DEPARTMENT OF MECHANICAL ENGINEERING

The Department of Mechanical Engineering offers a Master of Science degree in Advanced Manufacturing and Enterprise Engineering and Master of Science and Doctor of Philosophy degrees in Mechanical Engineering.

- M.S. in Advanced Manufacturing and Enterprise Engineering (p. 1)
- M.S. in Mechanical Engineering (p. 2)
- Ph.D. in Mechanical Engineering (p. 3)

Master of Science Degree in Advanced Manufacturing and Enterprise Engineering

The Master of Science program in Advanced Manufacturing and Enterprise Engineering (M.S. in AMEE) is designed to offer an opportunity to individuals for continued study toward positions of leadership in industry and academia and for continuing technical education in a more specialized area. The graduates of this program will have the fundamental knowledge and understanding of the operational complexity of enterprises, manufacturing and business process improvement/optimization, and integrated product/process/system design. In addition, they will have the cognitive skills to critically evaluate the potential benefits of alternative manufacturing strategies, to use virtual/simulated platforms to facilitate and improve business processes, and to analyze enterprise systems as systems of interacting units, components, and subsystems. The program offers three concentration areas, namely Advanced Manufacturing, Enterprise Engineering, and Sustainable Systems Engineering.

Program Admission Requirements

A complete application package consists of the following:

- Students must meet the University-Wide Admission Requirements as outlined in the graduate catalog
- Official transcripts of all undergraduate and graduate coursework
- Official Graduate Record Examination (GRE) scores. (GRE scores waived for current UTSA students and UTSA alumni of the B.S. in Mechanical Engineering and closely related engineering programs (BME, CE, EE), who have an overall GPA above 3.0)
- A statement of purpose/research experience
- Two professional and/or academic letters of recommendation
- Résumé or Curriculum Vitae (CV)

Due to the multidisciplinary nature of the program, the Graduate Advisor of Record (GAR), in consultation with the Mechanical Engineering Graduate Studies Committee and the Department Chair, will evaluate each student's transcript and determine course deficiencies, if any, on a case-by-case basis. Applicants who have insufficient preparation for the program may be admitted on a conditional basis. Students admitted with course deficiencies will be required to take additional remedial courses. Courses taken to make up deficiencies may not be counted toward the graduate degree requirements. Other applicants who wish to continue their education in the area of Advanced Manufacturing and Enterprise Engineering, but do not intend to pursue a Master of Science degree, may seek admission as a special graduate student.

Degree Requirements

Thesis Option

The minimum number of semester credit hours required for the degree is 30 for the thesis option.

A. 15 semester credit hours of required topical courses selected from the following:		**15**
ME 5213	Topics in Systems Modeling	
ME 5233	Advanced Quality Control	
ME 5503	Lean Manufacturing and Lean Enterprises	
ME 5563	Computer Integrated Manufacturing	
ME 5583	Process Improvement and Variability Reduction	
ME 5603	Advanced Manufacturing Systems Engineering	
ME 5643	Green and Sustainable Manufacturing and Enterprise Systems	
ME 5703	Lean Product Development and Service Systems	
ME 6033	Linear and Mixed Integer Optimization	
ME 6543	Machine Learning and Data Analytics	
B. 9 semester credit hours of Prescribed Electives approved by student's advisor:		**9**
Electives are approved in consultation with either the student's advisory committee or the Graduate Advisor of Record. See Mechanical Engineering Department's Handbook of Master's Programs for recommended courses.		
C. Degree candidates must complete a minimum of 6 credit hours of the following course requirements for the thesis option:		**6**
ME 6983	Master's Thesis (repeated)	
Total Credit Hours		30

Non-Thesis Option

The minimum number of semester credit hours required for the degree is 33 for the non-thesis option.

