ENGINEERING, MS

Program Description

The Master of Science in Engineering prepares students to enter professional work or seek higher academic degrees requiring advanced knowledge and study in the engineering disciplines represented by the undergraduate engineering programs at TAMU-CC. Upon completion of the degree, the graduate will have both a solid education in the fundamentals of engineering as well as specialized knowledge of current topics in the field, and will have developed the skills necessary to maintain knowledge of the current state-of-the-art in engineering, allowing for continuing career advancement.

The proposed MS is designed to operate in conjunction with the five-year BS/MS degree program in engineering at TAMU-CC, in which students are admitted into the program during their junior year, and then enter directly into the MS-ENGR program upon completion of their senior year, taking dual-credit courses during their senior year which are applied to both degrees (BS and MS). Students may also be admitted who have already completed their BS degrees in engineering, either at TAMU-CC or another institution whose engineering programs are accredited by ABET.

Fast Track Engineering BS to Engineering MS

The university allows the opportunity for high-achieving undergraduate students to count a select number of graduate credits toward their undergraduate degree and thereby obtain a graduate degree at an accelerated pace. Students interested in the Fast Track in Engineering should see the undergraduate catalog.

Program Goal

Prepare students to pursue careers in industry, academia, and government by offering a state-of-the-art curriculum and advanced knowledge.

Student Learning Outcomes

Upon completion of the MS in Engineering degree, graduates will be able to demonstrate the ability to

1. (1) identify, formulate, and solve complex engineering problems by selecting and applying appropriate tools and techniques;
2. (2) synthesize advanced technical knowledge in a traditional or emerging area of knowledge in a specialized area of engineering; and
3. (3) conduct research on topics related to the disciplines of engineering or other related disciplines, independently or with minimal direction.

Chronological Procedure Leading to the MS Degree

Completion of a degree plan

Upon admission to the MS degree program in engineering, and prior to enrollment in any course, the student must contact the Graduate Program Coordinator in the College of Engineering and Computer Science to be assigned a faculty advisor, who will come from the graduate faculty in the Department of Engineering. By the end of the first semester of study, the student and advisor should complete and file a degree plan with the Graduate Program Coordinator. Students should seek the advice of their faculty advisor on a regular basis about their progress toward their degree.

Progress toward the degree

Once admitted to the graduate degree program in engineering, a student must complete at least six semester hours of credit per year toward the degree until the degree is completed. (Note: Full-time student status requires nine semester hours of credit in a given fall or spring semester.) Failure to make this minimum progress will result in dismissal from the degree program with possible readmission based on the catalog in effect at the time of readmission. A student who is actively pursuing a graduate project or thesis and has completed all other course work for the degree will be given relief from this requirement, but must register continuously for the related project or thesis course until the project or thesis is completed, and all requirements are met and the student is approved for graduation in the semester the course is taken.

Thesis Option or Non-thesis Option

Thesis Option

Students choosing the thesis option must obtain permission from their faculty advisor (who will chair their MS committee) to register for ENGR 5311 Thesis Research (3 sch), which should be taken no later than the next to last semester. During the first month of ENGR 5311, the student and their advisor should determine the faculty members who will comprise the thesis committee. This committee consists of at least three full-time Texas A&M University-Corpus Christi graduate faculty members, including the committee chair, two of which must be in engineering.

While taking ENGR 5311, the student will develop a written proposal of the thesis work and present the proposal for approval. The student must continually register for ENGR 5311 Thesis Research (3 sch) until the research is near completion. When the student is ready and has the advisor's approval, the student may then register for ENGR 5312 Thesis (3 sch), to be taken in the last semester. If the student fails their final examination, which is an oral defense of their project, a grade of No Credit will be assigned to ENGR 5312 and all semesters of ENGR 5311 taken previously, and the student must begin the process again. If the student passes the examination but fails to meet the deadlines for graduation that semester, the student will be required to enroll in ENGR 5312 the following semester to meet the requirement that the student be enrolled in the course in the semester in which the student graduates.

While taking ENGR 5312 Thesis (3 sch), the student will produce a written thesis that discusses their work. A draft copy of the thesis will be given to all committee members and the student will make any changes required by the committee. Upon approval of the thesis committee chair, the student may schedule their final oral examination. The thesis will be published and archived in the Mary & Jeff Bell library. Guidelines for writing the thesis are available in the Department of Engineering office.

Non-Thesis Option

Students must take all required courses along with their chosen electives as outlined in the degree plan. ENGR 5313 Capstone Project (3 sch) is taken in the final semester and culminates in an appropriate project that requires a report and an oral presentation.

