ECEN 4503	Random Signals and Noise	3
<i>Computer Science</i>		
CS 4323	Design and Implementation of Operating Systems I	3
or ECEN 4283	Computer Networks	
CS 3353	Data Structures and Algorithm Analysis I (With a grade of "C" or better)	3
<i>Industrial Engineering &amp; Management</i>		
IEM 3503	Engineering Economic Analysis	3
<b>Software Engineering Electives</b>		
12 credit hours designated as software engineering courses		12
<b>Hours Subtotal</b>		<b>60</b>
<b>Total Hours</b>		<b>128</b>

<sup>1</sup> If a "B" or higher is not earned in ENGL 1113 Composition I or ENGL 1313 Critical Analysis and Writing I, then ENGL 1213 Composition II or ENGL 1413 Critical Analysis and Writing II is also required (per Academic Regulation 3.5 (p. 920)).

## Graduation Requirements

1. A minimum GPA of 2.00 Technical GPA. The Technical GPA is calculated from all courses in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A "C" or better in courses listed above as requiring a "C" or better.
3. The major engineering design experience, capstone course, is satisfied by ECEN 4013 Design of Engineering Systems and ECEN 4024 Capstone Design.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Electrical Engineering, BSEE

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 124**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
ENGL 1113	Composition I <sup>1</sup>	3
or ENGL 1313	Critical Analysis and Writing I	
ENGL 3323	Technical Writing	3
<i>American History &amp; Government</i>		
Select one of the following:		
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) (With a grade of "C" or better)	4
MATH 2153	Calculus II (A) (With a grade of "C" or better)	3
MATH 2163	Calculus III (With a grade of "C" or better)	3
<i>Humanities (H)</i>		
Courses designated (H)		
6		
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN)	4
or CHEM 1515	Chemistry II (LN)	
PHYS 2014	University Physics I (LN) (With a grade of "C" or better)	4
PHYS 2114	University Physics II (LN) (With a grade of "C" or better)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Course designated (S)		
3		
<b>Hours Subtotal</b>		<b>43</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
<i>Mathematics</i>		
MATH 2233	Differential Equations (With a grade of "C" or better)	3
<i>Engineering</i>		
ENGR 1111	Introduction to Engineering	1
<i>Engineering Science</i>		
ENSC 2113	Statics (With a grade of "C" or better)	3

ENSC 2611	Electrical Fabrication Lab (With a grade of "C" or better)	1
ECEN 3213	Computer Based Systems in Engineering (With a grade of "C" or better)	3
<i>Computer Science</i>		
CS 1113	Computer Science I (A) (With a grade of "C" or better)	3
CS 2433	C/C++ Programming (With a grade of "C" or better)	3
<i>Electrical &amp; Computer Engineering</i>		
ECEN 2714	Fundamentals of Electric Circuits (With a grade of "C" or better)	4
ECEN 3233	Digital Logic Design (With a grade of "C" or better)	3
<b>Hours Subtotal</b>		<b>24</b>
<b>Major Requirements</b>		
<i>Mathematics</i>		
MATH 3013	Linear Algebra (A) (With a grade of "C" or better)	3
<i>Electrical &amp; Computer Engineering</i>		
ECEN 3314	Electronic Devices and Applications	4
ECEN 3513	Signal Analysis	3
ECEN 3613	Applied Fields and Waves I	3
ECEN 3714	Network Analysis (With a grade of "C" or better)	4
ECEN 3903	Introduction to Semiconductor Devices (With a grade of "C" or better in ECEN 3903 or PHYS 3313)	3
or PHYS 3313	Introduction to Semiconductor Device Physics	
ECEN 4013	Design of Engineering Systems	3
ECEN 4024	Capstone Design	4
ECEN 4503	Random Signals and Noise	3
<i>Industrial Engineering &amp; Management</i>		
IEM 3503	Engineering Economic Analysis	3
<i>ECEN Junior Electives</i>		
Select one of the following with advisor approval:		
ECEN 3723	Systems I	3
ECEN 3913	Solid State Electronic Devices	
<i>ECEN Electives</i>		
Select Six ECEN or other courses selected from combinations on the departmentally approved list, including optionally one or more courses listed, but not taken, from the ECEN Junior Elective list above, and with advisor approval		18
<b>Hours Subtotal</b>		<b>54</b>
<b>Controlled Electives</b>		
Select 3 hours of the following controlled electives:		
ENSC 2123	Elementary Dynamics	3
ENSC 2143	Strength of Materials	
ENSC 2213	Thermodynamics	
Engineering courses 3000 level and above		
Other courses such as MATH, CS, STAT, etc., may be approved by advisor		

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<b>Hours Subtotal</b>	<b>3</b>
<b>Total Hours</b>	<b>124</b>

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<sup>1</sup> If a "B" or higher is not earned in ENGL 1113 Composition I or ENGL 1313 Critical Analysis and Writing I, then ENGL 1213 Composition II or ENGL 1413 Critical Analysis and Writing II is also required (per Academic Regulation 3.5 (p. 923)).

## Graduation Requirements

1. A minimum Technical GPA of 2.00. The Technical GPA is calculated from all courses in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A "C" or better in courses listed above as requiring a C or better.
3. The major engineering design experience, capstone course, is satisfied by ECEN 4013 Design of Engineering Systems and ECEN 4024 Capstone Design.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Electrical Engineering Technology

The electrical engineering technology (EET) curriculum provides preparation for outstanding career opportunities not only in the electrical and electronics industries, but also in many other sectors because of their dependence upon electricity and electronics control, power, communications, and computation. The job responsibility of electrical engineering technology graduates ranges from application engineer, testing engineer, and field engineer. In addition, the graduates also work as design and development engineer and application development engineer for modern microprocessors.

The EET program offers a Bachelor of Science in Engineering Technology degree with a major in Electrical Engineering Technology. An option with an emphasis on computers and computing is also available. The program focuses on a hands-on laboratory-oriented curriculum to meet the diverse needs of modern industries. It provides a strong foundation of specialized mathematics, science, applied electrical engineering, and related technical courses, as well as courses in the area of written and oral communications, humanities, and the social sciences.

### Program Educational Objectives

OSU Electrical Engineering Technology graduates a few years after graduation will:

- Show continuous career improvement, evidenced by assumption of greater responsibility or leadership, promotion, participation in continuing education or graduate studies, or transition into other technical or professional careers.
- Be able to work independently as well as collaboratively with others while demonstrating the professional and ethical responsibilities of the engineering profession.

Electrical Engineering Technology graduates can expect to obtain these student outcomes upon graduation:

### Program Outcomes

- (1) An ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve well-defined engineering problems appropriate to the discipline;
- (2) An ability to design solutions for well-defined technical problems and assist with the engineering design of systems, components, or processes appropriate to the discipline;
- (3) An ability to apply written, oral, and graphical communication in well-defined technical and non-technical environments; and an ability to identify and use appropriate technical literature;
- (4) An ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes; and
- (5) An ability to function effectively as a member of a technical team.

The *Electrical Engineering Technology major* provides graduates the ability to enter into many dynamic fields of electrical engineering and electrical technology. The demand for graduates having electronic and electrical engineering design and application skills continues to grow. Graduates of this program are prepared for a wide range of opportunities for employment in an industry that requires considerable knowledge of the electrical engineering and technology professions.

The *Electrical Engineering Technology–Computer option* curriculum provides the preparation for graduates to enter the growing field of computer hardware and software engineering. The demand for graduates having both computer hardware and software skills is of high demand as the intensity of automation, robotics, and artificial intelligence is growing.

The Electrical Engineering Technology program is accredited by the Engineering Technology Accreditation Commission of ABET, <http://www.abet.org> (<http://www.abet.org/>).

## Courses

### EET 1003 Introduction to Microcomputer Programming

**Prerequisites:** Consent of instructor.

**Description:** Programming a microcomputer using a spreadsheet and in BASIC. Application of algorithms to solve defined problems and an introduction to the numerical limitations of small machines. Previously offered as ECT 1003.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

### EET 1101 Fundamentals of DC Circuits Lab

**Prerequisites:** Consent of instructor.

**Description:** Elementary principles of dc electricity laboratory for Non-EET students who have taken a dc circuits course without a lab component.

This is the same curriculum and lab experience that students would experience taking EET 1114. May not be used for degree credit with EET 1134 or EET 1104.

**Credit hours:** 1

**Contact hours:** Lab: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Engineering Technology

### EET 1104 Fundamentals of Electricity

**Prerequisites:** Concurrent enrollment in MATH 2123 or MATH 2144 or Consent of Instructor.

**Description:** Elementary principles of electricity covering basic electric units. Ohm's law, Kirchoff's law, circuit solutions, network solutions, magnetism, inductance and capacitance. Previously offered as ECT 1104. May not be used for degree credit with EET 1134 or EET 1101.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

### EET 1134 Fundamentals of DC Circuits

**Prerequisites:** Concurrent enrollment in MATH 2123 or MATH 2144 or consent of instructor.

**Description:** Elementary principles of dc electricity laboratory for Non-EET students covering basic electrical units, Ohm's Law, Kirchoff's Law, circuit solutions, network solutions, magnetism, inductance and capacitance. May be substituted for EET 1104 and grade of "B" or better and consent of the department. May not be used for degree credit with EET 1101.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 1201 Fundamentals of AC Circuits Lab**

**Prerequisites:** "C" or better in EET 1104 OR "C" or better in EET 1134 or consent of instructor.

**Description:** Elementary principles of ac electricity laboratory for Non-EET students who have taken an ac circuits course without a lab component. This is the same curriculum and lab experience that students would experience taking EET 1214. May not be used for degree credit with EET 1214 or EET 1244.

**Credit hours:** 1

**Contact hours:** Lab: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Engineering Technology

**EET 1214 Fundamentals of AC Circuits**

**Prerequisites:** ("C" or better in EET 1104 OR "C" or better in EET 1134) AND ("C" or better in MATH 2123 OR "C" or better in MATH 2144) or consent of instructor.

**Description:** Elementary principles of ac electricity laboratory for Non-EET students covering basic electrical units, The use of network theorems and phasors, coupled circuits, resonance, filters and power will be studied. May be substituted for EET 1244 with grade of "B" or better and consent of the department. May not be used for degree credit with EET 1201.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 1244 Circuit Analysis I**

**Prerequisites:** ("C" or better in EET 1104 OR "B" or better in EET 1134) AND ("C" or better in MATH 2123 OR "C" or better in MATH 2144) OR consent of instructor.

**Description:** Analysis of AC electric circuits. The use of network theorems and phasors, coupled circuits, resonance, filters, and power. Course previously offered as ECT 1244. May not be used for degree credit with EET 1214 or EET 1201.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 2303 Technical Programming**

**Prerequisites:** Consent of instructor.

**Description:** Introduction to machine programming using industrial standard languages, emphasis on problems from science and technology. Course previously offered as ECT 2303.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**EET 2544 Pulse and Digital Techniques**

**Prerequisites:** ("C" or better in EET 1104 or "B" or better in EET 1134) OR Equivalent taken concurrently.

**Description:** Electronic circuits used in digital control and computation. Pulse generation, Boolean algebra and logic circuits. Course previously offered as ECT 2544.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 2635 Solid State Devices and Circuits**

**Prerequisites:** (EET 1244 with a grade of "C" or better OR EET 1214 with a grade of "B" or better) AND (MATH 2123 with a grade of "C" or better OR MATH 2144 with a grade of "C" or better).

**Description:** Diodes, transistors, LSI linear devices; their operation and applications in electronic circuits. Course previously offered as ECT 2635.

**Credit hours:** 5

**Contact hours:** Lecture: 4 Lab: 3 Contact: 7

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 3005 Electronics Analysis I**

**Prerequisites:** EET 1244 and EET 2544 and EET 2635.

**Description:** Extensive use of mathematics in analyzing discrete, linear device, linear systems and non-linear circuits. Development of the analytic skills necessary for upper-division work. The use of basic calculus in circuit analysis. Must obtain a "C" or better before admission to other 3000 level EET courses. Intended for transfer and returning students. Enrollment by adviser consent.

**Credit hours:** 5

**Contact hours:** Lecture: 5 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**EET 3104 Elements of Electricity and Electronics**

**Prerequisites:** MATH 1513.

**Description:** Essentials of electricity, controls, and electronics for non-majors. No credit for EET majors. Course previously offered as ECT 3104.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 3113 Circuit Analysis II**

**Prerequisites:** (EET 1244 with a grade of "C" or better OR EET 1214 with a grade of "B" or better) and (EET 2635 with a grade of "C" or better) AND (MATH 2133 with a grade of "C" or better OR MATH 2153 with a grade of "C" or better).

**Description:** Application of elementary switching functions and Laplace transforms to electronic circuit analysis. Circuit analysis in the S-plane, transfer functions and the application of circuit analysis software. Course previously offered as ECT 3113.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology



**EET 3124 Project Design and Fabrication**

**Prerequisites:** ("C" or better in EET 1244 OR "B" or better in EET 1214) AND "C" or better in EET 2544 AND "C" or better in EET 2635 OR Instructor Approval.

**Description:** Methods of designing, analyzing and fabricating electronic circuits using standard software packages. Heat transfer characteristics and problem solutions are included. Course previously offered as ECT 3124.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 3254 Microprocessors I**

**Prerequisites:** EET 2544.

**Description:** An introduction to microcontrollers and their uses in embedded applications. Topics include system architecture, assembly language, structured programming, memory systems, user I/O, timers, peripherals, etc. Course previously offered as ECT 3254.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 3264 Microprocessors II**

**Prerequisites:** EET 2303 with a grade of "C" or better and EET 3254 with a grade of "C" or better.

**Description:** A continuation of EET 3254. Programming and interfacing of microcontrollers in embedded application, including interrupts, EEPROM, serial programming, interfacing, power management, algorithms, stepper motor control. Course previously offered as ECT 3264.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 3303 Python Programming for Technology and Engineering**

**Prerequisites:** MATH 2123 or MATH 2144 plus previous programming experience in any language.

**Description:** The Python programming language including syntax, collections, modules, object-oriented programming, functions, and graphical user interfaces with emphasis on applications in technology and engineering.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**EET 3354 Communication and Signal Processing**

**Prerequisites:** "C" or better in EET 2635 and "C" or better in EET 3423.

**Description:** Bandpass signaling principles and circuits. The Fourier transform; AM, SSB, FM, and PM signaling; binary modulated bandpass signaling (FSK and PSK); superheterodyne receiver; phase locked loop (PLL); modulators and mixers; frequency multiplication; special purpose IC's. Course previously offered as ECT 3354.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 3363 Data Acquisition**

**Prerequisites:** "C" or better in EET 2544 and "C" or better in EET 2635.  
**Description:** Methods used to convert physical variables to digital signals and vice versa. Signal conditioning, digital-to-analog converters, analog-to-digital converters, sample-and-hold circuits, sensors, and transducers. The use of computers in data acquisition and signal processing. Course previously offered as ECT 3363.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 3373 Programmable Logic Controller Fundamentals**

**Prerequisites:** "C" or better in EET 2544.

**Description:** The course will introduce students with fundamentals of programming logic controllers, sensors and actuators interfacing and control using Ladder logic programming.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 3423 Applied Analysis for Technology**

**Prerequisites:** MATH 2133 with a grade of "C" or better OR MATH 2153 with a grade of "C" or better.

**Description:** Applications of elements of matrix algebra, ordinary differential equations, Fourier series, and infinite series to problems in engineering technology. Previously offered as GENT 3123.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**EET 3524 Advanced Logic Circuits**

**Prerequisites:** EET 2544 with a grade of "C" or better.

**Description:** Computer-based design, simulation and implementation of digital/mixed-signal systems using programmable logic, field programmable gate arrays, ASICs and system-on-chip technology.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 3533 Introduction to Telecommunications**

**Prerequisites:** "C" or better in EET 2544 AND "C" or better in EET 2635 AND ("C" or better in EET 3354 OR Concurrent).

**Description:** Introductory course to the field of telecommunications. Study of the various technologies and how the application of these technologies work together to form functioning systems and networks.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 3713 Introduction to Electric Power Technology I**

**Prerequisites:** ("C" or better in EET 1244 OR "B" or better in EET 1214) AND "C" or better in MATH 2133.

**Description:** Physical principles of electromagnetic and electromechanical energy conversion devices and their application to conventional transformers and rotating machines.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**EET 3723 Introduction to Electric Power Technology II**

**Prerequisites:** "C" or better in EET 3713.

**Description:** Physical principles of electromagnetic and electromechanical energy conversion devices and their application to conventional transformers and rotating machines.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**EET 3803 Fundamentals of Mechatronics**

**Prerequisites:** Grade of "C" or better in EET 2635.

**Description:** Fundamentals of mechatronic systems and components. Different modelling approaches used for mechatronics systems, sensors and actuators, data acquisition and interfacing, signal conditioning, and PLC's. Previously offered as GENT 3503. Same course as MET 3803.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 4050 Advanced Electronic Problems**

**Prerequisites:** Junior standing and consent of head of department.

**Description:** Junior standing and consent of head of department. Special problems in the electronic area. Course previously offered as ECT 4050. Offered for variable credit, 1-4 credit hours, maximum of 4 credit hours.

**Credit hours:** 1-4

**Contact hours:** Contact: 1-4 Other: 1-4

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Engineering Technology

**EET 4314 Elements of Control**

**Prerequisites:** "C" or better in EET 3113 AND "C" or better in EET 3363 AND "C" or better in EET 3423.

**Description:** Principles of analog and digital control, with emphasis on the analysis of feedback control systems in their various conceptual configurations. Application of feedback control theory to the analysis and design of present day circuits and systems. Use of circuit analysis software. Course previously offered as ECT 4314.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 4323 Applied Artificial Intelligence**

**Prerequisites:** "C" or better in EET 3303 AND "C" or better in EET 4813 AND ("C" or better in STAT 4033 OR "C" or better in STAT 4033).

**Description:** The course will follow a project based learning approach to introduce students with the theoretical and implantation of artificial intelligence algorithms. Topics include supervised learning, unsupervised learning, and deep reinforcement learning.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 4363 Digital Signal Processing**

**Prerequisites:** "C" or better in EET 3354 AND "C" or better in EET 3363.

**Description:** Introduction to Digital Signal Process. Theoretical development of Fourier transforms, IIR and FIR filters. Significant Design and programming projects.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**EET 4514 Advanced Telecommunication Topics**

**Prerequisites:** "C" or better in EET 3533.

**Description:** Study of data transmission techniques between digital electronic devices.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 4654 Microwave Techniques**

**Prerequisites:** "C" or better in EET 2635 and "C" or better in EET 3354.

**Description:** Study of topics pertaining to VHF behavior of circuits and systems. Transmission line theory: wave equations, SWR, impedance calculations and transformations, and lossy lines. Extensive use of the Smith chart to solve transmission line problems. Introduction to Maxwell's equations, with emphasis on steady state. Wave propagation in rectangular waveguides. Introduction to antennas. Modeling of transistors at VHF, UHF, and microwave frequencies. Design and analysis of transistor amplifiers at VHF using y and s parameters. Designing LC impedance matching networks. Previously offered as ECT 4654.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**EET 4803 Mechatronics System Design**

**Prerequisites:** Grade of "C" or better in GENT 3123 and EET 3803 (can be concurrent enrollment in GENT 3123).

**Description:** Modelling of mechanical, electrical, and hydraulic components. Feedback control systems, electro-hydraulic drives, electrical drives, and microcontroller programming. Previously offered as GENT 4503. Same course as MET 4803.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

### **EET 4833 Industrial Project Design I**

**Prerequisites:** "C" or better in EET 3124 AND ("C" or better in EET 3264 OR Concurrent) AND "C" or better in EET 3363 AND 10 credit hours of upper-division courses.

**Description:** Course mirrors the design process in industry. Topics covered are design team formation, identify objectives, define design specifications, write specifications, create a state of work and Gantt chart, create a project budget, perform a preliminary design review, design prototype. Previously offered as EET 4832 and ECT 4832.

**Credit hours:** 3

**Contact hours:** Lecture: 1 Lab: 5 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

### **EET 4843 Industrial Project Design II**

**Prerequisites:** "C" or better in EET 4833.

**Description:** Student continues in the project steps of Change Board Review, Critical Design Review, developing & writing test specs., product fabrication and testing, formal technical report submission and outcomes assessment exam.

**Credit hours:** 3

**Contact hours:** Lecture: 1 Lab: 5 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

### **EET 4903 Mechatronics of Autonomous Systems**

**Prerequisites:** "C" or better in EET 3803 OR "C" or better in MET 3803.

**Description:** The course will follow a project based learning approach to introduce students with the mechatronics of autonomous systems.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

## **Undergraduate Programs**

- Electrical Engineering Technology, BSET (p. 2229)
- Electrical Engineering Technology: Computer, BSET (p. 2230)

## **Faculty**

Avimanyu Sahoo, PhD—Assistant Professor and Program Coordinator

**Associate Professor:** Imad Abouzahr, PhD, PE

**Assistant Professors:** Ellis C. Nuckolls, MS, PE; Huaxia Wang, PhD

**Associate Professor (ENDEAVOR):** Brian Norton, MS, PE

# Electrical Engineering Technology, BSET

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 125**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I	3
	or ENGL 1313	Critical Analysis and Writing I
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History (or)	
HIST 1483	American History to 1865 (H) (or)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
OR other approved Calculus 2 course		
STAT 4013	Statistical Methods I (A)	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
PHYS 2014	University Physics I (LN)	4
Select 4 hours of any course designated (LN)		4
<i>Social &amp; Behavioral Sciences (S)</i>		
SPCH 2713	Introduction to Speech Communication (S)	3
<i>Additional General Education</i>		
Any Foreign Language, Speech, any course from the Spears School of Business, any course designate (H), (D), (S), or (I)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Electronics</i>		
ENGR 1111	Introduction to Engineering	1
ENGR 2421	Engineering Data Acquisition Controls Lab	1

EET 1104	Fundamentals of Electricity	4
EET 1244	Circuit Analysis I	4
EET 2303	Technical Programming	3
EET 2544	Pulse and Digital Techniques	4
EET 2635	Solid State Devices and Circuits	5
<b>Hours Subtotal</b>		<b>22</b>
<b>Major Requirements</b>		
EET 3113	Circuit Analysis II	3
EET 3124	Project Design and Fabrication	4
EET 3254	Microprocessors I	4
EET 3264	Microprocessors II	4
EET 3354	Communication and Signal Processing	4
EET 3363	Data Acquisition	3
EET 3303	Python Programming for Technology and Engineering	3
EET 3524	Advanced Logic Circuits	4
EET 3533	Introduction to Telecommunications	3
EET 4314	Elements of Control	4
EET 4363	Digital Signal Processing	3
EET 4654	Microwave Techniques	4
EET 4833	Industrial Project Design I	3
EET 4843	Industrial Project Design II	3
EET 3423	Applied Analysis for Technology (or GENT 3123)	3
MGMT 3013	Fundamentals of Management (S)	3
	or IEM 3503	Engineering Economic Analysis
	or IEM 3513	Economic Decision Analysis
Select 6 hours from any courses in CEAT, or with a prefix MATH or CS, or designated (N).		6
<b>Hours Subtotal</b>		<b>61</b>
<b>Total Hours</b>		<b>125</b>

## Graduation Requirements

1. A minimum Technical GPA of 2.00 is required. The Technical GPA is calculated from all courses counting in the curriculum with a prefix belonging to the degree program or substitutions for these courses.
2. A minimum grade of "C" is required for all EET coursework.
3. Students may not enter into a subsequent EET course that has a prerequisite if the minimum "C" grade is not met in the prerequisite without consent of instructor.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

# Electrical Engineering Technology: Computer, BSET

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 126**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History (or)	
HIST 1483	American History to 1865 (H) (or)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
OR other approved Calculus 2 Courses		
STAT 4033	Engineering Statistics	3
or STAT 4013	Statistical Methods I (A)	
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
PHYS 2014	University Physics I (LN)	4
Select 4 hours of any course designated (L),(N)		4
<i>Social &amp; Behavioral Sciences (S)</i>		
SPCH 2713	Introduction to Speech Communication (S)	3
<i>Additional General Education</i>		
Any Foreign Language, Speech, any course from the Spears School of Business, any course designate (H), (D), (S), or (I)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Electronics</i>		
ENGR 1111	Introduction to Engineering	1

ENGR 2421	Engineering Data Acquisition Controls Lab	1
CS 1113	Computer Science I (A)	3
EET 1104	Fundamentals of Electricity	4
EET 1244	Circuit Analysis I	4
EET 2303	Technical Programming	3
EET 2544	Pulse and Digital Techniques	4
EET 2635	Solid State Devices and Circuits	5
<b>Hours Subtotal</b>		<b>25</b>

## Major Requirements

EET 3113	Circuit Analysis II	3
EET 3124	Project Design and Fabrication	4
EET 3254	Microprocessors I	4
EET 3264	Microprocessors II	4
EET 3303	Python Programming for Technology and Engineering	3
EET 3354	Communication and Signal Processing	4
EET 3363	Data Acquisition	3
EET 3524	Advanced Logic Circuits	4
EET 3533	Introduction to Telecommunications	3
EET 4363	Digital Signal Processing	3
EET 4833	Industrial Project Design I	3
EET 4843	Industrial Project Design II	3
EET 3423	Applied Analysis for Technology (or GENT 3123)	3
MGMT 3013	Fundamentals of Management (S)	3
or IEM 3503	Engineering Economic Analysis	
or IEM 3513	Economic Decision Analysis	
Select 3 hours from any course in CEAT, any course with a MATH or CS prefix, or any designated (N)		3
CS 2133	Computer Science II	3
Select 6 hours of upper-division CS		6
<b>Hours Subtotal</b>		<b>59</b>
<b>Total Hours</b>		<b>126</b>

## Graduation Requirements

1. A minimum technical GPA of 2.00 is required. The technical GPA is calculated from all courses counting in the curriculum with a prefix belonging to the degree program or substitution for these courses.
2. A minimum grade of "C" is required for all EET coursework.
3. Students may not enter into a subsequent EET course that has a prerequisite if the minimum "C" grade is not met in the prerequisite without consent of instructor.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.

- Degrees that follow this plan must be completed by the end of Summer 2027.

# Engineering and Technology Management

## Master of Science in Engineering and Technology Management

**Dr. Sunderesh Heragu**—Regents Professor, IEM Head, ETM Program Director and Humphreys Chair  
**Valerie Quirey**—Graduate Programs Coordinator

OSU's Master of Science in Engineering and Technology Management is a rigorous degree program designed specifically for experienced engineers and scientists who are interested in accelerating their management careers. Managing today's global organizations requires a complex set of knowledge and skills. Effective planning, selection, implementation and management of technology, and the teams involved, are essential to the success of any business in today's time-critical, global markets. MSETM students learn to apply proven evaluation concepts and implementation strategies to fast moving, technical management decisions that make the difference in both career and business success addressing the real needs identified by industry leaders. The MSETM curriculum permits you to build a strong degree that directly addresses your needs and prepares you for the future, combining academic coursework with the latest business practices. The degree consists of 32 credit hours.

Please see the ETM website, <https://etm.okstate.edu> (<https://etm.okstate.edu/>), for more information about the program.

### Program Educational Objectives

The OSU Engineering and Technology Management program exists to provide accessible, career-enhancing educational opportunities to practicing engineers, scientists and technical managers.

### Program Student Learning Outcomes

ETM graduates will be able to:

1. View the organization systemically.
2. Critically analyze a management problem.
3. Identify and act on strategic issues.
4. Articulate and defend their ideas in a professional manner.

### Admission Requirements

The guidelines for admission to the MSETM program are a bachelor's or higher degree, in engineering or the physical/mathematical sciences, with a 3.00 GPA, and professional employment in a related technical field since graduation with a bachelor's degree. Applicants not meeting these standards may be granted provisional admission based upon their overall academic and professional practice history and accomplishments. An applicant must submit the following documents:

1. OSU Application for Graduate Admission,
2. Official transcript of all academic work and degrees received,
3. Application fee (\$50 domestic, \$75 international),
4. MSETM program application,
5. A professional resume,
6. A statement of goals and objectives.

International applicants must also submit official results of the TOEFL with a minimum score of 89 IBT. Application instructions can be found online at <https://etm.okstate.edu> (<http://etm.okstate.edu/>).

Degree requirements can be found at <https://etm.okstate.edu> (<https://etm.okstate.edu/>).

## Courses

### ETM 4173 Cost Control and Analysis for Engineering and Technology Professionals

**Prerequisites:** IEM 3503 or IEM 3513 or permission of the department.  
**Description:** Presents the fundamental concepts, methods, strategies and terminology necessary for engineers and engineering managers to interpret financial data properly. The information is designed to enable engineers and project managers to prepare, appraise, evaluate and approve financial plans to accomplish specific departmental and company objectives. May not be used for degree credit with ETM 5173.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### ETM 5110 Seminar

**Prerequisites:** Admission to the master's program or consent of instructor.

**Description:** Guided study in a topic area selected to enhance a student's program. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Engineering Technology

### ETM 5111 Introduction to Strategy, Technology and Integration

**Prerequisites:** Admission to the MSETM program or consent of instructor.

**Description:** Introduces students to the discipline of engineering and technology management, emphasizing the importance of strategy, technology, and integration, where timing of products and services are keys to market success.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### ETM 5133 Capstone to Strategy, Technology and Integration

**Prerequisites:** Enrolled in last semester of MSETM program or consent of advisor.

**Description:** Independent analysis of a business problem. Student prepares a proposal and report that makes substantive use of MSETM material, and is a notable and relevant contribution to the student's organization. Readings and discussions.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5143 Strategic Decision Analysis for Engineering and Technology Managers****Prerequisites:** Admission to MSETM program or consent of instructor.**Description:** Introduction to analytical concepts and procedures engineering and technology managers can use to strategically allocate resources to achieve business objectives. Strengths and weaknesses of alternative analytical procedures to evaluate alternative resource allocation decisions are outlined. Theoretical foundations, data requirements, application and strengths and weaknesses of cost-benefit analysis techniques when making strategic management decisions are evaluated.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**ETM 5153 Foundations of Engineering Management****Prerequisites:** Admission to MSETM program or consent of instructor.**Description:** Principles and practices of the management of engineering and technology activities. Focus is on the tools and methods for solving problems in service and industrial systems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**ETM 5163 Business Innovation and Technology****Description:** Advanced study of innovation and technology in a business setting. Strategic development of internal and external innovation. Planning, implementation, evaluation and control technology. No degree credit for those with credit in MGMT 5553 Management of Technology and Innovation.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**ETM 5173 Cost Control and Analysis for Engineering and Technology Professionals****Prerequisites:** IEM 3503 or IEM 3513 or permission of the department.**Description:** Presents the fundamental concepts, methods, strategies and terminology necessary for engineers and engineering managers to interpret financial data properly. The information is designed to enable engineers and project managers to prepare, appraise, evaluate and approve financial plans to accomplish specific departmental and company objectives. May not be used for degree credit with ETM 4173.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**ETM 5211 Enterprise Integration****Prerequisites:** Admission to the MS in ETM program or consent of instructor.**Description:** Conceptualizing, designing and operating advanced manufacturing systems within an integrated enterprise-wide framework. Recent developments in computer and communication technologies and conceptual breakthroughs regarding the nature and behavior of integrated enterprises.**Credit hours:** 1**Contact hours:** Lecture: 1 Contact: 1**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**ETM 5221 Engineering Teaming****Prerequisites:** Admission to the MS in ETM program or consent of instructor.**Description:** Management and group issues inherent in the application and implementation of high performing work teams. The team's roles in improving organizational performance, along with the best practice procedures and techniques that increase team effectiveness.**Credit hours:** 1**Contact hours:** Lecture: 1 Contact: 1**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**ETM 5231 Benchmarking****Prerequisites:** Admission to the MS in ETM program or consent of instructor.**Description:** Benchmarking as an effective approach to study and adopt or adapt methodologies representing best specific practices from any industry; or identify and assess performance based on equivalent and common measures, usually from those in the same or similar industries, including competitors.**Credit hours:** 1**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**ETM 5241 Strategic Project Management****Prerequisites:** Admission to the MS in ETM program or consent of instructor.**Description:** Overview of traditional project management concepts and techniques (i.e., Gantt charts, PERT, CPT) along with several technical issues related to their effective use. Fundamental nature of the problems associated with several technical issues related to their effective use. Fundamental nature of the problems associated with effectively managing and coordination of multiple discrete projects within an overall systems integration initiative. A framework for addressing these problems.**Credit hours:** 1**Contact hours:** Lecture: 1 Contact: 1**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology



**ETM 5253 Engineering Problem Solving and Decision-Making**

**Prerequisites:** Admission to the MSETM program or consent of instructor.

**Description:** Processes and tools for problem solving and decision making in technical organizations. Focus on issues involving both quantitative and qualitative factors, where the quantitative factors are the result of an engineering analysis. Risk and systems analysis tools provide a fundamental background to understanding the context in which technical decisions are made. Concentration on general systems theory as developed by Ludwig von Bertalanffy. Course previously offered as ETM 5251.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5271 Technology Forecasting and Assessment**

**Prerequisites:** Admission to the MS in ETM program or consent of instructor.

**Description:** A framework and analytical tools for developing technological foresight. Technology monitoring, forecasting and assessment in the context of a family of emerging technologies.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5283 Strategic Planning**

**Prerequisites:** Admission to the MSETM program or consent of instructor.

**Description:** Continuous and systematic process of thought about the future, resulting in a plan or specific course of action for communicating, coordinating and controlling activities. Strategic, long-range, tactical, operational, contingency and performance planning. Course previously offered as ETM 5282.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5291 Failure Mode and Effects Analysis in Design**

**Prerequisites:** Admission to the MS in ETM program or consent of instructor.

**Description:** A design technique for reducing risk and improving reliability of a system, design or process. Potential failures in any of these studied methodically during design. The concepts, tools and techniques applicable to any product or process.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5311 Value Engineering**

**Prerequisites:** Admission to the ETM program or consent of instructor.

**Description:** The application of Value Engineering (also known as Value Analysis, Value Methodology) to improve customer value for a project, process, or product during or after engineering design. The development of VE, its objectives, definitions and methodologies, the use of the VE system, and its range of application. VE's use for improving performance reducing life cycle cost.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5341 Leadership Strategies for Technical Professionals**

**Prerequisites:** Admission to the ETM program or consent of instructor.

**Description:** Leadership strategies, principles, styles and dynamics that must be understood by technical professionals engaged in the creation of products, processes, and services in technology-based organizations.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5351 Planning Technical Projects**

**Prerequisites:** Admission to the MSETM program or consent of instructor.

**Description:** Techniques and tools for project definition, staffing, scheduling, resource allocation, and time estimation. Behavioral and quantitative dimensions of project management. Performance measures of project progress and completion.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5361 Managing Virtual Project Teams**

**Prerequisites:** Admission to the MSETM program or consent of instructor.

**Description:** The management and group issues inherent in the application and implementation of effective teamwork in virtual workspaces. The appropriate use of virtual team issues and challenges associated with effective teamwork; virtual team structures, process, and technology facilitation skills; group dynamics; and team motivation.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5371 Ethics for Practicing Engineers**

**Prerequisites:** Admission to the MSETM program or consent of instructor.

**Description:** A values-based approach to professional ethics and its application to the decision-making in a technology-intensive environment. Ethical concerns related to the expectations of stakeholders.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5391 New Product Introduction and Commercialization**

**Prerequisites:** Admission to the MSETM program or consent of instructor.

**Description:** Elements of the new product introduction (NPI) process and its impact on business strategy and planning. Organizational resources required for NPI and tools for determining commercial viability.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5411 Engineering Economic Analysis**

**Prerequisites:** Admission to the MSETM program or consent of instructor.

**Description:** Quantitative evaluation of investment alternatives. Basis for comparison of alternatives, including present worth, annual worth, rate of return and payout period methods. Decision-making among capital constrained and unequal-life projects. Benefit-cost and cost effectiveness analysis.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5461 Intellectual Property Management**

**Prerequisites:** Admission to MS in ETM program or consent of instructor.

**Description:** Overview of intellectual property law and management of intellectual property. Exploration of ways to manage intellectual property from conception through production and licensing. Types of intellectual property and associated legal issues and management processes.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5471 Introduction to System Safety**

**Prerequisites:** Admission to the MSETM program or consent of instructor.

**Description:** System safety as a discipline in research, development and acquisition of systems, sub-systems and components. The history and methodologies of mishap prevention including the development of system safety management and engineering processes.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5481 Sustainable Enterprise Strategies**

**Prerequisites:** Admission to the MSETM program or consent of instructor.

**Description:** The principles of sustainability in the context of industrial enterprises. The implications of sustainability in design of products, industrial systems and infrastructure. The importance of life cycle cost analysis as a key engineering economy tool.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5491 ISO 9000**

**Prerequisites:** Admission to the MSETM program or departmental permission.

**Description:** A detailed look at the requirements of ISO 9001:2008 from a systems perspective. The relationship between ISO 9001, ISO 9000, ISO 9004 and industry-related standards. Implementation and improvement of quality management systems (both high quality and typical methods).

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5511 Capstone Preparation**

**Prerequisites:** Admission to the MSETM program and at least 17 hours earned toward MSETM degree or departmental permission.

**Description:** Introduction to the requirements for the ETM Capstone Project, including problem statements, strategic implications, management systems, and problem metrics. Emphasis is placed on persuasive technical communication.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5521 Quick Response Manufacturing**

**Prerequisites:** Admission to the MSETM program or departmental permission.

**Description:** Introduction to QRM, an enterprise-wide strategy for lead-time reduction. Discussion of the four core concepts of QRM - realizing the power of time, rethinking organizational structure, understanding and exploiting systems dynamics, and implementing a unified strategy enterprise-wide. Definitions of manufacturing critical-path time (MCT) map. Focused target market segment (FTMS), and material control strategy POLCA. Case studies and MPX software.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5531 Contract Law in Engineering and Technology**

**Prerequisites:** Graduate standing.

**Description:** This course will provide engineers and architects with a background in common law as it applies to contracts. Topics will include concepts such as offer, acceptance, consideration and breach; contracts under the Uniform Commercial Code; express and implied warranties; and employment contracts.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**ETM 5943 Lean Sigma Implementation**

**Prerequisites:** IEM 5113, admission to the MSETM program or departmental permission.

**Description:** Introduction to the implementation skills necessary to successfully apply lean manufacturing and six sigma concepts and manage continuous improvement within a small to mid-sized firm. Successfully combining leadership, organizational dynamics, and skills in meeting customer expectations. Planning, applying, and monitoring these learned skills.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

# Fire and Emergency Management Program

## Overview

Oklahoma State University's graduate program in Fire and Emergency Management Administration Program is one of the oldest programs in the nation. Students receive a superior academic experience in preparing leaders in the fire services, emergency management, emergency medical services, law enforcement, homeland security and related professions, as well as educators and researchers in these fields.

Students can complete degree requirements either online as distance students or as a resident on campus. Online Graduate courses typically meet in real time. Distance students join on-campus students in lecture, discussion, and group work, utilizing state of the art classrooms designed for distance education. FEMP students are encouraged to complete at least one course on campus in Stillwater, Oklahoma. This can be accomplished during one-week courses in the summer or select traditional semesters when available.

The program was established in 1996 as a Master of Arts specialization in Fire and Emergency Management within political science. In 1999, the degree changed to the Master of Science in Fire and Emergency Management Administration. The curriculum includes public policy, strategic administration and organizational management, human dimensions of disaster, leadership, and terrorism.

In 2009, the Doctor of Philosophy in Fire and Emergency Management Administration was instituted. The PhD degree is designed to produce proficient and active research scholars. It emphasizes preparing talented individuals for faculty careers at major research-oriented academic institutions, but we also welcome applicants whose career interests may lean towards non-academic settings or academic institutions that stress teaching.

Regardless of their post-graduation plans, all PhD students are given the same standard of preparation. After all, it takes a competent research scholar to maintain currency in the field and provide their students or employers the best, most contemporary information the discipline has to offer.

Only July 1<sup>st</sup>, 2018 the Fire and Emergency Management Program moved to the College of Engineering Architecture and Technology as part of the Division of Engineering Technology. This move strengthened the relationship between the FEMP program and the other internationally known, fire-related programs at Oklahoma State University.

