

## Program Overview

The Master of Science (M.S.) degree with a major in Engineering provides a practical, industry-driven focus via a long-term, targeted technical project or thesis related to real-world engineering applications. These projects will be conducted in partnership with local industries and may involve off-campus collaborations. The degree requires a large-scale project or thesis because the abilities to solve problems, innovate and make immediate contributions to industry are best developed by having students confront a substantial, open-ended problem; perform detailed research on the problem; develop various solutions; choose and implement the best solution; validate their choice; and effectively communicate the process to professional colleagues, executives, and customers.

## Application Requirements

The items listed below are required for admission consideration for applicable semesters of entry during the current academic year. Submission instructions, additional details, and changes to admission requirements for semesters other than the current academic year can be found on The Graduate College's website (<http://www.gradcollege.txstate.edu>). International students should review the International Admission Documents page (<http://mycatalog.txstate.edu/graduate/admission-documents/international/>) for additional requirements.

- completed online application
  - \$55 nonrefundable application fee
- or
- \$90 nonrefundable application fee for applications with international credentials
  - baccalaureate degree engineering, computer science, physics, technology, or a closely related field from a regionally accredited university (Non-U.S. degrees must be equivalent to a four-year U.S. Bachelor's degree. In most cases, three-year degrees are not considered. Visit our International FAQs (<https://www.gradcollege.txst.edu/international/faqs.html>) for more information.)
  - official transcripts from **each institution** where course credit was granted
  - 2.75 overall GPA or a 2.75 GPA in the last 60 hours of undergraduate course work (plus any completed graduate courses)
  - official GRE (general test only) with competitive scores in the verbal reasoning and quantitative reasoning and writing sections will be required. Texas State University students are exempt from this requirement
  - resume/CV detailing prior work experience, research experience, awards, scholarships, and other related qualifications
  - statement of purpose (two pages) conveying research interests, plans for graduate study, and professional aspirations
  - two letters of recommendation from non-related individuals familiar with the student's scholarly work and/or relevant work experience

### Approved English Proficiency Exam Scores

Applicants are required to submit an approved English proficiency exam score that meets the minimum program requirements below unless they have earned a bachelor's degree or higher from a regionally accredited U.S. institution or the equivalent from a country on our exempt

countries list (<http://www.gradcollege.txstate.edu/international/language.html#wave>).

- official TOEFL iBT scores required with a 78 overall
- official PTE scores required with a 52 overall
- official IELTS (academic) scores required with a 6.5 overall and minimum individual module scores of 6.0
- official Duolingo Scores required with a 110 overall
- official TOEFL Essentials scores required with an 8.5 overall

This program does **not** offer admission if the scores above are not met.

### Additional Information

Non-credit (leveling) course work may be required prior to admission into the program if the student lacks sufficient background course work. Any required leveling course work must be completed with grades of B or better prior to admission.

## Degree Requirements

The Master of Science (M.S.) degree with a major in Engineering concentration in Industrial Engineering requires 31 semester credit hours, including a thesis.

Non-credit (leveling) course work may be required prior to admission into the program if you lack sufficient background course work. Any required leveling course work must be completed with grades of B or better prior to admission.

All students will have a faculty advisor and a graduate committee composed of a minimum of three graduate faculty members (including the faculty advisor). The faculty advisor will provide technical direction for the student's thesis, and the graduate committee will be responsible for approving the thesis proposal, receiving thesis progress reports, and approving the final thesis presentation and written report. The oral project presentation will serve as the comprehensive examination.

## Course Requirements

| Code                                  | Title   | Hours |
|---------------------------------------|---|-------|
| <b>Required Courses</b>               |   |       |
| ENGR 5100                             | Seminar in Engineering  | 1     |
| ENGR 5310                             | Probability, Random Variables, & Stochastic Processes for Engineers | 3     |
| IE 5320                               | Modeling and Analysis of Manufacturing Systems                      | 3     |
| IE 5340                               | Applied Deterministic Operations Research for Engineers             | 3     |
| <b>Engineering Electives</b>          |   |       |
| Choose 9-15 hours from the following: |   | 9-15  |
| CE 5320                               | Water Quality Management  |       |
| CE 5340                               | Advanced Infrastructure Materials                                   |       |
| CE 5350                               | Highway Bridge Design   |       |
| CE 5360                               | Pavement Design   |       |
| CE 5370                               | Urban Stormwater Management   |       |
| CE 5390                               | Infrastructure Systems Analysis                                     |       |
| CE 5391                               | Advanced Mechanics of Materials                                     |       |
| EE 5320                               | Advanced Computer Architecture and Arithmetic                       |       |
| EE 5321                               | Computer-Aided Engineering Simulations on HPC Systems               |       |