A. 15 semester credit hours of required topical courses selected from the following:		**15**
ME 5213	Topics in Systems Modeling	
ME 5233	Advanced Quality Control	
ME 5503	Lean Manufacturing and Lean Enterprises	
ME 5563	Computer Integrated Manufacturing	
ME 5583	Process Improvement and Variability Reduction	
ME 5603	Advanced Manufacturing Systems Engineering	
ME 5643	Green and Sustainable Manufacturing and Enterprise Systems	
ME 5703	Lean Product Development and Service Systems	
ME 6033	Linear and Mixed Integer Optimization	
ME 6543	Machine Learning and Data Analytics	
B. 15 semester credit hours of Prescribed Electives approved by student's advisor:		**15**
Electives are approved in consultation with either the student's advisory commitee or the Graduate Advisor of Record. See Mechanical Engineering Department's Handbook of Master's Programs for recommended courses.		
C. Degree candidates must complete a minimum of 3 semester credit hours of the following course requirement for the non-thesis option:		**3**

ME 5973	Special Project	
Total Credit Hours		33

[1] Special Project, by definition, requires an oral presentation of the non-thesis project work to the student's advisory committee (chaired by a tenured or tenure-track graduate faculty member) at the end of the semester.

Thesis and Special Project Requirement (Advisory Committee and Oral Defense)

In addition to the coursework and other university-wide requirements for the master's degree, candidates must pass a thesis/special project defense administered by the student's advisory committee chaired by a full-time graduate faculty member affiliated with the AMEE program. The majority of the advisory committee members must be affiliated with the Department of Mechanical Engineering. The oral defense is in the form of a presentation of the thesis or special project. Students must register for at least one credit hour of master's thesis or special project during the semester in which the defense is to be scheduled.

Students pursuing either thesis or special project must select an Advisor within the first 9 credit hours of coursework and form a Committee with a minimum of three faculty members (including Advisor) within the first 18 credit hours of coursework. Within the first 9 credit hours of coursework, students must meet with the Advisor to develop their program of study. The Graduate Advisor of Record will advise new students until an Advisor has been selected.

Academic Probation and Dismissal

To receive the master's degree, students must follow the University-Wide Requirements of Master's Degree Regulations in the UTSA Graduate Catalog. The regulations of academic probation and dismissal are defined in the Academic Standing section of the General Academic Regulations in Student Policies.

Master of Science Degree in Mechanical Engineering

The Master of Science program in Mechanical Engineering is designed to offer students the opportunity to prepare for doctoral studies and/or leadership roles in government, industry, or research institutions. The program has three concentrations: Thermal and Fluid Systems, Mechanics and Materials, and Robotics and Control. The program offers thesis and non-thesis options.

Program Admission Requirements

The minimum requirements for admission to the Master's in Mechanical Engineering degree program are as follows:

- Students must meet the University-Wide Admission Requirements as outlined in the graduate catalog
- Official transcripts of all undergraduate and graduate coursework
- Official Graduate Record Examination (GRE) scores. (GRE scores waived for current UTSA students and UTSA alumni of the B.S. in Mechanical Engineering and closely related engineering programs (BME, CE, EE), who have an overall GPA above 3.0)
- A statement of purpose/research experience, and ranking of the concentration areas based on preference
- Two professional and/or academic letters of recommendation
- Résumé or Curriculum Vitae (CV)

Due to the multidisciplinary nature of the program, the Graduate Advisor of Record (GAR), in consultation with the Mechanical Engineering Graduate Studies Committee and the Department Chair, will evaluate each student's transcript and determine course deficiencies, if any, on a case-by-case basis. Applicants who have insufficient preparation for the program, may be admitted on a conditional basis. Students admitted with course deficiencies will be required to take additional remedial courses. Courses taken to make up deficiencies may not be counted toward the graduate degree requirements. Other applicants who wish to continue their education in an area of Mechanical Engineering but do not intend to pursue a Master of Science degree, may seek admission as special graduate students.

Degree Requirements

Thesis Option

The minimum number of semester credit hours required for the degree is 30 for the thesis option.

A. Required mathematics course:		**3**
ME 6013	Advanced Engineering Mathematics I	
B. Degree candidates are required to choose a major area and take two courses (6 semester credit hours) in their major area of study listed below:		**6**
Thermal and Fluid Systems		
ME 5243	Advanced Thermodynamics	
ME 6613	Advanced Fluid Mechanics	
Robotics and Control		
ME 5493	Fundamentals of Robotics	
ME 6123	Advanced Systems Dynamics and Control	
Mechanics and Materials		
ME 5713	Mechanical Behavior of Materials	
ME 6413	Elasticity	
C. 15 semester credit hours of Designated electives (with approval of the student's advisor):		**15**
See Mechanical Engineering Department's Handbook of Master's Programs for recommended courses.		
D. Degree candidates must complete a minimum of 6 credit hours of the following course requirements for the thesis option:		**6**
ME 6983	Master's Thesis (repeated)	
Total Credit Hours		30

Non-Thesis Option

The minimum number of semester credit hours required for the degree is 33 for the non-thesis option.