A major component of Oklahoma State University's land grant mission is service to community, state, and nation by preparing professionals for jobs in critical service sectors. The mission of the Fire and Emergency Management Administration Program is to prepare professionals for management positions in the critical service professions of fire and rescue, emergency management, emergency medical services, law enforcement, homeland security and related fields in both the public and private sectors. These professions are concerned with the mitigation of, preparedness for, response to, and recovery from the adverse effects of acute exposures to natural, technological, and social hazards. The program specializes in strategic policy, public management, and organizational behavior, human dimensions of disaster, leadership, and counter-terrorism. It also facilitates professional networking among its students and with leaders in the field. The curriculum is designed

to provide students with theoretical and substantive knowledge about management structures and functions, analytical skills that enable the practical application of theories, research skills that enable critical analysis of real-world problems, and written communication skills necessary for effective management.

The Learning Outcomes for the Fire Emergency Management programs are that:

1. Graduates can demonstrate mastery of substantive theories in and knowledge of fire and emergency management administration and of its application to practical problems and issues in the field.
2. Graduates are able to conduct research and critically analyze problems in the fire and emergency management field.
3. Graduates can demonstrate effective written communication skills.

## Courses

### FEMP 3103 Introduction to Emergency Management (S)

**Description:** An overview of the history and philosophy of the current emergency management system. Concepts, issues and programs associated with the development of an emergency management program. Local, state and federal roles and responsibilities for responding to disasters and emergencies with emphasis on man-made natural and technological hazards. This course is the same as POLS 3813.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**General Education and other Course Attributes:** Social & Behavioral Sciences

### FEMP 3733 Emergency Management: Preparedness and Response

**Description:** Introduction to preparedness and response activities for emergency personnel and managers. Covers components, policies, programs and organizations related to preparedness and response. Illustrates course concepts with case studies. This course is the same as POLS 3733.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### FEMP 3763 Emergency Management: Recovery and Mitigation

**Description:** Introduction to recovery and mitigation activities for emergency personnel and managers. Covers components, policies, programs and organizations related to recovery and mitigation. Illustrates course concepts with case studies. This course is the same as POLS 3763.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 4000 Topics in Emergency Management**

**Description:** Examination of timely topics and issues in Emergency Management. May be repeated with different topics. Offered for variable credit, 1-3 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-3

**Contact hours:** Lecture: 1-3 Contact: 1-3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 4050 Independent Study in Emergency Management**

**Description:** Application of major relevant theoretical perspectives to selected case studies of problems and issue areas in emergency management. Theories and case studies selected in collaboration between faculty and student. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Engineering Technology

**FEMP 5000 Thesis**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Thesis. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours. Same course as POLS 5000.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Engineering Technology

**FEMP 5013 Research Design & Methodology**

**Prerequisites:** Graduate standing.

**Description:** Overview of research design methods and skills necessary for conducting research projects, including: conceptualization and operationalization, literature review, deductive and inductive theorizing, hypothesis testing, quantitative and qualitative data collection and analysis, maintaining research records, experiment design, data validation, result presentation, and research ethics. Same course as FSEP 5013 and MERO 5013. Previously offered as POLS 5103.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5023 Quantitative Methods for Fire and Emergency Management I**

**Prerequisites:** Graduate standing and FEMP 5013 or consent of instructor.

**Description:** Fundamental methodological issues in the scientific study of fire administration and emergency management. Computer data manipulation and analysis. This course is the same as POLS 5013.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5113 Introduction to Fire Administration**

**Description:** Examines the content and historical evolution of fire administration including terminology, concepts, theories, and methods employed.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5123 Introduction to Emergency Management**

**Description:** Examines the content and historical evolution of emergency management, current state of science including terminology, concepts, theories, and methods employed.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5213 Disaster Response**

**Prerequisites:** Graduate standing.

**Description:** Review of scientific literature on human and organizational behavior in response to disasters. Identification of actors involved in emergency response, their roles and responsibilities. Examination of human response in context of organizational structures and resources including emergency operating centers. Review of local and national government response policies. This course is the same as POLS 5933.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5223 Preparedness and Planning**

**Prerequisites:** Graduate standing.

**Description:** Planning and training for hazards and disaster management at the organizational level; review of public education and preparedness efforts at the household and community level, review of research on disaster planning. This course is the same as POLS 5923.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5233 Disaster Recovery**

**Prerequisites:** Graduate standing.

**Description:** Processes, conditions and components of recovery in disaster contexts. Topics include environmental, economic, housing, infrastructure and policy. Roles of voluntary organizations; securing and managing resources. This course is the same as POLS 5383.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5243 Mitigation**

**Prerequisites:** Graduate standing.

**Description:** Structural and non-structural mitigation approaches to hazard reduction; description of policies, programs and planning methods relevant to all governmental levels; and review of research and case studies of mitigation efforts. This course is the same as POLS 6313.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5303 Introduction to Fire and Emergency Management**

**Prerequisites:** Graduate standing.

**Description:** Examines the content and historical evolution of fire and emergency management including terminology, concepts, theories and methods employed. Previously offered as POLS 5303.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5313 Political and Community Relations for Fire and Emergency Management Administration**

**Prerequisites:** Graduate standing.

**Description:** Navigating the political and policy context of emergency services administration including understanding how to develop and pass legislation and municipal codes affecting emergency services. Other topics include communicating with politicians, other agency administrators, and the community and building coalitions with relevant actors, agencies and governments. This course is the same as POLS 6213.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5323 Leadership and Management for Fire and Emergency Management**

**Prerequisites:** Graduate standing.

**Description:** Introduction to leadership and administrative processes required to deliver fire and emergency services; detailed examination of the social, political and economic issues that have an impact on service delivery and leadership and management approaches for emergency services. This course is the same as POLS 5343.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5333 Incident Command System**

**Description:** The purpose of the course is to understand current issues on implementing and discussing the Incident Command System. This will be done by (1) identifying and describing the major issues on the ICS; and (2) relating the research literature to some of the ICS design elements.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5413 Financial Administration for Fire and Emergency Management**

**Description:** Applying budgeting and finance theory to fire, emergency management, and other emergency service agencies, including principles of revenues and expenditures, which may include grant application and administration.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5423 Labor Management for Fire and Emergency Management**

**Description:** Current practices, problems and issues in labor administration for fire and emergency services agencies, including managing human resources, labor relations, affirmative action policies, and community representation.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5613 Complex Emergencies**

**Prerequisites:** Graduate standing.

**Description:** This course examines complex emergencies from an emergency management perspective. We will look at the collapse of governance, the causes of armed conflict, food insecurity, infectious disease, natural disasters, and so on, and examine specific cases in detail. Furthermore, we will look at how the international community responds to these crises, and which agencies are involved in relief efforts. We will apply the traditional four phases of disaster management to these situations. This course is the same as POLS 5943.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5623 Emergency Management in the International Setting**

**Prerequisites:** Graduate standing.

**Description:** Introduction to emergency management in the international setting. Provides background for students who may work with international assistance programs or who may become involved in the delivery of emergency management services abroad as part of an international assistance effort. This course is the same as POLS 5693.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FEMP 5633 Emergency Management and Public Policy in the United States****Prerequisites:** Graduate standing.**Description:** Examination of natural and man-made disasters in the U.S. along with the policies and programs intended to prevent, respond to, mitigate, and recover from such events. The evolution of the U.S. Emergency Management System, the emergency management profession, and future directions in emergency policy. This course is the same as POLS 5683.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 5643 Politics of Disaster****Prerequisites:** Graduate standing.**Description:** Situates disaster phases in the political context at the local, national and international levels. Examines research on specific events and their interactive effects between the political system and various phases of disaster. This course is the same as POLS 5393.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 5653 Hazard, Vulnerability, and Risk Analysis****Prerequisites:** Graduate standing.**Description:** Introduction to hazard, vulnerability and risk analysis (HVRA) techniques in fire and emergency management. Explains the role and uses of HVRA in decision-making, public policy and emergency management planning. This class is the same as POLS 5653.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 5810 Special Topics Seminar in Fire and Emergency Management****Prerequisites:** Graduate standing.**Description:** Specialized topics in emergency management. Offered for variable credit, 1-3 credit hours, maximum of 9 credit hours. This course is the same as POLS 5300.**Credit hours:** 1-3**Contact hours:** Lecture: 1-3 Contact: 1-3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 5820 Special Topics Seminar in Emergency Management****Description:** Specialized topics in emergency management. Offered for variable credit, 1-3 credit hours, maximum of 9 credit hours.**Credit hours:** 1-3**Contact hours:** Lecture: 1-3 Contact: 1-3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 5830 Special Topics Seminar in Fire Administration****Description:** Specialized topics in fire administration. Offered for variable credit, 1-3 credit hours, maximum of 9 credit hours.**Credit hours:** 1-3**Contact hours:** Lecture: 1-3 Contact: 1-3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 5903 Practicum in Fire and Emergency Management Administration****Prerequisites:** Consent of instructor.**Description:** Supervised practicum in fire and emergency management administration. This class is the same as POLS 5903.**Credit hours:** 3**Contact hours:** Contact: 3 Other: 3**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Engineering Technology**FEMP 6000 Dissertation****Prerequisites:** Graduate standing and permission of instructor.**Description:** Research for PhD dissertation. Offered for variable credit, 1-12 credit hours, maximum of 60 credit hours. Same course as POLS 6000.**Credit hours:** 1-12**Contact hours:** Contact: 1-12 Other: 1-12**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Engineering Technology**FEMP 6013 Qualitative Methods for Fire and Emergency Management****Prerequisites:** Graduate standing and FEMP 5013 or consent of instructor.**Description:** Qualitative methods for collecting and analyzing data regarding fire administration and emergency management. This course is the same as POLS 6013.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 6023 Quantitative Methods for Fire and Emergency Management II****Prerequisites:** Graduate standing and FEMP 5013 and FEMP 5023 or consent of instructor.**Description:** An advanced course that builds on the introductory level of statistics. Develop a systematic and critical understanding of alternative quantitative approaches and methodologies of fire and emergency management research. This course is the same as POLS 6123.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 6103 Proseminar in Fire and Emergency Management****Prerequisites:** Graduate standing.**Description:** Examines scope of the fire and emergency management field as an area of academic inquiry. This course is the same as POLS 6003.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology

**FEMP 6303 Populations at Risk****Prerequisites:** Graduate standing.**Description:** Describes populations at risk for increased injury, death and property loss. Identifies policies, programs and resources for risk reduction. Applies research for purposes of planning and capacity building. This course is the same as POLS 6303.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 6313 Comparative and International Dimensions of Emergency Management****Prerequisites:** Graduate standing.**Description:** Comparative analysis of the organization, management and policies of fire and emergency response services in other countries. This course is the same as POLS 6203.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 6323 Organizational Behavior in Disasters****Prerequisites:** Graduate standing.**Description:** Theoretical overview of organizational behavior in a disaster context. How organizations respond, adapt, fail and succeed when disrupted by disaster. Role of formal and informal organizational structures in confronting disasters. This course is the same as POLS 6343.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 6413 Seminar Risk Theory and Management****Description:** This course examines the risk literature from a perspective of individual and societal risk perception, regulation of risk, risk mitigation, legal aspects, legal aspects of risk and applies these literatures to natural and manmade hazards and disasters.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 6810 Advanced Special Topics Seminar in Fire Administration****Prerequisites:** Graduate standing.**Description:** Specialized topics in fire administration. Offered for variable credit, 1-3 credit hours, maximum of 9 credit hours. This course is the same as POLS 6300.**Credit hours:** 1-3**Contact hours:** Lecture: 1-3 Contact: 1-3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 6820 Advanced Special Topics Seminar in Emergency Management****Prerequisites:** Graduate standing.**Description:** Specialized topics in Emergency Management. Offered for variable credit, 1-3 credit hours, maximum of 9 credit hours.**Credit hours:** 1-3**Contact hours:** Lecture: 1-3 Contact: 1-3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FEMP 6840 Directed Readings in Fire and Emergency Management****Prerequisites:** Graduate standing or consent of instructor.**Description:** Directed readings for doctoral students in specialized areas of fire and emergency management. Offered for variable credit, 1-3 credit hours, maximum of 9 credit hours. This course is the same as POLS 6040.**Credit hours:** 1-3**Contact hours:** Contact: 1-3 Other: 1-3**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Engineering Technology

## Graduate Programs

The Fire and Emergency Management Program, housed in the CEAT Division of Engineering Technology offers a Master of Science degree in fire and emergency management administration, a PhD in fire and emergency management and administration, and an undergraduate minor in emergency management.

The MS and PhD in Fire and Emergency Management Administration are specialized degrees designed to provide an educational foundation for those who are currently serving or aspire to serve as managers or administrators in the fire service, emergency management, emergency medical services, law enforcement, or homeland security in the public, private, or nonprofit sectors.

## Admission Requirements for Master's Degree Programs

Any student having a bachelor's degree with an overall 3.00 grade-point average (on a 4.00 scale) may be admitted as a student in full standing. Those with less than an overall 3.00 grade-point average are considered for admission on a probationary basis.

In addition to the general requirements outlined above, candidates for the Master of Science degree in fire and emergency management administration must meet one of the following requirements:

1. Have significant practical experience in a fire or emergency service organization.
2. Have a bachelor's degree or a minor in fire or emergency services related discipline such as fire protection technology, fire management administration, fire science, emergency management, disaster science, criminal justice, emergency services administration; or
3. Not meeting the criteria specified in 1 or 2 above, completed a minimum of 12 hours of undergraduate study in fire protection and/or emergency management, or provide significant proof that studies in another field led to knowledge and experience in fire or emergency services field, such as a final project related to fire or one of the emergency services listed above or an internship with a fire,



emergency service, or law enforcement related organization in the public, private, or nonprofit sector.

A complete application for admission to the master's program must include:

1. A completed Graduate College application submitted with a non-refundable application fee.
2. A copy of undergraduate transcript(s).
3. Two letters of recommendation with at least one from an employer or faculty member familiar with the applicant's academic abilities.
4. TOEFL results for students for whom English is a second language. Students must have a score above 549 (paper exam) or 79 (internet based test) to be considered for admission.
5. A brief letter indicating interests, career goals and other information the applicant considers relevant.

## Degree Requirements for the MS in Fire and Emergency Management Administration

In addition to the general requirements of the Graduate College, requirements for the Master of Science degree in fire and emergency management administration are listed below.

1. A minimum of 33 credit hours in FEMP or closely related courses. Required courses include a 12-hour core requirement, a three-hour methods requirement, a three-hour administration course requirement, a six-hour emergency management or fire administration requirement, and six or nine hours of electives. Students must complete a three-hour practicum research project or a thesis with a minimum of six hours. Most courses in the FEMP MS program are conducted in the department's state-of-the-art virtual classroom, where both on-site and off-site students participate simultaneously in the same class sessions.
2. Satisfactory completion of a final assessment project (either a Thesis or a Practicum).
3. Minimum 3.00 grade-point average, with only one grade of "C" allowed.

## Admission Requirements for PhD in Fire and Emergency Management Administration

OSU Graduate College admission requirements include the following: an OSU Graduate College Application, payment of the OSU Graduate Application fee and transcripts of all previous college level coursework including transcripts that verify receipt of an undergraduate and graduate master's degree.

1. GPA: minimum cumulative GPA of 3.0.
2. GRE: Scores from the Graduate Record Examination taken within the past 5 years.
3. Professional experience in a fire or emergency services related field is preferred, but not required.
4. Academic experience in a fire or emergency services related field is preferred. If applicant has a degree outside of the fire or emergency services related field, they should spend time explaining how their academic background (i.e. degree, courses, research) has prepared

them for the pursuit of a PhD in Fire and Emergency Management Administration.

5. English Language Proficiency: For international students, a minimum TOEFL score of 79 (Internet) and 550 (paper) is required.
6. A current resume
7. Three letters of recommendation: At least two letters must come from individuals who can speak directly to the applicant's abilities in the classroom and conducting research (i.e. faculty members).
8. An essay: This 1-2 page essay should address the applicant's previous professional and academic experience and how it has prepared them to seek a PhD in Fire and Emergency Management Administration. Candidates should also address their 5 and 10 year goals, discuss their research interests, and explain how the FEMP program and faculty can help them reach their goals and develop their research interests.
9. Copy of the applicant's thesis or other written example of applicant's research abilities.
10. Copies of any published materials authored by the candidate.

## Degree Requirements for the PhD in Fire and Emergency Management Administration

Degree candidates must have completed a master's degree. In addition, they must complete 60 hours of required coursework that includes 15 hours in core courses, 12 hours of research tools, 18 hours of elective courses closely aligned with their academic and research interests, and 15 hours of dissertation research. Finally, candidates must take written and oral comprehensive exams and must successfully defend their dissertation before their dissertation committee. Most courses in the FEMP PhD program are conducted in the department's state-of-the-art virtual classroom, where both on-site and off-site students participate simultaneously in the same class sessions.

## Minors

- Emergency Management (EM), Minor (p. 2243)

## Faculty

Haley Murphy, PhD—Associate Professor and Program Coordinator  
**Assistant Professors:** Tony McAleavy, PhD; Xiangyu (Dale) Li, PhD

## Emergency Management (EM), Minor

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

Division of Engineering Technology, 405-744-5638

**Minimum Grade Point Average in Minor Coursework:** 2.50 with no grade below "C."

**Total Hours:** 15

Code	Title	Hours
FEMP 3103	Introduction to Emergency Management (S)	3
FEMP 3733	Emergency Management: Preparedness and Response	3
FEMP 3763	Emergency Management: Recovery and Mitigation	3
Choose 6 hours from the following:		6
FEMP 4000	Topics in Emergency Management	
FEMP 4050	Independent Study in Emergency Management	
POLS 3893	Terrorism & Counterterrorism	
POLS 2033	Introduction to Public Administration	
POLS 3493	Public Policy	
POLS 3613	State and Local Government	
SOC 4433	Environmental Sociology (S)	
SOC 4463	Technology and Society	
SOC 4493	Sociology of Environmental Hazards and Disasters (Has Prerequisites)	
FPST 1213	Fire Safety Hazards Recognition	
FPST 2153	Fire Protection Management	
FPST 3013	Safety Management (S)	
BAE 3313	Natural Resources Engineering	
CIVE 3633	Transportation Engineering	
CIVE 3714	Introduction to Geotechnical Engineering	
IEM 2903	Introduction to Industrial Engineering	
IEM 4013	Operations Research	
IEM 4163	Service Systems and Processes	
ENGR 4043	International Engineering Service Learning I (I)	
ENGR 4053	International Engineering Service Learning II (I)	
MGMT 4093	Management of Nonprofit Organizations	
MGMT 4163	Fundraising for Nonprofit Organizations	
AVED 3453	Aviation/Aerospace Security Issues	
AVED 3493	Analysis of Aviation Security Countermeasures	
AVED 3573	Aviation/Aerospace Finance	
AVED 4413	Aviation Terrorism and Asymmetrical Warfare	
AVED 4423	Aviation Security Organizations and Law	
GEOG 3033	Meteorology (N)	

GEOL 3513 Earthquakes, Volcanoes, and Disasters (N)

**Total Hours**

**15**

## Additional OSU Requirements Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).

## Fire Protection and Safety Engineering Technology

The fire protection and safety engineering technology (FPST) curriculum is structured to prepare individuals for assessing and reducing the risk for loss potential from fire, industrial incidents, exposure to toxic materials, and hazardous materials management. Reducing loss potential from fire involves setting design criteria with a particular emphasis on life safety, fire resistivity, automatic detection, or extinguishing systems specification. Reducing the risk of industrial incidents requires the application of specialized assessment techniques, redesign of machinery, processes and procedures, or use of special protective equipment or clothing. Reducing exposure to toxic materials requires sampling air for contaminants, such as toxic chemicals, monitoring noise levels, and developing procedures to address practical approaches for both risk reduction and compliance with state and federal regulations. Addressing hazardous materials management risks includes evaluating proper storage requirements, transportation, spill prevention, control and response, and regulatory reporting. Managing the risks of commercial and industrial operations, emphasizing risk reduction and compliance with laws and regulations, is an increasingly important job activity.

The fire protection and safety engineering technology program began at Oklahoma State University in 1937, the oldest fire-related program in North America. The demand by business and industry for loss control specialists has resulted in the program's evolution, emphasizing risk management for on fire protection, safety and occupational health. The FPST program prepares graduates for careers in loss control. The loss control profession is segmented into three major areas: loss from fire, loss from physical accidents and loss from environmental exposure.

The curriculum immediately introduces students to fire protection and safety studies, allowing them to measure their interests in a fire protection and safety career early in their academic career. The curriculum is rigorous in mathematics and the physical sciences requiring two semesters of calculus and a minimum of one semester of chemistry, and two semesters of physics. Computer usage is an essential component of most fire protection and safety courses. Interested high school students should design their high school programs to prepare them for college-level mathematics and science classes.

The program concludes with the Bachelor of Science in Engineering Technology degree in Fire Protection and Safety Engineering Technology.

### Program Educational Objectives

OSU Fire Protection and Safety graduates a few years after graduation will be:

1. Earning and pursuing personal, technical and professional advancement through their employment.
2. Continuing the pursuit of life-long learning through membership and participation in professional organizations.
3. Developing business expertise within their selected employment organization.
4. Successfully applying mathematical, analytical and technical skills to solve complex problems in the selected field.
5. Meeting the highest standards of ethical practice in their profession.

Fire Protection and Safety Technology degree graduates can expect to obtain these student outcomes upon graduation:

- (1) an ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve broadly-defined engineering problems appropriate to the discipline;
- (2) an ability to design systems, components, or processes meeting specified needs for broadly-defined engineering problems appropriate to the discipline;
- (3) an ability to apply written, oral, and graphical communication in broadly-defined technical and non-technical environments; and an ability to identify and use appropriate technical literature;
- (4) an ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes;
- (5) an ability to function effectively as a member as well as a leader on technical teams; and
- (6) an ability to understand ethical and professional responsibilities and the impact of technical and/or scientific solutions in global, economic, environmental, and societal contexts.

The graduates of the fire protection and safety engineering technology program at Oklahoma State University are consistently recruited by the major businesses and industries of the United States. Graduate placement, salary offers and advancement into managerial positions have been excellent due to the uniqueness and high technical quality of the OSU fire protection and safety engineering technology program.

The Fire Protection and Safety Engineering Technology program is accredited by the Engineering Technology Accreditation Commission of ABET, <http://www.abet.org> (<http://www.abet.org/>).

### Courses

#### FPST 1103 Applied Techniques in Fire Suppression

**Description:** Provides requisite knowledge to achieve basic certifications in fire suppression and emergency operations for municipal and industrial fire protection.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

#### FPST 1203 Applied Techniques in Emergency Operations

**Description:** Provides requisite knowledge to achieve advanced certifications in fire suppression and emergency operations for municipal and industrial fire protection.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

#### FPST 1213 Fire Safety Hazards Recognition

**Description:** "The Fire Problem" Physical, chemical and electrical hazards and their relationship to loss of property and/or life. Safe storage, transportation and handling practices to eliminate or control the risk of fire in the home, business and industry.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FPST 1373 Fire Suppression and Detection Systems**

**Description:** The design, installation, maintenance and utilization of portable fire-extinguishing appliances and pre-engineered systems. Operational capabilities and utilization requirements of fire detection and signaling systems. Fire detection and suppression applied in practical laboratory problems.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**FPST 2023 Industrial and Occupational Safety**

**Prerequisites:** A grade of "C" or better in FPST 1213 and a grade of "C" or better in either MATH 1613 or MATH 1715 or MATH 1813 or MATH 2123 or MATH 2144 or an ALEKS score of 65.

**Description:** Occupational facilities, equipment and operations and their inherent hazards. Directed toward worker, machine and environmental control.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**FPST 2050 Studies in Loss Control**

**Prerequisites:** Consent of instructor and adviser.

**Description:** Problems in applied fire protection technology, occupational safety, industrial hygiene or hazardous materials management of particular interest to the loss control specialist. Offered for variable credit, 1-4 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-4

**Contact hours:** Contact: 1-4 Other: 1-4

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Engineering Technology

**FPST 2153 Fire Protection Management**

**Description:** Applied human relations, technical knowledge and skills for achieving optimum effectiveness from a fire protection organization.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FPST 2243 Design and Analysis of Sprinkler Systems**

**Prerequisites:** Grade of "C" or better in FPST 1373, FPST 2483, ENGR 1322 or GENT 1153 or CMT 2203.

**Description:** Detailed current standards for selection, design, installation, operation and maintenance of automatic fire suppression systems. Laboratory problems on applicable technological principles.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**FPST 2343 Elements of Industrial Hygiene**

**Prerequisites:** Grade of "C" or better in STAT 2013, CHEM 1515 or CHEM 1225 or CHEM 1414.

**Description:** Toxic or irritating substances, physical, biological, ergonomic and other occupational stress factors causing employee illness or discomfort. Environmental pollution sources and controls. Previously offered as FPST 2344.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**FPST 2483 Fluid Mechanics for Fire Protection**

**Prerequisites:** Prior (grade of "C" or better) or concurrent enrollment in FPST 1373. A grade of "C" or better in MATH 1613 or MATH 1715 or MATH 1813 or MATH 2123 or MATH 2144 or an ALEKS score of 65.

**Description:** Fluid flow through hoses, pipes, pumps and fire protection appliances. Water supply and distribution analysis using hydraulic calculations. Testing techniques to detect anomalies in design or performance capabilities.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**FPST 2650 Technical Problems and Projects**

**Description:** Special problems or projects assigned by advisers with the approval of the department head. A comprehensive written report or equivalent creative effort. Offered for variable credit, 1-4 credit hours, maximum of 4 credit hours.

**Credit hours:** 1-4

**Contact hours:** Contact: 1-4 Other: 1-4

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Engineering Technology

**FPST 3013 Safety Management (S)**

**Prerequisites:** ENGL 1113 or ENGL 1123 or ENGL 1313. Must be enrolled in one of the following classes: Junior (JR) or Senior (SR).

**Description:** Understanding and implementing techniques for a safer work environment. Recognition, evaluation and control of occupational health and safety hazards. Accident prevention, accident analysis, training techniques, worker's compensation insurance, guarding and personal protective equipment.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**General Education and other Course Attributes:** Social & Behavioral Sciences

**FPST 3113 Advanced Special Hazard Suppression and Detection****Prerequisites:** FPST 2483 or ENSC 3233.**Description:** Design and analysis of special hazard suppression and detection systems using code requirements. Emphasis is also placed on the ability to select the appropriate system for a given hazard. May not be used for degree credit with FSEP 5123.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FPST 3143 Life Safety Analysis****Prerequisites:** A grade of "C" or better in FPST 1213 and FPST 1373 and (FPST 2243 or CMT 3463 or ARCH 2263).**Description:** Life safety concepts related to building codes including means of egress design criteria and components, exits, component details, occupancy types, occupancy load, emergency lighting, marking of means of egress, evacuation movement, human performance capabilities, human response to fire cues, occupant pre-evacuation, and toxicology.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 3 Contact: 5**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Engineering Technology**FPST 3213 Human Factors in Accident Prevention****Prerequisites:** Grade of "C" or better in (STAT 2013, STAT 4013, or STAT 4033) and (GENT 2323 or ENSC 2113).**Description:** Human factors and workplace ergonomics as it relates to the prevention of accidents and workplace injuries. Fundamentals and techniques of task analysis.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FPST 3373 Fire Dynamics****Prerequisites:** A grade of "C" or better in CHEM 1314 or CHEM 1215 or CHEM 1515, MATH 2133 or MATH 2153, STAT 2013, FPST 2483, and GENT 3433 or ENSC 2213 or GENT 4433.**Description:** Fundamental thermodynamics of combustion, fire chemistry and fire behavior. The physical evidence left by fire for investigation and the use of computer models to study fire behavior. Previously offered as FPST 4373.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 3 Contact: 5**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Engineering Technology**FPST 3383 Building Electrical Systems****Prerequisites:** FPST 1373.**Description:** Detail current standards for design, selection and installation of electrical distribution and utilization equipment. Emphasis on personnel safety and fire prevention using current codes and standards. May not be used for degree credit with FSEP 5163.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FPST 3713 Hydraulic Design of Automatics Sprinkler Systems****Prerequisites:** FPST 1373, FPST 2483, MATH 1513.**Description:** Hydraulic calculation technique for the design and analysis of automatic sprinkler fire extinguishing systems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FPST 3723 Industrial Fire Pump Installations****Prerequisites:** FPST 2483, MATH 1513.**Description:** Applications, design and analysis of industrial fire pump installations. Graphical analysis of fire pump contributions to existing fire protection water supply systems emphasized.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FPST 3733 Sprinkler System Design for High Piled and Rack Storage****Prerequisites:** FPST 2243, MATH 1513.**Description:** Specific design techniques for sprinkler system protection of commodities stored in solid piles or racks over 12 feet in height.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FPST 4050 Special Problems in Loss Control****Prerequisites:** Consent of department head.**Description:** Special technical problems in fire protection and safety.

Offered for variable credit, 1-4 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-4**Contact hours:** Contact: 1-4 Other: 1-4**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Engineering Technology**FPST 4143 Industrial Ventilation and Smoke Control****Prerequisites:** A grade of "C" or better in FPST 2344 and FPST 2483 and FPST 3373.**Description:** Principles of dilution and comfort ventilation; heat-cold stress control, system design, contaminant control; ventilation system testing and guidelines. Design and analysis of smoke management systems in buildings for survivability and safe egress. Assessment of human health hazards posed by smoke. Performance characteristics of smoke control systems. Previously offered as FPST 4133.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Engineering Technology**FPST 4153 Issues in Local Government and Fire Services****Prerequisites:** FPST 2153, MGMT 3013.**Description:** Issues relating to the proper operation of a fire department and the fire department's role within the structure of local government.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Engineering Technology

**FPST 4213 Advanced Building Design and Analysis**

**Prerequisites:** Grade of "C" or better in FPST 2243 or CMT 3463 or ARCH 2263.

**Description:** Fire protection and life safety concepts and applications in the built environment related to building and fire codes including building height and area, structural fire protection, occupancy classifications, passive fire protection systems, means of egress, active fire protection systems, fire detection systems, and fire department access. May not be used for degree credit with FSEP 5213.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FPST 4233 Advance Exposure Assessment**

**Prerequisites:** Grade of "C" or better in FPST 2344.

**Description:** Evaluation of CBRNE exposure risks in industry and emergency response including statistical/computational techniques, regulatory obligations, and the use of instrumentation. Same course as FPST 3233.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FPST 4333 System and Process Safety Analysis**

**Prerequisites:** Grade of "C" or better in FPST 2023, STAT 2013, and MATH 2123 or MATH 2144.

**Description:** Fire and safety techniques to anticipate, recognize and control hazards. Fault Tree, HazOp, FMEA and other process safety techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**FPST 4383 Fire and Evacuation Modeling**

**Prerequisites:** A grade of "C" or better in CHEM 1515 or CHEM 1225 or CHEM 1414 and FPST 2483 and MATH 2133 or MATH 2153 and STAT 2013 and GENT 3433 or MET 3433 or ENSC 2213 or GENT 4433 or MET 4433.

**Description:** Fundamentals of fire dynamics and occupant egress and their numerical approaches for computer models. Practical knowledge of how to use fire and evacuation modeling tools: CFAST, FDS, Pyrosim, and Pathfinder, and how to analyze modeling results. May not be used for degree credit with FSEP 5383.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FPST 4403 Hazardous Materials Incident Management**

**Prerequisites:** Grade of "C" or better in FPST 2023, FPST 2344, and CHEM 1225 or CHEM 1414 or CHEM 1515.

**Description:** An interdisciplinary approach to hazardous materials incident management. Legislative requirements. Emphasis on comprehensive safety and health program compliance relating to hazardous materials incidents or waste sites. Regulatory code activities, transport-related inspections, incident modeling, and use of environmental safety software for problem solving and documentation.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FPST 4683 Risk Control Engineering**

**Prerequisites:** Prior or concurrent enrollment in (FPST 4992 or FPST 4994) and grade of "C" or better in FPST 4982, ENGL 3323, and (MET 3433 or ENSC 2213 or MET 4433), and Department Permission.

**Description:** Analysis of specific processes, equipment, facilities and work practices for detecting and controlling potential hazards, evaluating risk and developing risk control methodologies.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**FPST 4982 Fire Protection and Safety Projects I**

**Prerequisites:** A grade of "C" or better in ENGL 1113 or ENGL 1123 or ENGL 1313. A grade of "C" or better or concurrent enrollment in ENGL 3323. A grade of "C" or better or concurrent enrollment in FPST 3013.

**Description:** Two-semester project with team format. Team members work with sponsors and faculty who serve as mentors in fields related to their topics. Students complete topic selection, progress reports, final reports, and poster presentations.

**Credit hours:** 2

**Contact hours:** Lecture: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FPST 4992 Fire Protection & Safety Projects II**

**Prerequisites:** A grade of "C" or better in ENGL 3323 and FPST 4982.

**Description:** Two-semester project with team format. Second of two-semester sequence of senior project courses.

**Credit hours:** 2

**Contact hours:** Lecture: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**FPST 4994 Fire Protection and Safety Interdisciplinary Projects**

**Prerequisites:** A grade of "C" or better in ENGL 1113 or ENGL 1123 or ENGL 1313. A grade of "C" or better or concurrent enrollment in ENGL 3323. A grade of "C" or better or concurrent enrollment in FPST 3013 and FPST 3373.

**Description:** Students work in small teams on a semester-long design project sponsored by a company, agency, or individual. Team members work with mentors from sponsors and with faculty members in fields related to their topics. Presentations on safety, patent law, product liability, report writing, oral presentations, scheduling and ideation. Oral presentations, progress reports, and a professional log book documenting personal activity and contributions. Previously offered as FPST 4993.

**Credit hours:** 4

**Contact hours:** Lecture: 4 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

## Undergraduate Programs

- Fire Protection and Safety Engineering Technology, BSET (p. 2249)

## Graduate Programs

The Fire Protection and Safety Engineering Technology (FPST) program offers a graduate program leading to the Master of Science in Engineering Technology with an option in Fire Safety and Explosion Protection (FSEP). The program extends the FPST undergraduate program into graduate research, scholarship and creative activities. The FSEP program is designed to prepare students for professional practice that may include research or consulting components, with major emphasis in fields of interest such as fire protection engineering, explosion protection, fire and explosion hazards, and process safety. This is the nation's only master's degree program that is dedicated to both fire and explosion protection and related to safety. The program is geared toward recent graduates and professionals in a variety of industries, including insurance companies, the oil & gas industry, and fire protection engineering companies. The graduates of this program will have the deeper knowledge base that is needed to safeguard people in Oklahoma, the nation and world. The FSEP program is intended to be especially attractive to engineering and engineering technology graduates from any disciplines, and many science majors. The program is interdisciplinary in nature and hence students with undergraduate degrees in fire and safety related fields or other STEM disciplines are invited to apply for admission. Students can complete degree requirements either online as distance students or as a resident on campus.

## Admission Requirements

Admission to the Master of Science degree program requires a B.S. degree in engineering or engineering technology from an ABET accredited (or equivalent) program. Alternately, B.S. students from other related disciplines may also be considered. Admission is competitive based on undergraduate GPA and TOEFL (for international students), statement of interests, experience and recommendations.

## Degree Requirements

A candidate for the graduate degree must satisfy at least the minimum University requirements for that particular degree. The program consists of 30 hours of coursework with a thesis option or 32 hours of coursework with a non-thesis option. For both options, the courses taken must include FSEP 5013, 5023, 5033, 5113, 5133, 5143.

## Minors

- Safety and Exposure Sciences (SAES), Minor (p. 2251)

## Faculty

Virginia Charter, PhD, PE— Associate Professor and Program Coordinator

**Associate Professor and Graduate Advisor:** Bryan Hoskins, PhD, PE

**Associate Professor:** Robert Agnew, PhD, CSP, CIH

**Assistant Professors:** Diana Rodriguez Coca, PhD; Haejun Park, PhD

**Assistant Professor of Professional Practice:** Leslie Stockel, MS, CSP

**Teaching Assistant Professor:** Timothy Wilson, MS, CSP

**Assistant Dean of Engineering Extension and Adjunct Assistant**

**Professor:** Ed Kirtley, MS

# Fire Protection and Safety Engineering Technology, BSET

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 125**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan.		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
Select one of the following:		3
ENGL 1113	Composition I	
ENGL 1123	International Freshman Composition I	
ENGL 1313	Critical Analysis and Writing I	
ENGL 3323	Technical Writing	3
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2123	Calculus for Technology Programs I (A)	3
or MATH 2144	Calculus I (A)	
MATH 2133	Calculus for Technology Programs II (A)	3
or MATH 2153	Calculus II (A)	
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
PHYS 2014	University Physics I (LN)	4
PHYS 1214	College Physics II (LN)	4
or PHYS 2114	University Physics II (LN)	
Select one of the following:		4
CHEM 1414	General Chemistry for Engineers (LN)	
CHEM 1314	Chemistry I (LN)	
& CHEM 1515	and Chemistry II (LN)	
CHEM 1215	Chemical Principles I (LN)	
& CHEM 1225	and Chemical Principles II (LN)	
<i>Social &amp; Behavioral Sciences (S)</i>		
Course designated (S)		3
<i>Additional General Education</i>		
Courses designated (A) or (N)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		

<b>College/Departmental Requirements</b>		
<i>Engineering</i>		
CET 2253	Printreading & BIM <sup>1</sup>	3
or ENGR 1322	Engineering Design with CAD	
<i>Engineering Science</i>		
ENSC 2113	Statics	3
or GENT 2323	Statics	
Select one of the following:		3
ENSC 2213	Thermodynamics	
MET 3433	Basic Thermodynamics	
MET 3453	Heat Transfer <sup>2</sup>	
ENGR 2400	Engineering Lab Topics	1
<i>Specialty</i>		
FPST 1213	Fire Safety Hazards Recognition	3
FPST 1373	Fire Suppression and Detection Systems	3
FPST 2023	Industrial and Occupational Safety	3
FPST 2243	Design and Analysis of Sprinkler Systems	3
FPST 2343	Elements of Industrial Hygiene	3
FPST 2483	Fluid Mechanics for Fire Protection	3
<b>Hours Subtotal</b>		<b>28</b>
<b>Major Requirements</b>		
Select one of the following:		3
ENSC 2143	Strength of Materials	
GENT 3323	Strength of Materials	
ENSC 3313	Materials Science	
Select one of the following:		3
STAT 2013	Elementary Statistics (A)	
STAT 4013	Statistical Methods I (A)	
STAT 4033	Engineering Statistics	
Select one of the following:		3
STAT 3013	Intermediate Statistical Analysis	
STAT 4023	Statistical Methods II	
STAT 4043	Applied Regression Analysis	
MATH 2233	Differential Equations	
MATH 3013	Linear Algebra (A)	
IEM 3503	Engineering Economic Analysis	3
or IEM 3513	Economic Decision Analysis	
FPST 3013	Safety Management (S)	3
FPST 3143	Life Safety Analysis	3
FPST 3213	Human Factors in Accident Prevention	3
FPST 3373	Fire Dynamics	3
FPST 4143	Industrial Ventilation and Smoke Control	3
FPST 4333	System and Process Safety Analysis	3
FPST 4403	Hazardous Materials Incident Management	3
FPST 4683	Risk Control Engineering	3
Select one of the Following		4
FPST 4982	Fire Protection and Safety Projects I	
& FPST 4992	and Fire Protection & Safety Projects II	
FPST 4994	Fire Protection and Safety Interdisciplinary Projects	
Select 6-7 hours of specialty electives of the following: <sup>1</sup>		6
CET 4443	Construction Safety and Loss Control	



FEMP 3103	Introduction to Emergency Management (S)	
FEMP 3733	Emergency Management: Preparedness and Response	
FEMP 3763	Emergency Management: Recovery and Mitigation	
FPST and FSEP courses not used elsewhere.		
FRNS 5143	Methods in Fire and Explosion Investigation NFPA 921/1033	
ENGR 2400	Engineering Lab Topics	
ENGR 2421	Engineering Data Acquisition Controls Lab	
ENSC courses not used elsewhere (except ENSC 2213 if MET 3433 is used for Engineering Science Requirements)		
MET 3453	Heat Transfer <sup>2</sup>	
	or ENSC 2213 Thermodynamics	
	or MET 3433 Basic Thermodynamics	
MET 3433 can NOT be used if ENSC 2213 is used for Engineering Science Requirements		
MGMT 3133	Developing Leadership Skills	
<b>Hours Subtotal</b>		<b>46</b>
<b>Electives</b>		
Select 9 hours of upper-division controlled electives of the following:		9
CET 4443	Construction Safety and Loss Control	
FPST 3113	Advanced Special Hazard Suppression and Detection	
FPST 3383	Building Electrical Systems	
FPST 4213	Advanced Building Design and Analysis	
FPST 4383	Fire and Evacuation Modeling	
FPST 4233	Advance Exposure Assessment	
FRNS 5143	Methods in Fire and Explosion Investigation NFPA 921/1033	
<b>Hours Subtotal</b>		<b>9</b>
<b>Total Hours</b>		<b>125</b>

<sup>1</sup> Students who take ENGR 1322 instead of CET 2253 will need to take an extra hour of related specialty

<sup>2</sup> MET 3453 replaces MET 4433 and is equivalent.

