

# MASTER OF SCIENCE (M.S.) MAJOR IN ENGINEERING (CIVIL ENGINEERING THESIS OPTION)

## Major Program

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 large, 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 webpage (<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
- official transcripts from **each institution** where course credit was granted
- minimum 3.0 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 sections)
- 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

### TOEFL or IELTS Scores

Non-native English speakers who do not qualify for an English proficiency waiver:

- official TOEFL iBT scores required with a 78 overall
- official IELTS (academic) scores required with a 6.5 overall and
  - minimum individual module scores of 6.0

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

## Degree Requirements

The Master of Science (M.S.) degree in Engineering concentration in Civil Engineering requires 34 semester credit hours, including a thesis.

Non-credit (leveling) coursework 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 project, and the graduate committee will be responsible for approving the project proposal, receiving project progress reports, and approving the final project presentation and written report. 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
CE 5370	Urban Stormwater Management	3
CE 5390	Infrastructure Systems Analysis	3
<b>Electives</b>		
Choose 9 from the following:		9
CE 5320	Water Quality Management	
CE 5350	Highway Bridge Design	
CE 5360	Pavement Design	
EE 5320	Advanced Computer Architecture and Arithmetic	
EE 5323	Digital Image Processing	
EE 5330	Embedded and Real-Time Computing	
EE 5350	Advanced Electronic Circuit Design	
EE 5355	Electronic Materials and Devices	
EE 5360	Thin Film Technology	
EE 5372	Advanced Networking	
EE 5374	Introduction to Wireless Communication	
EE 5377	Statistical Signal Processing	
EE 5385	Optoelectronic Devices	
EE 5398A	Antenna Theory, Design and Applications	
EE 5398B	Electronic Materials and Beyond for Sustainable Energy	
EE 5398C	Multimedia Signal Processing	
EE 5398D	Electroceramics	
ENGR 5384	Problems in Engineering	
IE 5310	Advanced Statistical Design of Experiments for Engineers	
IE 5320	Modeling and Analysis of Manufacturing Systems	

IE 5330	Advanced Quality Control and Reliability Engineering
IE 5340	Applied Deterministic Operations Research for Engineers
IE 5343	Non-Linear Optimization Techniques for Engineers
IE 5345	Advanced Optimization
IE 5347	Modern Heuristic Optimization
IE 5397	System Thinking and Analysis
IE 5398A	Healthcare Systems Engineering
IE 5398B	Response Surface Methodologies
IE 5398C	Data-Intensive Analysis and Simulation for Engineers
MFGE 5316	Advanced Computer Aided Design and Manufacturing
MFGE 5318	Reverse Engineering and Freeform Fabrication
MFGE 5320	Polymer Nanocomposites
MFGE 5326	Advanced Robotics in Manufacturing Automation
MFGE 5328	Advanced Control Techniques
MFGE 5398A	Multiscale Manufacturing
MFGE 5398B	Advanced Composite Materials

**Multidisciplinary Electives**

Choose 9 hours from the following: 9

**Business Administration**

BLAW 5333	Legal Issues of Sustainability and Responsibility
BLAW 5368E	Environmental Law and Policy
CIS 5358	Agile Project Management For Business Professionals
CIS 5364	Data Warehousing
CIS 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	Business Research Methods
QMST 5335	Forecasting and Simulation

**Industrial Technology**

TECH 5315	Engineering Economic Analysis
TECH 5382	Sustainability in Industrial Management
TECH 5390	Research in Technology
TECH 5392	Fundamentals of Microelectronics Manufacturing

**Computer Science**

CS 5306	Advanced Operating Systems
CS 5346	Advanced Artificial Intelligence
CS 5369L	Machine Learning and Applications

**Geography**

GEO 5312	Managing Urbanization
GEO 5313	Environmental Management
GEO 5334	Applied Water Resources
GEO 5336	Transportation Systems
GEO 5351	Regional Waste Management
GEO 5352	Air Quality Management
GEO 5393D	Water Resource Planning

**Mathematics**

MATH 5315	Mathematical Statistics
MATH 5340	Scientific Computation
MATH 5345	Regression Analysis
MATH 5388	Discrete Mathematics
MATH 5376A	Design and Analysis of Experiments
MATH 5376B	Analysis of Variance
MATH 5376D	Statistical Applications in Genetics and Bioinformatics

**Physics**

PHYS 5326	Electrical Characterization of Materials and Devices
PHYS 5327	Semiconductor Device Physics

**Materials Science, Engineering and Commercialization**

MSEC 7301	Practical Skills in Commercialization and Entrepreneurship
MSEC 7302	Leadership Skills in Commercialization and Entrepreneurship
MSEC 7310	Nanoscale Systems and Devices
MSEC 7311	Materials Characterization
MSEC 7340	Biomaterials and Biosensors

**Thesis**

ENGR 5399A	Thesis	3
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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 34

## Comprehensive Examination Requirements

All candidates for graduate degrees must pass one or more comprehensive examinations.