Final examination (Thesis Option)

After the student has completed all other requirements for the MS degree in engineering, the student must schedule an oral exam over the student's

graduate program of study. The oral exam will be administered by the graduate thesis committee and will focus heavily on the thesis itself.

For Additional Information

Website:
http://gradschool.tamucc.edu/degrees/engineering/engineering.html

Campus Address:
Robert Furgason Engineering Building, Room 222
Phone: (361) 825-5849

Mailing Address:
Department of Engineering, Unit 5797
College of Engineering and Computer Science
Texas A&M University-Corpus Christi
6300 Ocean Drive
Corpus Christi, Texas 78412-5825

Admission Requirements

- In addition to meeting all University requirements, students seeking admission to the program for the Master of Science in Engineering must submit the following to the College of Graduate Studies:
    - An application and application fee
    - Transcripts from regionally accredited institutions (international students will be required to submit relevant international transcripts, with translations through approved translation services, if not in English)
    - An essay (500-1000 words) discussing why the student wishes to obtain a Master's degree and the student's areas of interest
    - GRE scores (within five years of the date of application)
    - International students must show English language proficiency through either TOEFL or IELTS exam and submit additional documents to the College of Graduate Studies (see http://gradschool.tamucc.edu/international.htm for full requirements).
- A student entering the program is expected to have adequate preparation in engineering and mathematics through their undergraduate degree. The MS in Engineering has four concentration areas: civil engineering, electrical engineering, industrial engineering, and mechanical engineering. For civil engineering, this preparation must include successful completion of undergraduate coursework in structural engineering, materials, geotechnical engineering, and hydraulics/hydrology. For electrical engineering, this preparation must include successful completion of undergraduate course work in circuits and networks, electronics, signal processing, controls, and microprocessors. For industrial engineering, this preparation must include successful completion of undergraduate coursework in human factors, operations research, simulations, manufacturing processes, and logistics. For mechanical engineering, this preparation must include successful completion of undergraduate coursework in dynamics, materials science, strength of materials and solid mechanics, and fluid mechanics and heat transfer. In addition to these, in the area of mathematics, all students must have successfully completed course work in calculus through multivariable calculus, plus differential equations and at least one additional junior level or higher mathematics course such as linear algebra, numerical analysis, or applied probability and statistics.
- Students who have not successfully completed the above courses may be required to take undergraduate leveling courses in any missing subjects. All leveling courses must be completed with a grade of "B" or better. In addition, students can take no more than 9 credits towards their degree prior to completing all leveling courses.
- Students seeking admission to the MS in Engineering program must identify a faculty member willing to serve as their graduate faculty advisor. Applicants may review the research interests of faculty members at engineering.tamucc.edu. Applicants should contact faculty members via e-mail and determine if a particular faculty member is willing to serve as their faculty advisor. Applicants will not be admitted to the program without a graduate advisor.

Program Requirements

Requirements for the Master of Science in Engineering degree may be met through one of two options: Thesis Option (Option I) or Non-Thesis Option (Option II). The Thesis Option requires a minimum of 33 credit hours and the Non-Thesis Option requires a minimum of 36 credit hours. All students take a common required core of 12 SCH, consisting of three lecture courses and two seminar courses. Students take 9 SCH of prescribed electives in their chosen concentrations. Thesis-option students take an additional 6 SCH of free electives and 6 SCH of research / thesis. Non-thesis-option students take 12 SCH of free electives plus 3 SCH for a capstone projects course.

Code	Title	Hours
Core Courses (12 hours)		
ENGR 5401	Engineering Mathematics and Analysis	4
ENGR 5302	Numerical Methods for Engineers	3
ENGR 5305	Experimental Methods and Design in Engineering	3
ENGR 5101	Engineering Seminar I	1
ENGR 5102	Engineering Seminar II	1
Thesis or Non-Thesis Option		
Select one of the following options:		21-24
Option I - Thesis Option (21 hours)		
Select 9 hours of prescribed electives in the concentration area and 6 hours of electives either within or outside the concentration area (with approval of advisor) (15 hours)		
ENGR 5311	Thesis Research	
ENGR 5312	Thesis	
Option II - Non-Thesis Option (24 hours)		
Select 9 hours of prescribed electives in concentration area and 12 hours of electives within or outside the concentration area (with advisor's approval) (21 hours)		
ENGR 5313	Capstone Project (must be taken in last semester)	
Concentrations		
Civil Engineering		
Prescribed electives		
CEEN 5321	Structural Engineering	
CEEN 5331	Water Resources Engineering	
CEEN 5332	Environmental Fluid Mechanics	
Electives		
CEEN 5311	GIS for Civil Engineering	
CEEN 5322	Optimization	
CEEN 5323	Sustainable Infrastructure Engineering	
CEEN 5333	Environmental Engineering	
CEEN 5341	Transportation Engineering	
CEEN 5351	Geotechnical Engineering	