|   |  |
|---|--|
| EE 5323   | Digital Image Processing                                       |
| EE 5330   | Embedded and Real-Time Computing                               |
| EE 5331   | Machine Learning for Engineering Applications                  |
| EE 5350   | Advanced Electronic Circuit Design                             |
| EE 5353   | Fundamentals of Advanced Semiconductor Technology              |
| EE 5354   | Flexible Electronics   |
| EE 5355   | Electronic Materials and Devices                               |
| EE 5357   | Power Systems for Engineering                                  |
| EE 5360   | Thin Film Technology   |
| EE 5361   | Nanofabrication Technology for Semiconductor Device Processing |
| EE 5372   | Advanced Networking  |
| EE 5374   | Advanced Wireless Communication                                |
| EE 5375   | Smart Grid: an Application Development Platform                |
| EE 5377   | Statistical Signal Processing                                  |
| EE 5380   | Advanced Electric Machines                                     |
| EE 5381   | Advanced Sustainable Energy & Storage                          |
| EE 5382   | Advanced Power Systems Analysis                                |
| EE 5398A  | Antenna Theory, Design and Applications                        |
| EE 5398B  | Electronic Materials and Beyond for Sustainable Energy         |
| ENGR 5321   | Environmental Chemistry  |
| ENGR 5323   | Soil and Groundwater Remediation                               |
| ENGR 5324   | Water Reuse  |
| ENGR 5330   | Advanced Soil Mechanics  |
| ENGR 5333   | Ground Improvement Techniques                                  |
| ENGR 5334   | Advanced Foundation Engineering                                |
| ENGR 5341   | Advanced Bituminous Materials                                  |
| ENGR 5352   | Advanced Prestressed Concrete                                  |
| ENGR 5353   | Earthquake Engineering   |
| ENGR 5362   | Advanced Traffic Engineering                                   |
| ENGR 5363   | Road Infrastructure Safety                                     |
| ENGR 5372   | Water, Climate, and Disasters                                  |
| ENGR 5384   | Problems in Engineering  |
| IE 5310   | Advanced Statistical Design of Experiments for Engineers       |
| IE 5330   | Advanced Quality Control and Reliability Engineering           |
| IE 5343   | Non-Linear Optimization Techniques for Engineers               |
| IE 5345   | Advanced Optimization  |
| IE 5347   | Advanced Heuristic Optimization                                |
| IE 5397   | System Thinking and Analysis                                   |
| ME 5310   | Continuum Mechanics  |
| ME 5311   | Mechanical Vibrations  |
| ME 5312   | Mechanics of Composite Materials                               |
| ME 5321   | Applied Finite Element Analysis                                |
| ME 5332   | Modern Heating, Ventilating, and Air Conditioning              |
| ME 5341   | Computational Fluid Dynamics                                   |
| ME 5355   | Autonomous Systems and Robotics                                |
| MFGE 5315   | Energy and Thermofluids Engineering                            |
| MFGE 5316   | Advanced Computer Aided Design and Manufacturing               |
| MFGE 5318   | Additive Manufacturing   |
| MFGE 5320   | Polymer Nanocomposites   |
| MFGE 5326   | Advanced Robotics in Manufacturing Automation                  |
| MFGE 5330   | Multiscale Manufacturing                                       |
| <b>Multidisciplinary Electives</b>                          |  |
| Choose up to 6 hours from the following: <sup>1</sup> 0-6   |  |
| <b>Business Administration</b>                              |  |
| BLAW 5333   | Legal Issues of Sustainability and Responsibility              |
| ISAN 5357   | Computing for Data Analytics                                   |
| ISAN 5358   | Agile Project Management For Business Professionals            |
| ISAN 5370   | Enterprise Resource Planning and Business Intelligence         |
| MGT 5311  | Process Improvement Management in Organizations                |
| MGT 5315  | New Venture Management   |
| MGT 5321  | Supply Chain Management  |
| MGT 5390  | Managerial Data Analysis                                       |
| ANLY 5334   | Statistical Methods for Business                               |
| ANLY 5335   | Forecasting and Simulation                                     |
| <b>Technology</b>   |  |
| TECH 5315   | Engineering Economic Analysis                                  |
| TECH 5382   | Industrial Ecology and Sustainability Engineering              |
| TECH 5390   | Research in Technology   |
| <b>Computer Science</b>                                     |  |
| CS 5306   | Advanced Operating Systems                                     |
| CS 5346   | Advanced Artificial Intelligence                               |
| <b>Geography</b>  |  |
| GEO 5312  | Managing Urbanization  |
| GEO 5313  | Environmental Studies  |
| GEO 5334  | Applied Water Resources  |
| GEO 5336  | Transportation Systems   |
| GEO 5351  | Regional Waste Management                                      |
| GEO 5352  | Air Quality Management   |
| GEO 5393D   | Water Resource Planning  |
| <b>Mathematics</b>  |  |
| MATH 5315   | Mathematical Statistics  |
| MATH 5340   | Scientific Computation   |
| MATH 5345   | Regression Analysis  |
| MATH 5376A  | Design and Analysis of Experiments                             |
| MATH 5376B  | Analysis of Variance   |
| MATH 5376D  | Statistical Applications in Genetics and Bioinformatics        |
| MATH 5388   | Discrete Mathematics   |
| <b>Physics</b>  |  |
| PHYS 5327   | Semiconductor Device Physics                                   |
| <b>Materials Science, Engineering and Commercialization</b> |  |
| MSEC 7301   | Practical Skills in Commercialization and Entrepreneurship     |
| MSEC 7302   | Leadership Skills in Commercialization and Entrepreneurship    |
| MSEC 7340   | Biomaterials and Biosensors                                    |
| MSEC 7395H  | Environmental Chemistry  |

**Thesis**

|   |        |    |
|---|--------|----|
| ENGR 5399A                                      | Thesis | 3  |
| Choose a minimum of 3 hours from the following: |        | 3  |
| ENGR 5199B                                      | Thesis |    |
| ENGR 5299B                                      | Thesis |    |
| ENGR 5399B                                      | Thesis |    |
| ENGR 5599B                                      | Thesis |    |
| ENGR 5999B                                      | Thesis |    |
| Total Hours                                     |        | 31 |

<sup>1</sup> Choose up to 6 hours from the Multidisciplinary Electives above to make the total hours selected from Engineering Electives and from Multidisciplinary Electives to equal 15 hours.