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.       ), CE (p.       ), EE (p.       ), IE (p.       ), MFGE (p.       )

## 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. Restricted to students enrolled in the MS Engineering program.

**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. Restricted to students enrolled in the MS Engineering program.

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

**Course Attribute(s):** 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. Enrollment requires Ingram School Director's approval. Prerequisite: At least one academic year (or two long semesters) of enrollment in MS Engineering, a valid offer of engineering-related internship from industry, and a written internship plan approved by the Director of Ingram School of Engineering.

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

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

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

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

**Grade Mode:** Credit/No Credit

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

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

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

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

**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 foundation for mathematical analysis of physical systems involving randomness.

Applications to engineering topics are taught, including estimation, control, and systems theory. Prerequisite: IE 3320 with a grade of "C" or better, or equivalent, or approval of instructor. Restricted to students enrolled in the MS Engineering program.

**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. Restricted to students enrolled in the MS Engineering program and with approval of instructor.

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

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

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

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

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

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

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

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

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

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

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

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

**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. Registration requires Approval of Committee. Restricted to students enrolled in the MS Engineering program.

**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 5321. Transport and Fate of Contaminants.**

This course is a study of the transport and fate of contaminants in surface water, sub-surface water, and the atmosphere. Use of technology to monitor the transport and fate of contaminants is also addressed.

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

**Grade Mode:** Standard Letter

**CE 5340. Advanced Infrastructure Materials.**

This course is an advanced study of materials used in the construction of infrastructure assets. Topics include high-performance materials, nano-materials, and advanced material testing techniques. Use of technology to monitor in-situ performance of a material is also addressed.

**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 5372. Open Channel Flow.**

This course is an advanced study of uniform, gradually varying, and rapid varying water flow in both natural and engineered open channels. The use of technology to monitor and maintain open channel structures is also addressed.

**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. Prerequisites: EE 3420 and CS 3339, all with a grade of "C" or better, or equivalent, or approval of instructor. 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 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. Prerequisite: EE 3420 with a grade of "C" or better.

**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). Prerequisites: EE 3420 and CS 3339, all with a grade of "C" or better, or equivalent, or approval of instructor. 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 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.

**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. Prerequisite: EE 4350 with a grade of "C" or better, or equivalent, or approval of instructor. 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 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's approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**  
**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. Prerequisite: EE 3350 with a grade of "B" or better, or equivalent, with a grade of "B" or better, or approval of instructor. 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 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. Prerequisite: EE 3350 with a grade of "B" or better, or equivalent, with a grade of "B" or better, or approval of instructor. 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 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. 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 5374. Introduction to 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. Prerequisite: EE 4370 with a grade of "C" or better. 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 5375. Smart Grid: an Application Development Platform.**

In this course, students will learn how to develop real applications for the smart grid and model 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. Prerequisites: EE 3370.

**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 equivalent, or approval of instructor. 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 5385. Optoelectronic Devices.**

This course introduces the student to the concepts, physical operations, and design criteria of state-of-the-art optoelectronic devices and systems used in research, technology, medicine, communication, and other modern applications. Prerequisites: EE 3355 or EE 4350, or equivalent, with a grade of "C" or better; or approval of instructor. 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 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. Restricted to students enrolled in the MS Engineering program. Prerequisite: EE 3340 or EE 3370 (or an equivalent) with a grade of "C" or better, or Instructor's approval.

**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. Restricted to students enrolled in MS Engineering program. Prerequisite: EE 3355 or equivalent, with a grade of "B" or better.

**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 5398C. Multimedia Signal Processing.**

This course covers theory and applications of digital signal processing to multimedia signals, including speech, audio, image, and video. Key concepts and algorithms are discussed first, followed by a review of relevant industry standards. Hardware architectures and real-time implementation concepts appropriate for multimedia signals are also included. Restricted to students enrolled in MS Engineering program. Prerequisites: EE 3370 (or equivalent) and EE 4377 or EE 4323 (or an equivalent), all with a grade of "C" or better, or Instructor's approval.