Electrical Engineering	
Prescribed Electives	
EEEN 5311	Dynamics and Control Systems I
EEEN 5321	Materials Devices and Micro-electrical-mechanical Systems
EEEN 5331	Signal Processing I
Electives	
EEEN 5312	Mechatronics
EEEN 5313	Linear Systems
EEEN 5314	Robotics and Autonomous Systems
EEEN 5322	Embedded Systems
EEEN 5332	Machine Vision and Image Processing
EEEN 5333	Random Signal Processes
Industrial Engineering	
Prescribed Electives	
IEEN 5311	Linear and Nonlinear Programming
IEEN 5312	Modeling and Simulation
IEEN 5321	Human Factors
Electives	
IEEN 5313	Optimization
IEEN 5322	Ergonomics and Safety Engineering
IEEN 5331	Quality Control
IEEN 5332	Supply Chain Management
IEEN 5333	Manufacturing Process Engineering
Mechanical Engineering	
Prescribed Electives	
MEEN 5311	Dynamics and Control Systems I
MEEN 5321	Intermediate Fluid Mechanics
MEEN 5331	Intermediate Heat and Mass Transfer
Electives	
MEEN 5312	Mechatronics
MEEN 5313	Engineering System Design
MEEN 5314	Robotics and Autonomous Systems
MEEN 5322	Advanced Fluid Mechanics
MEEN 5323	Computational Fluid Dynamics I
MEEN 5324	Turbulent Flow
MEEN 5332	Advanced Heat Transfer
Additional Electives	
ENGR 5390	Special Topics
ENGR 5396	Directed Independent Study
MATH 5343	Mathematical Theory of Statistics
COSC 6354	Artificial Intelligence
Total Hours	**33-36**

Electives

Electives are chosen by the student but are subject to approval by the student's graduate faculty advisor (who is also the thesis committee chair for students in the Thesis Option). For the Thesis Option, electives should be taken that will support the student's thesis work. For the Non-Thesis Option, students must take two electives in their concentration and two electives outside their concentration. All electives must be approved by the student's graduate faculty advisor.

No more than six hours of approved electives may come from courses taken at another university and/or from outside of engineering. Credit from a master's degree earned at another institution will not be applied to a second master's degree at Texas A&M University-Corpus Christi. A maximum of six hours of approved Directed Independent Study courses may count toward the MS degree.

Courses

Engineering

ENGR 5101 Engineering Seminar I
1 Semester Credit Hour
The course focuses on developing professional research skills typically not provided in formal coursework such as methods for research, literature review, presenting scientific research, research ethics.

ENGR 5102 Engineering Seminar II
1 Semester Credit Hour
Continuation of topics from ENGR 5101. Students get experience in presenting research to peer audiences. Peer-review process, professional society engagement.
Prerequisite: ENGR 5101.

ENGR 5302 Numerical Methods for Engineers
3 Semester Credit Hours (3 Lecture Hours)
This course introduces students to algorithms and methods that are commonly needed in scientific computing. The mathematical construction of these methods is emphasized as much as their algorithmic aspects. This class will enable graduate students obtain the knowledge and competence in the design of mathematical models that can properly help develop their research objectives and experimentation through mathematical modeling and simulation. Topics cover mathematical preliminaries, computer arithmetic, solution of nonlinear equations, solving systems of linear equations, selected topics in numerical linear algebra, approximating functions, numerical differentiation and integration, numerical solution of ordinary differential equations, numerical solution of partial differential equations, and linear programming and related topics. This course work is enabled by the utilization of MATLAB as the main tool to compute the students work.

ENGR 5305 Experimental Methods and Design in Engineering
3 Semester Credit Hours (3 Lecture Hours)
Experimental methods in engineering. Includes measurement techniques, instrumentation, data acquisition, signal processing, and linear and digital electronics; uncertainty analysis. Design and analysis of experiments.

ENGR 5311 Thesis Research
3 Semester Credit Hours
This course is for MS in Engineering students choosing the thesis option. This course is only credit/no credit. Student will be given a grade of In-Progress until the thesis is successfully completed.