## Comprehensive Examination Requirement

An oral thesis defense is required. This oral defense will serve as the comprehensive examination requirement. If the thesis committee is not satisfied with a graduate student's oral defense, they specify all deficiencies the student must resolve. The thesis committee will not sign the Master's Comprehensive Examination Report Form and the Thesis Submission Approval Form until all specified deficiencies have been resolved. Should the thesis committee decide to hold a second oral defense, the chair of the thesis committee shall not schedule the second defense until the student has resolved all specified deficiencies.

Students who do not successfully complete the requirements for the degree within the timelines specified will be dismissed from the program.

If a student elects to follow the thesis option for the degree, a committee to direct the written thesis will be established. The thesis must demonstrate the student's capability for research and independent thought. Preparation of the thesis must be in conformity with the *Graduate College Guide to Preparing and Submitting a Thesis or Dissertation*.

## Thesis Proposal ([http://www.gradcollege.txstate.edu/docs/Thesis\\_Diss\\_Guide.pdf](http://www.gradcollege.txstate.edu/docs/Thesis_Diss_Guide.pdf))

The student must submit an official Thesis Proposal Form (<http://www.gradcollege.txstate.edu/forms.html>) and proposal to his or her thesis committee. Thesis proposals vary by department and discipline. Please see your department for proposal guidelines and requirements. After signing the form and obtaining committee members' signatures, the graduate advisor's signature if required by the program and the department chair's signature, the student must submit the Thesis Proposal Form with one copy of the proposal attached to the dean of The Graduate College for approval before proceeding with research on the thesis. If the thesis research involves human subjects, the student must obtain exemption or approval from the Texas State Institutional Review Board prior to submitting the proposal form to The Graduate College. The IRB approval letter should be included with the proposal form. If the thesis research involves vertebrate animals, the proposal form must include the Texas State IACUC approval code. It is recommended that the thesis proposal form be submitted to the dean of The Graduate College by the end of the student's enrollment in 5399A. Failure to submit the thesis proposal in a timely fashion may result in delayed graduation.

## Thesis Committee

The thesis committee must be composed of a minimum of three approved graduate faculty members.

## Thesis Enrollment and Credit

The completion of a minimum of six hours of thesis enrollment is required. For a student's initial thesis course enrollment, the student will need to register for thesis course number 5399A. After that, the student will enroll in thesis B courses, in each subsequent semester until the thesis is defended with the department and approved by The Graduate College. Preliminary discussions regarding the selection of a topic and assignment to a research supervisor will not require enrollment for the thesis course.

Students must be enrolled in thesis credits if they are receiving supervision and/or are using university resources related to their thesis work. The number of thesis credit hours students enroll in must reflect the amount of work being done on the thesis that semester. It is the responsibility of the committee chair to ensure that students are making adequate progress toward their degree throughout the thesis process. Failure to register for the thesis course during a term in which supervision is received may result in postponement of graduation. After initial enrollment in 5399A, the student will continue to enroll in a thesis B course as long as it takes to complete the thesis. Thesis projects are by definition original and individualized projects. As such, depending on the topic, methodology, and other factors, some projects may take longer than others to complete. If the thesis requires work beyond the minimum number of thesis credits needed for the degree, the student may enroll in additional thesis credits at the committee chair's discretion. In the rare case when a student has not previously enrolled in thesis and plans to work on and complete the thesis in one term, the student will enroll in both 5399A and 5399B.

The only grades assigned for thesis courses are PR (progress), CR (credit), W (withdrew), and F (failing). If acceptable progress is not being made in a thesis course, the instructor may issue a grade of F. If the student is making acceptable progress, a grade of PR is assigned until the thesis is completed. The minimum number of hours of thesis credit ("CR") will be awarded only after the thesis has been both approved by The Graduate College and released to Alkek Library.

A student who has selected the thesis option must be registered for the thesis course during the term or Summer I (during the summer, the thesis course runs ten weeks for both sessions) in which the degree will be conferred.

## Thesis Deadlines and Approval Process

Thesis deadlines are posted on The Graduate College (<http://www.gradcollege.txstate.edu/>) website under "Current Students." The completed thesis must be submitted to the chair of the thesis committee on or before the deadlines listed on The Graduate College website.

The following must be submitted to The Graduate College by the thesis deadline listed on The Graduate College website:

1. The Thesis Submission Approval Form bearing original (wet) and/or electronic signatures of the student and all committee members.
2. One (1) PDF of the thesis in final form, approved by all committee members, uploaded in the online Vireo submission system.

After the dean of The Graduate College approves the thesis, Alkek Library will harvest the document from the Vireo submission system for publishing in the Digital Collections database (according to the student's embargo selection). **NOTE: MFA Creative Writing theses will have a permanent embargo and will never be published to Digital Collections.**

While original (wet) signatures are preferred, there may be situations as determined by the chair of the committee in which obtaining original signatures is inefficient or has the potential to delay the student's progress. In those situations, the following methods of signing are acceptable:

- signing and faxing the form
- signing, scanning, and emailing the form
- notifying the department in an email from their university's or institution's email account that the committee chair can sign the form on their behalf
- electronically signing the form using the university's licensed signature platform.