## Graduation Requirements

1. A minimum technical GPA of 2.00 is required. The technical GPA is calculated from all courses counting in the curriculum with a prefix belonging to the degree program, or substitutions for the courses.
2. A grade of 'C' or better is required in each course that is a prerequisite to a required course that has an engineering or engineering technology prefix. A Grade of 'C' or better is also required in FPST 4683, FPST 4992 and FPST 4994.

Below are the courses that require a "C" using the 2020-2021 catalog but the prerequisites are subject to change.

Code	Title	Hours
CET 2253	Printreading & BIM	3
or ENGR 1322	Engineering Design with CAD	
CHEM 1414	General Chemistry for Engineers (LN)	4
ENGL 1113	Composition I	3

ENGL 3323	Technical Writing	3
ENSC 2113	Statics	3
or GENT 2323	Statics	
FPST 1213	Fire Safety Hazards Recognition	3
FPST 1373	Fire Suppression and Detection Systems	3
FPST 2023	Industrial and Occupational Safety	3
FPST 2243	Design and Analysis of Sprinkler Systems	3
FPST 2343	Elements of Industrial Hygiene	3
FPST 2483	Fluid Mechanics for Fire Protection	3
FPST 3013	Safety Management (S)	3
FPST 3373	Fire Dynamics	3
FPST 4683	Risk Control Engineering	3
FPST 4982	Fire Protection and Safety Projects I	2
FPST 4992	Fire Protection & Safety Projects II	2
FPST 4994	Fire Protection and Safety Interdisciplinary Projects	4
STAT 2013	Elementary Statistics (A)	3
or STAT 4013	Statistical Methods I (A)	
or STAT 4033	Engineering Statistics	
MATH 2123	Calculus for Technology Programs I (A)	3
or MATH 2144	Calculus I (A)	
MATH 2133	Calculus for Technology Programs II (A)	3
or MATH 2153	Calculus II (A)	
MET 3453	Heat Transfer <sup>2</sup>	3
	or ENSC 2213 Thermodynamics	
	or MET 3433 Basic Thermodynamics	
PHYS 2014	University Physics I (LN)	4

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Safety and Exposure Sciences (SAES), Minor

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

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Minimum Grade Point Average in Minor Coursework of 3.0 with no grade below "C."

**Total Hours: 15**

Code	Title	Hours
<b>Minor Requirements</b>		
FPST 1213	Fire Safety Hazards Recognition	3
FPST 2023	Industrial and Occupational Safety	3
FPST 2343	Elements of Industrial Hygiene	3
Select 6 hours of the following:		6
AVED 3243	Human Factors in Aviation	
AVED 4113	Aviation Safety	
AVED 4943	Basic Aircraft Accident Investigation	
CIVE 3813	Environmental Engineering Science	
ENGR 4123	Tort and Products Liability Law for Technical Professionals (S)	
ENGR 4133	Environmental Regulation for Technical Professionals (S)	
CET 4443	Construction Safety and Loss Control	
FPST 3013	Safety Management (S)	
FPST 3213	Human Factors in Accident Prevention	
FPST 4143	Industrial Ventilation and Smoke Control	
FPST 4233	Advance Exposure Assessment	
FPST 4333	System and Process Safety Analysis	
IEM 3813	Work Design, Ergonomics, and Human Performance	
<b>Total Hours</b>		<b>15</b>

been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).

## Additional OSU Requirements

### Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have

# Industrial Engineering and Management

Industrial engineering and management focuses on production systems that produce goods or provide services for customers. Industrial engineers define, design, build, operate and improve production processes that convert resources to high quality products or services effectively, efficiently and safely.

People are the fundamental component of production systems. People provide the creativity and leadership essential to make things happen. Hence, industrial engineering is the most people-oriented discipline within the engineering family. Industrial engineers are trained to think in both broad and specific terms. Practicing industrial engineers understand business parameters as well as physical and social parameters within production systems. This breadth allows industrial engineers to function effectively in a wide spectrum of activities ranging from strategic business planning to detailed task design. The wide-angle vision of industrial engineering provides career flexibility, leading to high-level leadership or specialized technical responsibilities.

Industrial engineers are employed in manufacturing organizations (e.g., automotive, electronics, food, and medical manufacturers), service enterprises (e.g., airlines, banks, consulting groups, hospitals, retail companies, theme parks, transportation companies, warehouses) and governmental organizations (e.g., public service and regulatory organizations).

## Vision

To inspire and empower our students to become leaders in a wide variety of industries, improve the quality of life for humankind, and change the world for the better, by making societal systems diverse, effective, efficient, and sustainable.

## Mission

Continuously and aggressively advance educational and research processes which will attract students who fulfill our vision.

## Core Values

Faculty, students and staff work together to build and maintain a learning/mentoring environment where:

- Innovative practices are developed, tested and validated.
- Knowledge and practices are shared.
- Each individual develops to his/her full potential.
- Professional ethics are practiced at all times.

## Educational Objectives and Outcomes

Within a few years after graduation, Industrial Engineering program graduates will become professionals, managers or leaders in a wide variety of industries and apply discovery, problem-solving, leadership and management skills for the benefit of their organization and society at large.

## Student Learning Outcomes

Graduating baccalaureate students possess an understanding of fundamental industrial engineering and management concepts, methodologies and technologies as demonstrated by:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The curriculum consists of three primary parts:

1. general studies,
2. core engineering, and
3. professional school topics.

General studies consist of courses such as mathematics, statistics, chemistry, physics, English, behavioral science, history, humanities and arts. Core engineering courses consist of engineering sciences such as materials, statics, electrical circuits, fluid mechanics and thermodynamics. Professional school courses consist of topics such as systems thinking and analysis in engineering, economic analysis, manufacturing processes, computer-aided modeling, work analysis, operations research, quality control, experimental design, facility location and layout, management and leadership, production control, system simulation modeling, information systems, ergonomics and human factors, and energy and water management. A capstone design experience, working with a real-world organization, integrates classroom and lab work together in the senior year. Details regarding degree requirements are available in the Undergraduate Programs and Requirements publication.

The IEM program is accredited by the Engineering Accreditation Commission of ABET, <https://www.abet.org>.

Each IEM student, along with the faculty advisor, develops an individual plan of study that guides the student through the curriculum. Coursework is sequenced and interrelated to provide theoretical and applied knowledge, along with hands-on laboratory and project experience. Students work as individuals and as teams to integrate and apply mathematical, scientific, and engineering knowledge and concepts in order to address both traditional academic questions as well as open-ended design and analysis challenges. Instruction in experimental methods is integrated in the curriculum through the design, execution, analysis and interpretation of experiments. Project work is used to develop both technical and communications skills. Technical skills are used to identify, formulate and address engineering problems, both simple and complex. Communications skills are developed and practiced in written, oral and team interaction formats.

The means to define and design detailed solutions to address customer needs from a system-wide perspective is introduced in the sophomore year, and reinforced through the capstone senior design project. Additionally, global perspectives or production systems are introduced and emphasized in the sophomore year so that students understand the nature of global customer bases as well as global competition early in their studies. The curriculum is continually updated to assure that contemporary issues, thinking and tools are integrated in course content as well as instructional delivery. Professional responsibility and ethical behavior are introduced and reinforced throughout the curriculum. Additionally, the need for life-long learning after graduation is stressed.

Students are offered opportunities to enhance their classroom and laboratory experiences through student organizations such as the student chapter of APICS, the Institute of Industrial and Systems Engineers, the Institute for Operations Research and the Management Sciences, and the American Society for Quality. Outstanding scholars are recognized by Alpha Pi Mu, the national honor society for industrial engineering students. Additionally, opportunities for internship and co-op experiences are offered to IEM students so that they can gain professional experience during their collegiate program. Please visit our Internet site <http://iem.okstate.edu> (<http://iem.okstate.edu/>) for more information.

## Courses

### IEM 2903 Introduction to Industrial Engineering

**Prerequisites:** ENGR 1111 with grade of "C" or better and MATH 2144 with grade of "C" or better.

**Description:** Introduces students to enterprise/production systems from the perspective of industrial engineering. As a part of this introduction, the basic concepts and issues involved in professional practice will be discussed. Useful analytical methods and practices for collecting and working with data will be presented. Additionally, modern applications of industrial engineering practices will be introduced. After completion of this class, students will have the ability to describe and apply various industrial engineering methods in the manufacturing and service industries.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

### IEM 3103 Probability and Statistics for Engineers I

**Prerequisites:** MATH 2153 with grade of "C" or better.

**Description:** An introduction to key concepts and results in probability, random variables, discrete and continuous distributions, mathematical expectations, and joint probability distributions that support applications in industrial engineering and management.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

### IEM 3303 Manufacturing Processes

**Prerequisites:** ENGR 1322 with grade of "C" or better or ENGR 1332 with grade of "C" or better and ENSC 3313 with grade of "C" or better.

**Description:** Manufacturing processes used to transform new materials including metals and non-metals into finished goods. Traditional and nontraditional manufacturing processes. Introduction to CAD/CAM. Basic process selection. Metrology and measurement fundamentals.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Industrial Engr & Mgmt

### IEM 3403 Engineering Project Management

**Prerequisites:** Junior standing or Senior Standing.

**Description:** Engineering management and group issues involved in project planning and implementation. Topics addressed include project management methodologies and software, ethics and social responsibility, organizational structures, situational leadership, individual behavior and motivation, teamwork structures, processes, collaborative technologies, process management, organizational culture, and diversity and inclusion.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

### IEM 3503 Engineering Economic Analysis

**Prerequisites:** MATH 2153 with grade of "C" or better or MATH 2133 with grade of "C" or better.

**Description:** Development and use of time value of money models. Bases for comparison of alternatives, including present worth, annual worth, rate of return and payout period methods. Decision-making among independent, dependent, capital-constrained and unequal-life projects. Replacement, breakeven and minimum cost analyses. Depreciation and depletion methods and their effect on corporate income taxes, leading to after-tax cash flow analysis. Introduction to financial reports.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

### IEM 3513 Economic Decision Analysis

**Prerequisites:** MATH 2123 with grade of "C" or better or MATH 2144 with grade of "C" or better.

**Description:** Quantitative evaluation of investment alternatives for non-engineering majors. The role of interest in economic equivalence and in formulating economic comparisons based on present worth, annual equivalent, rate of return and payout criteria. Accounting, depreciation and income tax considerations. Benefit-cost and cost-effectiveness analysis. Cost estimation and allowance for variance in estimates. Not available for credit in industrial engineering curriculum.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 3523 Engineering Cost Information and Control Systems****Prerequisites:** MATH 2144 with grade of "C" or better.**Description:** Introduction to basic accounting concepts and operating characteristics of accounting systems relevant to engineering analysis and decision making. Principles of financial and managerial accounting, activity based costing, taxes and depreciation. Emphasis on interpretation and use of accounting information for decision-making.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 3703 Probability and Statistics for Engineers II****Prerequisites:** IEM 3103 with grade of "C" or better.**Description:** An introduction to key concepts and results in statistics, including confidence intervals and hypothesis tests for the mean and the variance, analysis of variance, linear regression, correlation, goodness of fit tests and categorical data analysis that support applications in industrial engineering and management.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 3713 Software Programming for Data Analytics****Prerequisites:** ENGR 1412 with grade of "C" or better.**Description:** This course introduces basic concepts and applications that are important for understanding software programming in data analytics, such as raw data manipulation, exploratory analysis, and machine learning. The primary focus in this course is on programming ideas, algorithm toolboxes, implementations and applications of data analytics methods in industrial applications (e.g., manufacturing, healthcare). Programming will be done using Python and R with a focus on real-world data analytics problems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 3813 Work Design, Ergonomics, and Human Performance****Prerequisites:** ENSC 2113 with grade of "C" or better and IEM 2903 with grade of "C" or better and IEM 3103 with grade of "C" or better.**Description:** Evaluation and design of work systems and processes employing humans. Emphasis on simultaneously achieving high productivity and employee health, safety and satisfaction.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 3 Contact: 5**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Industrial Engr & Mgmt**IEM 4010 Industrial Engineering Projects****Prerequisites:** Consent of school head.**Description:** Special undergraduate projects and independent study in industrial engineering. Offered for variable credit, 1-3 credit hours, maximum of 6 credit hours.**Credit hours:** 1-3**Contact hours:** Contact: 1-3 Other: 1-3**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Industrial Engr & Mgmt**IEM 4013 Operations Research****Prerequisites:** MATH 3013 with grade of "C" or better.**Description:** Introduction to operations research, analytics, and mathematical optimization with an emphasis on topics in linear, integer, and network optimization. Effective model formulation and software solution of strategic, tactical and operational problems encountered in manufacturing, and service industries. Covers the simplex method, duality theory, sensitivity analysis, branch-and-bound, network simplex, and Dijkstra's algorithm. Previously offered as IEM 4014.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 4020 Undergraduate Engineering Practicum****Prerequisites:** Consent of IEM adviser and satisfactory completion of at least 12 hours of IEM 3000- or IEM 4000-level courses.**Description:** Professionally supervised experience in real life problem solving involving industrial projects for which the student assumes a degree of professional responsibility. Activities approved in advance by the instructor. May consist of full- or part-time engineering experience, on-campus or in industry, or both, either individually or as a responsible group member. Periodic reports both oral and written required as specified by the adviser. Offered for variable credit, 1-3 credit hours, maximum of 4 credit hours.**Credit hours:** 1-3**Contact hours:** Contact: 1-3 Other: 1-3**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Industrial Engr & Mgmt**IEM 4103 Quality Control and Reliability Analysis****Prerequisites:** IEM 3703 with grade of "C" or better.**Description:** Performance excellence in an enterprise, including relationships between industrial engineering and quality control. Statistical quality control concepts to measure, monitor, diagnose, and improve performance at the enterprise level, the operational level, and the project level. Perform basic reliability analysis. Quantitative and qualitative quality tools to solve problems and capture opportunities for improvement.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 4113 Industrial Experimentation****Prerequisites:** IEM 3703 with grade of "C" or better.**Description:** Analytical methods for the purpose of process improvement. Experimental designs including single, blocked and multiple factors. Introduction to fractional factorial designs, central composite designs, and Taguchi robust designs. Data collection, analysis, and interpretation, including graphical methods, confidence intervals, and hypothesis tests. Multiple linear regression analysis methods. Industrial applications.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt

**IEM 4163 Service Systems and Processes**

**Prerequisites:** IEM 3103 with grade of "C" or better and IEM 3503 with grade of "C" or better.

**Description:** Design and analysis of service systems and processes from the perspective of industrial engineering and engineering management. Application of basic industrial engineering principles and tools applied to service systems. Basics of service quality and productivity, including metrics, measurement and improvement.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 4203 Facilities and Material Handling System Design**

**Prerequisites:** IEM 3703 with grade of "C" or better and IEM 4013 with grade of "C" or better.

**Description:** Design principles and analytical procedures for determining facility location and location of physical assets within a facility. Introduction to material-handling concepts, technologies and methods. Considerations include production processes, product volume, material flow and information flows.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 4613 Production Planning and Control Systems**

**Prerequisites:** IEM 4013 with grade of "C" or better.

**Description:** Concepts of planning and control for production and control systems. Design of operation planning and control systems. Techniques used in demand forecasting, operations planning, inventory control, scheduling, and progress control.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 4623 Supply Chain and Logistics**

**Prerequisites:** IEM 3103 with grade of "C" or better and IEM 4013 with grade of "C" or better and concurrent requisite of IEM 4613.

**Description:** Introducing basic concepts and methods in supply chain management. Developing managerial insights into supply chain strategies in the global economy. Measuring supply chain performance under dynamic market conditions.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 4713 Systems Simulation Modeling**

**Prerequisites:** IEM 3703 with grade of "C" or better and IEM 4013 with grade of "C" or better.

**Description:** Simulation of discrete-event systems, including problem formulation, translation to a computer model, and use of a model for problem solution as well as concepts of random variable selection and generation, model validation and statistical analysis of results.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Industrial Engr & Mgmt

**IEM 4723 Information Systems Design and Development**

**Prerequisites:** Junior Standing or Senior Standing.

**Description:** Overview of IS/IT concepts. Systems development methodology, modeling methods, and software tools for the design and development of information systems, especially relational database applications. Data modeling using the Entity Relationship Diagram (ERD). Implementing and manipulating relational databases using SQL and MS Access. Process modeling using the UML Activity Diagram. Introduction to Enterprise Resource Planning and Geographic Information systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 4783 Applied Statistical Analysis in R for Engineers**

**Prerequisites:** ENGR 1412 with grade of "C" or better and IEM 3703 with grade of "C" or better and IEM 4013 with grade of "C" or better.

**Description:** The overall goal of this course is to provide an applied overview to statistical learning for real industrial engineering problems using R programming. Topics in this course cover advanced linear and non-linear methods of statistical learning such as multivariate regression, mixed-effects regression, advanced logit regression, clustering methods, generalized additive models, tree-based methods, support vector machines, and Bayesian methods. May not be used for degree credit with IEM 5783.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 4823 Industrial Ergonomics**

**Prerequisites:** IEM 3813.

**Description:** Characteristics of humans, equipment, and work environment examined using a systems approach. Job designs that concurrently emphasize multiple goals of productivity, safety and employee satisfaction, investigation of psychological, social, safety, reward, training and ergonomic parameters that affect work life of both employee and supervisor.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Graduate, Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Industrial Engr & Mgmt

**IEM 4913 Senior Design Projects**

**Prerequisites:** Terminal semester only and IEM majors only and IEM 3403 with grade of "C" or better and IEM 3503 with a grade of "C" or better.

**Description:** Student teams work on professional-level engineering projects selected from a wide range of participating organizations. Projects are equivalent to those normally experienced by beginning professionals and require both oral and written reports. Normally taken during student's last semester of undergraduate work.

**Credit hours:** 3

**Contact hours:** Lecture: 1 Lab: 4 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Industrial Engr & Mgmt

**Additional Fees:** Industrial Eng Equip Use fee of \$80 applies.

**IEM 4931 Industrial Engineering and Management Seminar**

**Prerequisites:** Senior standing.

**Description:** Designed to orient seniors to their professional work environment. Topics include placement procedures, resume construction, interviewing skills, professional dress, graduate school, professional societies and registration, personal management of time and money, and job-related expectations. Taught by senior faculty; utilizes outside speakers.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 4953 Industrial Assessment and Improvement**

**Prerequisites:** Senior standing and consent of instructor.

**Description:** Plant assessment and improvement-based concepts, strategies, and tools for manufacturing operations. Emphasis is on small to medium-sized manufacturing operations. Issues include energy, water, waste, quality, and productivity analysis across the organization from a systems perspective. Justification of improvement projects and measurement of results. May not be used for degree credit with IEM 5953 or MET 4953.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 4990 Selected Topics in Industrial Engineering and Management**

**Prerequisites:** Consent of instructor.

**Description:** Study of selected contemporary topics in industrial engineering and management, including operations research; quality; manufacturing systems; engineering management; enterprise systems and supply chains; facilities, energy, and environmental management. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Industrial Engr & Mgmt

**IEM 5000 Master's Research and Thesis**

**Prerequisites:** Approval of major adviser.

**Description:** Research and thesis for master's students. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Industrial Engr & Mgmt

**IEM 5003 Probability and Statistics for Engineers**

**Prerequisites:** STAT 4033 or IEM 3103.

**Description:** Probability and statistical topics and methods used in various areas of industrial engineering including random numbers, probability theory, conditional probabilities, parameter estimation, confidence intervals, hypothesis testing, and regression models.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5010 Industrial Engineering Projects**

**Prerequisites:** Consent of school head and approval of major adviser.

**Description:** Special graduate projects and independent study in industrial engineering. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Industrial Engr & Mgmt

**IEM 5013 Introduction to Optimization**

**Prerequisites:** IEM 4013 or equivalent.

**Description:** Introduction to mathematical optimization with an emphasis on linear, integer, network, and convex optimization. Effective formulation techniques, basic mathematical and algorithmic concepts, and software solution of large-scale problems arising in the practice of operations research, industrial and systems engineering, management sciences, and analytics.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5020 Graduate Engineering Practicum**

**Prerequisites:** Consent of School Head, approval of IEM advisor, and satisfactory completion of 12 hours of IEM 5000- or IEM 6000-level courses.

**Description:** Professionally supervised experience in real-life problem solving involving projects for which the student assumes a degree of professional responsibility. Activities approved in advance by the instructor and must reflect graduate level analysis. May consist of full or part-time engineering experience, on-campus or in industry, or both, either individually or as a responsible group member. Periodic reports, both oral and written, required as specified by the adviser. Offered for variable credit, 1-3 credit hours, maximum of 3 credit hours.

**Credit hours:** 1-3

**Contact hours:** Contact: 1-3 Other: 1-3

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Industrial Engr & Mgmt

**IEM 5030 Engineering Practice**

**Prerequisites:** Consent of School Head, approval of IEM advisor, and satisfactory completion of 12 hours of IEM 5000- or IEM 6000-level courses.

**Description:** Professionally supervised experience in a real-life problem involving authentic projects for which the student assumes a degree of professional responsibility. Activities must be approved in advance by the student's adviser. May consist of full or part-time engineering experience, on-campus or in industry, or both, either individually or as a responsible group member. Periodic reports, both oral and written, required as specified by the advisor. Offered for variable credit, 1-9 credit hours, maximum of 12 credit hours.

**Credit hours:** 1-9

**Contact hours:** Contact: 1-9 Other: 1-9

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Industrial Engr & Mgmt

**IEM 5063 Network Optimization**

**Prerequisites:** IEM 5013 or equivalent.

**Description:** Network flows and combinatorial optimization models and algorithms with an emphasis on mathematical and algorithmic fundamentals. Covers basics of graph theory, algorithmic analysis, and complexity theory. Covers Classical Algorithms for shortest paths, minimum spanning trees, max-flow and min-cut, min-cost flows; P versus NP, traveling salesman problem, local search, metaheuristics, Christofides algorithm. Previously offered as IEM 6013.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5103 Breakthrough Quality and Reliability**

**Prerequisites:** IEM 5003 of equivalent.

**Description:** Performance excellence in an enterprise, including relationships between industrial engineering and quality control. Statistical quality control concepts to measure, monitor, diagnose, and improve performance at the enterprise level, the operational level, and the project level. Perform basic reliability analysis. Quantitative and qualitative quality tools to solve problems and capture opportunities for improvement.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5113 Strategic Quality Leadership**

**Prerequisites:** STAT 4013 and IEM 5003.

**Description:** Quality-related strategies. Critical elements that differentiate high performing organizations from their competitors. Delivering value to customers. Quality leadership, strategic planning, customer value, learning organizations, knowledge management, quality systems and business results.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5123 Service Quality**

**Prerequisites:** STAT 4013 or equivalent.

**Description:** Theory and application of service quality, including characteristics of services (intangibility, heterogeneity, perishability and inseparability of production and consumption), dimensions of service quality, measurement methodologies for service quality and improvement methodologies for service quality. Certification and accreditation processes for service industries.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5133 Stochastic Processes**

**Prerequisites:** MATH 2233, MATH 3013, and IEM 5003 or STAT 5123.

**Description:** Definition of stochastic processes, probability structure, mean and covariance function, the set of sample functions. Renewal processes, counting processes, Markov chains, birth and death processes, stationary processes and their spectral analyses. Same course as STAT 5133 & MATH 5133.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5143 Reliability and Maintainability**

**Prerequisites:** STAT 4033 and IEM 5003.

**Description:** Probabilistic failure models of components and systems. Detailed study of reliability measures, and static and dynamic reliability models. Classical and Bayesian reliability testing for point and interval estimation of exponential and Weibull failures. Reliability optimization through allocation and redundancy. Fundamentals of maintainability. Previously offered as IEM 6113.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5203 Facility Location, Warehousing and Transportation**

**Prerequisites:** IEM 5003 and IEM 5013.

**Description:** Analytical models for single and multi-facility location problems. Algorithms for network location problems including the median, center, and covering problems. Storage policies such as dedicated, randomized and class-based and their relationship to the warehouse layout problem. Order picking and routing in warehouses. Warehouse material handling and storage/retrieval systems. Overview of the Vehicle Routing Problem (VRP). Clark and Wright heuristic for the single-depot VRP problem.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt



**IEM 5350 Industrial Engineering Problems****Prerequisites:** IEM 4413 or equivalent industrial experience.**Description:** A detailed investigation into one area of industrial engineering with a required written report. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Industrial Engr & Mgmt**IEM 5413 Engineering Entrepreneurship****Prerequisites:** IEM 4413 or equivalent industrial experience.**Description:** Advanced study of engineering entrepreneurship in the technical organization including: new product evaluation and selection, technology commercialization process, business plan preparation, intellectual property, patent search and discovery, new enterprise development, market analysis, and capital investment procurement strategies.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 5503 Financial and Advanced Capital Investment Analysis****Prerequisites:** IEM 3503, IEM 4013, STAT 4033 or IEM 3103 or equivalent.**Description:** An understanding of financial concepts and markets, and an advanced treatment of proper methods of capital project selection under risk and uncertainty. Decision making under capital rationing. Financial environment and valuing securities, representing cash flows, selecting investments, avoiding common pitfalls, evaluating timing consideration, depreciation and corporate taxation, replacement analysis, and incorporating risk and uncertainty.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 5603 Project Management****Prerequisites:** IEM 4413 or equivalent.**Description:** A systems approach to planning, organizing, scheduling and controlling projects. The behavioral and quantitative aspects of project management. Importance of working with personnel as well as technology. Project management software utilized.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 5613 Integrated Manufacturing Control Systems****Prerequisites:** IEM 4613.**Description:** Advanced treatment of planning and control philosophies and techniques for manufacturing and production systems. Approaches focusing on demand-driven control and achieving competitive advantage through manufacturing. Material requirements planning, capacity planning, shop floor control, master scheduling, production planning and demand management. Just-in-time and the theory of constraints.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 5633 Advanced Production and Inventory Control****Prerequisites:** IEM 5013 and IEM 5763.**Description:** Advanced concepts and quantitative techniques used in production planning and inventory control, including static and dynamic scheduling of machines and cells, deterministic and stochastic inventory control, multi-echelon supply chain management, demand forecasting, and revenue management.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 5703 Discrete System Simulation****Prerequisites:** IEM 5003.**Description:** Discrete-event systems via computer simulation models. Model building and the design and analysis of simulation experiments for complex systems. Application to a variety of problem areas. Use of simulation languages and related software tools.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt**IEM 5723 Data, Process and Object Modeling****Prerequisites:** Graduate standing or consent of instructor.**Description:** Systems development life cycle and methodology. Structured and object-oriented analysis and design techniques. Data modeling using the Entity-Relationship Diagram and IDEF1x. Data normalization techniques. Relational database implementation using SQL and MS Access. Object-oriented analysis and design using the Unified Process and the Unified Modeling Language (UML). Process modeling using the UML Activity Diagram and Petri nets.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Industrial Engr & Mgmt

**IEM 5743 Information Systems and Technology**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** For current and potential engineering and technology managers. Knowledge of information systems and technology to lead the specification, selection, implementation, and integration of information technology in manufacturing and service organizations. Management issues involved in the use of information technology in organizations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5763 Supply Chain Strategy**

**Prerequisites:** IEM 4613 or equivalents.

**Description:** Supply chain strategy including the philosophical base of business practice and the analytical base of modeling. Supply chain strategy, including key objectives and financial considerations, supply chain dynamics, supply chain performance measurement, supply chain integration, characteristics of different supply chains and supply chain performance modeling.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5783 Applied Statistical Analysis in R for Engineers**

**Prerequisites:** IEM 5003 and IEM 5013.

**Description:** The overall goal of this course is to provide an applied overview to statistical learning for real industrial engineering problems using R programming. Topics in this course cover advanced linear and non-linear methods of statistical learning such as multivariate regression, mixed-effects regression, advanced logit regression, clustering methods, generalized additive models, tree-based methods, support vector machines, and Bayesian methods. May not be used for degree credit with IEM 4783.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5803 Human Factors**

**Prerequisites:** Graduate standing and consent of instructor.

**Description:** Human factors theories and concepts and their impact on job and organization design. Evaluation and analysis of human performance in the workplace. System redesign for improved human-machine interaction.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Industrial Engr & Mgmt

**IEM 5813 Performance Measurement Systems**

**Prerequisites:** IEM 3813, IEM 4413 or equivalents.

**Description:** Strategies and methods to define, measure, and apply individual, group- and organizational-level performance metrics in a variety of service and production contexts. Implementation and effective use of metrics. Measurement's role in a management system, managerial decision styles and preferences, operational definitions of performance, processes for identifying and applying metrics, performance measurement tools and techniques, data collection, portrayal of quantitative and qualitative information, and the role of computer technology in measurement system application.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5953 Industrial Assessment and Improvement**

**Prerequisites:** Senior standing and consent of instructor.

**Description:** Plant assessment and improvement-based concepts, strategies, and tools for manufacturing operations. Emphasis is on small to medium-sized manufacturing operations. Issues include energy, water, waste, quality, and productivity analysis across the organization from a systems perspective. Justification of improvement projects and measurement of results. May not be used for degree credit with IEM 4953 or MET 4953.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 5990 Special Topics in Industrial Engineering and Management**

**Prerequisites:** Consent of instructor.

**Description:** Study of selected contemporary topics in industrial engineering and management including operations research; quality and reliability; manufacturing systems; engineering management; enterprise systems and supply chains; facilities, energy, and environmental management. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Industrial Engr & Mgmt

**IEM 6000 Doctoral Research and Dissertation**

**Prerequisites:** Approval of major adviser and advisory committee.

**Description:** Independent research for PhD dissertation requirement under direction of a member of the Graduate Faculty. Offered for variable credit, 1-15 credit hours, maximum of 30 credit hours.

**Credit hours:** 1-15

**Contact hours:** Contact: 1-15 Other: 1-15

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Industrial Engr & Mgmt

**IEM 6033 Linear Optimization**

**Prerequisites:** Concurrent Prerequisite IEM 5013 or consent of instructor.

**Description:** Mathematical theory of linear optimization and the implications for algorithm development. Fundamentals of convex analysis, polyhedral sets, development of the simplex method, Farkas' lemma, development of duality theory, sensitivity analysis, Dantzig-Wolfe decomposition, Benders decomposition, interior point algorithms. Previously offered as IEM 5033.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 6043 Nonlinear Optimization**

**Prerequisites:** IEM 6033 or consent of instructor.

**Description:** Mathematical foundations of nonlinear optimization theory and algorithms. Introduction to convex analysis, local/global optima, optimality conditions, and their implications for model and algorithm development. Convex functions and generalizations, Fritz John and Karush-Kuhn-Tucker optimality conditions, constraint qualifications, Lagrangian duality and saddle point optimality conditions, gradient-based and quasi-Newton methods for unconstrained optimization. Previously offered as IEM 5043.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 6053 Integer and Combinatorial Optimization**

**Prerequisites:** Concurrent prerequisites. IEM 5063, IEM 6033, or consent of instructor.

**Description:** Theory, algorithms, and applications of discrete optimization. Binary, pure, and mixed-integer linear optimization formulations, relaxations; preprocessing, branch and bound, formulation strength, polynomial equivalence of separation and optimization; theory of polyhedra, convex hulls and facets, valid inequalities for pure and mixed-integer problems, lifting, perfect formulations, extended formulations. Previously offered as IEM 6023.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 6063 Optimization Under Uncertainty**

**Prerequisites:** IEM 5013, IEM 6033, IEM 5003 or consent of instructor.

**Description:** Introduction to concepts, principles, and techniques for optimization under uncertainty. Formulating two-stage stochastic linear and integer programs; sample average approximation and decomposition methods; conditional value-at-risk and chance-constrained optimization; robust linear optimization, robust conic optimization, and robust multi-stage optimization; distributionally robust and data-driven optimization.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 6110 Special Problems in Industrial Engineering**

**Prerequisites:** Consent of school head and approval of major adviser.

**Description:** Special problems in industrial engineering and management under supervision of a member of the Graduate Faculty. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Industrial Engr & Mgmt

**IEM 6123 Queuing Systems: Theory and Manufacturing Applications**

**Prerequisites:** IEM 5003, STAT 5133 or consent of instructor.

**Description:** Review of probability, stochastic processes, and Markov chains. Single-server and multi-server exponential queuing models. Queuing models with Poisson arrivals and general service times. Product form queuing network models: open and closed network models, mean value analysis algorithms for closed models, and single class and multiclass models. Approximations for general single server queues and non-product form networks. Applications of queuing models in the performance analysis of transfer lines, automatic assembly systems, and flexible manufacturing systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Industrial Engr & Mgmt

**IEM 6903 IEM Doctoral Seminar**

**Description:** The IE&M Doctoral Seminar is designed to train the doctoral student in the doctoral dissertation research process and is normally taken in the first year of the student's program. The course involves significant work outside the classroom, under the supervision of the student's research advisor. The class meetings will be used for some formal instruction on research methods/process, discussion of current research in IEM lead by select faculty, guest speakers, and presentations by students.

**Credit hours:** 3

**Contact hours:** Lecture: 1 Contact: 3 Other: 2

**Levels:** Graduate

**Schedule types:** Independent Study, Lecture, Combined lecture & IS

**Department/School:** Industrial Engr & Mgmt

**IEM 6990 Advanced Topics in Industrial Engineering and Management**

**Prerequisites:** Consent of instructor.

**Description:** Advanced and emerging topics of interest to PhD-level students in Industrial Engineering and Management are discussed. Offered for variable credit, 1-6 credit hours, maximum of 18 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Industrial Engr & Mgmt

## Undergraduate Programs

- Industrial Engineering and Management, BSIE (p. 2263)

## Graduate Programs

The School of Industrial Engineering and Management offers graduate programs leading to the Master of Science Industrial Engineering and Management degree and the Doctor of Philosophy degree.

The Master of Science degree is characterized by a higher degree of technical specialization in a particular field of study (beyond a BS degree). This degree program is designed to prepare students for professional practice that may include research or consulting components. The Master of Science degree is especially attractive to industrial engineering graduates, engineering graduates from other disciplines, and many science majors. The MS degree includes a strong technical component and an orientation to business and engineering management that is complementary to a technical background.

The Doctor of Philosophy degree is designed to position the student on the leading edge of knowledge in the profession of industrial engineering and engineering management. It is intended to prepare students for highly specialized positions, such as research and consulting in industry, government and service organizations, and for teaching or research positions in colleges and universities.

The basic consideration in graduate education in industrial engineering and management is effective and efficient utilization of human, physical and economic resources. Instruction in management embraces both qualitative and quantitative concepts, including analytical methodologies and social considerations pertinent to organizations.

Advanced degree programs are designed with major emphasis in fields of interest such as engineering management, manufacturing systems, operations research, quality and reliability, facilities and energy-management, and enterprise systems and supply chains. Students may complement industrial engineering and management courses with work in other branches of engineering, as well as economics, business administration, computer science, statistics, mathematics, psychology, and sociology.

## Admission Requirements

Admission to the Graduate College is required of all students pursuing the MS or PhD degree. Graduation from an industrial engineering curriculum with scholastic performance distinctly above average qualifies the student for admission to the School of Industrial Engineering and Management as a candidate for the master's and doctorate degrees. Graduates from related disciplines may be admitted if an evaluation of their transcripts and other supporting materials by the School of Industrial Engineering and Management indicates that they are prepared to take graduate-level course work in industrial engineering, or can be expected to do so after a reasonable amount of prerequisite work.

All applicants must submit GRE scores. In addition, the Graduate College may require certain international applicants to submit TOEFL scores.

## Degree Requirements

The Master of Science degree in industrial engineering and management may be earned by one of two plans as follows:

Plan I—coursework with thesis. Minimum 30 credit hours consisting of 24 hours of coursework and 6 hours of research with a grade of "SR."

Plan II—coursework without thesis. Minimum of 33 credit hours. May include no more than three hours of independent study project.

The Doctor of Philosophy degree requires the completion of at least 90 credit hours beyond the bachelor's degree or 60 credit hours beyond the master's degree; including a minimum of 18 credit hours of dissertation research and a minimum of 30 credit hours of course work beyond the master's degree.

The School of Industrial Engineering and Management also participates in the Master of Science in Engineering and Technology Management program. Current IE&M program information can be found on the School website <http://iem.okstate.edu>.

## Minors

- Data Analytics for Engineers (DAEN), Minor (p. 2262)

## Faculty

Sunderesh S. Heragu, PhD—Regents Professor and Head, Donald and Cathey Humphreys Chair

**Professor and Wilson Bentley Chair:** Balabhaskar Balasundaram, PhD  
**Professor:** Manjunath Kamath, PhD

**Associate Professors:** Terry Collins, PhD, PE; Tieming Liu, PhD

**Assistant Professors:** Austin Buchanan, PhD, Juan Borrero, PhD; Katie Jurewicz, PhD; Chenang Liu, PhD; Joseph Nuamah, PhD; Bing Yao, PhD; Farzad Yousefian, PhD

**Lecturers:** Jennifer Glenn, PhD

## Data Analytics for Engineers (DAEN), Minor

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Total Hours:** 15

**Minimum Overall Grade Point Average:** 2.50 with a grade of "C" or better in each course submitted for the minor.

Code	Title	Hours
Select at least one course from each list:		15
<b>Data Visualization</b>		
EET 3363	Data Acquisition	
ENGR 2421	Engineering Data Acquisition Controls Lab	
<b>Descriptive Analytics</b>		
IEM 3103	Probability and Statistics for Engineers I	
IEM 4723	Information Systems Design and Development	
ECEN 4233	High Speed Computer Arithmetic	
STAT 4033	Engineering Statistics	
STAT 4023	Statistical Methods II	
STAT 4091	Sas Programming	
<b>Data Analysis Tools</b>		
CHE 4753	Introduction to Applied Numerical Computing for Scientists and Engineers	
CS 3513	Numerical Methods for Digital Computers	
IEM 3713	Software Programming for Data Analytics	
IEM 4783	Applied Statistical Analysis in R for Engineers	
MATH 4513	Numerical Analysis	
MATH 4553	Introduction to Optimization	
MATH 5553	Numerical Analysis for Linear Algebra	
MAE 3403	Computer Methods in Analysis and Design	
STAT 4191	R Programming	
STAT 4463	Statistical Machine Learning with R	
<b>Prescriptive Analytics</b>		
IEM 4013	Operations Research	
IEM 4113	Industrial Experimentation	
CHE 4002	Chemical Engineering Laboratory I	
CHE 4112	Chemical Engineering Laboratory II	
STAT 4073	Engineering Statistics with Design of Experiments	
<b>Predictive Analytics</b>		
IEM 4103	Quality Control and Reliability Analysis	
IEM 4713	Systems Simulation Modeling	
IEM 4783	Applied Statistical Analysis in R for Engineers	
STAT 4043	Applied Regression Analysis	
CHE 4493	Introduction to Molecular Modeling and Simulation	

## Additional OSU Requirements Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).

# Industrial Engineering and Management, BSIE

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 123**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
ENGL 1113	Composition I <sup>1</sup>	3
or ENGL 1313	Critical Analysis and Writing I	
ENGL 3323	Technical Writing	3
<i>American History &amp; Government</i>		
POLS 1113	American Government	3
Select one of the following: 3		
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
MATH 2163	Calculus III	3
or MATH 2233	Differential Equations	
<i>Humanities (H)</i>		
Courses designated (H) 6		
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN)	4
or CHEM 1515	Chemistry II (LN)	
PHYS 2014	University Physics I (LN)	4
PHYS 2114	University Physics II (LN)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
SPCH 2713	Introduction to Speech Communication (S)	3
<b>Hours Subtotal</b>		<b>43</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College Requirements</b>		
<i>Basic Science</i>		
<i>Engineering</i>		
ENGR 1111	Introduction to Engineering	1
ENGR 1322	Engineering Design with CAD	2
or ENGR 1332	Engineering Design with CAD for MAE	
ENGR 1412	Introductory Engineering Computer Programming	2
<i>Engineering Science</i>		

ENSC 2113	Statics	3
Select two of the following:		6
ENSC 2123	Elementary Dynamics	
ENSC 2143	Strength of Materials	
ENSC 2213	Thermodynamics	
ENSC 2613	Introduction to Electrical Science	
ENSC 3233	Fluid Mechanics	
<b>Hours Subtotal</b>		<b>14</b>
<b>Major Requirements</b>		
<i>Mathematics</i>		
MATH 3013	Linear Algebra (A)	3
<i>Engineering Science</i>		
ENSC 3313	Materials Science	3
<i>Industrial Engineering &amp; Management</i>		
IEM 2903	Introduction to Industrial Engineering	3
IEM 3103	Probability and Statistics for Engineers I	3
IEM 3303	Manufacturing Processes	3
IEM 3403	Engineering Project Management	3
IEM 3503	Engineering Economic Analysis	3
IEM 3523	Engineering Cost Information and Control Systems	3
IEM 3703	Probability and Statistics for Engineers II	3
IEM 3713	Software Programming for Data Analytics	3
IEM 3813	Work Design, Ergonomics, and Human Performance	3
IEM 4013	Operations Research	3
IEM 4103	Quality Control and Reliability Analysis	3
IEM 4113	Industrial Experimentation	3
IEM 4203	Facilities and Material Handling System Design	3
IEM 4613	Production Planning and Control Systems	3
IEM 4623	Supply Chain and Logistics	3
IEM 4713	Systems Simulation Modeling	3
IEM 4723	Information Systems Design and Development	3
IEM 4913	Senior Design Projects	3
Select 6 hours of the following:		6
IEM 4163	Service Systems and Processes	
IEM 4783	Applied Statistical Analysis in R for Engineers	
IEM 4953	Industrial Assessment and Improvement	
IEM 4990	Selected Topics in Industrial Engineering and Management (3)	
Any 3000/4000 level CEAT course	Requires advisor approval	
<b>Hours Subtotal</b>		<b>66</b>
<b>Total Hours</b>		<b>123</b>

<sup>1</sup> If a "B" or higher is not earned in ENGL 1113 Composition I or ENGL 1313 Critical Analysis and Writing I, then ENGL 1213 Composition II or ENGL 1413 Critical Analysis and Writing II is also required (per Academic Regulation 3.5 (p. 920)).