ENGR 5312 Thesis
3 Semester Credit Hours
This course is for MS in Engineering students choosing the thesis option. A student should register for this course in the semester in which the student plans to present and defend the MS thesis.
Prerequisite: ENGR 5311.

ENGR 5313 Capstone Project
3 Semester Credit Hours (3 Lecture Hours)
This course is for MS in Engineering students choosing the non-thesis option. Culminating research or design project under supervision of faculty member. Should be taken in last semester of residence in the MS in Engineering (non-thesis option) program. Final report and presentation required. Permission of instructor.

ENGR 5390 Special Topics
3 Semester Credit Hours (3 Lecture Hours)
Study of advanced topics in engineering. May be repeated. Topics vary by semester and offering.

ENGR 5396 Directed Independent Study
3 Semester Credit Hours
One-on-one study of advanced topics in engineering directed by individual faculty member. May be repeated for credit once. Topics vary by faculty member. Requires a formal proposal of study to be completed in advance of registration which must be approved by the supervising faculty member, department chair, and associate dean of the College of Engineering.

ENGR 5401 Engineering Mathematics and Analysis
4 Semester Credit Hours (4 Lecture Hours)
Analytic methods in ordinary differential equations, complex-variable theory, the Laplace transform and its inversion. Initial-value problems and boundary-value problems; eigenvalues, eigenvectors, and eigenfunctions.

Civil Engineering

CEEN 5311 GIS for Civil Engineering
3 Semester Credit Hours (3 Lecture Hours)
This course is focused on the advanced applications of GIS methods in civil engineering. The main topics include data acquisition, vector analysis, raster analysis, geospatial data visualization, utility network analysis, spatial statistics, space-time pattern mining, WebGIS, and programming for geospatial analysis.
Prerequisite: CEEN 3330.

CEEN 5321 Structural Engineering
3 Semester Credit Hours (3 Lecture Hours)
Matrix force and displacement methods of structural analysis; virtual work theorem and principles, virtual forces and displacements; computation of element stiffness matrices and load vectors; introduction to finite element analysis and structural stability. Applications in structural design.

CEEN 5322 Optimization
3 Semester Credit Hours (3 Lecture Hours)
This course focuses on problem formulation, software technologies and analytical methods for optimization serving as an introduction to a wide variety of optimization problems and techniques including dynamic programming, network flows, integer programming, heuristic approaches, Markov chains, game theory, and decision analysis. This course provides tools to formulate engineering problems as the optimization of some function under some set of constraints. As such operations research is a quantitative discipline that deals with the application of advanced analytical methods to help make better decisions. This course employs techniques from other mathematical sciences, such as mathematical modeling, statistical analysis, and mathematical optimization and provides optimal or near-optimal solutions to complex decision-making problems. (Cross-listed with IEEN 5313 Optimization.)
Prerequisite: ENGR 5302.

CEEN 5323 Sustainable Infrastructure Engineering
3 Semester Credit Hours (3 Lecture Hours)
This course aims at providing students with simple scientific techniques for the optimum design of materials to improve its performance while minimizing cost and environmental impacts. The course aims at providing students with metrics of sustainability, principles of design for the environment, methods for pollution prevention, and use of mass and energy balances in the design of sustainable systems. In addition, concepts of Life-Cycle Assessment (LCA) and cost analysis are introduced to students. The concepts of carbon footprint and embodied energy of construction materials will be introduced to the students. The course will include new technologies, materials, and design processes for sustainable infrastructure; energy management and renewable energy and efficiency in structures; and connections between societal needs and infrastructure development.
Prerequisite: CEEN 5321 and 5331.

CEEN 5331 Water Resources Engineering
3 Semester Credit Hours (3 Lecture Hours)
This course is focused on the advanced extension of the principles of hydraulics and hydrology to applications in water resources systems. The main topics include water supply systems, stormwater systems, wastewater systems, irrigation systems, water conservation, watershed analysis and simulation, system reliability and resilience, and integrated water resources management.
Prerequisite: CEEN 4312.

CEEN 5332 Environmental Fluid Mechanics
3 Semester Credit Hours (3 Lecture Hours)
This course is focused on applications of fluid mechanics that provide insight into the physics and transport in environmental systems. The major topics include: the development of basic transport equations of unsteady fluid flow including continuity, Navier-Stokes, and energy equations; Lagrangian and turbulent transport; scaling principles; analysis of viscous incompressible flows, stratified flows and flows with vorticity, and geophysical flows; jets and plumes; sediment transport; interactions between air and water systems.
Prerequisite: ENGR 3315.