If this process results in more than one document with signatures, all documents need to be submitted to The Graduate College together.

No copies are required to be submitted to Alkek Library. However, the library will bind copies submitted that the student wants bound for personal use. Personal copies are not required to be printed on archival quality paper. The student will take the personal copies to Alkek Library and pay the binding fee for personal copies.

Master's level courses in Engineering: ENGR (p. 4), CE (p. 8), EE (p. 8), IE (p. 10), MFG (p. 11)

## Courses Offered

### Engineering (ENGR)

#### ENGR 5100. Seminar in Engineering.

Graduate students attend seminars by invited speakers presenting relevant topics in academia and industry. The schedule of speakers will be developed each semester with strict faculty supervision. This course may only be taken for credit one time.

**1 Credit Hour. 1 Lecture Contact Hour. 0 Lab Contact Hours.**

**Grade Mode:** Credit/No Credit

#### ENGR 5101. Academic Instruction for Engineering Graduate Assistants.

This course is seminar based and covers topics related to teaching and employment responsibilities. Completion of this course is required as a condition of employment for graduate assistants. This course does not earn graduate degree credit.

**1 Credit Hour. 1 Lecture Contact Hour. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Graduate Assistantship|Exclude from Graduate GPA

**Grade Mode:** Leveling/Assistantships

#### ENGR 5105. Engineering Internship.

This course is a faculty-supervised, experiential, work-integrated learning course intended to help the student acquire engineering curriculum-related industrial experience and hence successfully make the transition into the workforce. Course cannot be counted toward graduation. Course may be repeated once. Prerequisite: Instructor approval.

**1 Credit Hour. 0 Lecture Contact Hours. 1 Lab Contact Hour.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Credit/No Credit

#### ENGR 5198B. Project.

This course represents a student's continuing project enrollments. The student continues to enroll in this course until the project is completed. Prerequisite: Instructor approval.

**1 Credit Hour. 1 Lecture Contact Hour. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Credit/No Credit

#### ENGR 5199B. Thesis.

This course represents a student's continuing thesis enrollments. The student continues to enroll in this course until the thesis is submitted for binding.

**1 Credit Hour. 1 Lecture Contact Hour. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Credit/No Credit

#### ENGR 5201. Academic Instruction for Engineering Graduate Assistants.

This course is seminar based and covers topics related to teaching and employment responsibilities. Completion of this course is required as a condition of employment for graduate assistants. This course does not earn graduate degree credit.

**2 Credit Hours. 2 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Graduate Assistantship|Exclude from Graduate GPA

**Grade Mode:** Leveling/Assistantships

#### ENGR 5298B. Project.

This course represents a student's continuing project enrollments. The student continues to enroll in this course until the project is completed.

**2 Credit Hours. 2 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Credit/No Credit

#### ENGR 5299B. Thesis.

This course represents a student's continuing thesis enrollments. The student continues to enroll in this course until the thesis is submitted for binding.

**2 Credit Hours. 2 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Credit/No Credit

**ENGR 5310. Probability, Random Variables, & Stochastic Processes for Engineers.**

This course develops theory underlying analysis and design of systems. Fundamental distributional concepts, applications of statistical methods, and theory of stochastic processes are introduced to create a mathematical foundation for engineering analysis of physical systems involving randomness. Applications to engineering topics are taught, including estimation, control, and systems theory.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5321. Environmental Chemistry.**

This course introduces environmental chemistry, emphasizing aquatic resources and engineering. It also examines fundamental geochemistry and atmospheric chemistry principles relating to pollutant impacts on aquatic ecosystems.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5322. Low Impact Development and Green Infrastructure.**

This course covers the principles and practices of Low Impact Development and Green Infrastructure (LID/GI) for sustainable development and water sustainability through rain harvesting, small systems, resource recovery, and technology-enhanced innovation.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5323. Soil and Groundwater Remediation.**

This course covers various remediation technologies to clean up contaminated soil and groundwater. Topics include, but are not limited to, subsurface hydrology, contaminant fate and transport, physicochemical and biological remediation, monitoring, and brownfield redevelopment. Significance of subsurface contamination and the importance of environmental health will also be addressed.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5324. Water Reuse.**

This course explores the critical role of water reuse in sustainable resource management, addressing both the engineering principles and interdisciplinary challenges involved. Students will examine water treatment technologies, regulatory frameworks, and the environmental and economic impacts of water reuse across various sectors. Case studies will highlight applications in agriculture, industry, and urban environments, with a focus on emerging technologies and innovative solutions. This course fosters cross-disciplinary collaboration and provides the technical and scientific foundations needed to advance water reuse initiatives in diverse contexts.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5330. Advanced Soil Mechanics.**

This course is a fundamental graduate-level geotechnical engineering course, covering the physical, mechanical, hydraulic, and electrical properties of soil. The mandatory laboratory component will provide hands-on experience with characterizing soils for engineering purposes (stress-deformation and strength characteristics) and help to familiarize students with ASTM geotechnical laboratory testing procedures and standards.