## Other Graduation Requirements

a. A minimum Technical GPA of 2.00. The Technical GPA is calculated from all courses counting in the curriculum with an IEM prefix, or substitutions for these courses.

b. A grade of 'C' or better is required in each course that is a prerequisite to another required course and also in MATH 2163/MATH 2233 and PHYS 2114.

These courses include:

Code	Title	Hours
CHEM 1414 or CHEM 1515	General Chemistry for Engineers (LN) Chemistry II (LN)	4-5
ENGR 1111	Introduction to Engineering	1
ENGR 1322 or ENGR 1332	Engineering Design with CAD Engineering Design with CAD for MAE	2
ENGR 1412	Introductory Engineering Computer Programming	2
ENSC 2113	Statics	3
ENSC 3313	Materials Science	3
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
MATH 2163 or MATH 2233	Calculus III Differential Equations	3
MATH 3013	Linear Algebra (A)	3
PHYS 2014	University Physics I (LN)	4
PHYS 2114	University Physics II (LN)	4
IEM 2903	Introduction to Industrial Engineering	3
IEM 3103	Probability and Statistics for Engineers I	3
IEM 3403	Engineering Project Management	3
IEM 3503	Engineering Economic Analysis	3
IEM 3703	Probability and Statistics for Engineers II	3
IEM 4013	Operations Research	3

c. The major engineering design experience is satisfied by IEM 4913 Senior Design Projects.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Materials Science and Engineering

The field of materials science and engineering is expanding into a period of unprecedented intellectual challenges, opportunities and growth. Products created using materials science and engineering research contribute to the economic strength and security of not only the state, but also the country.

The School of Materials Science and Engineering (MSE) is located at OSU-Tulsa Greenwood campus at the Helmerich Research Center, a premier facility which places the College of Engineering, Architecture and Technology in a unique position to conduct world-class education, research and technology development and transfer in advanced materials of strategic importance to our nation. Current research programs focus on materials for energy technologies, bio-materials for medical technologies, advanced materials for aerospace and defense, and materials for electronics and control technologies.

### Program Educational Objectives

OSU is currently offering only a graduate program in Materials Science and Engineering.

### Courses

#### MSE 5000 Master's Thesis

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Students will be performing thesis research under the guidance of a thesis advisor. This will involve performing literature search, writing proposal for the research and conducting research in the laboratories. At the end of the course students will present the findings of research to the committee and prepare a thesis for approval by the thesis committee. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Materials Sci. & Eng

#### MSE 5010 Materials Science and Engineering Seminar for Masters Students

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Advanced Research and Development Topics. Maximum 3 credit hours. Graded on pass/fail basis. Offered for variable credit, 1-3 credit hours, maximum of 3 credit hours.

**Credit hours:** 0

**Contact hours:** Contact: 0 Other: 0

**Levels:** Graduate

**Schedule types:** Discussion

**Department/School:** Materials Sci. & Eng

#### MSE 5013 Advanced Thermodynamics of Materials

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Thermodynamics of materials is important for materials synthesis, stability and performance. The course will cover basic laws of thermodynamics, solution theory, phase equilibrium diagrams and thermodynamics of electrochemical systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

#### MSE 5022 Masters of Engineering Capstone Project

**Description:** Students will conduct independent literature review or research as guided by the graduate advisory committee. The capstone project will be completed in conjunction with an approved graduate course in Materials Science and Engineering. At the end of the course students will prepare a final report for approval by the graduate program committee.

**Credit hours:** 2

**Contact hours:** Contact: 2 Other: 2

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Materials Sci. & Eng

#### MSE 5023 Diffusion and Kinetics

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Diffusion and kinetics are important for materials processing, stability, microstructure evolution and performance. The course will cover basic concepts underlying diffusion and kinetics as they relate to materials behavior. Topics on diffusion, nucleation and growth, spinodal decomposition, reactions involving solid with solids, gases and liquids, and phase transformation will be covered.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

#### MSE 5030 Independent Study in Materials Science and Engineering

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** This course can be used by individual faculty in specific areas related to a student's graduate study.

**Credit hours:** 1-3

**Contact hours:** Lecture: 1-3 Contact: 1-3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

#### MSE 5033 Composite Materials

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Composites are important for advancing performance and reliability of existing and new products for aerospace, electronics, and medical systems. This course is to introduce fundamental concepts for the design, fabrication and mechanical property evaluation of composites. This includes methods of fabricating fibers, matrices and composites, toughening mechanisms in composites, mechanical properties, and role of interfaces. The focus will be for composites useful at high temperatures.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng



**MSE 5043 Advanced Materials Characterization**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Advances in materials require availability, training, and proficiency in advanced instrumentation to characterize materials at length scales from macro- to nanometer-scale. This course is to introduce fundamental concepts forming the basis of different equipments, their operation and capability for developing advanced materials. This includes instruments such as SES, TEM, x-ray diffraction, FTIR, AFM, and Nanoindentation. The lectures will be complemented with hands-on experience to students in labs housing these equipments.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5053 Smart Materials**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Advances in new technologies rely on the availability of "smart" materials that adapt to environment. Examples include sun-sensor glasses that become dark in sunlight and clear-out when indoors, and shape-memory materials used as stents in human body. In this course, the definition of a smart material and to understand principles of using electrical and other functional properties of materials to create smart systems is covered. Students are also taught to search literature on a suitable topic and work as a group to write a term paper and make a presentation to the class.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5063 Biomedical Materials**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** The course will discuss about structure, composition, properties, and performance of materials with applications in medical and health science.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5073 Tissue Engineering**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Tissue engineering (TE) and the material strategy for different tissue constructs in bone TE, liver TE, neural TE, intestine TE, etc. will be discussed in this course. Same course as CHE 5073.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5083 Advanced Ceramics Processing**

**Prerequisites:** ENSC 2213 and ENSC 3233 and MATH 2153 or permission of instructor.

**Description:** An introduction to processing techniques to transform ceramics from raw materials to finished products. This includes powder synthesis and beneficiation, colloidal processing, forming techniques, sintering and finishing operations and an introduction to chemical processing routes.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5093 Fundamentals of Materials Science**

**Prerequisites:** Instructor approval.

**Description:** MSE 5093 is a first-year graduate course that covers basic concepts in materials science. The course is designed for both materials science and engineering graduates and graduates with other engineering or science backgrounds (physics, chemistry, mechanical engineering, chemical engineering, electrical engineering, etc.).

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5103 Electrical and Optical Properties of Ceramics**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Inorganic ceramic materials are useful in many applications because of their electrical, optical, dielectric, and magnetic properties. These are important for advancing performance and reliability of existing and new products for aerospace, electronics and medical systems. This course is to introduce fundamental concepts for the understanding of principles of electrical and optical behaviors of ceramic materials including atomic structure, conduction mechanisms, processing and electrical-optical properties.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5113 Diffraction in Materials**

**Prerequisites:** Graduate standing and consent of instructor.

**Description:** Introduction to crystallography and diffraction with an emphasis on X-ray diffraction, some exposure to Neutron diffraction, radiography, and tomography. Applications will focus on mechanical properties measurements. New methods will be surveyed with an emphasis on current research. Same course as MAE 5113.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5123 Advanced Composites Manufacturing: Materials, Methods and Applications**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Covers important topics such as basic concepts and definitions of composite materials, fabrication, structure, properties, and applications of fibrous materials, structure and properties of polymer matrix, metal matrix and ceramic matrix materials, constituent materials, fabrication and repair methods, properties and applications of polymer matrix composites, metal matrix composites, ceramic matrix composites and carbon/carbon composites and markets.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5133 Solid Oxide Fuel Cells**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** The objective of this course is to introduce fundamental concepts for energy production using solid oxide fuel cells. The course will include fundamentals of solid oxide fuel cells. Efficiency based on thermodynamics will be described. In addition, roles of important materials as electrolyte for oxygen transport, anode and cathodes as electronic conductors, and high temperature seals required for solid oxide fuel cells will be covered. The role of fuel cells in the current and future energy systems will also be described.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5143 Batteries and Supercapacitors for Energy Storage**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** The objective of this course is to introduce fundamental concepts for energy storage using batteries and supercapacitors. The course will include fundamentals of electrochemical systems/batteries and supercapacitors. Efficiency of storage based on thermodynamics will be described. In addition, role of important materials required in selected battery systems and capacitors will be included. The role of batteries and supercapacitors in the current and future energy storage devices will be described.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5153 Crystal Physics and Materials Properties**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** This course is about crystal physics and crystal chemistry, and their applications to engineering problems. It is designed as an introduction to the relationships between symmetry and the directional physical properties of crystals. Emphasis will be on the fundamental understanding of symmetry arguments as criteria in the material selection process for technological applications.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5173 Organic Electronic Materials and Devices**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** This course will serve as an introduction to organic materials with applications to active electronic and optoelectronic devices.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5174 Fundamentals of Photovoltaics**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** This course will serve as an introduction to photovoltaic materials and devices. This course will cover commercial and emerging photovoltaic technologies.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5193 Advanced Materials Processing**

**Prerequisites:** Instructor Approval.

**Description:** MSE 5193 is a first-year graduate course that covers basic concepts in materials processing. The course is designed for both materials engineering graduates and graduates with other engineering or science backgrounds (physics, chemistry, mechanical engineering, chemical engineering, industrial engineering, civil engineering, electrical engineering, etc.).

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5200 Applied Innovation I**

**Prerequisites:** Graduate standing or consent of graduate program coordinator.

**Description:** Theory and practice of commercialization of new technologies, business plan development and formation of project teams to commercialize technologies and new products. Same course as EEE 5200.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5223 Additive Manufacturing: Materials, Methods and Applications**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Theory and practice of additive manufacturing, materials and their applications in various fields. Discuss their applications in product development, data visualization, rapid prototyping, and specialized manufacturing, with special emphasis on direct digital manufacturing.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5273 Recycling and Sustainability for a Circular Economy**

**Description:** An experiential graduate level course about sustainable materials development for recycling materials such as composites, carpet, construction and demolition waste, tires, E-waste, precious platinum group metals from catalytic converters, and polymers such as PET, LDPE, HDPE, and PP. This fits with OSU's efforts in recycling carpet and PET based materials. The students will understand how to conduct LCA and cradle to cradle assessment of the products being recycled.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5553 Fatigue and Fracture**

**Prerequisites:** MAE 4333 or consent of instructor.

**Description:** The course provides an introduction to the mechanics of fracture of brittle and ductile materials and covers the basics of both linear-elastic fracture mechanics (LEFM) and elastic-plastic fracture mechanics (EPFM). Crack initiation and propagation is studied under quasi-static, dynamic, and cyclic loading conditions. Models are presented for time dependent fracture including creep and fatigue crack growth. Methods to experimentally determine fracture properties, based on relevant ASTM standards, are introduced. Same course as MAE 5553.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5583 Corrosion Engineering**

**Prerequisites:** ENSC 3313 or equivalent.

**Description:** Modern theory of corrosion and its applications in preventing or controlling corrosion damage economically and safely in service. Same course as MAE 5583.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5683 Thermodynamics and Thermostatistics of Materials**

**Prerequisites:** ENSC 3313 or equivalent.

**Description:** Notions of energy, entropy, equilibrium, macrostates, and microstates and their relation to material processes and properties. Deriving material properties from equations of state: Maxwell relations. Statistical thermodynamics: predicting material properties from microstates. Partition function. Phase transformations. Thermodynamics of surfaces and defects. Electrochemistry. Same course as MAE 5683.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 5693 Phase Transformations in Materials**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Principles of phase transformations in material. Structure of materials, phase diagrams, diffusion, solidification, and diffusional and diffusionless transformations will be covered. Recent developments in materials research relevant to phase transformations. Same course as MAE 5693.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Materials Sci. & Eng

**MSE 6000 Doctoral Dissertation**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Students will be performing dissertation research under the guidance of the student's doctoral dissertation advisor. This will involve performing literature search, writing proposal for the research, and conducting research in the laboratories. At the end of the course, students will present the findings of the research to the committee and prepare a dissertation for approval by the dissertation committee. Offered for variable credit, 1-9 credit hours, maximum of 60 credit hours.

**Credit hours:** 1-9

**Contact hours:** Contact: 1-9 Other: 1-9

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Materials Sci. & Eng

**MSE 6010 Materials Science and Engineering Seminar for PhD Students**

**Prerequisites:** Graduate standing and consent of graduate program coordinator.

**Description:** Graduate students need to learn about the advances in materials and their processing, training and proficiency at length scales from macro to nanometer. This seminar course will allow students to interact with the experts and other students in the field and introduce descriptions of projects, as well as the concepts of structure-property co-relationships of advanced materials. This will allow the students to become better researchers and form the basis of future ideas and concepts. Guest speakers from different areas, industry and other universities will be invited from time to time. Graduate students will be allowed an opportunity to present their work and obtain feedback from other students for improving their research projects. Maximum of three credit hours. Graded on pass/fail basis.

**Credit hours:** 0

**Contact hours:** Contact: 0 Other: 0

**Levels:** Graduate

**Schedule types:** Discussion

**Department/School:** Materials Sci. & Eng

## Graduate Programs

The School of Materials Science and Engineering offers programs leading to the Master of Science and Doctor of Philosophy. A program of independent study and research on a project under the direction of a member of the Graduate Faculty will be satisfactorily completed by all graduate students. For the Master of Science candidate, the project may result in a thesis. For the Doctor of Philosophy candidate, the project results in a dissertation.

Four research areas of strategic importance have been identified at the Helmerich Advanced Technology Research Center (HRC) at OSU by industry leaders in and around Tulsa. These include: Materials for Energy Technologies, Bio-Materials for Medical Technologies, Advanced Materials for Aerospace, and Materials for Electronics and Control

Technologies. All areas fall under the broad umbrella of the School of Materials Science and Engineering.

## Admission Requirements

Admission to either the Master of Science or Doctor of Philosophy degree program requires graduation from a materials science and engineering or related curriculum approved by the ABET or a recognized equivalent from any international program.

Students with related undergraduate degrees, such as chemistry, physics, engineering physics, applied physics, etc., can be admitted conditionally, subject to completing prescribed Materials Science and Engineering program core courses. Admission is competitive based on undergraduate GPA, GRE and TOEFL (for international students), statement of interests, experience and recommendations.

## The Master of Science Degree

The M.S. degree in MSE has both thesis and creative component (non-thesis) options. The thesis option requires a total of 30 credit hours, which includes 24 hours of formal coursework (regularly scheduled classes, not independent study) and 6 hours of a thesis. The non-thesis option or creative component requires a total of 35 credit hours, which includes 33 hours of formal coursework (regularly scheduled classes, not independent study) and 2 hours of a creative component or project. The main difference between the two options is that in the thesis option, students conduct independent research while in the creative component option, students conduct critical review of the literature on an advanced topic of interest to the MSE program. Both options require a professional report or thesis and an oral presentation. Students take 15 hours of core courses (required) with the remainder of the hours being MSE elective courses or their equivalent (to be approved by MSE graduate coordinator and the thesis advisor or has been considered as an equivalent MSE course). Students must complete no less than 21 hours of MSE 5000- and 6000-level courses through Oklahoma State University. For both options the courses taken must include:

Code	Title	Hours
MSE 5013	Advanced Thermodynamics of Materials	3
MSE 5023	Diffusion and Kinetics	3
MSE 5043	Advanced Materials Characterization	3
MSE 5093	Fundamentals of Materials Science	3
MSE 5193	Advanced Materials Processing	3
MSE 5010	Materials Science and Engineering Seminar for Masters Students	0

## The Doctor of Philosophy Degree

The general credit requirement is a minimum of 90 credit hours beyond the BS degree, including at least 36 hours of credit for research and at least 30 hours of class work. It is expected that the courses must include:

Code	Title	Hours
MSE 5013	Advanced Thermodynamics of Materials	3
MSE 5023	Diffusion and Kinetics	3
MSE 5043	Advanced Materials Characterization	3
MSE 6010	Materials Science and Engineering Seminar for PhD Students	0

Students are responsible for consultation with their doctoral advisory committee in preparing the plan of study. Furthermore, students have to

pass the PhD qualifying exam and the dissertation proposal defense to become eligible for candidacy for the PhD Degree, successfully conduct independent research for the dissertation, and pass the final dissertation defense in order to qualify for the PhD degree. More details can be found in the MSE Graduate Student Handbook.

## Faculty

Raman P. Singh, PhD—Associate Dean for Engineering at OSU-Tulsa and Director, Helmerich Research Center, Helmerich Family Endowed Chair Professor and Head

**Regents Professor:** Raj N. Singh, Sc.D.

**Varnadow Endowed Professor:** Ranji Vaidyanathan, PhD, PE

**Professor:** James Smay, PhD

**Associate Professor:** Pankaj Sarin, PhD

**Assistant Professor:** Do Young Kim, PhD

**Lecturer:** Srinivas Kolla, PhD

## Mechanical and Aerospace Engineering

No other professions unleash the spirit of innovation like Mechanical Engineering and Aerospace Engineering. From research to real-world applications, mechanical and aerospace engineers discover how to improve lives by creating bold new solutions that connect science to life in unexpected, forward-thinking ways. Few have such a direct and positive effect on everyday lives, and we count on mechanical and aerospace engineers, and their imaginations, to help us meet the needs of the 21st century.

Mechanical and aerospace engineers know that life takes engineering, and that their disciplines provide freedom to explore, shape the future, encompass an enterprising spirit, and call for limitless imagination.

Engineering makes a world of difference and is essential to our health, happiness and safety. Creative problem solving, while turning dreams into reality, is the core of Mechanical and Aerospace Engineering. These professional disciplines involve the invention, design and manufacture of devices, machines and systems that serve the ever-changing needs of modern society.

Mechanical engineering is an exceedingly diverse field that spans an exceptionally wide range of systems, devices and vehicles. Mechanical engineers are vitally concerned with all forms of energy production, utilization and conservation. They are the key professionals in bringing about the green revolution, finding ways to reduce or eliminate pollution, minimize waste, reduce energy usage, and re-use waste, scrap and recycled goods. They deal with everything mechanical and energy-consuming, whether small or large, simple or complex—from fuel cells to nuclear power plants, gas turbine engines to interplanetary space vehicles, artificial limbs to life support systems, robotic manipulators to complex automatic packaging machines, precision instruments to construction machinery, household appliances to mass transit systems, heating and air-conditioning systems to off-shore drilling platforms, and powered home and garden appliances to vehicles of all types. In virtually every organization where engineers are employed, mechanical engineers will be found.

The BS degree program in mechanical engineering is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org> (<http://www.abet.org/>), under the criteria for mechanical and similarly named engineering programs. Premedical, petroleum, and fire protection options are offered for the BS degree in mechanical engineering.

Aerospace engineering is concerned with the science and technology of flight, and the design of air, land and sea vehicles for transportation and exploration. This exciting field has led people to the moon and continues to lead in the expansion of frontiers deeper into space and into the ocean's depths. Because of their unique backgrounds in aerodynamics and lightweight structures, aerospace engineers are becoming increasingly involved in solving some of society's most pressing and complex problems, such as high-speed ground transportation and pollution of the environment.

The BS degree program in aerospace engineering is accredited by the Engineering Accreditation Commission of the ABET, <http://www.abet.org> (<http://www.abet.org/>), under the criteria for aerospace and similarly named engineering programs.

## MAE Mission

The mission of the School of Mechanical and Aerospace Engineering is to create a vibrant and stimulating learning and research environment and to instruct and encourage our students to reach their full potential in technical expertise, innovative expression, intellectual curiosity, and collaborative design.

## MAE Mission for Undergraduate Instruction

The School of Mechanical and Aerospace Engineering will support the MAE and CEAT missions and the mission for instruction of Oklahoma State University by providing a first-class education to students that is grounded in engineering fundamentals. The Faculty of MAE are committed to preparing engineers who are:

- Competitive nationwide and internationally for employment opportunities and who will become respected achievers within their discipline.
- Well-prepared for the pursuit of advanced studies at any university.
- Prepared for a lifetime of continuing development, which is demanded by disciplines involved with rapidly progressing technology.

## Rigor

The mechanical and aerospace engineering programs are among the most rigorous in the college, requiring broad knowledge and application of mathematics and the engineering sciences in addition to specialized knowledge and application of mechanical and aerospace engineering theory and design. The programs culminate in an intensive one-semester capstone design and rapid prototyping experience.

## Program Educational Objectives

Program educational objectives are statements that describe the expected accomplishments and professional status of mechanical and aerospace engineering graduates three to five years beyond the baccalaureate degree. The School of Mechanical and Aerospace Engineering at Oklahoma State University is dedicated to graduating mechanical and aerospace engineers who:

1. Our graduates will be recognized leaders with exemplary careers to the greater benefit of society.
2. Our graduates will strive to acquire new skills and knowledge throughout their careers and will earn a reputation as responsible and ethical professionals.
3. Our graduates will be collaborative innovators who adapt to changing professional and societal norms with wisdom and integrity.

## Student Outcomes

The student outcomes for students graduating from the mechanical and aerospace engineering BS programs are:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors.

3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Because mechanical engineering is perhaps the broadest of all engineering disciplines, the program provides not only excellent grounding in all engineering fundamentals, but also allows some flexibility in selecting controlled technical electives to suit the student's interests. In this selection, no one area may be unduly emphasized at the expense of another. For the aerospace engineering, petroleum, fire protection and premedical programs, prescribed coursework provides students with more focused development. Graduates are fully competent as mechanical or aerospace engineers, with abilities in design, and in-depth knowledge in their areas of concentration.

As a fundamental component of all BS programs, engineering design is strongly emphasized in the junior and senior years but is integrated throughout the curriculum. Most MAE courses at the 3000- and 4000-levels include some design content, ranging from a minimum of one-half to a maximum of four credit hours of design content. Each junior and senior level course builds upon the preceding mechanical and aerospace engineering courses to develop in the student the ability to identify and solve meaningful engineering problems. The coursework is specifically sequenced and interrelated to provide design experience at each level, leading to progressively more complex, open-ended problems. The coursework is specifically sequenced and interrelated to provide design experience at each level, leading to progressively more complex, open-ended problems. The coursework includes sensitizing students to socially-related technical problems and their responsibilities as engineering professionals to behave ethically and protect occupational and public safety. The program culminates in a senior-year design course in which students integrate analysis, synthesis and other abilities they have developed throughout the earlier portions of their study into a capstone experience. The design experiences include the fundamental elements and features of design with realistic constraints such as economics, safety, reliability, social and environmental impact, and other factors. At this point, students are able to design components, systems and processes that meet specific requirements, including such pertinent societal considerations as ethics, safety, environmental impact and aesthetics. Students develop and display the ability to design and conduct experiments essential to specific studies and to analyze experimental results to draw meaningful conclusions.

An integral part of this educational continuum, from basic science through comprehensive engineering design, are learning experiences that facilitate the students' abilities to function effectively in both individual and team environments. The program also provides every graduate with adequate learning experiences to develop effective written and oral communication skills. State-of-the-art computational tools are introduced and used as a part of their problem-solving experiences. Finally, the students' experience in solving ever-more-challenging problems gives

them the ability to continue to learn independently throughout their professional careers.

The broad background and problem-solving ability of mechanical and aerospace engineers make them suited to engage in one or more of the following activities: research, development, design, production, operation, management, technical sales and private consulting. Versatility is their trademark. A bachelor's degree in mechanical or aerospace engineering is also an excellent background for entering other professional schools such as medicine, dentistry, law or business (MBA). The premedical option in mechanical engineering is available for students wishing to enroll in medical school.

In the junior and senior years of the program, mechanical and aerospace engineering students extend their study of the engineering sciences and consider applications of fundamental principles and analysis tools to the solution of real technological problems of society. Some design courses involve students in the solution of authentic, current and significant engineering problems provided by industrial firms. Students may also help smaller firms that need assistance with the development of new products.

The student designs, with the guidance of an advisor, an individualized program of study consistent with his or her interests and career plans. Some students terminate their studies with a bachelor's degree, while others receive one of several graduate degrees.

## Courses

### MAE 3013 Engineering Analysis and Methods I

**Prerequisites:** A grade of "C" or higher in PHYS 2014 and MATH 2233.

**Description:** Setup and solution of equations which govern mechanical engineering systems. Application and solution of the governing equations to describe the steady state or transient behavior of dynamics, mechanics and circuit problems. Linear sets of equations, ODEs will be used to describe systems. Solutions may be simplified using complex numbers of Fourier/Laplace transforms. Numerical methods for solutions will be covered. Data analysis, quality control and statistical hypothesis testing will be covered.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Contact: 3 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Mech & Aerospace Engr

### MAE 3033 Design of Machines and Mechanisms

**Prerequisites:** Grades of "C" or higher in ENGR 1332 and MAE 3013 and MAE 3324.

**Description:** Study of the position, velocity, acceleration, and static and dynamic force behavior of machines and mechanisms. Analysis and synthesis of linkages and gear trains. Characteristics and selection of power sources, including electric motors, hydraulics, pneumatics and internal combustion engines. Lab: Machine tool safety. Use of common machine tools to build machine components. Use of lecture concepts in designing, building, and testing machines and mechanisms.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Mech & Aerospace Engr

**MAE 3113 Measurements and Instrumentation**

**Prerequisites:** Grades of "C" or higher in ENSC 2613 and MAE 3013.

**Description:** Application of basic electronic laboratory measurement equipment. Selection and testing of transducers for measurement of displacement, time frequency, velocity, pressure, force, temperature, flow-rate, and vibration, for machine design applications. Considerations of accuracy, uncertainty and repeatability. Design projects involving the use of analog and digital integrated circuits and construction of prototype sensors. Practice in the use of signal processing, including digital filtering and applications of Fast Fourier Transform theory. Practice in the use of computer-based data acquisition systems. Preparation of formal reports, including the presentation of plots, figures and tables.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Mech & Aerospace Engr

**MAE 3123 Manufacturing Processes**

**Prerequisites:** Grades of "C" or higher in ENSC 3313.

**Description:** An introduction to manufacturing processes including the fundamental processes of casting, forging, rolling, extrusion, drawing and metal cutting. Quantitative relationships to identify important parameters which influence a given process.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 3153 Introduction to MAE Design**

**Prerequisites:** Grades of "C" or higher in ENSC 2113 and ENSC 2213 and (ENSC 2123 and ENSC 2143 and MAE 3333 or concurrency).

**Description:** Identify, formulate and solve complex interdisciplinary engineering problems by applying principles of design, engineering science and mathematics.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Contact: 3 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 3223 Thermodynamics II**

**Prerequisites:** A grade of "C" or higher in MAE 3153.

**Description:** A continuation of ENSC 2213. Irreversibility and availability, power cycles, refrigeration cycles, mixtures and solutions, chemical reactions, phase and chemical equilibrium, and introduction to compressible flow.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 3233 Heat Transfer**

**Prerequisites:** A grade of "C" or higher in MAE 3333 or concurrency.

**Description:** Mechanisms of heat transfer. Steady and transient conduction, free and forced convection, heat exchanger design and analysis, radiation and multiphase behavior. Numerical methods, dimensional analysis and boundary layer theory.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 3253 Applied Aerodynamics and Performance**

**Prerequisites:** Grades of "C" or higher in MATH 2233 and MAE 3293.

**Description:** Relevant fluid properties; standard atmospheres; mathematical models of flows about bodies. Characteristic parameters of airfoils and wings. Thin airfoil theory and flows about finite wings. Boundary layers. Propeller theory. Supersonic and hypersonic flows about wings and lifting bodies. Drag polars. Power required for level flight. Rate of climb and descent. Steady turns. Maximum range and endurance. Design applications. Priority enrollment is given to Aerospace Engineering majors.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 3293 Fundamentals of Aerodynamics**

**Prerequisites:** Grades of "C" or higher in MATH 2233 and MAE 3333.

**Description:** Introduction to aerodynamic concepts; governing equations of gas flows in one and two dimensions. Inviscid, incompressible flow, flow over airfoils, flow over finite wings, 3D flow; Compressible flow; Basic thermodynamic and dynamic equations. Nozzle and duct flows, choking, normal and oblique shock waves, Prandtl-Meyer expansions, subsonic compressible flow over airfoils, compressible flow through nozzles, intro into viscous flows. Priority enrollment is given to Aerospace Engineering majors.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 3324 Mechanical Design I**

**Prerequisites:** Grades of "C" or higher in ENSC 3313 and MAE 3153.

**Description:** Introduction to the design process. Consideration of reliability, factors of safety, product liability, and economics. Use of codes, standards, and other design resources. Stress analysis of mechanical components such as beams, rings, cylinders, and shafts. Analysis of stiffness and deflection of straight and curved beams, frames, columns, and links. Consideration of static and fatigue failure theories for various types of engineering materials. Incorporation of stress and deformation analyses and applicable material failure theories iteratively until all design needs and constraints are satisfied. Same course as MAE 3323.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Contact: 4 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 3333 Fundamental Fluid Dynamics**

**Prerequisites:** Grades of "C" or higher in (ENGR 2421 or concurrent in MAE 3113) and ENSC 2113 and MATH 2153.

**Description:** Fluid statics; conservation of mass, momentum and energy in fixed and moving control volumes; steady and unsteady Bernoulli's equation; fluid kinematics and differential analysis of fluid flow; Navier-Stokes equations and exact solutions; dimensional analysis and similitude; laminar and turbulent flow; internal flows; boundary layer theory; lift and drag; pumps.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 3403 Computer Methods in Analysis and Design**

**Prerequisites:** A grade of "C" or higher in ENGR 1412 and MAE 3013.

**Description:** Application of linear algebra, numerical methods, statistics, and computer methods in the design, analysis, and simulation of mechanical, thermal, and fluid systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 3524 Thermal Fluids Design**

**Prerequisites:** Grades of "C" or higher in MAE 3153 and MAE 3233.

**Description:** Design, modeling and simulation of thermal systems. Analysis and modeling of components such as fans, pumps, ducts, pipes, fittings, heat exchangers, and heat pumps.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Contact: 4 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 3724 Dynamic Systems Analysis and Introduction to Control**

**Prerequisites:** Grades of "C" or higher in ENSC 2613 and MAE 3013 and (ENGR 2421 or concurrent in MAE 3113).

**Description:** Physical and mathematical modeling of mechanical, electrical, fluid, thermal and mixed dynamic systems. Systems analysis in the time domain and in the frequency domain, with an emphasis on first and second order systems. Laplace transform method for solving ordinary linear differential equations. Representation of system models using transfer functions, block diagrams and state variable forms. Use of computer methods for solving linear and nonlinear dynamic system models. Introduction to dynamic system control. Laboratory investigation to demonstrate application. Same course as MAE 3723.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Mech & Aerospace Engr

**MAE 4003 Introduction to Autonomous Systems**

**Prerequisites:** Grades of "C" or higher in MAE 3403 and (MAE 3724 or ECEN 3723).

**Description:** Review of representations, coordinate transformations, and kinematics and dynamics of mobile ground and/or aerial robots. Introduction to robot mobility, i.e., path planning, trajectory generation, and trajectory tracking. Introduction to robot perception using sensors such as inertial measurement units, odometry, laser distance scanners, and cameras. Introduction to robot localization using sensor fusion. Introduction to Robot Operating System (ROS).

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4010 Mechanical and Aerospace Engineering Projects**

**Prerequisites:** Senior standing in MAE and consent of adviser/instructor.

**Description:** Special projects and independent study in mechanical or aerospace engineering. Offered for variable credit, 1 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Mech & Aerospace Engr

**MAE 4053 Automatic Control Systems**

**Prerequisites:** A grade of "C" or higher in MAE 3724 or ECEN 3723.

**Description:** Properties of feedback control systems, mathematical models of basic components, state-variable models of feedback systems, design specifications of control systems, time-domain analysis, stability, stability robustness, transform analysis, frequency domain techniques, root-locus, design of single-input-single-output systems and compensation techniques for engineering systems. Same course as ECEN 4413.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4063 Mechanical Vibrations**

**Prerequisites:** A grade of "C" or higher in MAE 3724.

**Description:** Lumped parameter analysis of multi-mode vibrating systems. Analysis techniques including classical analytical methods, matrix methods and numerical methods. Selection and design of vibration isolation systems. Selection of vibration instrumentation. Machine dynamics, including balancing, whirl, nonlinear effects, and self-excited vibrations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr



**MAE 4213 Spacecraft Design**

**Prerequisites:** A grade of "C" or higher in MAE 3253 and (MAE 3113 or [ENGR 2421 and ENSC 2141 and ENSC 3231]).

**Description:** Elements of basic aerospace engineering concepts focusing on spacecraft design. Fundamental material will include orbital dynamics, rocket theory and launch vehicle performance, principles of spacecraft stability and control, propulsion systems, aerospace structures, space environments and its effect on spacecraft design (thermal, radiation, magnetosphere and solar wind), atmospheric reentry, thermal management, power systems, telecommunications, cost analysis, spacecraft design.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4223 Aerospace Engineering Laboratory**

**Prerequisites:** Grades of "C" or higher in MAE 3253 and MAE 4283 and (MAE 3113 or [ENSC 2421 and ENSC 2141 and ENSC 3231]).

**Description:** Experimental study of aerospace principles including topics in aeronautics and astronautics. State-of-the-art instrumentation, diagnostic, and computerized data acquisition equipment and techniques applied to experiments including application of low speed wind tunnel testing techniques, rocket propulsion and control-jet experiments, fundamentals of supersonic nozzles, and flight test evaluation of performance, stability, control, and handling qualities of a propeller-driven airplane.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Mech & Aerospace Engr

**MAE 4243 Aerospace Propulsion and Power**

**Prerequisites:** Grades of "C" or higher in MAE 3153 and MAE 3293.

**Description:** The study of aerospace power and propulsion engines utilizing a gas as the working fluid. Design and analysis of complete aircraft engine systems and individual components of the aircraft engine. Engine component matching for design using analysis routines, including inlets and diffusers, fans and compressors, combustors, turbines, nozzles, and propellers. Additional propulsion and power systems including chemical and non-chemical rocket motors and other internal combustion engines. Priority enrollment is given to Aerospace Engineering majors.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4263 Energy Conversion Systems**

**Prerequisites:** Grades of "C" or higher in MAE 3153 and MAE 3524.

**Description:** This course covers the use of renewable and non-renewable energy sources in power production. Energy conversion processes are analyzed, and performance characteristics of components and systems are modeled using modern computational methods. Applications include overall design of conventional Rankine power systems and may also include design of nuclear, solar, wind, wave, thermoelectric, and geothermal energy systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4273 Experimental Fluid Dynamics**

**Prerequisites:** Grades of "C" or higher in MAE 3153 and (MAE 3113 or [ENSC 2421 and ENSC 2141 and ENSC 3231]).

**Description:** Experimental study of basic and applied fluid dynamics systems with comparisons to analytical predictions. Fluid dynamics instrumentation, digital data acquisition and processing, design of facilities and experiments, technical report writing and design project with experimental verification.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4283 Aerospace Vehicle Stability and Control**

**Prerequisites:** Grades of "C" or higher in MAE 3253 and MAE 3724.

**Description:** Motion and control of aerospace vehicles. Derivation of equations of motion for aircraft and spacecraft. Aerodynamic stability derivatives. Static and dynamic aircraft stability and control. Handling qualities. Satellite orbital and attitude dynamics. Satellite attitude control. Design experience for stability and control in aeronautical and astronautical vehicles.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4313 Advanced Processing of Engineered Materials**

**Prerequisites:** Grades of "C" or higher in ENSC 3313 and MAE 3153.

**Description:** Introduction of novel processing methods for a range of engineered materials, such as electro-slag remelting, vacuum melting, melting to remove tramp elements, precision casting, sintering, hot-pressing, directional solidification, mechanical alloying, liquid infiltration, net-shaped finishing, superplastic forming, sol-gel processing, float glass process, tape laying, microwave processing, laser processing, CVD and PVD, sputtering, ion plating, ultraprecision machining and grinding, polishing and lapping, multilayer coatings, Czochralski single crystal growth, processing of nanocrystalline materials, engineered surfaces and surface modification, and layer processing for electronic materials.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4333 Mechanical Metallurgy****Prerequisites:** Grades of "C" or higher in ENSC 3313.**Description:** Mechanical deformation processes and strengthening mechanisms in engineering materials. Material failure modes including creep, fatigue, stress corrosion, ductile and brittle fractures.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Mech & Aerospace Engr**MAE 4342 Design Projects I****Prerequisites:** A grade of "C" or higher in MAE 3233 and MAE 3324 and (MAE 3113 or [ENGR 2421 and ENSC 2141 and ENSC 3231]).**Description:** Two-semester design project with team format. Projects are sponsored by a company, agency, or individual. Team members work with sponsors and faculty who serve as mentors in fields related to their topics. Students complete oral presentations, progress reports, and create a professional log book to document their activities and contributions. Topics include safety, patent law, product liability, report writing, and scheduling.**Credit hours:** 2**Contact hours:** Lecture: 2 Contact: 2**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 4344 Design Projects****Prerequisites:** Grades of "C" or higher in MAE 3524 and MAE 3324 and MAE 3724 and (MAE 3113 or [ENSC 2421 and ENSC 2141 and ENSC 3231]).**Description:** Students work in small teams on a semester-long design project sponsored by a company, agency, or individual. Team members work with mentors from sponsors and with faculty members in fields related to their topics. Presentations on safety, patent law, product liability, report writing, oral presentations, scheduling and ideation. Oral presentations, progress reports, and a professional log book documenting personal activity and contributions.**Credit hours:** 4**Contact hours:** Lab: 8 Contact: 8**Levels:** Undergraduate**Schedule types:** Lab**Department/School:** Mech & Aerospace Engr**MAE 4352 Design Projects II****Prerequisites:** A grade of "C" or higher in MAE 4342.**Description:** Second of two-semester sequence of senior design courses.**Credit hours:** 2**Contact hours:** Lecture: 2 Contact: 2**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 4353 Mechanical Design II****Prerequisites:** A grade of "C" or higher in MAE 3324.**Description:** Design of power transmission systems, including belts, chains and gears. Selection and application of hydraulic and pneumatic components in machine design applications. Selection of electric motors, actuators, encoders, and related electromechanical components. Design practice in the form of short projects integrating segments of the course. Same course as BAE 4353.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 4354 Aerospace Systems Design for Mechanical Engineers****Prerequisites:** Grades of "C" or higher in MAE 3524 and MAE 3324 and MAE 3724 and (MAE 3113 or [ENSC 2421 and ENSC 2141 and ENSC 3231]).**Description:** Multidisciplinary design of aerospace vehicles. Multidisciplinary teams that work on a semester-long project that includes the design, construction, and a flight test of an aerospace vehicle optimized for a given set of requirements. Teamwork, leadership and presentation skills emphasized.**Credit hours:** 4**Contact hours:** Lecture: 3 Contact: 5 Other: 2**Levels:** Undergraduate**Schedule types:** Independent Study, Lecture, Combined lecture & IS**Department/School:** Mech & Aerospace Engr**MAE 4363 Advanced Methods in Design****Prerequisites:** Grades of "C" or higher in MAE 3324 and (MAE 3113 or [ENSC 2421 and ENSC 2141 and ENSC 3231]).**Description:** Analytical and experimental techniques for the analysis of vibration, stress, force and motion. The finite element analysis method is introduced. Strain gages, photoelasticity, force gages, deflection gages, accelerometers and other transducers and methods are used in the laboratory. Projects involve the combined use of advanced analytical and experimental methods to realize optimal designs.**Credit hours:** 3**Contact hours:** Lecture: 2 Contact: 4 Other: 2**Levels:** Undergraduate**Schedule types:** Independent Study, Lecture, Combined lecture & IS**Department/School:** Mech & Aerospace Engr**MAE 4374 Aerospace System Design****Prerequisites:** A grade of "C" or higher in MAE 4243 and MAE 4283 and MAE 4513.**Description:** Multidisciplinary design of aerospace vehicles. Multidisciplinary teams that work on a semester-long project that includes the design, construction, and a flight test of an aerospace vehicle optimized for a given set of requirements. Teamwork, leadership and presentation skills emphasized.**Credit hours:** 4**Contact hours:** Lecture: 3 Contact: 4 Other: 1**Levels:** Undergraduate**Schedule types:** Independent Study, Lecture, Combined lecture & IS**Department/School:** Mech & Aerospace Engr

**MAE 4513 Aerospace Structures**

**Prerequisites:** A grade of "C" or higher in MAE 3324 and MAE 3403.

**Description:** Design and analysis of flight structures. Topics from two and three-dimensional elasticity. Behavior of composite materials. Stress and deflection analysis of thin-skinned stiffened structures. Introduction to the finite element method and its applicability in the design process. Priority enrollment is given to Aerospace Engineering majors.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4583 Corrosion**

**Prerequisites:** A grade of "C" or better in ENSC 3313 and MAE 3153.

**Description:** Modern theory of corrosion and its applications in preventing and controlling corrosion. Thermodynamics, Pourbaix diagrams, kinetics, polarization, passivation, effect of stress, cathodic protection, alloying, coatings. Lab experiments to characterize, simulate, diagnose and control corrosion.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Mech & Aerospace Engr

**MAE 4623 Biomechanics**

**Prerequisites:** Grades of "C" or higher in MATH 2163 and MAE 3153 and MAE 3324.

**Description:** This course will provide students with the basic knowledge necessary to conduct biomechanics investigations, design implants and prosthetics, and interact with other medical professionals. Covering a wide selection of topics ranging from cell to whole-body mechanics and behaviors. Specific topics will be: cellular biomechanics, bone biomechanics and fracture, muscle biomechanics and injuries, physiological functions, human motion analysis, biomaterials and implants design, prosthetics design.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4703 Design of Indoor Environmental Systems**

**Prerequisites:** A grade of "C" or higher in MAE 3524.

**Description:** Design of heating, ventilating and air conditioning systems. Calculation of heating and cooling loads.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4713 Thermal Systems Realization**

**Prerequisites:** A grade of "C" or higher in MAE 3524.

**Description:** This course will develop the tools required to design, analyze, and improve thermal energy systems. There will be an emphasis on practical understanding and detailed analysis techniques for system components, integration, and design. Some topics included are: the vapor compression cycle (for refrigeration and heat pump applications); compressor and heat exchanger analysis; and waste-heat recovery topics including Organic Rankine Cycles (ORC).