CEEN 5333 Environmental Engineering
3 Semester Credit Hours (3 Lecture Hours)
This course is focused on the advanced extension of the fundamentals of environmental engineering. The main topics include water and wastewater treatment systems, solid waste management, air pollution management, environmental systems analysis, system sustainability and resilience, and other selected topics.

CEEN 5341 Transportation Engineering
3 Semester Credit Hours (3 Lecture Hours)
Planning, design, staging, construction, test, and maintenance of the public works and facilities for air, water, rail, and highway transit systems. Introduction to concepts from traffic engineering including traffic flow theory and capacity and quality of traffic flow.

CEEN 5351 Geotechnical Engineering
3 Semester Credit Hours (3 Lecture Hours)
Soil dynamics, ground improvement, soil and foundation systems; problems of dynamic soil-structure interaction. Elasticity and plasticity models; stress-strain relations for soils; failure criteria. Site preparation and improvement; flexible retaining structures, pile foundations, and other foundational structures such as caissons, pile foundations, and drilled shafts.

Electrical Engineering

EEEN 5311 Dynamics and Control Systems I
3 Semester Credit Hours (3 Lecture Hours)
This course is designed to prepare students with the study of the intersection between dynamic systems and how to control them. Dynamics is a section of mechanics that deals with the accelerated motion of a body or system. Dynamics can be presented in two parts: kinematics (geometric aspects of motion) and kinetics (analysis of forces causing the motion). In order to analyze an enable dynamics on mechanical systems control systems theory can be implemented. Control systems consist of subsystems and processes assembled for the purpose of obtaining a desired output with desired performance, given and specified inputs. Control theory then enables the student with the knowledge to enable a desired output on dynamic systems based on inputs. Topics cover Planar Kinematics and Kinetics of a Rigid Body, Three-Dimensional Kinematics and Kinetics of a Rigid Body and Vibrations. That will be done with the complementary analysis and utilization of control systems tools such as Multidomain Modeling (frequency and time), Reduction of Multiple Subsystems, Stability, Steady-State Errors and Root Locus Techniques. (Cross-listed with MEEN 5311 Dynamics and Control Systems I.)

EEEN 5312 Mechatronics
3 Semester Credit Hours (3 Lecture Hours)
This course introduces a multidisciplinary field that combines electrical engineering, mechanical engineering, control systems and computer science. It presents key aspects in the design of systems, devices and products and it aims at the analysis of the behavior and control of the systems. Topics covered in this course bring together different areas of technology involving actuation systems, computer-aided design, sensors, signal conditioning, data acquisition, and programming. Course includes hands-on activities related to acquiring experience with electronics, computer-aided design, programming, and control systems. (Cross-listed with MEEN 5312 Mechatronics.)
Prerequisite: EEEN 5311.

EEEN 5313 Linear Systems
3 Semester Credit Hours (3 Lecture Hours)
This course is designed to introduce graduate students to the fundamental state space concepts needed for the analysis and design of linear systems. Modeling, analysis, and design of continuous-time control systems using the state space approach will be covered. Other topics involve Vector spaces, linear operators, and linear equation solution theory are used to describe system solutions and their stability, controllability, and observability properties. State observers and state feedback control will be developed, along with an introduction to linear quadratic optimal control.
Prerequisite: EEEN 5311.

EEEN 5314 Robotics and Autonomous Systems
3 Semester Credit Hours (3 Lecture Hours)
Robots and Autonomous Systems are projected to benefit our society as new technologies are being developed. This course involves an introduction and survey of contemporary robotic mechanisms or systems, and field applications. This course includes the understanding of basic principles of robotics such as embedded systems in automated systems, manipulator kinematics and design, and principles of unmanned ground, aquatic, surface, and aerial vehicles. The student will be introduced to the Robotic Operating System (ROS) environment and its application in modern robotics. Also, there will be a survey in multi-agent modeling and its application on multi-robot systems. Other topics to be discussed are path-planning for navigation, task allocation and decision making, machine learning and artificial intelligence technologies with the complement of multi-sensor data fusion that can currently enable certain levels of autonomy in robots. (Cross-listed with MEEN 5314 Robotics and Autonomous Systems.)
Prerequisite: EEEN 5311.