**3 Credit Hours. 2 Lecture Contact Hours. 1 Lab Contact Hour.**

**Grade Mode:** Standard Letter

**ENGR 5332. Earth retaining structures and slopes.**

The course will cover the design and analysis of various earth retaining structures as well as slope stability analysis. Fundamental lateral earth pressure theories will be taught, followed by application through design for gravity walls, cantilever walls, mechanically stabilized earth walls, soil nails, and tiebacks. Slope stability analysis will include infinite methods, methods of slices, chart methods, and finite element methods with commercial software. Additional topics include slope remediation techniques and geosynthetics for slope stabilization.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5333. Ground Improvement Techniques.**

This course presents advanced topics in ground improvement for challenging sites to remediate seepage and/or strength issues. Students will learn to assess and implement techniques such as deep soil mixing, jet grouting, compaction, stone columns and rigid inclusions. Emphasis is placed on mitigating issues like liquefaction, settlement, hydraulic conductivity and stability. The course integrates practical field investigation methods, design principles, and performance evaluation, preparing students to address complex engineering challenges in both natural and reclaimed land environments.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5334. Advanced Foundation Engineering.**

This course examines advanced topics in foundations design including design, analysis and construction of shallow and deep foundations. Deep foundations include driven piles, drilled shafts, micropiles, and auger cast in place piles. The course will cover bearing/axial capacity, settlement, pile group effects, and lateral capacity of the various foundation types. Additional topics include subsurface exploration and analysis of pile behavior using wave equation analysis.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5341. Advanced Bituminous Materials.**

This course provides a comprehensive presentation of bituminous materials, mix design procedures, and construction techniques. Emphasis is placed on a fundamental understanding of asphalt cements and aggregates, and how these materials affect mixture design and pavement performance. Modern asphalt pavement design and construction practices are also introduced.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5351. Advanced Reinforced Concrete Members.**

This course covers advanced topics related to reinforced concrete materials and specifications, and the behavior and design of reinforced concrete members. The topics includes the following: flexural behavior and design of reinforced concrete, behavior and design of slender columns, design of structural components, frame joints, and walls, serviceability and durability issues, and anchorage design using splices, hooks, and mechanical devices.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5352. Advanced Prestressed Concrete.**

This course covers the theories, principles, and concepts of prestressed concrete, including analysis and design of prestressed components for axial, flexure, shear, and torsion. This course will also introduce the applications of prestressed elements in various types of infrastructure.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5353. Earthquake Engineering.**

This course covers the theories, principles, and concepts of earthquake waves and wave equations, structural dynamics, and the effect of earthquakes on structures, including modal analysis and linear and nonlinear analyses of single- and multi-degree of freedom systems. Additionally, different earthquake-resistant design principles (e.g., force-based, displacement-based, and energy-based) will be discussed.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5361. Pavement Asset Management.**

This course is about applications of pavement condition evaluation technologies, pavement distress data analysis and modeling, and pavement maintenance and rehabilitation decision making in the management of pavement systems. The course covers methods of evaluating field performance of rigid and flexible pavements by measuring surface distresses, profiles, friction resistance, and structural integrity. In addition, the course also discusses pavement performance evaluation models, and ranking and optimization methods for decision-making of pavement maintenance and rehabilitation strategies.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5362. Advanced Traffic Engineering.**

This course is an introduction to basic components of transportation systems and fundamentals of transportation engineering. Topics include geometric design of highways, study of warrants for traffic control devices, analysis of traffic flow theory and characteristics, levels of service, capacity of urban and rural highways, design and analysis of traffic signals and timing plans, and analysis of urban and highway traffic characteristics using simulation software.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5363. Road Infrastructure Safety.**

This course will cover topics including an introduction to road infrastructure safety, fundamentals of road safety analysis, highway safety management systems, count data modeling, crash severity modeling, highway safety design, basics of artificial intelligence and machine learning, human factors, and safe system design.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5372. Water, Climate, and Disasters.**

This course introduces the interactions between water and climate systems and their relationship with occurrences, magnitude, and frequencies of natural disasters with a focus on climate impacts on hydrology, water resources, and extreme events (e.g., floods, drought, heat waves, landslides, and wildfires). This course covers disaster risk management and adaptation strategies for a sustainable and resilient natural environment and human society against weather and climate extreme disasters.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**ENGR 5384. Problems in Engineering.**

Graduate students investigate a special topic by developing a technical problem, researching the topic, and presenting the findings. Plans will be developed on an individual basis with strict faculty supervision. This course may be repeated once for additional credit with permission of the School Director. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Standard Letter

**ENGR 5398A. Project.**

This course represents a student's initial project enrollment. No project credit is awarded until the student has completed the project in ENGR 5x98B. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Credit/No Credit

**ENGR 5398B. Project.**

This course represents a student's continuing project enrollments. The student continues to enroll in this course until the project is completed. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Credit/No Credit

**ENGR 5399A. Thesis.**

This course represents a student's initial thesis enrollment. No thesis credit is awarded until the theses is completed in ENGR 5x99B.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Credit/No Credit

**ENGR 5399B. Thesis.**

This course represents a student's continuing thesis enrollments. The student continues to enroll in this course until the thesis is submitted for binding.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Credit/No Credit

**ENGR 5598B. Project.**

This course represents a student's continuing project enrollments. The student continues to enroll in this course until the project is completed. Prerequisite: Instructor approval.