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4723 Refrigeration Systems Design**

**Prerequisites:** A grade of "C" or higher in MAE 3524.

**Description:** This course covers the modeling, analysis, and design of vapor compression refrigeration systems applied to air-conditioning and refrigeration applications. There will be an emphasis on practical understanding of components, system integration, and system design. This includes analysis and selection of compressors, heat exchangers and expansion devices as well as the integration of these components into system.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 4733 Mechatronics Design**

**Prerequisites:** Grades of "C" or higher in MAE 3153 and MAE 3403 and (MAE 3113 or [ENSC 2421 and ENSC 2141 and ENSC 3231]).

**Description:** Design of mechanical and electrical components, including sensors and actuators into an integrated environment using microcontrollers. Software design using an easy-to-program microcontroller embodies the importance of software implementation into the overall engineering system. Design practice with given design projects to build up skills plus an open-ended term design project of the student's choosing.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5000 Master's Thesis**

**Prerequisites:** Graduate standing in MAE and consent of student's adviser.

**Description:** A student studying for a master's degree who elects to write a thesis must enroll in this course. Offered for variable credit, 1-9 credit hours, maximum of 9 credit hours.

**Credit hours:** 1-9

**Contact hours:** Contact: 1-9 Other: 1-9

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Mech & Aerospace Engr

**MAE 5003 Advanced Biomaterials Science and Engineering****Prerequisites:** Graduate standing or consent of instructor.**Description:** Engineering issues that are implicit in understanding the interactions of living tissue and processed materials will be introduced. Emphasis is on identifying the processes in which cells interact with surfaces and particulate matter and the outcome of these interactions. Highlighted biological responses will include inflammation and coagulation. Also, biomaterial issues related to drug delivery and tissue engineering will be discussed. Same course as CHE 5263.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5010 Mechanical and Aerospace Engineering Projects****Description:** Project in research assigned by the student's adviser. This course may also be used as a temporary number for new graduate course offerings. (3 credit hours). Offered for variable credit, 1-12 credit hours, maximum of 12 credit hours.**Credit hours:** 1-12**Contact hours:** Contact: 1-12 Other: 1-12**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Mech & Aerospace Engr**MAE 5013 Physiological System Analysis for Engineers****Prerequisites:** Graduate standing or consent of instructor.**Description:** Introduce the basic physiology concepts used widely in biomedical engineering research; and introduce and develop engineering concepts and approaches for quantitative analysis of physiological systems. Engineering principles of mechanical properties of various tissue and organ systems under normal and diseased conditions. Same course as CHE 5273.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5023 Advanced Biofluid Mechanics****Prerequisites:** Graduate standing or MAE 3233 (or equivalent).**Description:** From sub-cellular to the organ level, life is supported by mass transfer processes, which encompass everything from free diffusion to the convection of bulk fluids. Therefore, to understand the body's functions, it is necessary to apply the fundamental fluid mechanics and heat transfer laws to physiological systems. Special emphasis will be placed on different length scales in physiological system, biorheology, conservation laws, mechanical coupling to vessel deformation and relevant physiology.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5030 Engineering Practice****Prerequisites:** Graduate standing in MAE and consent of student's adviser.**Description:** Solution of real-life engineering design and development problems in an actual or simulated industrial environment. Activities include application of design and testing procedures, economic evaluation and periodic oral and written reporting on one or more assigned problems. Activities must be approved in advance by the adviser. Offered for variable credit, 1-12 credit hours, maximum of 12 credit hours.**Credit hours:** 1-12**Contact hours:** Contact: 1-12 Other: 1-12**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Mech & Aerospace Engr**MAE 5033 Advanced Biomedical Engineering****Prerequisites:** Consent of instructor.**Description:** Principles and engineering analysis of biomedical processes. Artificial organs, biomaterials, tissue engineering, transport in biological systems, biomedical imaging and drug delivery systems. Same course as CHE 5293.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5053 Design of Engineering Experiments****Prerequisites:** Graduate standing.**Description:** The purpose of this course is to teach graduate students how to apply statistical methods to the solution of biological and engineering problems. They will learn how to use statistical methods to design experiments, present and analyze experimental data.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5063 Soft Tissue Mechanics****Prerequisites:** MAE 3324 or an equivalent course with the consent of the instructor.**Description:** Introduction to the most commonly used computational techniques for investigating and analyzing the behavior of biological soft tissues. Application of computational methods such as elasticity, viscoelasticity, and poroelasticity for numerically modeling the properties of biomaterials.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5073 Advanced Mechanical Vibrations****Prerequisites:** MAE 4063 or consent of instructor.**Description:** Analysis of nonlinear vibrations, classical analysis of continuous systems and numerical methods.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr

**MAE 5080 Fundamental Topics**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Fundamental topics that are typically introduced in the undergraduate senior year curriculum with additional depth and breadth commensurate with the graduate program. Repeat credit may be earned with different course subtitles assigned. Offered for 3 credit hours, maximum of 9 credit hours allowed.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5083 Engineering Acoustics**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Acoustical analysis and measurement techniques, with emphasis on design applications for noise and vibration control in machinery and in buildings.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5093 Numerical Engineering Analysis**

**Prerequisites:** Undergraduate course in computer programming and consent of professor.

**Description:** Practical digital methods for obtaining steady-state and transient solutions to lumped and distributed mechanical, fluid and thermal problems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5103 Advanced Dynamics**

**Prerequisites:** Graduate standing or consent of instructor; ENSC 2123, MAE 3013 and MAE 3724.

**Description:** This course will address the effects of forces on the motion of a body or system of bodies to solve real-world engineering problems. It will emphasize the tools of analytical dynamics to develop mathematical models that describe the dynamics of particles, rigid bodies, and systems of particles or rigid bodies. The course will also address the formulation of equations of motion for complex mechanical systems and computational methods for solving these equations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5113 Diffraction in Materials**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Introduction to crystallography and diffraction with an emphasis on X-Ray diffraction, some exposure to Neutron diffraction, radiography and tomography. Applications will focus on mechanical properties measurements. New methods will be surveyed with an emphasis on current research. Same course as MSE 5113.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5123 Advanced Material Removal Processes**

**Prerequisites:** ENSC 3313 and MAE 3123 and graduate standing or consent of instructor.

**Description:** Understanding the fundamental principles and practice (mechanics and material aspects) of machining and grinding of materials. Historical aspects; physics of metal cutting, mechanics of machining (orthogonal and oblique); shear stress and shear strain in machining, dynamometry; tool materials, tool wear, tool life, and machinability; vibrations in machining; thermal aspects of machining, cutting fluids; economics; surface finish accuracy and surface integrity, and grinding.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5133 Mechanical Behavior of Materials**

**Prerequisites:** ENSC 3313 or equivalent.

**Description:** A unified approach to the behavior and response of engineering materials to applied loads. Mechanical and metallurgical fundamentals of deformation processes. Spatial scales of atomic physics, micromechanics and continuum mechanics.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5143 Tribology**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** The principles of tribology. Definition of tribology, contact of solids, surface topography, real area of contact, friction of various materials, basic mechanisms of friction, mechanisms of wear (adhesion, abrasion, fatigue, erosion, and fretting), hardness of solids, frictional heating and surface temperatures, material properties that influence surface interactions, surface roughness measurement, surface integrity residual stresses and subsurface deformation, application of tribology to manufacturing, wear resistant materials, wear-resistant coatings, experimental methods in tribology, surface analytical tools in tribology, scanning tunneling microscopy/atomic force microscopy, wear monitoring and wear prevention, and systems approach to tribology.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5153 Precision Engineering I**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** An integrated approach to underlying engineering principles governing product and process designs requiring accuracies typically better than 1 part in 10<sup>6</sup>. Design and control of precision machines and instruments, dimensional and surface metrology, scanning probe microscopy, ultra-precision machining and grinding, and precision assembly.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5163 Precision Manufacturing Process****Prerequisites:** MAE 3123 or equivalent.**Description:** Introduction to precision manufacturing, design principle of precision machine tools and source of errors, diamond turning and milling, grinding, polishing and lapping, sensors for precision manufacturing, precision manufacturing applications.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5173 Biomimetics in Engineering****Prerequisites:** Graduate standing or consent of instructor.**Description:** Nature has developed processes, techniques, and materials that function optimally from the nanoscale to the macroscale. The goal is to introduce methods and techniques derived from Nature and used to solve engineering and research problems. This course will provide students with the most common nature-derived concepts used in engineering. Relevant techniques will then be applied to each student's research project.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5183 Nanostructured Materials****Prerequisites:** Graduate standing and basic undergraduate materials science course or equivalent.**Description:** Size and shape dependence of material properties at the nanoscale. Interaction, surface energy, functionalization, binding, and immobilization of nanostructures. Top-down and bottom-up nanofabrication, atomic processes and self assembly. Lithography, thin films, functional coating, Langmuir-Blodgett films, layer-by-layer growth. Properties, applications and synthesis of well-studied building blocks; quantum dots (semiconductor nanocrystals), carbon nanostructures (nanotubes and fullerenes), semiconductor nanowires, metal nanoparticles and nanowires.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5193 Computational Biomechanics****Prerequisites:** Graduate standing or consent of instructor; MATH 2233 and ENSC 2123.**Description:** Introduction to human anatomy, skeletal and musculoskeletal modeling, human modeling packages, kinematics and dynamics of human system, posture and motion predictions, digital human modeling, tissue biomechanics, and optimization theory and applications in human modeling.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5213 Engineering Plasticity****Prerequisites:** Graduate standing or consent of instructor.**Description:** This course will present the fundamentals of the continuum theory of plasticity applicable in analysis and design of materials forming processes. The following topics will be covered: Yielding, Stress and Strain, Isotropic Yield Criteria, Work Principles, Anisotropic Plasticity, Effects of Strain Hardening and Strain-Rate Dependence, Defect Analysis, Effects of Pressure and Sign of Stress State, Plasticity Tests.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5223 Mechanics of Bonds****Prerequisites:** Graduate standing or consent of instructor.**Description:** The course will focus on the principles of mechanics of bond (adhesion) between the materials in relation to the design, fabrication and testing of bonds. Especially, the contents will focus attention to adhesive bonding.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5233 Advanced Fluid Dynamics I****Prerequisites:** ENSC 3233.**Description:** Introduction to fluid flows. Governing equations for mass, momentum and energy. Exact solutions of Navier-Stokes' equations. Dimensional analysis and similitude. Potential flows. Boundary layer theory. Low Reynolds number flows. Introduction to vorticity dynamics.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5243 Micro Flows****Prerequisites:** Graduate standing or consent of instructor.**Description:** Fundamentals and simulation of micro flows including governing equation, slip models, shear- and pressure-driven micro flows. Thermal effects in micro scales. Applications; MEMS and micro propulsion. Numerical methods for continuum simulation and atomistic simulation.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr

**MAE 5253 Multiphase Flow****Prerequisites:** Graduate standing.**Description:** Theory, methods and practical experience for studying complex transient multiphase flows: basic concepts and definition, dynamics of bubbles, drops and rigid particles, gas-liquid transport in ducts, fluid-solid transport in ducts, aerosol and spray systems, foam, fluidization, particle separation systems multiphase flow in porous media, breakup of liquid sheets and jets, modeling, advanced experimental techniques for multiphase flow.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5263 Combustion****Prerequisites:** Graduate standing or consent of instructor.**Description:** Chemical thermodynamics, chemical kinetics, conservation equations for reacting systems, premixed laminar flames, diffusion flames, turbulent flames, mechanism reduction and chemistry solvers, combustion diagnostics, new combustion technologies.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5273 Advanced Fluid Dynamics II****Prerequisites:** MAE 5233.**Description:** Application of advanced fundamental concepts and methods to vorticity dynamics, gravity waves, instability, and an introduction to turbulence. Specialty topics (e.g. geophysical flows, compressible flows, biofluids) will also be discussed.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5283 Data Assimilation in Science and Engineering****Prerequisites:** (ENGR 1412 or equivalent course in computer programming and knowledge of scientific computing) and (MAE 3013 or equivalent course in differential equation and engineering mathematics) and (MAE 3403 or equivalent undergraduate course in computational methods).**Description:** Data assimilation is a well-established scientific discipline that combines computational models observations. It is geoscience terminology and refers to the estimation of the state of a physical system given a model and measurements. In other words, it is the process of fitting models to data. In engineering fields the terms filtering, estimation, and smoothing are often used. In the last decades data assimilation has gained popularity in many computational disciplines at both universities and research centers. In this course, starting from mathematical preliminaries (e.g., numerical linear algebra, model reduction, optimization techniques, etc), common methods of data assimilation (both sequential and variational methods) are introduced and derived in the context of both variational and estimation theory with emphasis on computational aspects.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5303 Advanced Space Propulsion and Power****Prerequisites:** MAE 4243 (or equivalent).**Description:** Advanced analysis of chemical, nuclear, electric and solar thermal rockets with a focus on solid, liquid and hybrid rocket propulsion. Progression from fundamentals to design and analysis of complete rocket systems, including design case studies. Design, build, test and evaluation of chemical rocket components.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5313 Autopilot Design and Test****Prerequisites:** Graduate standing or consent of instructor; MAE 3403 and MAE 3724 and MAE 4053 and MAE 4283.**Description:** Basic theory, hardware, and implementation, and test techniques for contemporary autopilot design, with a particular example on unmanned aerial systems. Flight mechanics modeling and simulation, basic sensor modeling and usage, filtering and state estimation, and feedback strategies are discussed. Typical computing hardware platforms and their limitations for autopilots usage are discussed. General purpose computing hardware is extended to field UAV platforms. Validation techniques are introduced, including an introduction to formal methods verification and a more thorough exercise in operational hardware testing.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5343 Advanced Aero Propulsion and Power****Prerequisites:** MAE 4243; Graduate Standing or Consent of Instructor.**Description:** Advanced analysis of aircraft engines. Preliminary aerodynamic and structural design of major engine components including inlets, compressors, combustors, turbines, mixers, afterburners, and nozzles.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5353 Testing, Control, and Simulation of Thermal Systems****Prerequisites:** Graduate standing or consent of instructor; MAE 3524 or equivalent.**Description:** This course introduces the usage of computer software for the simulation and experimental testing of thermal systems and their components. Specifications of sensors and test plans based on uncertainty calculation as well as HVAC controls are introduced.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 3 Contact: 5**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Mech & Aerospace Engr

**MAE 5363 Advanced Analytical Electron Microscopy**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Fundamentals of electron microscopy and the associated characterization techniques; functions of the SEM/TEM and how it works; basic analytical microscopy techniques (imaging, diffraction, EDS, EELS) and data interpretation to develop an understanding of structure-property correlations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5403 Computer-Aided Analysis and Design**

**Prerequisites:** Undergraduate course in computer programming and consent of professor.

**Description:** Theory, application and implementation of digital-computer-oriented algorithms for the synthesis, simulation, analysis and design of engineering systems. Advanced FORTRAN methods for optimization, simulation and data analysis. Implementation of these methods uses program libraries, batch processing, remote terminals and graphic display units.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5413 Optimal Control**

**Prerequisites:** MAE 5713 or ECEN 5713.

**Description:** Optimal control theory for modern systems design. Specification of optimum performance indices. Dynamic programming, calculus of variations and Pontryagin's minimum principle. Iterative numerical techniques for trajectory optimization. Same course as ECEN 5413.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5433 Robotics, Kinematics, Dynamics and Control**

**Prerequisites:** MAE 4053 or ECEN 4413 or consent of instructor.

**Description:** Kinematic and dynamic analysis of robot manipulators. Inverse kinematics, motion planning and trajectory generation. Industrial practice in robot servo control. Dynamics and control in the presence of constraints. Actuators and sensors. Force sensors and vision systems. Robotic force control and its applications in industry. Passivity based control algorithms. Advanced control techniques for motion and force control. Same course as ECEN 5433.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5463 Nonlinear System Analysis and Control**

**Prerequisites:** MAE 4053 or ECEN 4413.

**Description:** Failure of superposition of effects; phase-plane analysis; limit-cycles; Lyapunov stability; hyperstability and input-output stability; controllability and observability of nonlinear systems; feedback linearization; robust nonlinear control system design. Same course as ECEN 5463. Previously offered as MAE 5723.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5473 Digital Control Systems**

**Prerequisites:** MAE 4053 or ECEN 4413.

**Description:** Input output and state space representations of linear discrete-time systems. Approximate methods in discrete-time representation. Stability methods. Controllability, observability, state estimation, and parameter identification. Design and analysis of feedback control system using frequency-domain and state-space methods. Introduction to optimal control. Same course as ECEN 5473.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5483 Advanced Mechatronics Design**

**Prerequisites:** MAE 4733 or similar course and consent of instructor.

**Description:** Continuation of topics covered in the undergraduate course MAE 4733 Mechatronics Design. Optimizing C programming code for microcontrollers using the assembly language instruction set, RS-232 microcontroller communication protocol, Controller Area Network (CAN) communication protocol plus hands-on CAN bus development boards, advanced topics which could include but are not limited to sensor design, real time operating systems, and advanced communication protocols. Same course as ECEN 5483.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5503 Mechanics of Advanced Composites for Structural Design**

**Prerequisites:** ENSC 2113, ENSC 2143 or consent of instructor.

**Description:** Basic principles governing the micro-mechanics of a lamina, and the macro-mechanics of a laminate are discussed in detail. Analysis of continuous fiber, short-fiber, and woven-fiber polymer matrix composites. A computer program for an analysis and design of composite laminates is developed.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr



**MAE 5513 Stochastic Systems**

**Prerequisites:** ECEN 3513 and 4503 or STAT 4033 or MAE 4053 or MAE 4063 or consent of instructor.

**Description:** Theory and applications involving probability, random variables, functions of random variables, and stochastic processes, including Gaussian and Markov processes. Correlation, power spectral density, and non-stationary random processes. Response of linear systems to stochastic processes. State-space formulation and covariance analysis. Same course as ECEN 5513. Previously offered as MAE 6063.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5523 Estimation Theory**

**Prerequisites:** MAE 5513 or ECEN 5513.

**Description:** Stochastic model development, parameter estimation and state estimation. The linear model, model order determination, least squares, estimation, maximum likelihood estimation, Bayesian estimation. Gaussian random vectors, estimation in linear and Gaussian models, state estimation, the Kalman filter, prediction and smoothing. Same course as ECEN 5523.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5533 Theory of Elasticity**

**Prerequisites:** Graduate standing or consent of instructor; MAE 3324 or equivalent.

**Description:** Basics of tensor calculus, field equations (strain-displacement, compatibility, equilibrium, and constitutive relation), solution of plane elastostatics problems in cartesian and polar coordinates, potential function formulation, introduction to 3D problems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5543 Modern Materials**

**Prerequisites:** ENSC 3313.

**Description:** Properties, applications and recent innovations of structural engineering materials. Metals, ceramics, polymers and composites considered.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5553 Fatigue and Fracture Mechanics**

**Prerequisites:** MAE 4333 or consent of instructor.

**Description:** The course provides an introduction to the mechanics of fracture of brittle and ductile materials and covers the basics of both linear-elastic fracture mechanics (LEFM) and elastic-plastic fracture mechanics (EPFM). Crack initiation and propagation is studied under quasi-static, dynamic, and cyclic loading conditions. Models are presented for time dependent fracture including creep and fatigue crack growth. Methods to experimentally determine fracture properties, based on relevant ASTM standards, are introduced. Same course as MSE 5553.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5563 Finite Element Methods**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Introduction to the finite element method in mechanical engineering. Numerical and mathematical formulations including an introduction to variational methods. Computer applications in solid mechanics, heat transfer and fluid mechanics.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5573 Continuum Mechanics**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Principles governing the mechanics of a continuum. Tensor calculus. Strain and kinematics of deformation. Conservation laws, stress and equilibrium. Constitutive equations of elastic, viscoelastic, and plastic solids. Solving boundary value problems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5583 Corrosion Engineering**

**Prerequisites:** ENSC 3313 or equivalent.

**Description:** Modern theory of corrosion and its applications in preventing or controlling corrosion damage economically and safely in service. Same course of MSE 5583.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5593 Viscoelasticity**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Advanced stress analysis and constitutive modelling of time-dependent materials such as polymers or metals near their melting point. Overview of viscoelastic materials and applications. Experimental material characterization and thermodynamic foundation of the constitutive behavior. Time-temperature superposition principle for thermo-rheologically simple materials. Differential and integral formulation of basic rheological models.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5603 Stability of Structures**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Stability is a fundamental problem in solid mechanics, which is crucial to the safety of structures against collapse. The theory of stability is of great importance for structural engineering, aerospace engineering, nuclear engineering, etc. Elastic and non-elastic theories of stability will be discussed for structures such as columns, frames, thin-walled beams, plates and shells. Energy methods for discrete and continuous structures will also be discussed.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5633 Advanced Thermal Energy Systems Analysis**

**Prerequisites:** MAE 3524 and MAE 3233; Graduate Standing or Consent of Instructor.

**Description:** This course will develop the tools required to design, analyze, and improve advanced thermal energy systems. There will be an emphasis on practical understanding of components, system integration, and system design. Some topics included are; improvements to the vapor compression cycle (for refrigeration and heat pump applications); compressor and heat exchanger analysis; heat-driven vapor compression cycles; waste-heat recovery topics including Organic Rankine Cycles (ORC) and expander analysis.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5653 Refrigeration**

**Prerequisites:** MAE 3524; Graduate Standing or Consent of Instructor.

**Description:** Thermal engineering of refrigeration and heat pump systems, vapor compression systems, absorption refrigeration cycles, cryogenics, compressors, heat exchangers, flow control devices, laboratory simulators and measurements, socio-economics and environmental impact of systems and refrigerants. A general-purpose computer software program is used for analysis and design of several refrigeration systems and components.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5663 Advanced Finite Element Analysis**

**Prerequisites:** MAE 5563 or consent of instructor.

**Description:** Development of three-dimensional isoparametric solid elements using Lagrange and serendipity family of elements, solution of three-dimensional thermoelasticity problems, linear time dependent problems, variational formulation and computer implementation of structural dynamics analysis using implicitly operators, implementation of three-dimensional diffusion and heat transfer analysis, solution of a nonlinear system of equations, and finite element analysis using commercial software packages.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5673 Mechanics of Fracture, Contact and Friction**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Rigorous derivation and presentation of the equations of fracture mechanics, contact and friction. Equations of solid mechanics and mathematical preliminaries, elastic stress field near a crack tip, stress intensity factors, fracture toughness, Griffith solution and J-integral, elastic-plastic fracture, fatigue, Dugdale model and cohesive zone laws, experimental techniques in fracture mechanics, contact mechanics, friction modeling. More advanced topics and projects will be chosen from interfacial crack growth, subsonic and intersonic dynamic fracture, rate- and state-dependent friction laws, fracture and friction at the small scales (nanomechanics), and finite-element analysis using commercial packages.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate, Undergraduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5683 Thermodynamics and Thermostatistics of Materials**

**Prerequisites:** ENSC 3313 or equivalent.

**Description:** Notions of energy, entropy, equilibrium, macrostates, and microstates and their relation to material processes and properties. Deriving material properties from equations of state: Maxwell relations. Statistical thermodynamics: predicting material properties from microstates. Partition function. Phase transformations. Thermodynamics of surfaces and defects. Electrochemistry. Same course as MSE 5683.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5693 Phase Transformations in Materials**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Principles of phase transformations in material. Structure of materials, phase diagrams, diffusion, solidification, and diffusional and diffusionless transformations will be covered. Recent developments in materials research relevant to phase transformations. Same course as MSE 5693.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5703 Optimization Applications****Prerequisites:** Graduate standing.**Description:** A survey of various methods of unconstrained and constrained linear and non-linear optimization. Applications of these methodologies using hand-worked examples and available software packages. Intended for engineering and science students. Same course as CHE 5703, ECEN 5703 & IEM 5023.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5713 Linear Systems****Prerequisites:** Graduate standing or consent of instructor.**Description:** Introduction to the fundamental theory of finite-dimensional linear systems with emphasis on the state-space representation. Mathematical representations of systems; linear dynamic solutions; controllability, observability, and stability; linearization and realization theory; and state feedback and state observer. Same course as ECEN 5713.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5733 Neural Networks****Prerequisites:** Graduate standing.**Description:** Introduction to mathematical analysis of networks and learning rules, and on the application of neural networks to certain engineering problems image and signal processing and control systems. Same course as CHE 5733 & ECEN 5733.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5753 Advanced Experimental Mechanics of Solids****Prerequisites:** MAE 5573 or consent of instructor.**Description:** Application of advanced experimental mechanics techniques to investigate and characterize response of solid materials. Course material includes use of at-a-point and full-field techniques, characterizing rate- and time-dependent material response, and techniques for finite deformation.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Mech & Aerospace Engr**MAE 5763 Wave Motion and Vibration of Continuous Media****Prerequisites:** MAE 5573 or consent of instructor.**Description:** Fundamentals of the formulation and solution of the problem of wave motion and vibration in continuous media. Propagation of stress waves and the implication of high-rate loading on mechanics problems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5773 Intelligent Systems****Prerequisites:** MAE 5733 or ECEN 5733.**Description:** Introduction to the state-of-the art intelligent control and system successfully deployed to industrial and defense applications. Emerging intelligent algorithms (e.g., bottom-up, top-down, semiotics); reinforcement learning and hybrid systems; and case studies and design projects. Same course as ECEN 5773.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5783 Principles of Autonomous Decision Making****Description:** This course will provide a detailed overview of the fundamental principles of autonomous decision making and their applications to various engineering and computer-science domains. This course will survey popular and emerging techniques in reasoning and perception as well as optimal decision making methodologies. Learning and reasoning paradigms include support vector machines, Gaussian Processes, and Bayesian Nonparametric Learning. Optimal decision making techniques include Markov Decision Processes, Planning and reinforcement learning.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5803 Advanced Thermodynamics I****Prerequisites:** Graduate standing or consent of instructor.**Description:** A rigorous examination of the fundamental principles of engineering thermodynamics to include the First Law, Second Law and availability, thermodynamics equations of state for single phase and multi-phase systems, chemically reactive systems, and equilibrium. A general purpose computer software program is used for examination of case studies of thermodynamic processes.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5813 Intermediate Heat Transfer****Prerequisites:** MAE 3233 or equivalent.**Description:** Continuation of the topics covered in the undergraduate heat transfer course (MAE 3233) with the addition of mass transfer. This course covers problems of heat and mass transfer in greater depth and complexity than is done in the undergraduate heat transfer course and incorporates the subjects that are not included or are treated lightly in that course. Analysis will be given greater emphasis than the use of correlations.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr

**MAE 5823 Radiation Heat Transfer**

**Prerequisites:** MAE 3233 or equivalent and graduate standing or consent of instructor.

**Description:** The mechanism of the transfer of energy by thermal radiation; radiant properties of materials, energy transfer prediction methods and solar energy topics.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5833 Transient Simulation of Thermal Systems**

**Prerequisites:** Graduate Standing or consent of instructor.

**Description:** This course provides an introduction to the transient simulation of building thermal systems. Learned material is reinforced in lab sections as well as in a semester project.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Mech & Aerospace Engr

**MAE 5843 Conduction Heat Transfer**

**Prerequisites:** ENSC 3233.

**Description:** Advanced heat transfer analysis and design, with primary emphasis on conduction.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5853 Computational Heat Transfer**

**Prerequisites:** MAE 3233, graduate standing, knowledge of FORTRAN.

**Description:** Computational techniques for the solution of two-dimensional heat transfer, fluid flow and related processes in problems of practical interest. A general-purpose computer program used to demonstrate the capabilities of the numerical method through a wide variety of engineering problems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5863 Building Heat Transfer and Simulation**

**Prerequisites:** ENSC 3233 and MAE 3524 and MAE 3233; Graduate Standing or Consent of Instructor.

**Description:** Conduction, convection and radiation heat transfer applied to building thermal simulation. Solar radiation.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5873 Advanced Indoor Environmental Systems**

**Prerequisites:** MAE 4703.

**Description:** Heating, air-conditioning, ventilation and refrigeration systems. System and component analysis, design and simulation.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5913 Advanced Aerodynamics**

**Prerequisites:** ENSC 3233 or equivalent.

**Description:** Aerodynamics of the subsonic, transonic, supersonic, and hypersonic flow regimes. Derivation of governing equations and fundamental principles. Analytical and computational analysis methods. Recent developments.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5923 Guidance and Control of Aerospace Vehicles**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Navigation, guidance and attitude control of aircraft, launch vehicles and spacecraft. Inertial navigation mechanizations and error analysis. Stability augmentation systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5933 Aeroelasticity**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Interaction between fluid dynamic, inertial and elastic forces. Development of analytical and computational methods for analysis. Application to a broad range of problems in engineering.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5943 Unsteady Aerodynamics and Aeroacoustics**

**Prerequisites:** ENSC 3233 or equivalent.

**Description:** Development of governing fluid dynamic equations for unsteady flows; linear unsteady aerodynamics for isolated and cascaded lifting surfaces; acoustics in moving media; three-dimensional duct acoustics; sound generation from isolated airfoils, cascaded airfoils, rotor-stator interactions, multiple pure-tone sources, propellers and jets.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Mech & Aerospace Engr

**MAE 5953 Aerospace Systems Engineering****Prerequisites:** MAE 3253 or equivalent.**Description:** Aircraft and spacecraft design from a systems perspective, covering basic systems engineering, cost and weight estimation, basic vehicle performance and trade study analysis, safety and reliability, lifecycle analysis, subsystem integration, risk analysis and management, system realization, and multi-disciplinary optimization (MDO). Additional topics include requirements identification and development, and program planning and control.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5963 Unmanned Aerial Systems Design and Analysis****Prerequisites:** Graduate standing or permission of instructor; MAE 5313.**Description:** This course covers concepts related to design and operation of unmanned systems focusing on unmanned aircraft, including remotely piloted and autonomous vehicles. History of unmanned systems.

Design of unmanned air systems including concepts of operations, communications, payloads, control and navigation, multiple air vehicle architectures, cooperative control and ISR. Design requirements for unmanned versus manned vehicles. Operation in conflicted airspace. Aspects of other unmanned systems, including ground, surface, underwater and space vehicles.

**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5973 Unmanned Aerial Systems Propulsion****Prerequisites:** Graduate standing or permission of instructor.**Description:** This course will cover propulsion topics used on Unmanned Aerial Systems (UAS). These will include: Historical perspective on UAS propulsion systems; Classification of propulsion types; Propulsion requirements for UAV; Propeller performance and design; Internal combustion engine; Heavy-Fuel ICE; ICE Muffler design; Electric motor; Hybrid-Electric engine; Fuel Cell engine; Flapping Wing propulsion; Jet engine; Propulsion system integration and installation effects.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 5983 Aircraft Certification and Test****Prerequisites:** Graduate standing or consent of instructor.**Description:** Exploration of the major engineering processes for airworthiness certification of manned and unmanned aircraft. Assessment of civil and military airworthiness regulations and their impact on certification program management and testing. Development of foundational concepts and processes for laboratory, ground and flight testing for airworthiness.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Mech & Aerospace Engr**MAE 5993 Microstructural Mechanics****Prerequisites:** Graduate standing or consent of instructor.**Description:** Build a framework to understand the various microstructures of materials with their respective roles in controlling mechanical properties. Grain size, orientation, surface facets, compositional gradients, and second or multiple phases, in combination with the three-dimensional arrangement of the various types of imperfections, together constitute the microstructure of a material. An emphasis will be placed on new research areas and exposure to methods for controlling and probing microstructures.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 6000 Doctoral Dissertation****Prerequisites:** Admission to MAE PhD program and consent of the student's dissertation adviser.**Description:** Independent research under the direct supervision of the student's doctoral dissertation adviser. Offered for variable credit, 1-15 credit hours, maximum of 42 credit hours.**Credit hours:** 1-15**Contact hours:** Contact: 1-15 Other: 1-15**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Mech & Aerospace Engr**MAE 6010 Advanced Study****Prerequisites:** Approval of the student's advisory committee.**Description:** Study and investigation under the supervision of a member of the faculty along lines of interest well advanced of and supported by the 5000-series courses. Offered for variable credit, 1-12 credit hours, maximum of 12 credit hours.**Credit hours:** 1-12**Contact hours:** Contact: 1-12 Other: 1-12**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Mech & Aerospace Engr**MAE 6123 Advanced Processing of Materials****Prerequisites:** Graduate standing or consent of instructor.**Description:** Rationale for non-traditional machining; various non-traditional machining processes, including electro-discharge machining, electro-chemical machining, plasma arc-, microwave-, and laser assisted processing, waterjet (abrasive) cutting, ultrasonic machining, chemical machining, thermal assisted processing and electron beam machining.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 6133 Surface Mechanics****Prerequisites:** Consent of instructor.**Description:** Models and solutions basic to surface studies. Equations of continuum mechanics, thermal field solutions at sliding interfaces, elasticity, plasticity. Applications of solution techniques to surface, surface layer and interface phenomena.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr

**MAE 6143 Thermal Analysis of Manufacturing Processes****Prerequisites:** Graduate standing and consent of instructor.**Description:** Thermal analysis of various moving heat source problems encountered in a variety of manufacturing processes, including machining, grinding, polishing, casting, welding, energy beam cutting and other tribological applications such as meshing of gears, cams, bearings. Analysis of both transient and steady state conditions.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 6233 Turbulent Fluid Dynamics****Prerequisites:** MAE 5233.**Description:** Isotropic turbulence, turbulent wakes and jets, bound turbulent shear flows, transition, hydrodynamic stability and integral calculation methods for turbulent boundary layers.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 6263 Computational Fluid Dynamics****Prerequisites:** Graduate standing; MAE 5093 and MAE 5233.**Description:** Numerical method and computational tool development for solving canonical partial differential equations and incompressible Navier-stokes equations employing both finite difference and finite volume algorithms. Strategies for improved pressure-velocity coupling and implicit time-stepping.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 6293 Geophysical Fluid Dynamics****Prerequisites:** MAE 5233.**Description:** Development of governing fluid dynamic equations for high-Reynolds number flows, including their stability, their waves, and the influence of rotating and stratification as applied to geophysical and astro-physical fluid dynamics. Examples of problems studies include vortex dynamics in planetary atmospheres and protoplanetary disks, jet streams, and waves (Rossby, Poincare, inertial, internal gravity, and Kelvin) in the ocean and atmosphere.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 6313 Atmospheric Flight Control****Prerequisites:** (MAE 4283 and MAE 4053) or (MAE/ECEN 5713 or MAE/ECEN 5473 or MAE 5923) or equivalent. Graduate standing or consent of instructor.**Description:** Application of modern multivariable control and estimation techniques to aerospace flight vehicles. Fundamental tradeoffs between controller complexity and performance requirements, and translation of handling quality specifications into requirements for control system designs.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 6423 System Identification****Prerequisites:** MAE 5473 or MAE 5713 or ECEN 5473 or ECEN 5713.**Description:** Linear and nonlinear system modeling of random systems. Models of linear time-invariant systems, nonparametric methods and preliminary model development, parameter estimation methods, convergence and consistency, asymptotic distributions of parameter estimates, nonlinear modeling. Same course as ECEN 6423.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 6453 Adaptive Control****Prerequisites:** MAE 5473 or ECEN 5473 or ECEN 5713 or MAE 5713.**Description:** Analysis and design of control techniques which modify their performance to adapt to changes in system operation. Review of systems analysis techniques, including state variable representations, linearization, discretization, covariance analysis, stability, and linear quadratic gaussian design. On-line parameter estimation, model reference adaptive systems, self-tuning regulators, stable adaptive systems. Same course as ECEN 6453.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 6463 Advances in Nonlinear Control****Prerequisites:** MAE 5463 or ECEN 5463.**Description:** Introduction to vector fields and Lie algebra: controllability and observability of nonlinear systems; local decompositions; input-output and state-space representation on nonlinear systems; feedback linearization; controlled invariance and distribution; control of Hamiltonian systems. Same course as ECEN 6463.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr

**MAE 6483 Robust Multivariate Control Systems****Prerequisites:** MAE 5713 or ECEN 5713.**Description:** Introduction to multivariable systems: SISO robustness vs. MIMO robustness; multivariable system poles and zeros; MIMO transfer functions; multivariable frequency response analysis; multivariable Nyquist theorem; performance specifications; stability of feedback systems; linear fractional transformations (LFT's); parameterization of all stabilizing controllers; structured singular value; algebraic Riccati equations; H<sub>2</sub> optimal control; H-infinity controller design. Same course as ECEN 6483.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr**MAE 6843 Convection Heat Transfer****Prerequisites:** MAE 5233 or equivalent.**Description:** Advanced convective heat transfer in laminar and turbulent flows over external surfaces and inside channels. Heat transfer at high velocities, free convection boundary layers, and mass transfer.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Mech & Aerospace Engr

## Undergraduate Programs

- Aerospace Engineering, BSAE (p. 2290)
- Mechanical Engineering, BSME (p. 2292)
- Mechanical Engineering: Fire Protection Systems, BSME (p. 2294)
- Mechanical Engineering: Petroleum, BSME (p. 2296)
- Mechanical Engineering: Pre-Medical, BSME (p. 2298)

## Graduate Programs

The School of Mechanical and Aerospace Engineering offers programs leading to the degree of Master of Science and Master of Engineering in Mechanical and Aerospace Engineering, and the degree of Doctor of Philosophy in Mechanical and Aerospace Engineering. The Master of Science and the Doctor of Philosophy degrees offer an option in Unmanned Aerial Systems and prepare the graduate for research and development positions in industry and government, or for the teaching profession in engineering. They are distinguished by the incorporation of a research component.