EEEN 5321 Materials Devices and Micro-electrical-mechanical Systems
3 Semester Credit Hours (3 Lecture Hours)
This course deals with the analysis and design of electronic devices. In order to analyze and design these devices, detailed knowledge of semiconductor physics is needed. Therefore, the course will begin with treatment of semiconductor physics. The second part of the course will focus on applying knowledge of semiconductor physics to electronic devices. Devices that will be covered include diodes, field-effect transistors and bipolar junction transistors. Device physics will be used to relate internal charged-carrier behavior with external terminal characteristics of the devices. Electronic devices are used in circuits to make complex analog and digital functions such as amplifiers (for audio, high-frequency, wireless, etc.) and microprocessors. This course is fundamental to electrical engineering and will benefit persons in all areas of concentration especially solid-state devices and materials, electronics engineering, computer engineering, and mechanical engineering. This course will be complemented with the introduction of Micro-electro-mechanical Systems and its function in the development of modern Inertial Measurement Units for sensing of dynamic phenomena.

EEEN 5322 Embedded Systems
3 Semester Credit Hours (3 Lecture Hours)
This course covers the study and operation of embedded computer systems which include a microcomputer with mechanical, chemical, and electrical devices attached to it. Such systems are programmed for a specific purpose and package up as a complete system. The class is enabled by the utilization of the TI MSP432 ARM Cortex-M based microcontroller. The class is mainly focused on the programming and implementation of C based programs (with some assembly language as necessary) with the microcontroller. Topics covered in this course are Introduction to Computing, C for Embedded Systems, Input/output Programming, LCD and Keyboard interfacing, UART Serial Port Programming, Timer Programming, Interrupt and Exception Programming, ADC, DAC, and Sensor Interfacing, SPI Protocol and DAC interfacing, I2C Protocol and RTC Interfacing, and several Motors/Actuators interfacing.

EEEN 5331 Signal Processing I
3 Semester Credit Hours (3 Lecture Hours)
Discrete time signals & systems, z-transform, discrete Fourier transform, flow graph and matrix representation of digital filters, digital IIR and FIR filter design techniques and computation of the fast Fourier transform (FFT). In addition, linear predictive coding, LMS filtering, Wiener filters, adaptive filters will be covered. MATLAB and/or C programming tools will be used in this course.
Prerequisite: ENGR 5401.

EEEN 5332 Machine Vision and Image Processing
3 Semester Credit Hours (3 Lecture Hours)
This course covers machine vision systems, system components, design criteria including lighting and camera specifications, as well as testing and measurements with such systems. In addition, fundamentals of image processing are introduced. Topics include image processing and analysis of color and gray scale images in spatial and frequency domain. Topics also include other transform domains, filtering, segmentation, object detection, recognition, tracking, and introduction to machine learning for image segmentation.
Prerequisite: EEEN 5331.

EEEN 5333 Random Signal Processes
3 Semester Credit Hours (3 Lecture Hours)
This course extends in the study of random processes as a natural extension of random variables when dealing with signals. This will enable students to study signals as random rather than deterministic. This topic is essential into the study of non-ideal characteristics of signals and the development of noise mitigation techniques. Topics covered in this class are survey of probability fundamentals, Random Variables, Statistical Averages, Wide-Sense Stationary and Multiple Random Processes, Random Processes and Linear Systems, Power Spectral Density of Stationary Processes and a Sum Process, Gaussian Processes, White Processes and Filtered Noise Processes.
Prerequisite: EEEN 5331.

Industrial Engineering

IEEN 5311 Linear and Nonlinear Programming
3 Semester Credit Hours (3 Lecture Hours)
This course introduces the fundamentals of linear and nonlinear optimization theory and methods. This course is a major part of the toolbox of the applied mathematician, and more broadly, of researchers in quantitative sciences including economics, data science, machine learning, and quantitative social sciences. The course provides an introduction to linear programming and convex optimization. Topics include unconstrained and constrained optimization, linear and quadratic programming, Lagrange and conic duality theory, interior-point algorithms and theory, Lagrangian relaxation, generalized programming, and semi-definite programming.
Prerequisite: ENGR 5302.

IEEN 5312 Modeling and Simulation
3 Semester Credit Hours (3 Lecture Hours)
Students learn simulation theory, learn modeling and analysis techniques that can be applied to the design, operation, and evaluation of complex systems, and apply them to real problems.