**5 Credit Hours. 5 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Credit/No Credit

**ENGR 5599B. Thesis.**

This course represents a student's continuing thesis enrollments. The student continues to enroll in this course until the thesis is submitted for binding.

**5 Credit Hours. 5 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing

**Grade Mode:** Credit/No Credit

**ENGR 5998B. Project.**

This course represents a student's continuing project enrollments. The student continues to enroll in this course until the project is completed. Prerequisite: Instructor approval.

**9 Credit Hours. 9 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Credit/No Credit

**ENGR 5999B. Thesis.**

This course represents a student's continuing thesis enrollments. The student continues to enroll in this course until the thesis is submitted for binding.

**9 Credit Hours. 9 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Credit/No Credit

**Civil Engineering (CE)****CE 5320. Water Quality Management.**

This course is an advanced study of the processes used to monitor, measure, and manage water quality for municipal, commercial, or industrial use. The use of technology to enhance water quality management processes is also investigated. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**CE 5331. Computational Methods in Civil Engineering.**

This course is an introduction to numerical analysis and computational methods as applicable to civil engineering. A survey of finite element method with a review of differential equations, boundary conditions, integral forms and numerical integration will be covered. This course particularly focuses on application of numerical techniques to simulate and solve steady-state and transient solid and fluid problems in civil engineering.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**CE 5340. Advanced Infrastructure Materials.**

This course provides a comprehensive presentation of advanced infrastructure materials including cement concrete, asphalt concrete, wood, steel, etc. Emphasis is placed on a fundamental understanding of the raw ingredients of cement concrete and how these ingredients affect concrete fresh and hardened properties. A brief introduction of other common infrastructure materials is also included in this course.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**CE 5350. Highway Bridge Design.**

This course covers the design of highway bridge structures, including both the super- and sub-structure. Design is in accordance with current Federal Highway Administration (FHWA) specifications. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**CE 5360. Pavement Design.**

This course covers the design of concrete, asphalt, and pervious pavements. Included are highway pavements, urban streets, airport pavements, industrial pavements, and roller compacted concrete. Design is in accordance with current FHWA specifications. Common construction methods are also addressed.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**CE 5370. Urban Stormwater Management.**

This course examines the planning, design, operation, and maintenance of urban stormwater management systems. Political, social, economic, and environmental influences on such systems are examined. The impact of extreme events on stormwater systems and the urban landscape are also considered. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**CE 5390. Infrastructure Systems Analysis.**

This course is an advanced study of the planning, operation, and maintenance of municipal and commercial infrastructure assets. Political, social, economic, environmental, and engineering influences on infrastructure systems are addressed. Use of technology to enhance the safety and economic value of the infrastructure is also investigated. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**CE 5391. Advanced Mechanics of Materials.**

This course is an advanced study of stress, strain, and deformation in elastic bodies. Topics covered include torsion, unsymmetrical bending, nonlinear beams, stress concentrations, beams on elastic foundations, Mohr's circle, and an introduction to the theory of elasticity.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**Electrical Engineering (EE)****EE 5320. Advanced Computer Architecture and Arithmetic.**

This course teaches design and analysis of high-performance computer systems, focusing on quantitative analysis of the latest processors and compilers. Current processor architectures are surveyed for system design. Topics include instruction sets, parallelizing architectures, pipelining, I/O, memory and cache organization, parallel/vector processing, fast arithmetic units design, and implementation using HDL.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5321. Computer-Aided Engineering Simulations on HPC Systems.**

This course covers development of simulations for engineering applications that are solved using High Performance Computing (HPC) environments. Topics include programming techniques for multicore processors, processor and memory architecture, computation for dense and sparse linear algebra applications, computational temperature analysis, fluid dynamics, stencil and stochastic algorithms, and other applications. Prerequisite: EE 5320 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5323. Digital Image Processing.**

This course provides the necessary fundamental techniques to analyze and process digital images. It covers principles, concepts, and techniques of digital image processing and computer vision. Restricted to students enrolled in the MS Engineering program.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5330. Embedded and Real-Time Computing.**

This course teaches development of embedded computing systems with strong resource constraints. Key concepts include managing constrained memory and processing speed limitations, and programming for soft and hard real-time constraints. Students will learn use of a Real-Time Operating System (RTOS).

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5331. Machine Learning for Engineering Applications.**

This course covers an introduction to machine learning focused on deep learning techniques using engineering applications with Python. Topics include model characteristics, neural network theory, classifiers for network and signal processing applications, regression and convolutional modeling for object-detection, time-series and forecasting machine learning models for Smart City concepts. Prerequisite: ENGR 5310 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5350. Advanced Electronic Circuit Design.**

This course includes low and high power RF amplifier design techniques, oscillators, FM demodulators, limiters, and mixer design. Additional topics include circuit design to minimize intermodulation and other forms of distortion, and RD and high-speed analog circuits with emphasis on digital-friendly applications.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5353. Fundamentals of Advanced Semiconductor Technology.**

In this course students will learn key concepts and trends of advanced semiconductor device technology. Topics include Moore's law, MOSFET, CMOS and scaling, high-K gate dielectrics, new channel materials replacing silicon, three dimensional and compound semiconductor device structures. In addition students will be involved in laboratories and seminar presentations. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5354. Flexible Electronics.**