The Master of Engineering degree is a coursework only degree that prepares the graduate for technical leadership positions in industry and government.

Students may select coursework and participate in research or design projects in the following areas: aerospace & mechanical thermal systems, dynamics & controls, fluid mechanics, solid mechanics, mechanics of materials, materials & manufacturing and unmanned & aerospace systems integration, and design. Students are encouraged to take courses in mathematics and science and in other fields of engineering which fit into their programs.

## Admission Requirements

Admission to the Graduate College is required of all students pursuing the MS, ME, or PhD degree. Graduation from a mechanical or aerospace engineering curriculum accredited by ABET, with scholastic performance

distinctly above average, qualifies the student for admission to the School of Mechanical and Aerospace Engineering as a candidate for the MS, ME, and PhD degrees. Graduates from disciplines other than mechanical or aerospace engineering may be admitted if an evaluation of their transcripts by the School of Mechanical and Aerospace Engineering indicates they are prepared to take graduate-level coursework in mechanical or aerospace engineering or can be expected to do so after a reasonable amount of prerequisite work.

## Degree Requirements

All degree programs follow an approved plan of study designed to satisfy the individual goals of the student, while conforming to the general requirements of the School of Mechanical and Aerospace Engineering and the Graduate College.

The Master of Science degree program requires 24 credit hours of approved graduate-level coursework and a suitable research thesis of six credit hours. The Master of Engineering degree requires 30 credit hours of approved graduate-level coursework and 3 hours of capstone experience coursework.

The Doctor of Philosophy degree requires a minimum of 60 credit hours beyond the master's degree consisting of 24-30 hours of formal coursework, 6 hours of Preliminary Examination credit and 24-30 hours of dissertation research credit. Qualified students may also enter the Ph.D. program directly with a Bachelor of Science degree. The direct to Ph.D. program requires a minimum of 90 credit hours beyond the Bachelor of Science degree consisting of 48-54 hours of formal coursework, 6 hours of Preliminary Examination credit and 30-36 hours of dissertation research credit.

## Faculty

**Daniel E. Fisher, PhD, PE—Professor and Head****Professor and Albert H. Nelson, Jr. Chair:** Daniel E. Fisher, PhD, PE**Regents Professor and Herrington Chair in Advanced Materials:** Don A. Lucca, PhD, Drhc, CMfgE**Regents Professor and OG&E Energy Technology Chair:** J.D. Spittle, PhD, PE**Professor and Tom J. Cunningham Chair and Director, NASA Oklahoma Space Grant Consortium/ EPSCoR:** Andrew S. Arena, Jr., PhD**Professor and John Hendrix Chair and Director, Unmanned Systems****Research Institute:** Jamey D. Jacob, PhD**Professor and Associate Dean, OSU-Tulsa, Helmerich Family Chair and Director, Helmerich Research Center:** Raman P. Singh, PhD**Professors:** Afshin J. Ghajar, PhD, PE (emeritus); James K. Good, PhD, PE (emeritus); Geir Hareland, PhD, PE (adjunct); Sandip Harimkar, PhD; Lawrence L. Hoberock, PhD, PE (emeritus); David G. Lilley, PhD, DSc, PE (emeritus); Richard L. Lowery, PhD, PE (emeritus); Christopher E. Price, PhD, PE (emeritus); Karl N. Reid, ScD (emeritus); Robert L. Swaim, PhD, PE (emeritus); Gary E. Young, PhD, PE (emeritus); Larry D. Zirkle, PhD, PE (emeritus)**Associate Professor and John Brammer Professorship:** Brian R. Elbing, PhD**Associate Professor and Carroll M. Leonard Fellow:** Arvind Santhanakrishnan, PhD**Associate Professors:** Christian Bach, PhD; Frank W. Chambers, PhD, PE (emeritus); Jay C. Hanan, PhD; Kaan Kalkan, PhD; James M. Manimala; Khaled A. Sallam, PhD; Shuodao Wang, PhD**Assistant Professors:** Aurelie Azoug, PhD; He Bai, PhD; Jacob Bair, PhD; Craig Bradshaw, PhD; Nicoletta Fala, PhD; Imraan Faruque, PhD; Jerome Hausselle, PhD; Rushikesh Kamalapurkar, PhD; Kursat Kara, PhD, PhD;

Hadi Noori, PhD; Ryan C. Paul, PhD; Kurt P. Rouser, PhD; Ritesh Sachan, PhD; Omer San, PhD; Yujiang "Mike" Xiang, PhD

**Lecturers:** Joseph P. Connor, Jr. (adjunct assistant professor); Ronald D. Delahoussaye, PhD (adjunct professor); Ehsan Moallem, PhD (adjunct assistant professor); Laura Southard (adjunct assistant professor)

**Research Professor and Director, New Product Development Center:**

Robert M. Taylor, PhD



## Aerospace Engineering, BSAE

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 123**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II <sup>1</sup>	
ENGL 1413	Critical Analysis and Writing II <sup>1</sup>	
ENGL 3323	Technical Writing <sup>1</sup>	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) <sup>1</sup>	4
MATH 2153	Calculus II (A) <sup>1</sup>	3
MATH 2163	Calculus III <sup>1</sup>	3
MATH 2233	Differential Equations <sup>1</sup>	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN) <sup>1</sup>	4
or CHEM 1515	Chemistry II (LN)	
PHYS 2014	University Physics I (LN) <sup>1</sup>	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Course designated (S)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2114	University Physics II (LN) <sup>1</sup>	4
Select one of the following:		3
ASTR 1013	The Solar System (N)	
ASTR 1023	Stars, Galaxies, Universe (N)	
BIOL 1114	Introductory Biology (LN)	
CHEM 3053	Organic Chemistry I	

GEOL 1114	Physical Geology (LN)	
GEOL 3413	Petroleum Geology for Engineers	
PHYS 3213	Optics	
PHYS 3313	Introduction to Semiconductor Device Physics	
PHYS 3713	Modern Physics	
<i>Engineering and Engineering Science</i>		
ENGR 1111	Introduction to Engineering <sup>1</sup>	1
ENGR 1332	Engineering Design with CAD for MAE <sup>1</sup>	2
ENGR 1412	Introductory Engineering Computer Programming <sup>1</sup>	2
ENGR 2421	Engineering Data Acquisition Controls Lab <sup>1</sup>	1
ENSC 2113	Statics <sup>1</sup>	3
ENSC 2123	Elementary Dynamics <sup>1</sup>	3
ENSC 2141	Strength of Materials Lab <sup>1</sup>	1
ENSC 2143	Strength of Materials <sup>1</sup>	3
ENSC 2213	Thermodynamics <sup>1</sup>	3
ENSC 2613	Introduction to Electrical Science <sup>1</sup>	3
<b>Hours Subtotal</b>		<b>29</b>
<b>Upper Division Major Requirements <sup>2</sup></b>		
ENSC 3231	Fluids and Hydraulics Lab	1
ENSC 3313	Materials Science	3
MAE 3013	Engineering Analysis and Methods I	3
MAE 3153	Introduction to MAE Design	3
MAE 3253	Applied Aerodynamics and Performance	3
MAE 3293	Fundamentals of Aerodynamics	3
MAE 3333	Fundamental Fluid Dynamics	3
MAE 3324	Mechanical Design I	4
MAE 3403	Computer Methods in Analysis and Design	3
MAE 3724	Dynamic Systems Analysis and Introduction to Control	4
MAE 4223	Aerospace Engineering Laboratory	3
MAE 4243	Aerospace Propulsion and Power	3
MAE 4283	Aerospace Vehicle Stability and Control	3
MAE 4374	Aerospace System Design	4
MAE 4513	Aerospace Structures	3
IEM 3503	Engineering Economic Analysis	3
<i>Upper Division Elective Requirements</i>		
3 hours of technical elective to be selected from the following list:		3
3000-level or above from:		
BAE, CHE, CIVE, ECEN, IEM, MAE, PETE engineering		
BCOM 3223	Oral Communication	
MATH 3303	Advanced Perspectives on Functions and Modeling for Secondary Teachers	
MGMT 3133	Developing Leadership Skills	
PHIL 3803	Business Ethics (H)	
PHIL 3833	Biomedical Ethics (H)	
4000-level or above courses from:		
ECON 4113	Energy Economics: Traditional and Renewable Energy Markets	
MGMT 4073	Management and Ethical Leadership	
MGMT 4533	Leadership Dynamics	

Or from MATH, MET, or STAT

<b>Hours Subtotal</b>	<b>52</b>
<b>Total Hours</b>	<b>123</b>

- <sup>1</sup> MAE requires grades of "C" or better in all prerequisite courses, and their prerequisites.
- <sup>2</sup> Grades of "C" or higher in all Upper Division Major Requirements courses

## Graduation Requirements

1. A minimum Technical GPA of 2.00. The Technical GPA is calculated from all courses in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A "C" or better is required in each course that is designated with footnote 1 and footnote 2. In cases where there is a choice on a course that has footnote 1, the footnote applies to both courses.
3. The major engineering design experience, capstone course, is satisfied by MAE 4374 Aerospace System Design.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Mechanical Engineering, BSME

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 121**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II <sup>1</sup>	
ENGL 1413	Critical Analysis and Writing II <sup>1</sup>	
ENGL 3323	Technical Writing <sup>1</sup>	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) <sup>1</sup>	4
MATH 2153	Calculus II (A) <sup>1</sup>	3
MATH 2163	Calculus III <sup>1</sup>	3
MATH 2233	Differential Equations <sup>1</sup>	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN) <sup>1</sup>	4
or CHEM 1515	Chemistry II (LN)	
PHYS 2014	University Physics I (LN) <sup>1</sup>	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Course designated (S)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2114	University Physics II (LN) <sup>1</sup>	4
Select one of the following:		3
ASTR 1013	The Solar System (N)	
ASTR 1023	Stars, Galaxies, Universe (N)	
BIOL 1114	Introductory Biology (LN)	
CHEM 3053	Organic Chemistry I	

GEOL 1114	Physical Geology (LN)	
GEOL 3413	Petroleum Geology for Engineers	
PHYS 3213	Optics	
PHYS 3313	Introduction to Semiconductor Device Physics	
PHYS 3713	Modern Physics	
<i>Engineering and Engineering Science</i>		
ENGR 1111	Introduction to Engineering <sup>1</sup>	1
ENGR 1332	Engineering Design with CAD for MAE <sup>1</sup>	2
ENGR 1412	Introductory Engineering Computer Programming (1) <sup>1</sup>	2
ENSC 2113	Statics <sup>1</sup>	3
ENSC 2123	Elementary Dynamics <sup>1</sup>	3
ENSC 2143	Strength of Materials (STW students are recommended to concurrently take ENSC 2141) <sup>1</sup>	3
ENSC 2213	Thermodynamics <sup>1</sup>	3
ENSC 2613	Introduction to Electrical Science <sup>1</sup>	3
Choose one of the below laboratory options <sup>1</sup>		3
ENGR 2421 & ENSC 2141 & ENSC 3231	Engineering Data Acquisition Controls Lab and Strength of Materials Lab and Fluids and Hydraulics Lab	
MAE 3113	Measurements and Instrumentation	
<b>Hours Subtotal</b>		<b>30</b>
<b>Upper Division Major Requirements <sup>2</sup></b>		
ENSC 3313	Materials Science	3
MAE 3013	Engineering Analysis and Methods I	3
MAE 3153	Introduction to MAE Design	3
MAE 3233	Heat Transfer	3
MAE 3333	Fundamental Fluid Dynamics (STW students are recommended to concurrently take ENSC 3231)	3
MAE 3324	Mechanical Design I	4
MAE 3403	Computer Methods in Analysis and Design	3
MAE 3524	Thermal Fluids Design	4
MAE 3724	Dynamic Systems Analysis and Introduction to Control	4
IEM 3503	Engineering Economic Analysis	3
Select 7 hours of the following 2 categories, selecting one course from each category so that both categories are represented:		7
Category I (Realization): <sup>2</sup>		
MAE 4243	Aerospace Propulsion and Power	
MAE 4263	Energy Conversion Systems	
MAE 4353	Mechanical Design II	
MAE 4363	Advanced Methods in Design	
MAE 4513	Aerospace Structures	
MAE 4623	Biomechanics	
MAE 4703	Design of Indoor Environmental Systems	
MAE 4713	Thermal Systems Realization	
MAE 4723	Refrigeration Systems Design	
Category II (Capstone Design): <sup>2</sup>		
MAE 4344	Design Projects	
MAE 4354	Aerospace Systems Design for Mechanical Engineers	

*Upper Division Elective Requirements*

6 hours of MAE electives to be selected from the following list, or from courses in the Category I listed above, but not used to satisfy the category requirement: 6

MAE 3033	Design of Machines and Mechanisms
MAE 3123	Manufacturing Processes
MAE 3223	Thermodynamics II
MAE 3253	Applied Aerodynamics and Performance
MAE 3293	Fundamentals of Aerodynamics
MAE 4053	Automatic Control Systems
MAE 4063	Mechanical Vibrations
MAE 4273	Experimental Fluid Dynamics
MAE 4313	Advanced Processing of Engineered Materials
MAE 4333	Mechanical Metallurgy
MAE 4583	Corrosion
MAE 4733	Mechatronics Design

3 hours of technical elective to be selected from the following list (or from courses in the Category I listed above, but not used to satisfy the category requirement): 3

3000-level or above from:

BCOM 3223	Oral Communication
MATH 3303	Advanced Perspectives on Functions and Modeling for Secondary Teachers
MGMT 3133	Developing Leadership Skills
PHIL 3803	Business Ethics (H)
PHIL 3833	Biomedical Ethics (H)

Or from BAE, BIOL, BIOC, CHE, CHEM, CIVE, CS, ECEN, IEM, GEOL, LSB, MAE, PETE, or PHYS

4000-level or above courses from:

ECON 4113	Energy Economics: Traditional and Renewable Energy Markets
MGMT 4073	Management and Ethical Leadership
MGMT 4533	Leadership Dynamics

**Hours Subtotal** 49

Or from MATH, MET, or STAT

**Total Hours** 121

<sup>1</sup> MAE requires grades of "C" or better in all prerequisite courses, and their prerequisites.

<sup>2</sup> Grades of "C" or higher in all Upper Division Major Requirements courses and ME Realization Category course and Capstone Design Category course.

## Graduation Requirements

1. A "C" or better is required in each course that is designated with footnote 1 and footnote 2.
2. The major engineering design experience, capstone course, is satisfied by MAE 4344 Design Projects or MAE 4354 Aerospace Systems Design for Mechanical Engineers.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.

- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

# Mechanical Engineering: Fire Protection Systems, BSME

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average:** 2.00

**Total Hours:** 130

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
	or ENGL 1313	Critical Analysis and Writing I
Select one of the following:		3
ENGL 1213	Composition II <sup>1</sup>	
ENGL 1413	Critical Analysis and Writing II <sup>1</sup>	
ENGL 3323	Technical Writing <sup>1</sup>	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) <sup>1</sup>	4
MATH 2153	Calculus II (A) <sup>1</sup>	3
MATH 2163	Calculus III <sup>1</sup>	3
MATH 2233	Differential Equations <sup>1</sup>	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN) <sup>1</sup>	4
	or CHEM 1515	Chemistry II (LN)
PHYS 2014	University Physics I (LN) <sup>1</sup>	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Course designated (S)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2114	University Physics II (LN) <sup>1</sup>	4
<i>Engineering and Engineering Science</i>		
ENGR 1111	Introduction to Engineering <sup>1</sup>	1
ENGR 1332	Engineering Design with CAD for MAE <sup>1</sup>	2

ENGR 1412	Introductory Engineering Computer Programming (1) <sup>1</sup>	2
ENSC 2113	Statics <sup>1</sup>	3
ENSC 2123	Elementary Dynamics <sup>1</sup>	3
ENSC 2143	Strength of Materials (STW students are recommended to concurrently take ENSC 2141) <sup>1</sup>	3
ENSC 2213	Thermodynamics <sup>1</sup>	3
ENSC 2613	Introduction to Electrical Science <sup>1</sup>	3
Choose one one of the below laboratory options <sup>1</sup>		3
ENGR 2421 & ENSC 2141 & ENSC 3231	Engineering Data Acquisition Controls Lab and Strength of Materials Lab and Fluids and Hydraulics Lab	
MAE 3113	Measurements and Instrumentation	
Substitute Option to taking three 1-hour lab courses: ENGR 2421, ENSC 2141, and ENSC 3231		
<b>Hours Subtotal</b>		<b>27</b>
<b>Upper Division Major Requirements <sup>2</sup></b>		
ENSC 3313	Materials Science	3
MAE 3013	Engineering Analysis and Methods I	3
MAE 3153	Introduction to MAE Design	3
MAE 3233	Heat Transfer	3
MAE 3333	Fundamental Fluid Dynamics (STW students are recommended to concurrently take ENSC 3231)	3
MAE 3324	Mechanical Design I	4
MAE 3403	Computer Methods in Analysis and Design	3
MAE 3524	Thermal Fluids Design	4
MAE 3724	Dynamic Systems Analysis and Introduction to Control	4
IEM 3503	Engineering Economic Analysis	3
FPST 1213	Fire Safety Hazards Recognition	3
FPST 1373	Fire Suppression and Detection Systems	3
FPST 2243	Design and Analysis of Sprinkler Systems	3
FPST 3373	Fire Dynamics	3
FPST 4143	Industrial Ventilation and Smoke Control	3
Select 7 hours of the following 2 categories, selecting one course from each category so that both categories are represented:		7
Category I (Realization): <sup>2</sup>		
MAE 4243	Aerospace Propulsion and Power	
MAE 4263	Energy Conversion Systems	
MAE 4353	Mechanical Design II	
MAE 4363	Advanced Methods in Design	
MAE 4513	Aerospace Structures	
MAE 4703	Design of Indoor Environmental Systems	
MAE 4713	Thermal Systems Realization	
MAE 4723	Refrigeration Systems Design	
Category II (Capstone Design): <sup>2</sup>		
MAE 4344	Design Projects	
MAE 4354	Aerospace Systems Design for Mechanical Engineers	
<i>Upper Division Elective Requirements</i>		

3 hours of MAE electives to be selected from the following list, 3  
or from courses in the Category I listed above, but not used to  
satisfy the category requirement:

MAE 3033	Design of Machines and Mechanisms
MAE 3123	Manufacturing Processes
MAE 3223	Thermodynamics II
MAE 3253	Applied Aerodynamics and Performance
MAE 3293	Fundamentals of Aerodynamics
MAE 4053	Automatic Control Systems
MAE 4063	Mechanical Vibrations
MAE 4273	Experimental Fluid Dynamics
MAE 4313	Advanced Processing of Engineered Materials
MAE 4333	Mechanical Metallurgy
MAE 4583	Corrosion
MAE 4733	Mechatronics Design

3 hours of FPST/CET electives to be selected from the following 3  
list, or from courses in the Category I listed above, but not used to  
satisfy the category requirement:

3000-level or above from:

CET 4443	Construction Safety and Loss Control
FPST 3113	Advanced Special Hazard Suppression and Detection
FPST 3383	Building Electrical Systems
FPST 4213	Advanced Building Design and Analysis
FPST 4383	Fire and Evacuation Modeling

<b>Hours Subtotal</b>	<b>61</b>
<b>Total Hours</b>	<b>130</b>

<sup>1</sup> MAE requires grades of "C" or better in all prerequisite courses, and  
their prerequisites.

<sup>2</sup> Grades of "C" or higher in all Upper Division Major Requirements  
courses and ME Realization Category course and Capstone Design  
Category course.

## Graduation Requirements

1. A "C" or better is required in each course that is designated with  
footnote 1 and footnote 2.
2. The major engineering design experience, capstone course, is  
satisfied by MAE 4344 Design Projects or MAE 4354 Aerospace  
Systems Design for Mechanical Engineers.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at  
OSU; 15 of the final 30 or 50% of the upper-division hours in the major  
field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-  
fourth of hours earned by correspondence; 8 transfer correspondence  
hours.
- Students will be held responsible for degree requirements in effect at  
the time of matriculation and any changes that are made, so long as  
these changes do not result in semester credit hours being added or  
do not delay graduation.
- Degrees that follow this plan must be completed by the end of  
Summer 2027.

# Mechanical Engineering: Petroleum, BSME

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 130**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
	or ENGL 1313	Critical Analysis and Writing I
Select one of the following:		3
ENGL 1213	Composition II <sup>1</sup>	
ENGL 1413	Critical Analysis and Writing II <sup>1</sup>	
ENGL 3323	Technical Writing <sup>1</sup>	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) <sup>1</sup>	4
MATH 2153	Calculus II (A) <sup>1</sup>	3
MATH 2163	Calculus III <sup>1</sup>	3
MATH 2233	Differential Equations <sup>1</sup>	3
<i>Humanities (H)</i>		
Courses designated (H)		6
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		
CHEM 1414	General Chemistry for Engineers (LN) <sup>1</sup>	4
	or CHEM 1515	Chemistry II (LN)
PHYS 2014	University Physics I (LN) <sup>1</sup>	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Course designated (S)		3
<b>Hours Subtotal</b>		<b>42</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2114	University Physics II (LN) <sup>1</sup>	4
GEOL 3413	Petroleum Geology for Engineers	3
<i>Engineering and Engineering Science</i>		
ENGR 1111	Introduction to Engineering <sup>1</sup>	1

ENGR 1332	Engineering Design with CAD for MAE <sup>1</sup>	2
ENGR 1412	Introductory Engineering Computer Programming <sup>1</sup>	2
ENSC 2113	Statics <sup>1</sup>	3
ENSC 2123	Elementary Dynamics <sup>1</sup>	3
ENSC 2143	Strength of Materials (STW students are recommended to concurrently take ENSC 2141) <sup>1</sup>	3
ENSC 2213	Thermodynamics <sup>1</sup>	3
ENSC 2613	Introduction to Electrical Science <sup>1</sup>	3
Select one of the following: <sup>1</sup>		3
ENGR 2421 & ENSC 2141 & ENSC 3231	Engineering Data Acquisition Controls Lab and Strength of Materials Lab and Fluids and Hydraulics Lab <sup>1</sup>	
MAE 3113	Measurements and Instrumentation	
<b>Hours Subtotal</b>		<b>30</b>

<b>Upper Division Major Requirements <sup>2</sup></b>		
ENSC 3313	Materials Science	3
MAE 3013	Engineering Analysis and Methods I	3
MAE 3153	Introduction to MAE Design	3
MAE 3233	Heat Transfer	3
MAE 3333	Fundamental Fluid Dynamics	3
MAE 3324	Mechanical Design I	4
MAE 3403	Computer Methods in Analysis and Design	3
MAE 3524	Thermal Fluids Design	4
MAE 3724	Dynamic Systems Analysis and Introduction to Control	4
IEM 3503	Engineering Economic Analysis	3
GEOL 4323	Applied Well Log Analysis for Engineers	3
PETE 4303	Petroleum Rocks and Fluids	3
PETE 4313	Drilling and Well Completions	3
PETE 4333	Production Engineering	3
PETE 4343	Reservoir Engineering and Well Testing	3
Select 7 hours of the following 2 categories, selecting one course from each category so that both categories are represented:		7
Category I (Realization): <sup>2</sup>		
MAE 4243	Aerospace Propulsion and Power	
MAE 4263	Energy Conversion Systems	
MAE 4353	Mechanical Design II	
MAE 4363	Advanced Methods in Design	
MAE 4513	Aerospace Structures	
MAE 4623	Biomechanics	
MAE 4703	Design of Indoor Environmental Systems	
MAE 4713	Thermal Systems Realization	
MAE 4723	Refrigeration Systems Design	
Category II (Capstone Design): <sup>2</sup>		
MAE 4344	Design Projects	
MAE 4354	Aerospace Systems Design for Mechanical Engineers	

<b>Upper Division Elective Requirements</b>		
3 hours of MAE electives to be selected from the following list, or from courses in the Category I listed above, but not used to satisfy the category requirement:		3
MAE 3033	Design of Machines and Mechanisms	

MAE 3123	Manufacturing Processes
MAE 3223	Thermodynamics II
MAE 3253	Applied Aerodynamics and Performance
MAE 3293	Fundamentals of Aerodynamics
MAE 4053	Automatic Control Systems
MAE 4063	Mechanical Vibrations
MAE 4273	Experimental Fluid Dynamics
MAE 4313	Advanced Processing of Engineered Materials
MAE 4333	Mechanical Metallurgy
MAE 4583	Corrosion
MAE 4733	Mechatronics Design
<b>Hours Subtotal</b>	<b>58</b>
<b>Total Hours</b>	<b>130</b>

- <sup>1</sup> MAE requires grades of "C" or better in all prerequisite courses, and their prerequisites.
- <sup>2</sup> Grades of "C" or higher in all Upper Division Major Requirements courses and ME Realization Category course and Capstone Design Category course.

## Graduation Requirements

1. A minimum Technical GPA of 2.00. The Technical GPA is calculated from all courses in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A "C" or better is required in each course that is designated with footnote 1 and footnote 2. In cases where there is a choice on a course that has footnote 1, the footnote applies to both courses.
3. The major engineering design experience, capstone course, is satisfied by MAE 4344 Design Projects or MAE 4354 Aerospace Systems Design for Mechanical Engineers.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.



# Mechanical Engineering: Pre-Medical, BSME

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average:** 2.00

**Total Hours:** 135

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
	or ENGL 1313	Critical Analysis and Writing I
Select one of the following:		3
ENGL 1213	Composition II <sup>1</sup>	
ENGL 1413	Critical Analysis and Writing II <sup>1</sup>	
ENGL 3323	Technical Writing <sup>1</sup>	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) <sup>1</sup>	4
MATH 2153	Calculus II (A) <sup>1</sup>	3
MATH 2163	Calculus III <sup>1</sup>	3
MATH 2233	Differential Equations <sup>1</sup>	3
<i>Humanities (H)</i>		
Select 3 hours designated (H) from PHIL <sup>2</sup>		3
Select 3 hours designated (H) from ENGL		3
<i>Natural Sciences (N) <sup>1</sup></i>		
Must include one Laboratory Science (L) course		
CHEM 1515	Chemistry II (LN) <sup>1</sup>	5
BIOL 1114	Introductory Biology (LN)	4
<i>Social &amp; Behavioral Sciences (S)</i>		
Select 3 hours designated (S) from PSYC or SOC <sup>2</sup>		3
<b>Hours Subtotal</b>		<b>43</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>College/Departmental Requirements</b>		
<i>Basic Science</i>		
PHYS 2014	University Physics I (LN) <sup>1</sup>	4
PHYS 2114	University Physics II (LN) <sup>1</sup>	4
CHEM 3053	Organic Chemistry I	3
BIOL 1604	Animal Biology	4

## Engineering and Engineering Science

ENGR 1111	Introduction to Engineering <sup>1</sup>	1
ENGR 1332	Engineering Design with CAD for MAE <sup>1</sup>	2
ENGR 1412	Introductory Engineering Computer Programming <sup>1</sup>	2
ENSC 2113	Statics <sup>1</sup>	3
ENSC 2123	Elementary Dynamics <sup>1</sup>	3
ENSC 2143	Strength of Materials <sup>1</sup>	3
ENSC 2213	Thermodynamics <sup>1</sup>	3
ENSC 2613	Introduction to Electrical Science <sup>1</sup>	3
Select one of the following:		3
ENGR 2421 & ENSC 2141 & ENSC 3231	Engineering Data Acquisition Controls Lab and Strength of Materials Lab and Fluids and Hydraulics Lab	
MAE 3113	Measurements and Instrumentation	
<b>Hours Subtotal</b>		<b>38</b>
<b>Upper Division Major Requirements <sup>3</sup></b>		
ENSC 3313	Materials Science	3
MAE 3013	Engineering Analysis and Methods I	3
MAE 3153	Introduction to MAE Design	3
MAE 3233	Heat Transfer	3
MAE 3333	Fundamental Fluid Dynamics	3
MAE 3324	Mechanical Design I	4
MAE 3403	Computer Methods in Analysis and Design	3
MAE 3524	Thermal Fluids Design	4
MAE 3724	Dynamic Systems Analysis and Introduction to Control	4
CHEM 3112	Organic Chemistry Laboratory	2
CHEM 3153	Organic Chemistry II	3
IEM 3503	Engineering Economic Analysis	3
MICR 3033	Cell and Molecular Biology	3
Select 7 hours of the following 2 categories, selecting one course from each category so that both categories are represented:		7
Category I (Realization): <sup>3</sup>		
MAE 4243	Aerospace Propulsion and Power	
MAE 4263	Energy Conversion Systems	
MAE 4353	Mechanical Design II	
MAE 4363	Advanced Methods in Design	
MAE 4513	Aerospace Structures	
MAE 4623	Biomechanics	
MAE 4703	Design of Indoor Environmental Systems	
MAE 4713	Thermal Systems Realization	
MAE 4723	Refrigeration Systems Design	
Category II (Capstone Design): <sup>3</sup>		
MAE 4344	Design Projects	
MAE 4354	Aerospace Systems Design for Mechanical Engineers	
<i>Upper Division Elective Requirements</i>		
6 hours of MAE electives to be selected from the following list, or from courses in the Category I listed above, but not used to satisfy the category requirement:		6
MAE 3033	Design of Machines and Mechanisms	
MAE 3123	Manufacturing Processes	

MAE 3223	Thermodynamics II
MAE 3253	Applied Aerodynamics and Performance
MAE 3293	Fundamentals of Aerodynamics
MAE 4053	Automatic Control Systems
MAE 4063	Mechanical Vibrations
MAE 4273	Experimental Fluid Dynamics
MAE 4313	Advanced Processing of Engineered Materials
MAE 4333	Mechanical Metallurgy
MAE 4583	Corrosion
MAE 4733	Mechatronics Design

The following are suggested, but not required:

BIOC 3653	Survey of Biochemistry
BIOL 3023	General Genetics
BIOL 3204	Physiology
BIOL 4134	Embryology

CHEM 1314 is recommended with CHEM 1515 to meet the Oklahoma medical schools' requirement for 9 hours of inorganic chemistry

<b>Hours Subtotal</b>	<b>54</b>
<b>Total Hours</b>	<b>135</b>

- <sup>1</sup> MAE requires grades of "C" or better in all prerequisite courses, and their prerequisites.
- <sup>2</sup> Denotes medical school requirements. PSYC 1113 Introductory Psychology (S) is recommended to satisfy (3) hours of (S) requirement. PHIL 3833 Biomedical Ethics (H) is recommended to satisfy (3) hours of (H) requirement.
- <sup>3</sup> Grades of "C" or higher in all Upper Division Major Requirements courses and ME Realization Category course and Capstone Design Category course.

Note: The entrance requirements of medical schools of choice should be reviewed to ensure an application is competitive.

#### Graduation Requirements

1. A minimum Technical GPA of 2.00. The Technical GPA is calculated from all courses in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A "C" or better is required in each course that is designated with footnote 1 and footnote 3. In cases where there is a choice on a course that has footnote 1, the footnote applies to both courses.
3. The major engineering design experience, capstone course, is satisfied by MAE 4344 Design Projects or MAE 4354 Aerospace Systems Design for Mechanical Engineers.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as

these changes do not result in semester credit hours being added or do not delay graduation.

- Degrees that follow this plan must be completed by the end of Summer 2027.

## Mechanical Engineering Technology

Mechanical Engineering Technology (MET) is the component of engineering that specializes in mechanical design, computer-aided technologies, materials, mechanical power and manufacturing. MET is an excellent major for students interested in mechatronics, robotics, automotive manufacturing, agricultural machinery and processing, mining, shipbuilding, spacecraft, electronics manufacturing, food processing, aircraft metals and plastics production—nearly the entire spectrum of the industry. In the power areas, MET graduates are involved in vapor power cycles, gas power cycles, air conditioning, fluid power and power transmission. Manufacturing areas involving MET graduates include tool design, cost evaluation and control, plant operations, production planning and manufacturing methods.

At OSU, the MET curriculum is as rigorous as engineering programs and is nearly identical to the Mechanical Engineering (ME) curriculum for the first two years, but the upper-level major courses are taught with more emphasis on applications. Multiple MET major courses are popular among engineering undergraduate and graduate students who find value for their job search and thesis/dissertation research.

An important element in MET is the use of laboratory experience as a teaching tool. The MET program has laboratories in mechatronics, fluid power, materials, fluid mechanics, thermal science, basic instrumentation, 3D printing, computer-aided design, manufacturing and engineering (CAD/DAM/CAE). Senior capstone design courses, composed of student teams for SpeedFest (autonomous vehicle competition) or industry-sponsored interdisciplinary design projects, integrates the knowledge and skills learned during their course of study. The latest computer software is provided and supported for the courses that MET students take. Where appropriate, laboratories with modern computer data acquisition systems and on-screen displays are available.

In addition to the required mechanical engineering technology courses, students are provided a solid foundation in calculus, physics, chemistry, and computer science. Minor degree choices are available in mechatronics or entrepreneurship.

### Program Educational Objectives

The Mechanical Engineering Technology (MET) program at Oklahoma State University focuses on preparing graduates so that they are able to productively contribute at their workplace after a short introductory period. A graduate from the OSU MET program should be able to:

1. Employ the latest design and analysis tools in engineering and manufacturing.
2. Be a life-long learner through participation and membership in professional organizations, continuation of professional/graduate studies, and/or self-study.
3. Introduce new technologies and methods into their workplace to maximize value to their employer.
4. Work collaboratively in multi-disciplinary teams.
5. Demonstrate professionalism in the workplace by using the highest standards of ethics and personal integrity.

### Student Outcomes

Students graduating from the MET program are expected to achieve the following outcomes (1-5):

1. an ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve broadly-defined engineering problems appropriate to the discipline;
2. an ability to design systems, components, or processes meeting specified needs for broadly-defined engineering problems appropriate to the discipline;
3. an ability to apply written, oral, and graphical communication in broadly defined technical and non-technical environments; and an ability to identify and use appropriate technical literature;
4. an ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes; and
5. an ability to function effectively as a member as well as a leader on technical teams.

Preparation for a specific industrial function is accomplished by selecting courses that emphasize a given design area, such as fluid power, mechanical design, computer-aided design/manufacturing/engineering (CAD/CAM/CAE), power generation, and air conditioning and heating. Because the program focuses on the application of engineering principles to the pragmatic solution of problems, graduates are immediately productive with minimal on-the-job training, thus increasing their value to industry. Graduates of the MET program are prepared to function in the areas of product design, testing and evaluation; product application and maintenance field engineering; and technical sales and liaison. Industries employing MET graduates include manufacturing companies of all types (aircraft, automobile, compressor and turbine, fluid power manufacturers and others); energy companies (such as natural gas, electrical power generation, and the oil and gas industries); and service companies (transportation industry, architecture and professional engineering firms, and those supporting the oil and gas industry).

Companies utilizing the talents of MET graduates are diversified in their products, as well as geographical location, thus providing a variety of choices in respect to both type of work and place of residence and in diverse industrial, governmental and educational institutions.

The Mechanical Engineering Technology program is accredited by the Engineering Technology Accreditation Commission of ABET, <http://www.abet.org> (<http://www.abet.org/>).

### Program Educational Objectives

The Mechanical Engineering Technology (MET) program at Oklahoma State University focuses on preparing graduates so that they are able to productively contribute at their workplace after a short introductory period. A graduate from the OSU MET program should be able to:

1. Employ the latest design and analysis tools in engineering and manufacturing.
2. Be a life-long learner through participation and membership in professional organizations, continuation of professional/graduate studies, and/or self-study.
3. Introduce new technologies and methods into their workplace to maximize value to their employer.
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## Student Outcomes

Students graduating from the MET program are expected to achieve the following outcomes (1-5):

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2. an ability to design systems, components, or processes meeting specified needs for broadly-defined engineering problems appropriate to the discipline;
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Companies utilizing the talents of MET graduates are diversified in their products, as well as geographical location, thus providing a variety of choices in respect to both type of work and place of residence and in diverse industrial, governmental and educational institutions.

The Mechanical Engineering Technology program is accredited by the Engineering Technology Accreditation Commission of ABET, <http://www.abet.org> (<http://www.abet.org/>).

## Courses

### MET 1103 Introduction to Mechanical Engineering Technology

**Description:** Introduction to mechanical engineering technology, analytical techniques, and data presentation. Orientation to the mechanical engineering technologist's profession. Previously offered as MPT 1103.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

### MET 1121 Technical Graphics

**Prerequisites:** A grade of "C" or better in ENGR 1332 or ENGR 1322.

**Description:** Visualization of 3-D objects, sketching, manual drafting of engineering drawings to ANSI standards, interpreting typical industrial drawings.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Engineering Technology

### MET 1123 Technical Drawing and Basic CAD

**Description:** Sketching, manual drafting and CAD generation of engineering drawings to ANSI standards. Interpreting typical industrial drawings. Students with two years high school or one year practical ANSI drafting/CAD may substitute an advanced course in mechanical engineering technology with consent of their advisers. Previously offered as GENT 1153.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### MET 2103 Industrial Materials

**Prerequisites:** CHEM 1314 or CHEM 1215 or CHEM 1414.

**Description:** A survey of the properties, characteristics and applications of metals, polymers, ceramics and other industrial materials. Terminology, concepts and principles involved in material selection, specification and processing. Laboratory activities include data collection and report generation, determination of material properties, and evaluation of material characteristics. Previously offered as GENT 1103.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### MET 2223 Geometric Dimensioning and Tolerancing with Computer-Aided Design

**Prerequisites:** A grade of "C" or better in (GENT 1153 or MET 1123) or a grade of "C" or better in (ENGR 1332 or equivalent) and MET 1121 (can be concurrent enrollment in MET 1121).

**Description:** Theory and application of Geometric Dimensioning and Tolerancing (GD&T) technique. Creation and analysis of tolerances for manufacturing with advanced computer-aided design (CAD) and engineering drawings.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### MET 2313 Fundamentals of Hydraulic Fluid Power

**Prerequisites:** A grade of "C" or better in ENSC 2113 or GENT 2323.

**Description:** Basic fluid power concepts. Standard hydraulic symbols, component design and application, fluid power system considerations, design and operation. Previously offered as MPT 2313.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 3003 Dynamics**

**Prerequisites:** A grade of "C" or better in GENT 2323 or ENSC 2113.

**Description:** Plane motion of particles and rigid bodies. Force-acceleration, work-energy, and impulse-momentum principles. Graphical analysis, mechanisms and vibrations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 3113 Basic Instrumentation**

**Prerequisites:** A grade of "C" or better in MATH 2123 or MATH 2144, and PHYS 1214 or PHYS 2114, and GENT 3323 or ENSC 2143, and ENGR 2421.

**Description:** Data analysis. Theory, operational characteristics and application of transducers for measurement of strain, force, velocity, acceleration, displacement, time, frequency, temperature, pressure. Previously offered as MPT 3114.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 3223 Geometric Dimensioning and Tolerancing**

**Prerequisites:** A grade of "C" or better in MET 1123 or ENGR 1332 or equivalent.

**Description:** Theory and Application of Geometric Dimensioning and Tolerancing (GD&T) technique based on ASME Y14.5. Creation, analysis, and inspection of tolerances for manufacturing.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 3313 Applied Fluid Mechanics**

**Prerequisites:** A grade of "C" or better in (MATH 2123 or MATH 2144), (PHYS 1114 or PHYS 2014), and (GENT 2323 or ENSC 2113).