**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 5398D. Electroceramics.**

This course covers binary and ternary phase diagrams, non-centrosymmetric crystal structures and symmetry groups, nonlinear dielectrics (ferroelectricity, piezoelectricity, pyroelectricity), nonlinear magnetics, oxide wideband gap semiconductors, detectors and sensors, introduction to MEMS, radhard electronics, and spintronics technology. Labs and additional research-oriented instruction are related to materials processing, characterization, fabrication, and testing. Restricted to students enrolled in the MS Engineering program. Prerequisite: EE 3355 with a grade of "B" or better, or Instructor's Approval.

**3 Credit Hours. 3 Lecture Contact Hours. 3 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's approval. Restricted to students enrolled in the MS Engineering program.

**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. Prerequisites: IE 3320 and IE 3340 and MFGE 4396, all with a grade of "C" or better; or instructor's approval. Restricted to students enrolled in the MS Engineering program.

**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. Prerequisite: ENGR 5310 with a grade of "C" or better, or approval of instructor. Restricted to students enrolled in the MS Engineering program.

**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. Prerequisites: CS 1428 and MATH 3377 all with a grade of "C" or better, or approval of instructor. Restricted to students enrolled in the MS Engineering program.

**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 or equivalent, or approval of instructor. Restricted to students enrolled in the MS Engineering program.

**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. Restricted to students enrolled in the MS Engineering program.

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

**Grade Mode:** Standard Letter

### IE 5347. Modern 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. Prerequisite: IE 3340 with a grade of "C" or better, or equivalent, or approval of instructor. Restricted to students enrolled in the MS Engineering program.

**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 approval of instructor. Restricted to students enrolled in the MS Engineering program.

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

**Grade Mode:** Standard Letter

### IE 5398A. Healthcare Systems Engineering.

This course provides an introduction into healthcare delivery with particular attention to the application of systems engineering techniques. Topics include the organization of healthcare systems, characteristics of US healthcare, decision-making in the healthcare environment, health informatics, and performance measurement tools. Student project involves integration and application of systems engineering methodologies. Restricted to students enrolled in the MS Engineering program. Prerequisite: IE 5340 with a grade of "C" or better, or instructor's approval.

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

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

**Grade Mode:** Standard Letter

### IE 5398B. Response Surface Methodologies.

This course continues the examination of the design and analysis of controlled experiments, demonstrating how design of experiments (DOE) and response surface methodologies (RSM) are used in product optimization and process improvement. Topics include factorial and fractional factorial designs, steepest ascent, fitting response surfaces, variance-optimal design, and mixture experiments. Restricted to students enrolled in MS Engineering, MS Computer Science, MS Mathematics, MS Physics or MS Technology Management. Prerequisite: IE 5310 with a grade of "C" or better, or Instructor's approval.

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

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

**Grade Mode:** Standard Letter

**IE 5398C. Data-Intensive Analysis and Simulation for Engineers.**

This course covers foundational topics in data science, including data-intensive analysis and simulation. Specific topics include data science, data extracting and preprocessing, data visualization, and design of simulation experiments. Prerequisite: IE 5310 with a grade of "C" or better, or Instructor's Approval.

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

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

**Grade Mode:** Standard Letter

**Manufacturing Engineering (MFGE)****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. Registration required instructor's approval. Restricted to students enrolled in the MS Engineering program.

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

**Grade Mode:** Standard Letter

**MFGE 5318. Additive Manufacturing.**

The course covers theory, techniques, and applications of Advanced Reverse Engineering & Freedom Fabrication. Topics include reverse engineering generic process, reverse modeling, contact and noncontact scanning, point cloud, geometric modeling, data extraction, rapid prototyping processes, uniform and adaptive slicing, industrial and medical applications, hardware, and software. Registration requires instructor's approval. Restricted to students enrolled in MS Engineering program.

**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. Registration requires instructor's approval. Restricted to students enrolled in the MS Engineering program.

**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. Registration requires instructor's approval. Restricted to student's enrolled in the MS Engineering program.

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

**Grade Mode:** Standard Letter

**MFGE 5328. Advanced Control Techniques.**

This course covers advanced control techniques in manufacturing processes. Topics include modeling of dynamic systems, feedback control systems analysis, stability analysis, PID control, optimal control, programmable logic control, design of control systems, transducer and sensor technology, and digital control. Registration requires instructor's approval. Restricted to students enrolled in the MS Engineering program.

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

**Grade Mode:** Standard Letter

**MFGE 5398A. Multiscale Manufacturing.**

This course covers 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. Restricted to students enrolled in MS Engineering, MS Computer Science, MS Mathematics, MS Physics, or MS Technology Management. Instructor's approval required.

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

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

**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. Restricted to students enrolled in MS Engineering program.

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

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

**Grade Mode:** Standard Letter