This course will cover the materials systems, processes, device physics and applications of flexible electronics. The materials range from amorphous and nanocrystalline silicon, organic and polymeric semiconductors to solution cast films of carbon nanotubes. Real device discussions include high speed transistors, photovoltaics, flexible flat-panel displays, medical image sensors, etc. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**EE 5355. Electronic Materials and Devices.**

This course covers theoretical concepts applicable to the understanding of unique properties exhibited by electronic materials, especially by dielectrics, oxide semiconductors, ferroelectrics, pyroelectrics, piezoelectrics, magnetic, and multifunctional and multiferroic materials. The various microelectronic devices and modern novel technologies based on these materials are emphasized.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5357. Power Systems for Engineering.**

This course introduces the analysis of various elements of power systems, including power generation, transformer action, transmission line modeling, symmetrical components, power factor correction, real and quadrature power calculations, load flow analysis, and economic considerations in operating systems.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5360. Thin Film Technology.**

This course covers the theoretical and practical aspects of thin film technology in modern devices. The design and fabrication of thin film heterostructures is discussed. Growth and nucleation of epitaxial thin films with diverse properties and devices with combined properties will be emphasized.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5361. Nanofabrication Technology for Semiconductor Device Processing.**

This course provides an overview of nanofabrication techniques for conventional and emerging micro- and nano-electronic devices. Topics include semiconductor crystal growth, wafer preparation, epitaxial growth, oxidation, control of dopant profiles for the formation of shallow junctions, ion-implantation, thin film deposition, photolithography, metallization etching, device and circuit formation, and testing.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5372. Advanced Networking.**

This course develops important theoretical and application topics related to advanced networking. Theoretical topics are introduced using mathematical treatments, including queuing theory and some random processes. The course includes applications of these topics to communications networks, and focuses on architectures, applications and technologies which affect modern computer and data networks.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5374. Advanced Wireless Communication.**

This course teaches principles and practices in designing and analyzing cellular and other wireless communication systems. Topics include RF propagation modeling, fast and slow fading, modulation, demodulation, coding, and multiple access techniques.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5375. Smart Grid: an Application Development Platform.**

This course introduces students to the development of real applications for the smart grid and models its performance with simulations and stochastic models. Topics include energy informatics, smart metering, home energy management, demand response, load disaggregation and APIs/OpenData. The mathematical tools used include: Optimization/Control, Machine Learning and Stochastic Processes.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5377. Statistical Signal Processing.**

This course develops the theory and applications of random processes using mathematical treatments, including elementary discrete and continuous time linear systems theory, elementary probability, and transform theory. Topics include applications of random processes to information and communication theory, estimation and detection, control, signal processing, and stochastic systems theory. Prerequisite: ENGR 5310 with a grade of "C" or better or instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5380. Advanced Electric Machines.**

This course teaches the principles and analysis of electromechanical systems. Students will develop analytical techniques for predicting device and system interaction characteristics as well as learn to design major classes of electric machines.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5381. Advanced Sustainable Energy & Storage.**

This course examines the consumption and production of energy and the principles and technologies behind renewable energy sources. It also introduces the basics of energy storage systems such as batteries, gravitational, and hybrid. Current research in the field is examined.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5382. Advanced Power Systems Analysis.**

This course is an advanced treatment of various elements of power systems, including case studies, analysis of relevant peer-reviewed literature, symmetrical and unsymmetrical faults, symmetrical components, system protection, transient stability, transient operation of transmission lines, and supervisory control and data acquisition (SCADA).

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**EE 5398A. Antenna Theory, Design and Applications.**

This course covers the basic theory, design and applications of antennas. The topics include antenna radiation, fundamental parameters of antennas, linear wire antennas, loop antennas, antenna arrays, long-periodic antennas, horn antennas, microstrip antennas and modern nano-antennas.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Topics

**Grade Mode:** Standard Letter

**EE 5398B. Electronic Materials and Beyond for Sustainable Energy.**

This course covers the basic science and technology for sustainable energy from the view of materials, where electronic materials are highly emphasized. The topics include solar cells, thermoelectrics, batteries, supercapacitors, artificial photosynthesis, fuel cells, biomass and nuclear energy.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Topics

**Grade Mode:** Standard Letter

**Industrial Engineering (IE)****IE 5310. Advanced Statistical Design of Experiments for Engineers.**

This course examines the design and analysis of controlled experiments, demonstrating engineering applications of design of experiments (DOE) in the manufacturing and service industries. Topics include full and fractional factorial designs, response surface methodology, and Taguchi methods. In a semester-long project, students apply DOE to improve a real manufacturing process. Prerequisite: ENGR 5310 with a grade of "C" or better or instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**IE 5320. Modeling and Analysis of Manufacturing Systems.**

This course covers the methods for modeling and analyzing manufacturing systems. Critical manufacturing issues that are addressed by these models include sustainable production systems, material handling systems, scheduling, and supply chains. Prerequisite: IE 3320 and IE 3340 and MFGE 4396 all with grades of "C" or better or instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**IE 5330. Advanced Quality Control and Reliability Engineering.**

This course provides in-depth knowledge in reliability modeling and maintenance optimization for components and systems. The course also covers advanced quality control techniques including multivariate process control. Methodologies are applied to solve practical problems arising from various industry domains. Restricted to students enrolled in the MS Engineering program. Prerequisite: ENGR 5310 with a grade of "C" or better or instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**IE 5340. Applied Deterministic Operations Research for Engineers.**