**Description:** Practical analysis of fluid systems including static forces, the Bernoulli and general energy equations, laminar and turbulent flows, measurements of flow and pressure, lift and drag, pumps, and fans. Previously offered as MPT 3313.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 3343 Physical Metallurgy**

**Prerequisites:** A grade of "C" or better in (CHEM 1215 or CHEM 1314 or CHEM 14114 or CHEM 1515).

**Description:** Analysis and evaluation of the properties of metals commonly used in product design. Property change caused by hot and cold working, and by heat treatment. Laboratory activities including metallographic specimen preparation, inspection and testing; and standard tests of tensile properties, hardenability, hardness and toughness. Previously offered as MFGT 3343.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 3353 Plastics**

**Prerequisites:** A grade of "C" or better in (MET 1123 or ENG 1332) and (MET 3343 or ENSC 3313).

**Description:** The course will provide an overview of commonly used commercial plastics processes. Plastic materials types, additives, polymer flow and physical and mechanical properties. The use of CAE will be used to generate part designs and process simulations.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 3413 Fundamentals of Pneumatic Fluid Power**

**Prerequisites:** A grade of "C" or better in MET 2313.

**Description:** Basic pneumatics concepts, gas laws, component design and application, system design considerations. Air logic. Previously offered as MPT 2413.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 3423 Intermediate Hydraulic Fluid Power**

**Prerequisites:** A grade of "C" or better in MET 2313.

**Description:** Review of fundamentals of hydraulic fluid power. Energy-efficient hydraulic systems, cartridge valves, dynamics of hydraulic systems, special topics associated with mobile hydraulic equipment.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 3433 Basic Thermodynamics**

**Prerequisites:** A grade of "C" or better in (MATH 2123 or MATH 2144) and (PHYS 1114 or PHYS 2014).

**Description:** Basic scientific principles of energy and the behavior of substances as related to engines and systems. Gas laws, vapors and engine cycles. Previously offered as MPT 3433 and GENT 3433.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 3453 Heat Transfer**

**Prerequisites:** A grade of "C" or better in (MATH 2144 or MATH 2123 and (PHYS 2014 or PHYS 1114).

**Description:** Conduction, convection, radiation, condensation and boiling heat transfer. Heat exchangers. Prediction of heat transfer rates. Retardation and enhancement of heat transfer. Course previously offered as MPT 4433 and GENT 4433.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 3543 Manufacturing Processes**

**Prerequisites:** Grade of "C" or better in (MET 1123 or ENG 1332) and (MET 3343 or ENSC 3313).

**Description:** Manufacturing processes used to transform new materials including metals and non-metals into finished goods. Traditional and nontraditional manufacturing processes. Introduction to CAD/CAM. Basic process selection. Meteorology and measurement fundamentals. Previously offered as GENT 1223 and MET 1213.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 3573 Advanced Production Processes**

**Prerequisites:** Grade "C" or better in (GENT 1223 or MET 1213) and (MET 1223 or MET 2223).

**Description:** Advanced manufacturing and production processes including polymers and plastics, powder metallurgy, foundry, welding and metal forming. Design for assembly (FDA) and design for manufacture (FDM). Previously offered as MFGT 3573.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 3803 Fundamentals of Mechatronics**

**Prerequisites:** Grade of "C" or better in EET 3104 or EET 2635.

**Description:** Fundamentals of mechatronic systems and components. Different modelling approaches used for mechatronics systems, sensors and actuators, data acquisition and interfacing, signal conditioning, and PLCs. Previously offered as GENT 3503. Same course as EET 3803.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4003 Machine Elements**

**Prerequisites:** A grade of "C" or better in (MATH 2133 or MATH 2153) and (GENT 3323 or ENSC 2143).

**Description:** Applications of statics and strength to the design of machine components. Problems of choosing materials, impact and fatigue loading.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4013 Parametric Computer-Aided Modeling**

**Prerequisites:** A grade of "C" or better in MET 1223.

**Description:** Computer-aided drafting and design using parametric, feature-based solid modeling techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4023 Advanced Mechanical Computer-Aided Design**

**Prerequisites:** A grade of "C" or better in MET 1123 or ENGR 1332 or equivalent.

**Description:** Computer-aided design methodologies and processes. State-of-the-art technologies and methodologies in 3D modeling and design processes.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4033 Applied Vibration and Acoustics**

**Prerequisites:** A grade of "C" or better in GENT 3323 or ENSC 2143.

**Description:** Free and forced vibration of mechanical systems with an emphasis on practical applications. Introduction to sound wave generation and propagation. Mechanical system design methods for noise and vibration mitigation.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4050 Advanced Mechanical Design**

**Prerequisites:** Junior standing and consent of instructor.

**Description:** Special problems in mechanical engineering technology. Previously offered as MFGT 4050 and MPT 4050. Offered for variable credit, 1-3 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-3

**Contact hours:** Contact: 1-3 Other: 1-3

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Engineering Technology

**MET 4103 Senior Design I**

**Prerequisites:** A grade of "C" or better in (MET 1223 or MET 2223 or MET 3223) and MET 4003.

**Description:** First part of a two semester sequence for the MET capstone project. Focuses on finding and beginning a practical engineering design project. Includes selected topics in engineering design, project management, ethics, and intellectual property.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4113 Practical Computational Fluid Dynamics**

**Prerequisites:** A grade of "C" or better in MET 3313 or ENSC 3233.

**Description:** An introduction to the practical use of Computational Fluid Dynamics (CFD) commercial software. Students will be introduced to the concepts governing CFD, but the majority of the class will be utilized in learning the use of a popular commercial code. May not be used for degree credit with MET 5113.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4123 Senior Design II**

**Prerequisites:** A grade of "C" or better in MET 4103 and ENGL 3323. Must be taken in the immediately subsequent semester after completing MET 4103.

**Description:** Second part of a two semester sequence for the MET capstone project. Finishes work on the practical engineering design project begun in MET 4103. Includes selected topics in engineering design, project management, ethics, and intellectual property.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4133 Interdisciplinary Design I**

**Prerequisites:** A grade of "C" or better in (MET 1223 or MET 2223) and MET 4003 and permission of the instructor.

**Description:** First part of an interdisciplinary capstone project for engineering technology seniors. Conduct mechanical design, prototype development, and project management on practical engineering design project. Same course as MET 4103.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4143 Interdisciplinary Design II**

**Prerequisites:** A grade of "C" or better in (MET 1223 or MET 2223) and MET 4003 and permission of the instructor.

**Description:** Second part of an interdisciplinary capstone project for engineering technology seniors. Conduct mechanical design, prototype development, and project management on practical engineering design project. Same course as MET 4123.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4173 Additive Manufacturing: Materials, Methods and Applications**

**Prerequisites:** Senior standing or consent of instructor.

**Description:** Theory and practice of additive manufacturing, materials and their applications in various fields. Discuss their applications in product development, data visualization, rapid prototyping, and specialized manufacturing, with special emphasis on direct digital manufacturing.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4203 Finite Element Methods**

**Prerequisites:** A grade of "C" or better in GENT 3323 or ENSC 2143.

**Description:** Application of Finite Element Methods to machine component design. Problems involving stress, strain, temperature and vibration will be solved using state of the art Finite Element Software. May not be used for degree credit with MET 4203.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4303 Computer Integrated Manufacturing**

**Prerequisites:** A grade of "C" or better in (GENT 1223 and MET 1213) and (MET 1223 or MET 2223).

**Description:** Introduction to programming techniques and manufacturing applications of computer numerical control (CNC) and robotics. Machine capabilities and tooling requirements with programs being prepared manually and with COMPACT II computer assistance.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4313 Electrohydraulics and Motion Control**

**Prerequisites:** Grade of "C" or better in MET 2313 and EET 1114.

**Description:** Principles of electronics as applied to fluid power controls. Trends in modern fluid power systems. Solenoid systems, proportional control, servosystems, programmable controllers, and robotics. Lab includes design, fabrication and operation of practical systems.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4413 Ground Source Heat Pump Systems**

**Prerequisites:** GENT 4433 and a grade of "C" or better in MET 3313 and GENT 3433.

**Description:** Design and applications of ground sourced heat pump systems. Heat pump performance, borehole heat transfer, pressure loss calculations and installation methods.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4453 Applied Thermodynamics**

**Prerequisites:** A grade of "C" or better in ENSC 2213 or GENT 3433.

**Description:** Mixtures, psychrometrics, combustion, heat engine cycles, heat pumps cycles, internal and external combustion engines. Refrigeration. Previously offered as MPT 4453.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4463 Thermal Fluids Laboratory**

**Prerequisites:** Grade "C" or better in (MET 3313 or ENSC 3233) and (GENT 3433 or MET 3433 or ENSC 2213). Prerequisite or concurrent enrollment in GENT 4433 or MET 4433.

**Description:** Prerequisite or concurrent enrollment in GENT 4433.

Experimental study of topics in fluid mechanics, thermodynamics, and heat transfer. Interpretation of experimental data and technical report writing. Previously offered as MPT 4463.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4503 Petroleum Operations**

**Prerequisites:** A grade of "C" or better in GENT 2323 or ENSC 2113.  
**Description:** An introduction to the petroleum industry and available careers is presented for all engineering technology disciplines. Coverage includes basic petroleum geology, drilling, well completions, producing equipment, field operations, blowout recovery procedures, and transportation of hydrocarbons along the flow path from reservoir to the refinery.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4713 Internal Ballistics**

**Prerequisites:** "C" or better in (ENSC 2123 or MET 3003) and (ENSC 3233 or MET 3313).

**Description:** This course focuses on the motion of a projectile in the air. Course topics include the vacuum trajectory, ballistic coefficient, aerodynamic forces and moments on the projectile, the point mass trajectory, the Coriolis effect, wind drift, gyroscopic drift, stability of projectiles, interaction between the firearm and the shooter, applications to long-range shooting, and project. May not be used for degree credit with MET 5713.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4723 External Ballistics**

**Prerequisites:** "C" or better in (ENSC 2123 or MET 3003) and (ENSC 3233 or MET 3313).

**Description:** This course focuses on the motion of a projectile in the air. Course topics include the vacuum trajectory, ballistic coefficient, aerodynamic forces and moments on the projectile, the point mass trajectory, the Coriolis effect, wind drift, gyroscopic drift, stability of projectiles, interaction between the firearm and the shooter, applications to long-range shooting, and project. May not be used for degree credit with MET 5723.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4733 Terminal Ballistics and Armor**

**Prerequisites:** Grade of "C" or better in (MET 3003 or ENSC 2123) and permission of the instructor.

**Description:** Practical applications of dynamics theories to the mechanical behavior of projectiles and targets at impact. Structural and body armor system design, test, and analyses. May not be used for degree credit with MET 5733.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4803 Mechatronics System Design**

**Prerequisites:** Grade of "C" or better in GENT 3123 and MET 3803 (can be concurrent enrollment in GENT 3123).

**Description:** Modelling of mechanical, electrical, and hydraulic components. Feedback control systems, electro-hydraulic drives, electrical drives, and microcontroller programming. Previously offered as GENT 4503. Same course as EET 4803.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4883 Tool Design**

**Prerequisites:** A grade of "C" or better in MET 2213 and MET 3343.

**Description:** Basic design and development of special tools for processing or manufacturing engineering materials. Design and specification and inspection tools using appropriate techniques of engineering graphics and analysis. Previously offered as MFGT 4883.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Engineering Technology

**MET 4953 Industrial Assessment and Improvement**

**Prerequisites:** Senior standing and consent of instructor.

**Description:** Plant assessment and improvement-based concepts, strategies, and tools for manufacturing operations. Emphasis is on small to medium-sized manufacturing operations. Issues include energy, water, waste, quality, and productivity analysis across the organization from a systems perspective. Justification of improvement projects and measurement of results. May not be used for degree credit with IEM 4953 or IEM 5953.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 4993 Mechanical Engineering Technology Practice**

**Prerequisites:** Junior standing and consent of department head.

**Description:** Supervised industrial experience in mechanical engineering technology practice with minimal continual duration of eight weeks. Comprehensive journal, written report, and oral presentation.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

**MET 5113 Practical Computational Fluid Dynamics**

**Prerequisites:** MET 3313 or ENSC 3233.

**Description:** An introduction to the practical use of Computational Fluid Dynamics (CFD) commercial software. Students will be introduced to the concepts governing CFD, but the majority of the class will be utilized in learning the use of a popular commercial code. May not be used for degree credit with MET 4113.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology



### **MET 5203 Finite Element Methods**

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### **MET 5713 Internal Ballistics**

**Prerequisites:** Graduate standing.

**Description:** This course is about launching a projectile using a gun barrel. Course topics include solid propellant combustion, design and manufacturing of ammunition, design and manufacturing of barrels, dynamics of bullets inside the barrel, design and dynamics of weapon systems, and project. May not be used for degree credit with MET 4713.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### **MET 5723 External Ballistics**

**Prerequisites:** Graduate standing.

**Description:** This course focuses on the motion of a projectile in the air. Course topics include the vacuum trajectory, ballistic coefficient, aerodynamic forces and moments on the projectile, the point mass trajectory, the Coriolis effect, wind drift, gyroscopic drift, stability of projectiles, interaction between the firearm and the shooter, applications to long-range shooting, and project. May not be used for degree credit with MET 4723.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

### **MET 5733 Terminal Ballistics and Armor**

**Prerequisites:** Graduate standing.

**Description:** Practical applications of dynamics theories to the mechanical behavior of projectiles and targets at impact. Structural and body armor system design, test, and analyses. May not be used for degree credit with MET 4733.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Engineering Technology

## **Undergraduate Programs**

- Mechanical Engineering Technology, BSET (p. 2307)

## **Faculty**

Chulho Yang, PhD, PE—Professor and Program Coordinator

**Professors:** Young Chang, PhD, PE, CFPS

**Associate Professors:** Aaron Alexander, PhD; Warren L. Lewis, MS

**Assistant Professors:** Hitesh Vora, PhD; Ilchung Park, PhD

**Teaching Associate:** Laura Emerson, MS

# Mechanical Engineering Technology, BSET

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average:** 2.00

**Total Hours:** 120-123

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan.		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
	or ENGL 1313	Critical Analysis and Writing I
ENGL 3323	Technical Writing <sup>1</sup>	3
<i>American History &amp; Government</i>		
Select one of the following:		
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2123	Calculus for Technology Programs I (A)	3-4
	or MATH 2144	Calculus I (A)
MATH 2133	Calculus for Technology Programs II (A)	3
	or MATH 2153	Calculus II (A)
<i>Humanities (H)</i>		
Courses designated (H)		
6		
<i>Natural Sciences (N) and Scientific Investigation (L)</i>		
Select one of the following:		
CHEM 1215	Chemical Principles I (LN)	
CHEM 1314	Chemistry I (LN)	
CHEM 1414	General Chemistry for Engineers (LN)	
PHYS 2014	University Physics I (LN)	4
PHYS 1214	College Physics II (LN)	4
	or PHYS 2114	University Physics II (LN)
<i>Social &amp; Behavioral Sciences (S)</i>		
Select one of the following:		
SPCH 2713	Introduction to Speech Communication (S)	3
<i>Additional General Education</i>		
Preparation for Calculus (A) (or three hours of (A) or (N) or (S) if MATH 1813 is not needed)		
3		
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
<b>Hours Subtotal</b>		<b>42-44</b>
<b>College/Departmental Requirements</b>		
<i>Specialty</i>		

MET 2223	Geometric Dimensioning and Tolerancing with Computer-Aided Design <sup>2</sup>	3
MET 2313	Fundamentals of Hydraulic Fluid Power	3
MET 3543	Manufacturing Processes <sup>3</sup>	3
<i>Related Specialty</i>		
ENGR 1111	Introduction to Engineering	1
ENGR 1412	Introductory Engineering Computer Programming	2-3
	or EET 1003	Introduction to Microcomputer Programming
EET 1134	Fundamentals of DC Circuits	4
EET 1214	Fundamentals of AC Circuits	4
ENSC 2113	Statics	3
	or GENT 2323	Statics
Select one of the following		3
MET 1123	Technical Drawing and Basic CAD <sup>4</sup>	
ENGR 1322 & MET 1121	Engineering Design with CAD and Technical Graphics	
ENGR 1332 & MET 1121	Engineering Design with CAD for MAE and Technical Graphics	
ENSC 2141	Strength of Materials Lab	1
ENGR 2421	Engineering Data Acquisition Controls Lab	1
ENSC 3231	Fluids and Hydraulics Lab	1
ENGR 2400	Heat Transfer and Thermodynamics Lab	1
<b>Hours Subtotal</b>		<b>30-31</b>
<b>Major Requirements</b>		
ENSC 2143	Strength of Materials	3
	or GENT 3323	Strength of Materials
MET 3433	Basic Thermodynamics <sup>5</sup>	3
MET 3453	Heat Transfer <sup>6</sup>	3
MET 3003	Dynamics	3
MET 3113	Basic Instrumentation	3
MET 3313	Applied Fluid Mechanics	3
MET 3343	Physical Metallurgy	3
MET 4003	Machine Elements	3
MET 4103	Senior Design I	3
	or MET 4133	Interdisciplinary Design I
MET 4123	Senior Design II	3
	or MET 4143	Interdisciplinary Design II
IEM 3503	Engineering Economic Analysis	3
	or IEM 3513	Economic Decision Analysis
Select 9 hours of the following:		9
MET 3353	Plastics	
MET 3413	Fundamentals of Pneumatic Fluid Power	
MET 3423	Intermediate Hydraulic Fluid Power	
MET 3573	Advanced Production Processes	
MET 3803	Fundamentals of Mechatronics	
MET 4023	Advanced Mechanical Computer-Aided Design	
MET 4033	Applied Vibration and Acoustics	
MET 4050	Advanced Mechanical Design	
MET 4113	Practical Computational Fluid Dynamics	
MET 4203	Finite Element Methods	

MET 4173	Additive Manufacturing: Materials, Methods and Applications	
MET 4303	Computer Integrated Manufacturing	
MET 4313	Electrohydraulics and Motion Control	
MET 4413	Ground Source Heat Pump Systems	
MET 4503	Petroleum Operations	
MET 4803	Mechatronics System Design	
MET 4993	Mechanical Engineering Technology Practice	
MET 4953	Industrial Assessment and Improvement	
<b>Hours Subtotal</b>		<b>42</b>
<b>Electives</b>		
A total of 6 credit hours from the following with at least 3 being upper-division hours: Accounting, Astronomy, Biology, Chemistry, Computer Science, Engineering, Engineering Technology, Entrepreneurship and Emerging Enterprise, Finance, Geology, Legal Studies in Business, Management, Marketing, Mathematics, Physics and Statistics. <sup>7</sup>		6
<b>Hours Subtotal</b>		<b>6</b>
<b>Total Hours</b>		<b>120-123</b>

<sup>1</sup> If B or higher is not earned in ENGL 1113 Composition I or ENGL 1313 Critical Analysis and Writing I, ENGL 1213 Composition II or ENGL 1413 Critical Analysis and Writing II is also required (per Academic Regulation 3.5 (p. 920)).

<sup>2</sup> MET 1223 also permitted.

<sup>3</sup> MET 1213 or GENT 1223 also permitted.

<sup>4</sup> GENT 1153 also permitted.

<sup>5</sup> GENT 3433 is also permitted.

<sup>6</sup> MET 4433 or GENT 4433 is also permitted.

<sup>7</sup> MATH 1513 can be taken here if a student needs to take MATH 1513 as a prerequisite for MATH 1813.

## Graduation Requirements

1. A minimum average Technical GPA of 2.00 is required. The technical GPA is calculated from all courses counting in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A grade of 'C' or better is required in all courses with an analytical or natural science designation or engineering or engineering technology prefix.
3. Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made so long as the changes do not delay graduation or result in semester hours being added.
4. The minimum requirements for the Mechanical Engineering Technology degree is 120. In cases where two courses can meet a requirement and they have differing credit hours, the lower credit hour course is typically recommended. The alternatives are largely listed to facilitate transfer into the MET degree from other programs.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.

- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## School of Architecture

The School of Architecture, founded in 1909, offers professional degree programs in both architecture and architectural engineering. The integration of these programs through shared faculty, facilities and coursework is a major strength of the School. It is one of few such integrated programs in the United States, and as such produces graduates who are particularly prepared for the interdisciplinary nature of professional practice. The School of Architecture is a primary unit in the College of Engineering, Architecture and Technology, and therefore benefits from excellent state-of-the-art resources which significantly enhance the student experience.

Oklahoma State University graduates are recruited by the leading architectural and architectural engineering firms across the United States and beyond. School of Architecture graduates are routinely accepted into premier graduate schools in architecture and related fields. The Oklahoma State University School of Architecture is particularly proud of having among its alumni many of the leaders of the best firms in the country, an AIA Gold Medalist (the highest award given to an architect), and presidents of the American Institute of Architects (AIA), the National Architectural Accreditation Board (NAAB), and the National Council of Structural Engineering Associations (NCSEA).

### Mission and Goals

Architecture is the creative blend of the art and science of designing a setting for human life. It is unique among today's professions in that its successful practice requires a blend of traits normally often considered less than compatible: human empathy, artistic creativity, technological competence, and organizational acumen and economic awareness. In contrast to other fine arts, architecture is rarely self-generated; it is rather a creative response to a stated or perceived human need. It must, therefore, be more user-oriented than fine art alone and more humane than pure science. Its design solutions are simultaneously subjective and objective, while striving to be functionally, technically and economically sound. Yet, in a seemingly insoluble contradiction, the keenest technological and economic functionality will fall far short of becoming architecture unless it also strongly appeals to spiritual and emotional values. When one thinks of the environment, one cannot help but see or recall architectural images: pyramids in Egypt, Greek and Roman temples, gothic cathedrals, medieval castles, industrial cities, modern skyscrapers and dwellings or entire cities which significantly express the culture and values of the people who live or lived there.

The mission of the School of Architecture is to cultivate a collaborative learning community focused upon critical thinking and ethical responsibility. To do so, the faculty embrace established fundamentals and encourage the exploration of emerging innovations in design. The vision of the school is to empower students to make creative contributions in the cause of architecture.

The School of Architecture endeavors to instill in each individual a sensitivity to human needs, a genuine concern for quality, integrity and high ideals, a positive attitude for life-long learning, and personal confidence in one's ability to make positive contributions to society.

The School's primary goal is to provide excellence in professional educational for students preparing to enter the private practice of architecture or architectural engineering, or affiliated disciplines. The School is proud to educate students that will become licensed

professionals in their field and assume positions of leadership within the profession and society.

### Accreditation

The School of Architecture offers two separately accredited professional degree programs. The Bachelor of Architecture degree, BArch, is accredited by the NAAB. The Bachelor of Architectural Engineering degree, BArchE, is accredited by the Accreditation Board for Engineering and Technology (ABET <http://www.abet.org> (<http://www.abet.org/>)) as an engineering program. Both programs require approximately five years of study to complete. In the United States, most registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB) is the sole agency authorized to accredit U.S. professional degree programs in architecture offered by institutions with U.S. regional accreditation. NAAB recognizes three types of degrees: the Bachelor of Architecture, the Master of Architecture and the Doctor of Architecture. A program may be granted an eight-year, three-year or two-year term of accreditation, depending on the extent of its conformance with established educational standards. Doctor of Architecture and Master of Architecture degree programs may require a pre-professional undergraduate degree in architecture for admission. However, the pre-professional degree is not, by itself, recognized as an accredited degree. The Oklahoma State University School of Architecture offers the following NAAB-accredited degree programs - BArch. (154 undergraduate credits).

The next NAAB accreditation visit will occur in 2025.

The next ABET accreditation visit will occur in 2021.

### Architecture

Architecture is the complex synthesis of creatively solving problems involving both art and science through the disciplined orchestration of image-making, activity organization, technological applications, legal constraints and budgetary parameters which together express culture, enhance quality of life and contribute to the environment.

Education in architecture consists of on-campus classroom and studio courses, where the focus is on observation and experimentation, and hands-on learning. The intellectual climate stimulates inquiry, introduces principles and values, and teaches the discipline necessary to work in collaboration with others. The goal of the program is to educate future leaders within the architecture profession.

In the pre-professional portion of the architectural program (approximately two years of study), the focus is on the fundamental principles of design and technology supplemented by appropriate general education courses in English, social sciences, natural sciences, math and humanities. These courses allow students to assimilate a beginning knowledge base in architecture along with a broader liberal-based component to their education.

Students who demonstrate proficiency in this portion of the program by meeting a specific set of admission criteria are eligible for admission to the professional program in architecture.

The professional program in architecture (typically three years) builds on the knowledge acquired in the pre-professional curriculum. Students expand their design and problem-solving abilities through a sequential series of design studios informed by courses dealing with structure, systems and materials, building technology, the history and theory of architecture, and business and project management

principles. In addition students fully utilize the computer as a design and communication tool in the problem-solving process.

The design studio is the center of the School's educational program. It is the setting where students and faculty work most closely together, and where all specialized study and knowledge comes together as a synthesized study in design. The record of OSU students' achievements in the design studios is evidenced by the success in national and international architectural design competitions.

## Architectural Engineering

Architectural engineering is a profession that combines the art and science known as architecture with a detailed knowledge of fundamental and applied engineering principles. In its broadest sense, it involves the creative application of science and technology to the design of structures meant for human occupancy. Architectural engineering differs from architecture in its focus upon the design of elements, systems and procedures for buildings, rather than the design of buildings themselves. Architectural engineers practice in a wide variety of professional engineering settings such as consulting firms, architectural firms, industrial or commercial organizations and governmental agencies.

The objective of the Bachelor of Architectural Engineering program is to provide a professional education to engineering students in building-related systems. OSU graduates possess broad-based knowledge, skills and judgment that prepare them to succeed in the profession of architectural engineering or in further studies at the graduate level. The program is designed to prepare students to contribute to society as professional engineers dealing with analysis, design and related activities within the construction industry. The program utilizes the broad resources of the University and a close relationship with the architectural program to provide in-depth understanding of professional engineering and sensitivity to other qualitative concerns related to the building environment faced by architectural engineers.

The primary focus of the architectural engineering program at OSU is the safe and economical design of technical systems used in buildings. Structural systems must withstand the various forces of nature such as gravity, winds and earthquakes while also accommodating users. These systems require a working knowledge of the mechanics of materials commonly used for building structures such as steel, timber and reinforced concrete. Within the major of Architectural Engineering, the School offers the option in Structural Engineering, and an option in Construction Project Management.

In the pre-professional portion of the architectural engineering program (approximately two years of study), the focus is on the underlying scientific and mathematical principles of engineering and basic design principles supplemented by appropriate general education courses in English, social sciences, natural sciences, math and humanities. These courses allow students to assimilate a beginning knowledge base in architecture and engineering along with a broader liberal-based component to their education. Students who demonstrate proficiency in this portion of the program by meeting a specific set of admission criteria are eligible for admission to the professional program in architectural engineering.

The professional program in architectural engineering (typically two to three years) builds on the scientific and architectural knowledge acquired in the pre-professional curriculum. Students acquire detailed technical engineering knowledge and problem-solving abilities through a series of progressively more detailed and comprehensive courses and studios.

Each architectural engineering course builds upon the preceding architectural engineering courses to develop in the student the ability to identify and solve meaningful architectural engineering problems. The coursework is specifically sequenced and interrelated to provide design experience at each level, leading to progressively more complex, open-ended problems. This coursework includes sensitizing students to socially-related technical problems and their responsibilities as engineering professionals to behave ethically and protect public safety. The program culminates in a capstone design course in which the students integrate analysis, synthesis and other abilities they have developed throughout the earlier portions of their study.

An integral part of this educational continuum from basic knowledge through comprehensive architectural engineering design are learning experiences that facilitate the students' abilities to function effectively in both individual and team environments. Students are exposed to a wide variety of problems dealing with contemporary issues in many contexts. Moreover, the program provides every graduate with learning experiences to develop effective written and oral communication skills. State-of-the-art computational tools are introduced and used as a part of the students' problem-solving process. Finally, the students' experience in solving ever-more-challenging problems provides them the ability to continue to learn independently throughout their professional careers.

The Architectural Engineering Program Educational Objectives expected of program graduates a few years after graduation are as follows. Graduates will:

- Be successful in pursuing a graduate degree if they choose to continue their education past a Bachelor's degree.
- Utilize their education in architectural engineering to contribute to society as licensed professional engineers;
- Excel in their careers, displaying leadership, initiative, and ethical character, technical ability, and engineering skills;
- Utilize the close relationship with the architecture program to develop a special ability to collaborate on interdisciplinary design teams
- Maintain membership in professional organizations, have an awareness of emerging technologies in the field, and have a positive attitude toward advancing their professional skills through life-long learning.

The architectural engineering program has adopted the following student outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The program outcomes were adopted with the concept that they would provide students with the educational experience necessary to successfully achieve the longer-term program educational objectives.

## Undergraduate Curriculum

The programs in architecture and architectural engineering are approximately five years long and offer the professional degrees of Bachelor of Architecture and Bachelor of Architectural Engineering.

Professional and liberal study electives provide extensive opportunities for educational breadth and depth. Minor plans of study are also available from the School of Architecture; the Architectural History/Theory minor (ASHT), the Architecture and Entrepreneurship minor (ASAE). A minor in Design (ASDS) is available for non-majors. A twelve-credit hour Graduate Certificate focused upon the Integrative Design of the Building Envelope is also available.

## Undergraduate Admission

Students who satisfy the University admission requirements and CEAT Admissions standards are eligible to enroll for the first two years of the program (pre-Professional School). Upon completion of these two years, the most qualified students are selected, upon application, by the School for admission to the upper division (Professional School). Admission is based upon academic achievement and professional potential. Admission criteria are subject to annual review by the School and may be obtained directly from the School.

Transfer students are required to furnish transcripts and course descriptions for previous classroom courses, as well as a portfolio with examples of previous studio work. Evaluation and enrollment by the School is on a course-by-course basis for all transfer students.

## General Education

All students of OSU are required to complete 40 hours of general education coursework. English composition, American History, Political Science, Social Sciences, Basic Science and Mathematics are part of the General Education requirements. Some required coursework in History and Theory of Architecture can be used for General Education (H) credit.

## Electives

Electives should be selected to comply with the appropriate undergraduate degree requirements for the program. (See 3.2 "Changes in Degree Requirements" in the "University Academic Regulations (<http://catalog.okstate.edu/university-academic-regulations/>)" section of the Catalog.) These requirements assure compliance with institutional and accreditation criteria.

## Study Abroad

The School of Architecture is committed to preparing its graduates for the professional opportunities presented by the expanding global economy. As part of this preparation, the School requires all architecture students to participate in one of its summer study-abroad courses of at least four weeks in length. Students study, in an organized and disciplined fashion, major examples of modern and historic architecture,

including urban issues in a range of places outside the United States. Analytic and artistic sketching skills, descriptive writing, and other forms of observational research and record keeping are important in these courses of study.

Alternatively, a student of Architecture may elect to spend a semester abroad, which would meet the conditions of the degree plan as well. At least a year before a student plans to study a semester abroad, foreign university program and coursework must be coordinated with the School of Architecture advisor and the OSU Study Abroad Office to ensure that courses taken abroad meet the requirements of the degree plan.

Experience has shown that participation in a study-abroad program significantly increases a student's level of maturity, independent thinking, and cultural and social awareness of others. Knowing the values and accomplishments of other cultures also makes a student a better and more responsible citizen of his or her own country.

## Faculty and Facilities

School of Architecture faculty have extensive academic and professional experience as successful practicing architects and architectural engineers. The faculty is diverse: one third are women, and one quarter are culturally diverse.

The school moved into the Donald W. Reynolds School of Architecture Building, a newly renovated facility in 2009, which provides spacious design studios, a large expanded architectural library, a day-lighting lab, workshops, classroom facilities and many other amenities. The Donald W. Reynolds School of Architecture Building received an AIA Oklahoma Honor Award recognizing it for outstanding design in 2011.

## Computers

All School of Architecture students enrolled in either the architecture or architectural engineering programs are required to purchase a laptop computer as they enter the design studio sequence. Updated specifications for the computer and software are provided each year, and posted to the School's website.

## Student Work

Projects submitted for regular class assignments may be retained by the School for archival and accreditation purposes. All work not retained for this purpose will be returned to the student.

## Student Body

Annual student enrollment is approximately 300 students.

## Academic Advising

Students admitted to CEAT and who wish to study in the School of Architecture are advised by the Architecture Academic Advisor. The College's Office of Student Academic Services also has the capability to provide advisement for all entering freshmen pre-professional architecture and architectural engineering students.

Each student is personally advised in the planning and scheduling of his or her coursework and is counseled and advised individually on matters of career choice, his or her activities at OSU, and on other academic matters. A digital academic file is created for each student at the time of initial enrollment.

## Admission to Professional School

Students applying for admission to the Professional School must first meet the required criteria established for each program. Applicants will be selected based upon their performance in the First and Second Year Architecture and Architectural Engineering curricula. Particular courses in the curricula, which have proven to be good indicators of success in the two programs, will be factored with a multiplier to increase their influence in the selection procedure. To be considered for either program, applicants must:

1. Complete a minimum of 55 credit hours of coursework (applicable to the degree plan) prior to admission to professional school.
2. Complete the following required first- and second-year courses with a grade of 'C' or better:
  - a. For the Architecture program: ARCH 1112, 1216, 2116, 2216, 2252, 2183, 2283, 2263, MATH 2114, PHYS 1114 or 2014, ENSC 2113, and ENGL 1113.
  - b. For the Architectural Engineering program: ARCH 1112, 1216, 2116, 2252, 2003, 2263, MATH 2114, PHYS 2014, ENSC 2113, ENSC 2143, ENGR 1412, and ENGL 1113.
3. Achieve a grade of "C" or better in all required ARCH prefix courses, substitutes for ARCH prefix courses, and prerequisites for ARCH prefix courses.
4. Achieve a 2.8 or higher Selection Grade Point Average. The Selection Grade Point Average (SGPA) will be calculated for each applicant by multiplying course credit hours by the multiplier, multiplying by the numerical course grade and dividing by the total factored hours. For consideration of admission to the Architecture program, several of the listed courses will have multipliers applied in the calculation of the Selection GPA. See the School of Architecture website for the Professional School Admissions Policy and the SGPA worksheet.

## Double Degree

Applicants wishing to enter into the Professional School in both the BArch and BArchE degree programs must apply for both programs and be accepted to each, independent of the other.

## Declaration and/or Change of Program

When students apply to Professional School, they must indicate whether they are applying for the architecture program or the architectural engineering program. Further, architectural engineering applicants must indicate which degree option they wish to pursue. If changing programs, Architecture to Architectural Engineering or vice versa, a formal application and admission to the other program through the Professional School application and admission process is required.

## Taking ARCH Prefix Courses When Not Admitted to Professional School

Students not admitted to Professional Schools may not enroll in any 3000-level or higher without prior permission of the instructor and Academic Advisor.

## Transfer Students

Students wishing to transfer into Professional School of the OSU School of Architecture must apply for admission to the Professional School in the same manner as OSU students.

## Completion of Required Pre-Professional School Courses

All students applying for admission to Professional School must satisfactorily complete all required courses for consideration by the end of the spring semester of the year of application.

## Application and Notification Dates

Application for admission, readmission or transfer to the Professional School of Architecture and Architectural Engineering must be made by the last working day of April of the year of intended admission. Notification of selection decisions will normally be made soon after June 1st but not before a two-week period after Grade Reports have been received by the School—if there should be any problem with a grade that may impact acceptance to Professional School the student should contact the School immediately. Selected applicants must confirm acceptance of the offer of a position in Professional School by the date indicated in the letter of offer.

## Reapplication

Applicants not admitted may reapply for admission to Professional School the following year; such applicants do not carry any priority or disadvantage but are included in the full application pool.

## Graduation

Students will graduate with the Bachelor of Architecture or Bachelor of Architectural Engineering degree upon the successful completion of the requirements articulated on the degree sheet. Architectural Engineering students are encouraged to complete the Fundamentals of Engineering Exam before graduation. Architecture majors are encouraged to establish an NCARB record before graduation. It is important to note that the accredited degree is the first step toward professional licensure; internship experience hours and examination are needed post-graduation for a student to become a licensed architect or licensed professional engineer.

## Courses

### ARCH 1112 Introduction to Architecture

**Description:** An introduction to the professions of architecture and architectural engineering. Previously offered as ARCH 1111.

**Credit hours:** 2

**Contact hours:** Lecture: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 1216 Architectural Design Studio I**

**Prerequisites:** Grade of "C" or better in ARCH 1112, or consent of instructor.

**Description:** Architectural graphics and design fundamentals. Students progressing in the Physics 1114/2014 and MATH 2144 course sequence will be given preference in enrollment. Additionally, students who have not received a grade for ARCH 1216 will be given first priority in enrollment. Students who have received a grade in this course will be admitted on a space available basis and at the discretion of the school head and architecture advisor.

**Credit hours:** 6

**Contact hours:** Lab: 12 Contact: 12

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**ARCH 2003 Architecture and Society (HI)**

**Description:** Design, planning, and building considered in their social and aesthetic contexts. Some sections may be restricted to Architectural Engineering majors, see course offerings. May not be used for degree credit with ARCH 2183.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**General Education and other Course Attributes:** Humanities, International Dimension

**ARCH 2100 Architectural Studies**

**Description:** Beginning studies in graphics and design in architecture. Offered for variable credit, 1-4 credit hours, maximum of 4 credit hours.

**Credit hours:** 1-4

**Contact hours:** Contact: 1-4 Other: 1-4

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Architecture

**ARCH 2116 Architectural Design Studio II**

**Prerequisites:** Grade of "C" or better in ARCH 1216.

**Description:** Students who have not received a grade for ARCH 2116 will be given first priority in enrollment. Students who have received a grade in this course will be admitted on a space available basis and at the discretion of the school head and architecture advisor. Problems in architectural design.

**Credit hours:** 6

**Contact hours:** Lab: 12 Contact: 12

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**ARCH 2183 History and Theory of Architecture I**

**Description:** History and theory of the Pre-Enlightenment era of architecture in the Western world. May not be used for degree credit with ARCH 2003.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 2203 History and Theory of Architecture Since 1900**

**Prerequisites:** ARCH 2003. Grade of "C" or better.

**Description:** History and theory of world architecture in the 20th century and beyond. May not be used for degree credit with ARCH 2283.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 2216 Architectural Design Studio III**

**Prerequisites:** Grade of "C" or better in ARCH 1216 and ARCH 2116.

Students who have not received a grade for ARCH 2216 will be given first priority in enrollment. Students who have received a grade in this course will be admitted on a space available basis and at the discretion of the school head and architecture advisor.

**Description:** Problems in architectural design.

**Credit hours:** 6

**Contact hours:** Lab: 12 Contact: 12

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**ARCH 2252 Design Communication I: Visual and Graphic Acuity**

**Prerequisites:** Co-requisite enrollment in ARCH 2116 or permission of instructor.

**Description:** Introduction to the communication strategies unique to the professions of architecture and architectural engineering.

**Credit hours:** 2

**Contact hours:** Lecture: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 2263 Building Systems**

**Prerequisites:** Grade of "C" or better in ARCH 1216 and ARCH 2116.

**Description:** Architectural, structural, and environmental control systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 2283 History and Theory of Architecture II (H)**

**Description:** A study of mankind's accomplishments exhibited in architecture from the renaissance to the present day. May not be used for degree credit with ARCH 2203.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**General Education and other Course Attributes:** Humanities



**ARCH 2890 Honors for Topics in Architecture****Prerequisites:** Honors student standing.**Description:** Honors Topics course to be used as an Add on for students concurrently enrolled in other ARCH courses, or can be used as a stand-alone course. Enrichment experiences to enhance the understanding of Architectural design. Offered for variable credit, 1-3 credit hours, maximum of 3 credit hours.**Credit hours:** 1-3**Contact hours:** Lecture: 1-3 Contact: 1-3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Architecture**General Education and other Course Attributes:** Honors Credit**ARCH 3043 Structural Loadings in Architecture****Prerequisites:** "C" or better in ENSC 2143, and/or co-requisite enrollment in ARCH 3143.**Description:** An exploration of types of loadings and their application in the design of building structures.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Architecture**ARCH 3083 History and Theory of Renaissance and Baroque Architecture (H)****Prerequisites:** ARCH 2003. Grade of "C" or better. Or ARCH 2283. Grade of "C" or better.**Description:** History and theory of Renaissance and Baroque architecture in the western world.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Architecture**General Education and other Course Attributes:** Humanities**ARCH 3100 Special Topics in Architecture****Description:** Subjects to be selected by the faculty in architecture from advances in state-of-the-art areas. Offered for variable credit, 1-6 credit hours, maximum of 12 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Architecture**ARCH 3116 Architectural Design Studio IV****Prerequisites:** Grade of "C" or better in ARCH 1216 and admission to Professional School.**Description:** Problems in architectural design.**Credit hours:** 6**Contact hours:** Lab: 12 Contact: 12**Levels:** Undergraduate**Schedule types:** Lab**Department/School:** Architecture**ARCH 3143 Structures: Analysis I****Prerequisites:** Grade of "C" or better in ENSC 2143.**Description:** Structural theory for applications in architecture. Previously offered as ARCH 3243.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Architecture**ARCH 3163 Architectural Science I: Thermal Systems and Life Safety for Architects****Prerequisites:** Admission to Professional School, or permission of instructor.**Description:** A survey of the scientific and design fundamentals of thermal comfort, building physics, building performance and energy concerns, and mechanical systems for buildings as well as the basic principles of life safety. May not be used for degree credit with ARCH 4134 or ARCH 4163. Previously offered as ARCH 3134.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Architecture**ARCH 3173 History and Theory of American Architecture****Prerequisites:** ARCH 2003. Grade of "C" or better. Or ARCH 2283. Grade of "C" or better.**Description:** History and theory of American architecture from the colonial period to the present day.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Architecture**ARCH 3216 Architectural Design Studio V****Prerequisites:** Grade of "C" or better in ARCH 3116.**Description:** Problems in architectural design.**Credit hours:** 6**Contact hours:** Lab: 12 Contact: 12**Levels:** Undergraduate**Schedule types:** Lab**Department/School:** Architecture**ARCH 3223 Structures: Timbers****Prerequisites:** Grade of "C" or better in ARCH 3323.**Description:** Analysis and design of timber structures used in architecture.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Architecture**ARCH 3224 Structures: Steel II****Prerequisites:** Grade of "C" or better in ARCH 3323 and ARCH 3143.**Description:** Design and analysis of multi-story steel frames, trusses, arches, and other architectural structure components. Previously offered as ARCH 4244 and ARCH 4144.**Credit hours:** 4**Contact hours:** Lecture: 3 Lab: 2 Contact: 5**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Architecture

**ARCH 3252 Computer Applications in Architecture I**

**Prerequisites:** Grade of C or better in ARCH 2116, and concurrent enrollment in ARCH 2216.

**Description:** Introduction to 2D and 3D computer topics and their application in the design process. No credit for students with credit in ARCH 3253.