IEEN 5313 Optimization
3 Semester Credit Hours (3 Lecture Hours)
This course focuses on problem formulation, software technologies and analytical methods for optimization serving as an introduction to a wide variety of optimization problems and techniques including dynamic programming, network flows, integer programming, heuristic approaches, Markov chains, game theory, and decision analysis. This course provides tools to formulate engineering problems as the optimization of some function under some set of constraints. As such operations research is a quantitative discipline that deals with the application of advanced analytical methods to help make better decisions. This course employs techniques from other mathematical sciences, such as mathematical modeling, statistical analysis, and mathematical optimization and provides optimal or near-optimal solutions to complex decision-making problems. (Cross-listed with CEEN 5322 Optimization.)
Prerequisite: ENGR 5302.

IEEN 5321 Human Factors
3 Semester Credit Hours (3 Lecture Hours)
Introduction to the basic concepts and principles of human factors to demonstrate and apply a broad knowledge of various modern industrial engineering methods and tools associated with designing systems in manufacturing and other related fields. Apply engineering design methods to represent, integrate and solve problems, including the ability to recognize problem context and integrate knowledge and skills appropriate sources.

IEEN 5322 Ergonomics and Safety Engineering
3 Semester Credit Hours (3 Lecture Hours)
This course covers occupational safety in the manufacturing environment and the use of ergonomic principles to recognize, evaluate, and control workplace conditions that cause or contribute to employee safety and productivity issues. Topics cover Occupational Safety and Health Administration (OSHA) safety guidelines including electrical, chemical, and hazardous material safety. Ergonomic considerations to include repetitive motion, plant layout, and machine design and industrial safety awareness, accident cost and prevention, and workman's compensation issues are discussed.
Prerequisite: IEEN 5321.

IEEN 5331 Quality Control
3 Semester Credit Hours (3 Lecture Hours)
This course provides the knowledge and techniques required to improve product quality and process efficiency by identifying and measuring production process variability which, if not successfully addressed, leads to inconsistent product quality, costly wastage, non-standardization and other reliability and productivity problems. This course introduces basic quality management concepts and definitions and builds on that knowledge to explore Statistical Process Control (SPC) based quality improvement techniques as a means to diagnose, reduce, and eliminate causes of variation and to assist in process improvement, production control, production planning, and decision making. A brief review of the fundamentals of statistics and probability and their applications in quality management is provided, and various measurement and control techniques -- for example, charts for variables and attributes, are presented.
Prerequisite: IEEN 5321.

IEEN 5332 Supply Chain Management
3 Semester Credit Hours (3 Lecture Hours)
In this course, students develop the ability to conceptualize, design, and implement supply chains aligned with product, market, and customer characteristics. Business competition is now between supply networks rather than individual corporations. Managing the flow of products, information, and revenue across supply chains differentiates the ability of supply networks to fulfill customer needs. Students develop the ability to evaluate how information flows can substitute for the stock of physical resources, such as inventory, and why such systems succeed or fail. They assess how internet technologies, dynamic markets, and globalization are impacting supply chain strategies and practices, including logistics, digital coordination of decisions and resources, inventory and risk management, procurement and supply contracting, product and process design, and revenue management.

IEEN 5333 Manufacturing Process Engineering
3 Semester Credit Hours (3 Lecture Hours)
Theory and application of the design of modern manufacturing facilities. Facility location and layout; materials handling practice and systems, manufacturing systems layout, and warehouse operations. Automated systems. Total process analysis; optimization and economics of manufacturing systems.
Prerequisite: IEEN 5321.

Mechanical Engineering

MEEN 5311 Dynamics and Control Systems I
3 Semester Credit Hours (3 Lecture Hours)
This course is designed to prepare students with the study of the intersection between dynamic systems and how to control them. Dynamics is a section of mechanics that deals with the accelerated motion of a body or system. Dynamics can be presented in two parts: kinematics (geometric aspects of motion) and kinetics (analysis of forces causing the motion). In order to analyze an enable dynamics on mechanical systems control systems theory can be implemented. Control systems consist of subsystems and processes assembled for the purpose of obtaining a desired output with desired performance, given and specified inputs. Control theory then enables the student with the knowledge to enable a desired output on dynamic systems based on inputs. Topics cover Planar Kinematics and Kinetics of a Rigid Body, Three-Dimensional Kinematics and Kinetics of a Rigid Body and Vibrations. That will be done with the complementary analysis and utilization of control systems tools such as Multidomain Modeling (frequency and time), Reduction of Multiple Subsystems, Stability, Steady-State Errors and Root Locus Techniques. (Cross-listed with EEEN 5311 Dynamics and Control Systems I.)