This course introduces students to modeling of linear, non-linear, and integer problems applied to engineering design, manufacturing, service, supply chain, healthcare and electrical systems. Mathematical programming software is emphasized in class exercises, homework, and project. Techniques including revised simplex method, duality theory, sensitivity analysis, and networks are also covered.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**IE 5343. Non-Linear Optimization Techniques for Engineers.**

This course covers engineering applications of mathematical modeling and computational methods for nonlinear programming problems. The primary goal of this course is to present techniques and strategies essential to optimize non-linear models. Prerequisite: IE 3340 with a grade of "C" or better or instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**IE 5345. Advanced Optimization.**

This course covers advanced concepts in linear and integer programming. Solution techniques for stochastic and dynamic programming and formulation and solution of decision models in manufacturing, service, supply chain, healthcare and electrical systems are presented. Prerequisite: IE 5340 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**IE 5347. Advanced Heuristic Optimization.**

This course covers heuristic methods that search beyond local optima such as simulated annealing, tabu search, genetic algorithms, ant-colony systems and particle swarm. Papers from the literature, problem-specific heuristics, evaluation methods, and implementations are discussed.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**IE 5360. Advanced Inventory Control.**

This course delves into advanced concepts of inventory management systems, focusing on analytical techniques and strategic decision-making processes essential for efficient production and operations management. Students will gain practical and theoretical insights crucial for effective inventory control in complex environments by exploring demand forecasting, inventory policies, and supply chain optimization. Prerequisite: IE 5340 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**IE 5370. Scheduling.**

This course focuses on advanced scheduling methodologies and algorithms applied to real-world problems in industrial engineering. The topics covered include deterministic and stochastic scheduling models, single and multi-machine environments, job shop scheduling, flow shop scheduling, and multi-echelon systems. Students will explore theoretical concepts and learn to apply these using both mathematical and computational tools. Prerequisite: IE 5340 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**IE 5397. System Thinking and Analysis.**

This course is an introduction to systems engineering and the systems thinking process, providing important considerations related to the engineering of large scale systems. These considerations include system understanding, modeling and design, the system development process, needs analysis, concept exploration and definition, design, integration and evaluation, and systems engineering management. Prerequisite: ENGR 5310 with a grade of "C" or better or instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**Manufacturing Engineering (MFGE)****MFGE 5315. Energy and Thermofluids Engineering.**

This course covers core engineering concepts of energy and thermofluids based on fluid mechanics, thermodynamics, and heat transfer. The main topics include properties of pure substances, fluid statics and dynamics, non-Newtonian fluid, differential analysis of fluid flow, viscous flow in pipes, external flows, boundary layer, open channel flows, mass and energy analysis of control volumes, first and second laws of thermodynamics, steady-state and transient conduction, internal and external forced convection, natural convection, fundamentals of radiation, and mass transfer.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**MFGE 5316. Advanced Computer Aided Design and Manufacturing.**

Topics include design process, mathematical presentation of wireframe/surface/solid modes, transformation and manipulation of objects, finite element analysis, data exchange, process planning, fundamentals of multi-axis NC programming for turning and milling processes, fundamentals of CAD/CAM systems, CNC code generation by CAD/CAM software for the CNC, and waterjet machines. Prerequisites: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 1 Lab Contact Hour.**

**Grade Mode:** Standard Letter

**MFGE 5318. Additive Manufacturing.**

In this course CAD standards, theory, techniques, applications, and development of additive manufacturing technology, photopolymerization, powder bed fusion, extrusion-based systems, printing processes, sheet lamination processes, beam deposition processes, design for additive manufacturing, and safety considerations in a hands-on approach will be explained. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 1 Lab Contact Hour.**

**Grade Mode:** Standard Letter

**MFGE 5320. Polymer Nanocomposites.**

This course covers polymer nanocomposites focusing on materials, manufacturing, characterization, and applications. The primary focus is on fiber reinforced polymer nanocomposites. Morphological, Thermal, Mechanical, and Electrical Characterization will be discussed in detail. Applications include fire-resistant, ablative, fatigue-resistant, impact-resistant, and bio-based composites. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 1 Lab Contact Hour.**

**Grade Mode:** Standard Letter

**MFGE 5326. Advanced Robotics in Manufacturing Automation.**

This course covers principles and techniques involved in advanced robotics. Topics include introduction to robotics, industrial robotics, robot kinematics, path planning, robot dynamics, advanced control, force control, sensors and actuators, mobile robotics, and introduction to nanorobotics. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**MFGE 5330. Multiscale Manufacturing.**

This course covers the multiscale manufacturing processes, techniques, and applications. Topics include micro and nano-manufacturing, polymer and semiconductor fabrication, thin film technologies, bulk and surface micromachining, physics of multiscale manufacturing, microelectromechanical (MEMS) devices, and design issues for fabrication of micro and nano-systems. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**MFGE 5398B. Advanced Composite Materials.**

This course examines various aspects of fiber-reinforced polymeric composites. The topics covered include constituent materials (fibers and matrices), mechanics, performance, manufacturing, and introduction to nanocomposites. This course also provides introductory treatments concerning ceramic matrix composites, metal matrix composites, and carbon/carbon composites.

**3 Credit Hours. 3 Lecture Contact Hours. 1 Lab Contact Hour.**

**Course Attribute(s):** Exclude from 3-peat Processing|Topics

**Grade Mode:** Standard Letter