**Credit hours:** 2

**Contact hours:** Lecture: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 3262 Design Communication II: Advanced Digital Applications**

**Prerequisites:** Grade of "C" or better in ARCH 2252 and ENGR 1412 and admission to Professional School.

**Description:** State-of-the-art applications of computers to the practice of architecture and architectural engineering. Previously offered as ARCH 4053.

**Credit hours:** 2

**Contact hours:** Lecture: 1 Lab: 2 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 3263 Materials In Architecture**

**Prerequisites:** Grade of "C" or better in ARCH 2263 and admission to Professional School.

**Description:** Introduction to the basic materials used in the construction of architecture and how such materials affect both the design and implementation of the systems that incorporate these materials.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 3273 History and Theory of Medieval Architecture**

**Prerequisites:** ARCH 2003, Grade of "C" or better. Or ARCH 2183, Grade of "C" or better. Or consent of instructor.

**Description:** History and theory of the architecture created between the 8th and 15th centuries in Europe, and its impact on the subsequent religious architecture of today.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 3323 Structures: Steel I**

**Prerequisites:** Grade of "C" or better in ENSC 2113 and admission to the Professional Program or permission of school head and advisor.

**Description:** Analysis and design of steel structures used in architecture.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 3343 Structures: Steel II**

**Prerequisites:** Grade of "C" or better in ARCH 3323, ARCH 3043, and ARCH 3143.

**Description:** Analysis, design, detailing and documentation of multi-story steel structures, and other structural components used in architecture applications. Previously offered as ARCH 3224.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 3353 Advanced Graphics and Theory of Representation**

**Prerequisites:** Grade of "C" or better in ARCH 2252 or consent of instructor.

**Description:** Manual and digital graphic techniques are explored in a project-based studio learning environment.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 3373 Design and Diversity in Urban Centers of the US**

**Prerequisites:** Permission of Instructor.

**Description:** Field study analysis of the diverse social and cultural issues evidenced through the design of architecture in major urban centers of the United States. Previously offered as ARCH 3370.

**Credit hours:** 3

**Contact hours:** Lab: 6 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**ARCH 3433 Architectural Science II: Acoustics, Lighting, and Service Systems**

**Prerequisites:** MATH 2144, Grade of "C" or better.

**Description:** A survey of scientific and design fundamentals of architectural acoustics, lighting, electrical, and signal, conveying, and plumbing systems for buildings. May not be used for degree credit with ARCH 4433.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 3473 History and Theory of Structures in Architecture (H)**

**Prerequisites:** "C" or better in ARCH 2003 or ARCH 2183 or ARCH 2283.

**Description:** A study of the language of structural systems as manifested in architecture through the ages.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**General Education and other Course Attributes:** Humanities

**ARCH 4073 History and Theory of Early Modern Architecture**

**Prerequisites:** ARCH 2003, Grade of "C" or better. Or ARCH 2283, Grade of "C" or better.

**Description:** History and theory of modern architecture in the western world from the industrial revolution to the early twentieth century.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 4093 Architectural Project Management**

**Prerequisites:** Concurrent enrollment in ARCH 4216 or ARCH 5226 or consent of instructor.

**Description:** Principles of management as applied to architectural and architectural engineering projects. Previously offered as ARCH 5293.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 4100 Special Topics in Architecture**

**Prerequisites:** Consent of instructor and head of the school.

**Description:** Subjects to be selected by the faculty in architecture from advances in state-of-the-art areas. Offered for variable credit, 1-6 credit hours, maximum of 12 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Architecture

**ARCH 4116 Design Studio VI**

**Prerequisites:** Grade of "C" or better in ARCH 3216 and ARCH 3262.

**Description:** Problems in architectural design. Previously offered as ARCH 4517.

**Credit hours:** 6

**Contact hours:** Lab: 12 Contact: 12

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**ARCH 4123 Structures: Concrete I**

**Prerequisites:** Grade of "C" or better in ARCH 3323.

**Description:** Analysis and design applications in architectural problems using concrete structures.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 4131 Architectural Science Lab**

**Prerequisites:** Enrollment by permission of instructor or academic advisor; senior standing.

**Description:** Laboratory experiments for building systems. Systems may include heating, cooling, electrical, lighting, acoustics and plumbing.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**ARCH 4143 Structures: Foundations for Buildings**

**Prerequisites:** Grade of "C" or better in ARCH 4123.

**Description:** Subsurface soil conditions and design of foundation systems and retaining walls for buildings.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 4163 Architectural Science I: Thermal Systems and Life Safety for Architectural Engineers**

**Prerequisites:** Admission to Professional School, or permission of instructor.

**Description:** A survey of the scientific and design fundamentals of thermal comfort, building physics, building performance and energy concerns, and mechanical systems for buildings, as well as the basic principles of life safety. May not be used for degree credit with ARCH 3134, ARCH 4134, or ARCH 3163. Previously offered as ARCH 4134.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 4173 History and Theory of Skyscraper Design (H)**

**Prerequisites:** ARCH 2003, Grade of "C" or better. Or ARCH 2283, Grade of "C" or better.

**Description:** History and theory of the development of the skyscraper in the USA from the late 19th century to the present.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**General Education and other Course Attributes:** Humanities

**ARCH 4183 History and Theory of Architecture: Cities**

**Prerequisites:** ARCH 2003, Grade of "C" or better. Or ARCH 2283, Grade of "C" or better.

**Description:** The development of cities as an aspect of architecture from ancient times to the twentieth century.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 4203 Experimental Design Lab**

**Credit hours:** 3

**Contact hours:** Lab: 6 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**ARCH 4216 Architectural Design Studio VII**

**Prerequisites:** Grade of "C" or better in ARCH 3134 and ARCH 3433 and ARCH 4116 and ARCH 4123.

**Description:** Problems in Architectural Design. May not be used for degree credit with ARCH 5226.

**Credit hours:** 6

**Contact hours:** Lab: 16 Contact: 16

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**Additional Fees:** Architecture Field Trip fee of \$16 applies.

**ARCH 4224 Structures: Concrete II**

**Prerequisites:** Grades of "C" or better in ARCH 3262, ARCH 4123, and concurrent enrollment in ARCH 4143.

**Description:** Design and analysis of multi-story reinforced concrete frames used in architecture applications. Previously offered as ARCH 4225.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 4233 Sustainable Design in Architecture**

**Prerequisites:** Grade of "C" or better in ARCH 3134 or ARCH 3163.

**Description:** Sustainability topics and their application to architecture.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 4263 Architecture Seminar**

**Prerequisites:** Co-requisite enrollment in ARCH 4216 or ARCH 5226, or permission of instructor.

**Description:** Topics in architecture and architectural engineering. May not be used for degree credit with ARCH 5263.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 4273 History and Theory of Islamic Architecture**

**Prerequisites:** ARCH 2003, Grade of "C" or better. Or ARCH 2183, Grade of "C" or better.

**Description:** Architecture of the Islamic World.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 4293 The Ethics of the Built Environment (H)**

**Prerequisites:** Admission to the professional program or consent of instructor.

**Description:** Analysis of basic values that determine the form of the built environment.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**General Education and other Course Attributes:** Humanities

**ARCH 4343 Structures: Concrete II**

**Prerequisites:** Grade of "C" or better in ARCH 3262 and ARCH 4123.

**Description:** Analysis, design, detailing and documentation of multi-story reinforced concrete structures, and other structural components used in architecture applications. Previously offered as ARCH 4224.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 4353 Computational Foundations**

**Description:** The use of advanced 3D digital design tools for architectural applications.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 4373 Field Study in Europe I**

**Prerequisites:** Senior standing in architecture or consent of instructor.

**Description:** On-site analysis and study of European architecture, culture, and urban design.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 4374 International Field Study (HI)**

**Prerequisites:** Admission to Professional Program in Architecture or Architectural Engineering or approval of instructor and head of school.

**Description:** On-site analysis and study of international architecture, culture and urban design.

**Credit hours:** 4

**Contact hours:** Lab: 8 Contact: 8

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**General Education and other Course Attributes:** Humanities, International Dimension

**ARCH 4383 History and Theory of Modern Architecture in Italy**

**Prerequisites:** ARCH 2003, Grade of "C" or better. Or ARCH 2283, Grade of "C" or better.

**Description:** History and theory of the progressive experimental architecture created in Italy in the Modern era amidst the cultural, economic, and political realities of 1909-1943.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 4433 Architectural Science II: Acoustics, Lighting, and Service Systems for Architectural Engineers**

**Prerequisites:** ENSC 2613, Grade of "C" or better.

**Description:** Engineering fundamentals of architectural acoustics, lighting, electrical, and signal, conveying, and plumbing systems for buildings. May not be used for degree credit with ARCH 3433.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 4444 Structures: Analysis II**

**Prerequisites:** Grade of "C" or better in ARCH 3143 and ENGR 1412.

**Description:** Mathematical formulation of architectural structural behavior. Matrix applications, finite element, finite differences, stability considerations, and three dimensional structural modeling.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

**ARCH 4991 Professional Development for Architects and Architectural Engineers**

**Prerequisites:** Admission to Professional School, or permission of instructor.

**Description:** Professional values, culture, mentorship, and leadership development companion course to a professional experience.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**ARCH 5003 Integrative Design**

**Prerequisites:** Admission to the Graduate College and the Architecture Graduate Certificate Program.

**Description:** Advanced Topics in Integrative Design.

**Credit hours:** 3

**Contact hours:** Contact: 3 Other: 3

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Architecture

**ARCH 5016 Architectural Design Studio VIII**

**Prerequisites:** Grade of "C" or better in ARCH 4216 or permission of school head or advisor.

**Description:** Problems in architectural design. May not be used with degree credit in ARCH 5117.

**Credit hours:** 6

**Contact hours:** Lab: 12 Contact: 12

**Levels:** Graduate, Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**ARCH 5023 Masonry Design and Analysis**

**Prerequisites:** Grade of "C" or better or concurrent enrollment in ARCH 4123, or by permission of instructor.

**Description:** Analysis and design of low-rise masonry structures and multi-story masonry shear walls, including code requirements, analysis techniques, design of components, and detailing of architectural engineering contract documents conforming to the relevant codes.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate, Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 5093 Real Estate Development**

**Prerequisites:** Admission to professional program, or consent of instructor.

**Description:** Introduction to real estate development as a function of project conception, analysis, design and delivery. Same course as EEE 5200.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate, Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 5100 Special Topics in Architecture**

**Prerequisites:** Consent of instructor and head of the school.

**Description:** Subjects to be selected by the faculty in architecture from advances in state-of-the-art areas. Offered for variable credit, 1-6 credit hours, maximum of 12 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate, Undergraduate

**Schedule types:** Independent Study

**Department/School:** Architecture

**ARCH 5117 Architectural Design Studio VIII**

**Prerequisites:** Grade of "C" or better in 4216 or permission of school head or advisor.

**Description:** Problems in architectural design. No credit for students with credit in ARCH 5116.

**Credit hours:** 7

**Contact hours:** Lab: 16 Contact: 16

**Levels:** Graduate, Undergraduate

**Schedule types:** Lab

**Department/School:** Architecture

**ARCH 5133 Advanced Energy Issues in Architecture**

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate, Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

**ARCH 5143 Structures: Special Loadings****Prerequisites:** Grade of "C" or better in ARCH 4444.**Description:** Mathematical formulations and modeling in architectural structures. Human response to vibrations. Seismic design in building. Design for extreme winds on buildings. Approximate methods for preliminary design of architectural structures. Previously offered as ARCH 5243.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Graduate, Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Architecture**ARCH 5193 Management of Architectural Practice****Prerequisites:** Fifth-year standing in architecture or architectural engineering or consent of instructor.**Description:** Principles of management as applied to the private practice of architecture and architectural engineering.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate, Undergraduate**Schedule types:** Lecture**Department/School:** Architecture**ARCH 5217 Architectural Design Studio IX****Prerequisites:** Grade of "C" or better in 5117 or consent of instructor.**Description:** Problems in architectural design. Previously offered as ARCH 5216.**Credit hours:** 7**Contact hours:** Lab: 16 Contact: 16**Levels:** Graduate, Undergraduate**Schedule types:** Lab**Department/School:** Architecture**ARCH 5226 Architectural Engineering Comprehensive Design Studio****Prerequisites:** Grade of "C" or better in ARCH 3224, ARCH 4134, ARCH 4224, and ARCH 4433.**Description:** Problems in architectural and architectural engineering design. May not be used for degree credit with ARCH 4216.**Credit hours:** 6**Contact hours:** Lab: 16 Contact: 16**Levels:** Graduate, Undergraduate**Schedule types:** Lab**Department/School:** Architecture**Additional Fees:** Architecture Field Trip fee of \$16 and Architecture Lecture fee of \$25 per credit hour apply.**ARCH 5263 Advanced Architecture Technology Seminar****Prerequisites:** Concurrent enrollment in ARCH 4216 or ARCH 5226, or permission of instructor.**Description:** Advanced topics in technology related to the disciplines of architecture and architectural engineering. May not be used for degree credit with ARCH 4263.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Architecture**ARCH 5373 Field Study in Europe II****Prerequisites:** Senior standing in architecture or consent of instructor**Description:** On-site analysis and study of European architecture, culture and urban design.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate, Undergraduate**Schedule types:** Lecture**Department/School:** Architecture**ARCH 5493 Entrepreneurship and Architecture****Prerequisites:** Senior standing.**Description:** Introduction to entrepreneurship within the context of architecture, with direct application to architectural services, activities, and products. Emphasis on implementing the entrepreneurial process in starting and sustaining new ventures that significantly shape the built environment. Same course as EEE 5493.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate, Undergraduate**Schedule types:** Lecture**Department/School:** Architecture**ARCH 6000 Special Problems****Prerequisites:** Consent of instructor and head of school.**Description:** Theory, research or design investigation in specific areas of study in the field of architecture and its related disciplines. Plan of study determined jointly by student and graduate faculty. Offered for variable credit, 1-15 credit hours, maximum of 15 credit hours.**Credit hours:** 1-15**Contact hours:** Contact: 1-15 Other: 1-15**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Architecture**ARCH 6083 History and Theory of Contemporary Architecture****Prerequisites:** Graduate standing or consent of instructor**Description:** American architecture beginning in the 16th century through the 20th century.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate, Undergraduate**Schedule types:** Lecture**Department/School:** Architecture**ARCH 6113 Creative Component Research****Prerequisites:** Admission to graduate program.**Description:** Data gathering, analysis and program formulation related to creative component.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Architecture**ARCH 6117 Graduate Design Studio****Prerequisites:** Admission to graduate program.**Description:** Problems in architectural design.**Credit hours:** 7**Contact hours:** Lab: 14 Contact: 14**Levels:** Graduate**Schedule types:** Lab**Department/School:** Architecture

### **ARCH 6203 Creative Component in Architectural Engineering**

**Description:** A design project based on a program previously developed by the student, to include a written report and supporting documents when appropriate. Must be approved by the project advisor and completed in the final semester of the graduate program.

**Credit hours:** 3

**Contact hours:** Lab: 6 Contact: 6

**Levels:** Graduate

**Schedule types:** Lab

**Department/School:** Architecture

### **ARCH 6207 Creative Component in Architecture**

**Prerequisites:** ARCH 6117.

**Description:** A design project based on a program previously developed by the student to include a written report and supportive documents when appropriate. Must be approved by the project adviser and completed in the final semester of the graduate program.

**Credit hours:** 7

**Contact hours:** Contact: 7 Other: 7

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Architecture

### **ARCH 6243 Structures: Analysis III**

**Prerequisites:** Grade of "C" or better in ARCH 4444 and admission to the graduate program.

**Description:** Analysis techniques for architectural structures including stability, space frames, computer applications, guyed towers and project research.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Architecture

### **ARCH 6343 Structures: Steel III**

**Prerequisites:** Grade of "C" or better in ARCH 3224, or by permission of instructor.

**Description:** Advanced topics in structural steel design, and steel connection design and detailing.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate, Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

### **ARCH 6543 Structures: Concrete III**

**Prerequisites:** Grade of C or better in ARCH 4224.

**Description:** Design of prestressed concrete structures, including pre- and post-tensioning.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate, Undergraduate

**Schedule types:** Lecture

**Department/School:** Architecture

## **Undergraduate Programs**

- Architectural Engineering: Construction Project Management, BEN (p. 2321)
- Architectural Engineering: Structures, BEN (p. 2323)
- Architecture, BAR (p. 2328)

## **Minors**

- Architectural Studies: Architecture and Entrepreneurship (ASAE), Minor (p. 2325)
- Architectural Studies: Design (ASDS), Minor (p. 2326)
- Architectural Studies: History and Theory (ASHT), Minor (p. 2327)

## **Faculty**

Suzanne D. Bilbeisi, MArch, AIA—Centennial Professor and Head

**AT&T Professor and Associate Dean, CEAT Academic Affairs:** Randy Seitsinger, MArch, FAIA

**Regents Professor:** Mohammed Bilbeisi, MArch, RA

**Professors:** Khaled Mansy, PhD; John Phillips, MArchE, PE; Tom Spector, PhD, AIA

**Associate Professors:** Jeanne Homer, MArch, AIA; Seung Ra, MArch, AIA; Michael Rabens, PhD; Carisa Ramming, MArchE, PE; Nathan Richardson, MArch, AIA; Awilda Rodriguez, MArch, RA; Paulo Sanza, MArch, RA; Jerry L. Stivers, MArch, AIA

**Assistant Professors:** Jay Yowell, MArch, AIA; Keith Peiffer, MArch, AIA; Christina McCoy, MArchE, SE, RA; Jared Macken, Dr. Sc.; Sarah Ra, MArch, AIA, NCIDQ

# Architectural Engineering: Construction Project Management, BEN

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 140**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) <sup>1</sup>	4
MATH 2153	Calculus II (A)	3
<i>Humanities (H)</i>		
ARCH 2003	Architecture and Society (HI)	3
Select 3 hours:		3
ARCH 3083	History and Theory of Renaissance and Baroque Architecture (H)	
ARCH 3473	History and Theory of Structures in Architecture (H)	
ARCH 4173	History and Theory of Skyscraper Design (H)	
ARCH 4293	The Ethics of the Built Environment (H)	
ARCH 4374	International Field Study (HI)	
Any other ARCH course (H)		
Any upper-division HIST (H) Any upper ART (H)		
<i>Natural Sciences (N)</i>		
CHEM 1414	General Chemistry for Engineers (LN)	4
PHYS 2014	University Physics I (LN) <sup>1</sup>	4
PHYS 2114	University Physics II (LN)	4
Three additional hours of (N)		3
<i>Social &amp; Behavioral Sciences (S)</i>		
Any lower division course designated (S)		3
<i>Diversity (D)</i>		

Any course designated (D)

Students are encouraged to meet the requirement in their selection of (H) or (S) course work

*International Dimension (I)*

ARCH 2003 meets the (I) requirement.

*Scientific Investigation (L)*

Any course designated (L). Normally met by Natural Sciences and/or Basic Science requirements.

**Hours Subtotal** **43**

## College/Departmental Requirements

*Architecture*

ARCH 1112	Introduction to Architecture <sup>1</sup>	2
ARCH 1216	Architectural Design Studio I <sup>1</sup>	6
ARCH 2116	Architectural Design Studio II <sup>1</sup>	6
ARCH 2252	Design Communication I: Visual and Graphic Acuity <sup>1</sup>	2
ARCH 2263	Building Systems <sup>1</sup>	3

*Engineering Science*

ENGR 1412	Introductory Engineering Computer Programming <sup>1</sup>	2
ENSC 2113	Statics <sup>1</sup>	3
ENSC 2143	Strength of Materials <sup>1</sup>	3
ENSC 2141	Strength of Materials Lab <sup>1</sup>	1

**Hours Subtotal** **28**

## Major Requirements/Professional School

Admitted to Professional School of Architecture (see requirements for admission to the upper-division)

*Architecture*

ARCH 3043	Structural Loadings in Architecture	3
ARCH 3262	Design Communication II: Advanced Digital Applications	2
ARCH 3323	Structures: Steel I	3
ARCH 4093	Architectural Project Management	3
ARCH 4123	Structures: Concrete I	3
ARCH 4143	Structures: Foundations for Buildings	3
ARCH 4163	Architectural Science I: Thermal Systems and Life Safety for Architectural Engineers	3
ARCH 4263	Architecture Seminar	3
ARCH 4433	Architectural Science II: Acoustics, Lighting, and Service Systems for Architectural Engineers	3
ARCH 5023	Masonry Design and Analysis	3
ARCH 5226	Architectural Engineering Comprehensive Design Studio	6

*Civil Engineering*

CIVE 3623	Engineering Materials Laboratory	3
CIVE 4183	Construction Estimating	3
or CIVE 4103	Construction Simulation	
or CIVE 4113	Construction Business Management	
or CIVE 4133	Construction Contracts and Specifications	
CIVE 4273	Construction Engineering and Project Management	3
CIVE 4711	Basic Soils Testing Laboratory	1

*Industrial Engineering & Management*



IEM 3503	Engineering Economic Analysis	3
<i>Engineering Science, Engineering</i>		
ENSC 2123	Elementary Dynamics	3
ENSC 3313	Materials Science	3
<i>Mathematics</i>		
MATH 2163	Calculus III	3
MATH 2233	Differential Equations	3
<i>Statistics</i>		
STAT 4033	Engineering Statistics	3
<b>Hours Subtotal</b>		<b>63</b>
<b>Controlled Electives</b>		
Select 6 credit hours from:		6
ARCH 2890	Honors for Topics in Architecture	
ARCH 3100	Special Topics in Architecture	
ARCH 3473	History and Theory of Structures in Architecture (H)	
ARCH 4100	Special Topics in Architecture	
ARCH 4233	Sustainable Design in Architecture	
ARCH 4293	The Ethics of the Built Environment (H)	
ARCH 5093	Real Estate Development	
ARCH 5193	Management of Architectural Practice	
ARCH 5493	Entrepreneurship and Architecture	
CIVE 5123	The Legal and Regulatory Environment of Engineering	
CIVE 5133	Construction Contracts and Specifications	
CIVE 5143	Project Engineering and Management	
CIVE 5153	Contract Administration	
CET 2263	Estimating I	
CET 3273	Scheduling Construction Projects	
CET 4263	Estimating II	
CET 4283	Business Practices for Construction	
Upper division ARCH, CIVE, CET ENGR, FPST, MAE		
<b>Hours Subtotal</b>		<b>6</b>
<b>Total Hours</b>		<b>140</b>

<sup>1</sup> Courses that must be completed prior to admission to professional school with a "C" or better.

## Admission to Professional School (required)

- Refer to the OSU Catalog corresponding to your matriculation date for detailed admissions requirements.

## Graduation Requirements

- A minimum GPA of 2.00 Technical GPA. The Technical GPA is calculated from all courses in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
- A final grade of 'C' or better in all ARCH prefix courses, substitutions for ARCH prefix courses, and all non-ARCH prefix courses that are a prerequisite to an ARCH prefix course. The final grade of "C" is however not needed in the terminal courses in a series.
- The capstone course for Architectural Engineering majors is ARCH 5226 Architectural Engineering Comprehensive Design Studio.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

# Architectural Engineering: Structures, BEN

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 140**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
	or ENGL 1313 Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) <sup>1</sup>	4
MATH 2153	Calculus II (A)	3
<i>Humanities (H)</i>		
ARCH 2003	Architecture and Society (HI)	3
Select 3 hours from the following:		3
ARCH 3083	History and Theory of Renaissance and Baroque Architecture (H)	
ARCH 3473	History and Theory of Structures in Architecture (H)	
ARCH 4173	History and Theory of Skyscraper Design (H)	
ARCH 4293	The Ethics of the Built Environment (H)	
ARCH 4374	International Field Study (HI)	
Any other ARCH (H)		
Any other upper division HIST (H) Any upper ART (H)		
<i>Natural Sciences (N)</i>		
CHEM 1414	General Chemistry for Engineers (LN)	4
PHYS 2014	University Physics I (LN) <sup>1</sup>	4
PHYS 2114	University Physics II (LN)	4
3 hours of (N)		3
<i>Social &amp; Behavioral Sciences (S)</i>		
Select 3 hours lower division (S)		3
<b>Hours Subtotal</b>		<b>43</b>
<b>Diversity (D) &amp; International Dimension (I)</b>		
May be completed in any part of the degree plan		

At least one Diversity (D) course

At least one International Dimension (I) course

Scientific Investigation (L) Any course designated (L). Normally met by Natural Sciences and/or Basic Science requirements.

## College/Departmental Requirements

### Architecture

ARCH 1112	Introduction to Architecture <sup>1</sup>	2
ARCH 1216	Architectural Design Studio I <sup>1</sup>	6
ARCH 2116	Architectural Design Studio II	6
ARCH 2252	Design Communication I: Visual and Graphic Acuity <sup>1</sup>	2
ARCH 2263	Building Systems <sup>1</sup>	3

### Engineering Science

ENGR 1412	Introductory Engineering Computer Programming <sup>1</sup>	2
ENSC 2113	Statics <sup>1</sup>	3
ENSC 2143	Strength of Materials <sup>1</sup>	3
ENSC 2141	Strength of Materials Lab <sup>1</sup>	1

**Hours Subtotal** **28**

## Major Requirements

### Architecture

ARCH 3043	Structural Loadings in Architecture	3
ARCH 3143	Structures: Analysis I	3
ARCH 3262	Design Communication II: Advanced Digital Applications	2
ARCH 3323	Structures: Steel I	3
ARCH 3343	Structures: Steel II	3
ARCH 4093	Architectural Project Management	3
ARCH 4123	Structures: Concrete I	3
ARCH 4143	Structures: Foundations for Buildings	3
ARCH 4163	Architectural Science I: Thermal Systems and Life Safety for Architectural Engineers	3
ARCH 4263	Architecture Seminar	3
ARCH 4343	Structures: Concrete II	3
ARCH 4433	Architectural Science II: Acoustics, Lighting, and Service Systems for Architectural Engineers	3
ARCH 5023	Masonry Design and Analysis	3
ARCH 5226	Architectural Engineering Comprehensive Design Studio	6

### Civil Engineering

CIVE 4711	Basic Soils Testing Laboratory	1
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### Industrial Engineering & Management

IEM 3503	Engineering Economic Analysis	3
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### Engineering Science, Engineering

ENSC 2123	Elementary Dynamics	3
ENSC 3313	Materials Science	3

### Mathematics

MATH 2163	Calculus III	3
MATH 2233	Differential Equations	3

### Statistics

STAT 4033	Engineering Statistics	3
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**Hours Subtotal** **63**

<b>Electives</b>	
Select 6 credit hours from:	6
ARCH 2890	Honors for Topics in Architecture
ARCH 3100	Special Topics in Architecture
ARCH 3473	History and Theory of Structures in Architecture (H)
ARCH 4100	Special Topics in Architecture
ARCH 4233	Sustainable Design in Architecture
ARCH 5143	Structures: Special Loadings
ARCH 6243	Structures: Analysis III
ARCH 6343	Structures: Steel III
ARCH 6543	Structures: Concrete III
CIVE 3623	Engineering Materials Laboratory
CIVE 3614	Engineering Surveying
CIVE 5403	Advanced Strength of Materials
CIVE 5433	Energy Methods in Applied Mechanics
CIVE 5533	Prestressed Concrete
CIVE 5573	Timber Design
Upper division ARCH, FPST, MAE, ENGR, CIVE, CET	
<b>Hours Subtotal</b>	<b>6</b>
<b>Total Hours</b>	<b>140</b>

<sup>1</sup> Courses that must be completed prior to admission to professional school with a "C" or better.

## Admission to Professional School (required)

- Refer to the OSU Catalog corresponding to your matriculation date for detailed admissions requirements.

## Graduation Requirements

1. A minimum GPA of 2.00 Technical GPA. The Technical GPA is calculated from all courses in the curriculum with a prefix belonging to the degree program, or substitutions for these courses.
2. A final grade of 'C' or better in all ARCH prefix courses, substitutions for ARCH prefix courses, and all non-ARCH prefix courses that are a prerequisite to an ARCH prefix course. The final grade of "C" is however not needed in the terminal courses in a series.
3. The capstone course for Architectural Engineering majors is ARCH 5226 Architectural Engineering Comprehensive Design Studio.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.

## Architectural Studies: Architecture and Entrepreneurship (ASAE), Minor

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Suzanne Bilbeisi**, [suzanne.bilbeisi@okstate.edu](mailto:suzanne.bilbeisi@okstate.edu), 101 DWR Arch. Bldg, 405-744-6043

**Minimum Overall Grade Point Average:** 2.50 with no grade below "C."

**Total Hours:** 21

Code	Title	Hours
<b>Minor Requirements</b>		
ARCH 5093	Real Estate Development	3
ARCH 5193	Management of Architectural Practice	3
ARCH 5493	Entrepreneurship and Architecture	3
Select six hours of the following:		6
ECON 3033	Economics of Entrepreneurship and Innovation	
LSB 3213	Legal and Regulatory Environment of Business	
MGMT 3013	Fundamentals of Management (S)	
MKTG 3213	Marketing (S)	
Six hours of Entrepreneurship (EEE) courses		6
<b>Total Hours</b>		<b>21</b>

## Additional OSU Requirements

### Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).

## Architectural Studies: Design (ASDS), Minor

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**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Suzanne Bilbeisi**, [suzanne.bilbeisi@okstate.edu](mailto:suzanne.bilbeisi@okstate.edu), 101 DWR Arch. Bldg, 405-744-6043

**Minimum Overall Grade Point Average:** 2.50 with no grade below "C."  
**Total Hours:** 23

Code	Title	Hours
<b>Required Courses</b>		
ARCH 1112	Introduction to Architecture	2
Select 12 hours of lower-division ARCH		12
Select nine hours of upper-division ARCH as approved by the advisor		9
<b>Total Hours</b>		<b>23</b>

### Additional Requirements

- Students in the Bachelor of Architecture or Bachelor of Architectural Engineering majors are not eligible to receive this minor.

### Additional OSU Requirements

#### Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).

## Architectural Studies: History and Theory (ASHT), Minor

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Suzanne Bilbeisi**, [suzanne.bilbeisi@okstate.edu](mailto:suzanne.bilbeisi@okstate.edu), 101 DWR Arch. Bldg, 405-744-9051

**Minimum Overall Grade Point Average:** 2.50 with no grade below "C."  
**Total Hours:** 21

Code	Title	Hours
<b>Minor Requirements</b>		
ARCH 2003	Architecture and Society (HI)	3
or ARCH 2283	History and Theory of Architecture II (H)	
Select any six additional Architectural history/theory courses <sup>1</sup>		18
<b>Total Hours</b>		<b>21</b>

<sup>1</sup> May include ARCH 4373 Field Study in Europe I/ARCH 5373 Field Study in Europe II (European Program), ARCH 4374 International Field Study (HI) and/or ARCH 3373 Design and Diversity in Urban Centers of the US (Urban USA Program).

\* Up to 6 hours of ART History and Theory coursework may be included, but must be approved by Head of the School of Architecture or Architecture Academic Advisor.

## Additional OSU Requirements

### Undergraduate Minors

- An undergraduate minor must include between fifteen and thirty hours, inclusive of undergraduate coursework.
- A minimum of six credit hours for the minor must be earned in residence at OSU.
- The courses required for a minor may be included in the course requirements for any undergraduate degree or they may be in addition to degree requirements, depending on the overlap between the minor and degree requirements. However, an undergraduate minor must be earned in an academic field other than the student's declared degree option. The minor may not duplicate the degree major or option (for example, a student who earns a BA in Art with an Art History option may earn a minor in Studio Art but not Art History).
- A student generally follows the minor requirements associated with his or her matriculation year or newer requirements that have been established since matriculation. The time limit for following requirements from a given academic year is six years.

For additional information on requirements on minors, click here (<https://adminfinance.okstate.edu/site-files/documents/policies/requirements-for-undergraduate-and-graduate-minors.pdf>).

## Architecture, BAR

**Requirements for Students Matriculating in or before Academic Year 2021-2022.** Learn more about University Academic Regulation 3.1 (p. 922).

**Minimum Overall Grade Point Average: 2.00**

**Total Hours: 154**

Code	Title	Hours
<b>General Education Requirements</b>		
All General Education coursework requirements are satisfied upon completion of this degree plan		
<i>English Composition</i>		
See Academic Regulation 3.5 (p. 923)		
ENGL 1113	Composition I <sup>1</sup>	3
or ENGL 1313	Critical Analysis and Writing I	
Select one of the following:		3
ENGL 1213	Composition II	
ENGL 1413	Critical Analysis and Writing II	
ENGL 3323	Technical Writing	
<i>American History &amp; Government</i>		
Select one of the following:		3
HIST 1103	Survey of American History	
HIST 1483	American History to 1865 (H)	
HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
<i>Analytical &amp; Quantitative Thought (A)</i>		
MATH 2144	Calculus I (A) <sup>1</sup>	4
<i>Humanities (H)</i>		
ARCH 2003	Architecture and Society (HI) <sup>1</sup>	3
or ARCH 2283	History and Theory of Architecture II (H)	
Select 3 hours ARCH history designated (H):		3
ARCH 3083	History and Theory of Renaissance and Baroque Architecture (H)	
ARCH 4173	History and Theory of Skyscraper Design (H)	
ARCH 3473	History and Theory of Structures in Architecture (H)	
ARCH 4293	The Ethics of the Built Environment (H)	
Any other ARCH (H)		
ART 3603	History of Classical Art (H)	
ART 3623	History of Italian Renaissance Art (H)	
ART 3633	History of Baroque Art (H)	
ART 3663	History of American Art (DH)	
ART 3683	History of 20th Century Art (HI)	
<i>Natural Sciences (N)</i>		
Must include one Laboratory Science (L) course		4
PHYS 1114	College Physics I (LN) <sup>1</sup>	
or PHYS 2014	University Physics I (LN)	
Select 3 hours designated (N)		3
<i>Social &amp; Behavioral Sciences (S)</i>		
Courses designated (S)		
Select 3 hours		3

### Additional General Education

Three Hours additional hours of (A), (H), (N), (S)	3
Six Additional Hours of Upper Level Courses Designated (A), (H), (N), or (S)	6

**Hours Subtotal 41**

### Diversity (D) & International Dimension (I)

May be completed in any part of the degree plan

At least one Diversity (D) course

At least one International Dimension (I) course

### College/Departmental Requirements

#### Architecture

ARCH 1112	Introduction to Architecture <sup>1</sup>	2
ARCH 1216	Architectural Design Studio I <sup>1</sup>	6
ARCH 2116	Architectural Design Studio II <sup>1</sup>	6
ARCH 2216	Architectural Design Studio III <sup>1</sup>	6
ARCH 2263	Building Systems <sup>1</sup>	3
ARCH 2252	Design Communication I: Visual and Graphic Acuity <sup>1</sup>	2
ARCH 2183	History and Theory of Architecture I	3
ENSC 2113	Statics <sup>1</sup>	3

**Hours Subtotal 31**

### Major Requirements

#### Architecture

ARCH 3116	Architectural Design Studio IV	6
ARCH 3216	Architectural Design Studio V	6
ARCH 3163	Architectural Science I: Thermal Systems and Life Safety for Architects	3
ARCH 3262	Design Communication II: Advanced Digital Applications	2
ARCH 3323	Structures: Steel I	3
ARCH 3433	Architectural Science II: Acoustics, Lighting, and Service Systems	3
ARCH 4203	Experimental Design Lab	3
ARCH 4093	Architectural Project Management	3
ARCH 4116	Design Studio VI	6
ARCH 4123	Structures: Concrete I	3
ARCH 4216	Architectural Design Studio VII	6
ARCH 4263	Architecture Seminar	3
ARCH 4374	International Field Study (HI)	4
ARCH 4991	Professional Development for Architects and Architectural Engineers	1
ARCH 5016	Architectural Design Studio VIII	6
ARCH 5193	Management of Architectural Practice	3

#### Architecture Electives

Select 12 hours from:

ARCH 3100	Special Topics in Architecture	
ARCH 3083	History and Theory of Renaissance and Baroque Architecture (H)	
ARCH 3143	Structures: Analysis I	
ARCH 3173	History and Theory of American Architecture	
ARCH 3273	History and Theory of Medieval Architecture	

ARCH 3353	Advanced Graphics and Theory of Representation
ARCH 3373	Design and Diversity in Urban Centers of the US
ARCH 3473	History and Theory of Structures in Architecture (H)
ARCH 4100	Special Topics in Architecture
ARCH 4073	History and Theory of Early Modern Architecture
ARCH 4143	Structures: Foundations for Buildings
ARCH 4173	History and Theory of Skyscraper Design (H)
ARCH 4183	History and Theory of Architecture: Cities
ARCH 4233	Sustainable Design in Architecture
ARCH 4273	History and Theory of Islamic Architecture
ARCH 4293	The Ethics of the Built Environment (H)
ARCH 4353	Computational Foundations
ARCH 4383	History and Theory of Modern Architecture in Italy
ARCH 5023	Masonry Design and Analysis
ARCH 5093	Real Estate Development
ARCH 5493	Entrepreneurship and Architecture

<b>Hours Subtotal</b>	<b>73</b>
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<b>Electives</b>	<b>9</b>
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Additional ARCH Courses	
SPCH 2713	Introduction to Speech Communication (S)
MUSI 2610	University Bands I
MUSI 2620	Symphony Orchestra I
MUSI 2630	University Choral Ensembles I
MATH 2153	Calculus II (A)
MATH 2163	Calculus III
ENSC 2143	Strength of Materials
PHYS 1214	College Physics II (LN)
PHYS 2114	University Physics II (LN)
ART 2000 level, approved by ARCH Advisor	
Lower division CHIN, LATN, FREN, GRMN, SPAN, JAPN	
Upper division AMST, ANTH, ART, CET, CMT, DHM, ECON, EEE, ENGR, ENGL, GEOG, GWST, HIST, HTM, LA, LSB, MC, MKTG, MGMT, PHIL, POLS, REL, SC, SOC and any other upper division course that is approved by the departmental advisor.	

<b>Hours Subtotal</b>	<b>9</b>
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<b>Total Hours</b>	<b>154</b>
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<sup>1</sup> Courses that must be completed prior to admission to professional school with a grade of C or better.

## Admission to Professional School (required)

- Refer to the OSU Catalog corresponding to your matriculation date for detailed admissions requirements.

## Graduation Requirements

- A minimum 2.00 Technical GPA. The Technical GPA is calculated from all required courses in the curriculum with a prefix belonging to the degree program, or substitution for these courses.
- A final grade of 'C' or better in all ARCH prefix courses and ARCH course substitutes which are prerequisites to other ARCH courses. A final grade of 'C' or better in all non-ARCH prefix courses that are a prerequisite to an ARCH prefix course and ARCH substitutes.

## Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as these changes do not result in semester credit hours being added or do not delay graduation.
- Degrees that follow this plan must be completed by the end of Summer 2027.