MEEN 5312 Mechatronics
3 Semester Credit Hours (3 Lecture Hours)
This course introduces a multidisciplinary field that combines electrical engineering, mechanical engineering, control systems and computer science. It presents key aspects in the design of systems, devices and products and it aims at the analysis of the behavior and control of the systems. Topics covered in this course bring together different areas of technology involving actuation systems, computer-aided design, sensors, signal conditioning, data acquisition, and programming. Course includes hands-on activities related to acquiring experience with electronics, computer-aided design, programming, and control systems. (Cross-listed with EEEN 5312 Mechatronics.)
Prerequisite: MEEN 5311.

MEEN 5313 Engineering System Design
3 Semester Credit Hours (3 Lecture Hours)
Application of systems engineering principles to mechanical engineering design. Determination of functional and performance requirements; optimization and trade-offs; conceptual design. Inclusion of life-cycle and manufacturability considerations in design. Principles will be applied in a design project in the course.
Prerequisite: ENGR 5302.

MEEN 5314 Robotics and Autonomous Systems
3 Semester Credit Hours (3 Lecture Hours)
Robots and Autonomous Systems are projected to benefit our society as new technologies are being developed. This course involves an introduction and survey of contemporary robotic mechanisms or systems, and field applications. This course includes the understanding of basic principles of robotics such as embedded systems in automated systems, manipulator kinematics and design, and principles of unmanned ground, aquatic, surface, and aerial vehicles. The student will be introduced to the Robotic Operating System (ROS) environment and its application in modern robotics. Also, there will be a survey in multi-agent modeling and its application on multi-robot systems. Other topics to be discussed are path-planning for navigation, task allocation and decision making, machine learning and artificial intelligence technologies with the complement of multi-sensor data fusion that can currently enable certain levels of autonomy in robots. (Cross-listed with EEEN 5314 Robotics and Autonomous Systems.)
Prerequisite: MEEN 5311.

MEEN 5321 Intermediate Fluid Mechanics
3 Semester Credit Hours (3 Lecture Hours)
Differential equations of fluid mechanics, Newtonian and non-Newtonian fluids, boundary-layer theory, similarity solutions and integral methods for laminar flows. Two-dimensional and axisymmetric boundary layers. Introduction to transition and turbulent flow.
Prerequisite: ENGR 5401.

MEEN 5322 Advanced Fluid Mechanics
3 Semester Credit Hours (3 Lecture Hours)
Equations of motion for compressible fluid flow; nozzle flows; shocks and expansions; flows with heat addition and friction; unsteady one-dimensional flows; method of characteristics for one-dimensional unsteady and two-dimensional steady flows; flows about two-dimensional and axisymmetric bodies.
Prerequisite: MEEN 5321.

MEEN 5323 Computational Fluid Dynamics I
3 Semester Credit Hours (3 Lecture Hours)
Classification of partial differential equations. Finite-difference and finite-volume discretization techniques and solution methods for linear and non-linear, steady and unsteady problems; accuracy, convergence, and stability. Multigrid methods, validation techniques. Current computational techniques and solution methods.
Prerequisite: ENGR 5302 and MEEN 5321.

MEEN 5324 Turbulent Flow
3 Semester Credit Hours (3 Lecture Hours)
Transition from laminar flow; turbulent wall-bounded flows, jets, and wakes. The nature of turbulent flow; Reynolds averaging and correlated variables; mixing length and integral scales; law of the wall and wake law; the Kolmogorov structure of turbulence, the energy cascade, diffusion; energy, mass, and momentum exchange; structure of turbulent flows; fundamentals of modeling turbulent flows.
Prerequisite: MEEN 5321.

MEEN 5331 Intermediate Heat and Mass Transfer
3 Semester Credit Hours (3 Lecture Hours)
Heat and mass transfer by diffusion in one-dimensional, two-dimensional, transient, periodic, and phase change systems. Convective heat transfer for external and internal flows. Similarity and integral solution methods. Heat, mass, and momentum analogies. Turbulence. Buoyancy driven flows. Convection with phase change. Radiation exchange between surfaces and radiation transfer in absorbing-emitting media. Fickian and non-Fickian diffusion, multi-component diffusion, and diffusional transport in porous media.
Prerequisite: ENGR 5401.

MEEN 5332 Advanced Heat Transfer
3 Semester Credit Hours (3 Lecture Hours)
An advanced treatment of conduction, convection, and radiation heat transfer from a Reynolds transport theorem perspective. Topics include: three dimensional steady-state and transient conduction, phase change; forced and free convection; internal and external flows; black body radiation; radiative exchange between nongray surfaces; radiative transfer equation; numerical modeling and simulation of heat transfer phenomena; term project.
Prerequisite: MEEN 5331.