A. Required mathematics course:		**3**
ME 6013	Advanced Engineering Mathematics I	
B. Degree candidates are required to choose a major area and take two courses (6 semester credit hours) in their major area of study listed below:		**6**
Thermal and Fluid Systems		
ME 5243	Advanced Thermodynamics	
ME 6613	Advanced Fluid Mechanics	
Robotics and Control		
ME 5493	Fundamentals of Robotics	
ME 6123	Advanced Systems Dynamics and Control	
Mechanics and Materials		

ME 5713	Mechanical Behavior of Materials	
ME 6413	Elasticity	
C. 21 semester credit hours of Designated electives (with approval of the student's advisor):		**21**
See Mechanical Engineering Department's Handbook of Master's Programs for recommended courses.		
D. Degree candidates must complete a minimum of 3 semester credit hours of the following course requirement for the non-thesis option:		**3**
ME 5973	Special Project	
Total Credit Hours		33

[1] Special Project, by definition, requires an oral presentation of the non-thesis project work to the student's advisory committee (chaired by a tenured or tenure-track graduate faculty member) at the end of the semester.

Thesis and Special Project Requirement (Advisory Committee and Oral Defense)

In addition to the coursework and other university-wide requirements for the master's degree, candidates must pass a thesis/special project defense administered by the student's advisory committee and chaired by a full-time graduate faculty member affiliated with the ME program. The majority of the advisory committee members must be affiliated with the Department of Mechanical Engineering. The oral defense is in the form of a presentation of the thesis or special project. Students must register for at least one credit hour of master's thesis or special project during the semester in which the defense is to be scheduled.

Students pursuing either thesis or special project must select an Advisor within the first 9 credit hours of coursework and form a Committee with a minimum of three faculty members (including Advisor) within the first 18 credit hours of coursework. Within the first 9 credit hours of coursework, students must meet with the Advisor to develop their program of study. The Graduate Advisor of Record will advise new students until an Advisor has been selected.

Academic Probation and Dismissal

To receive the master's degree, students must follow the University-Wide Requirements of Master's Degree Regulations in the UTSA Graduate Catalog. The regulations of academic probation and dismissal are defined in the Academic Standing section of the General Academic Regulations in Student Policies.

Doctor of Philosophy Degree in Mechanical Engineering

The Department of Mechanical Engineering offers advanced coursework integrated with research leading to the Doctor of Philosophy degree in Mechanical Engineering. The program has four concentrations: Thermal and Fluid Systems, Design and Manufacturing Systems, Mechanics and Materials, and Robotics and Control. The Ph.D. degree in Mechanical Engineering will be awarded to candidates who have displayed an in-depth understanding of the subject matter and demonstrated the ability to make an original contribution to knowledge in their field of specialty.

The regulations for this degree comply with the general University regulations (refer to Student Polices, General Academic Regulations, and the Graduate Catalog, Doctoral Degree Regulations).

Admission Requirements

The minimum requirements for admission to the Doctor of Philosophy in Mechanical Engineering degree program are as follows:

- Students must meet the University-Wide Admission Requirements as outlined in the graduate catalog.
- Official transcripts of all undergraduate and graduate coursework. Transcripts must be submitted from a regionally accredited college or university in the United States or have proof of equivalent training at a foreign institution.
- Official Graduate Record Examination (GRE) scores. (GRE scores waived for (1) UTSA students and alumni of the M.S. in Mechanical Engineering and the M.S. in Advanced Manufacturing and Enterprise Engineering and (2) UTSA B.S. in Mechanical Engineering students with GPA above 3.5).
- Résumé or Curriculum Vitae (CV)
- A statement of research experience, interests and goals
- Three professional and/or academic letters of recommendation attesting to the applicant's readiness for doctoral study

Degree Requirements

The degree requires 63 semester credit hours of course and research work beyond the bachelor's degree or 42 semester credit hours beyond the master's degree, and passing of Qualifying Examinations, Dissertation Proposal, Dissertation Defense and acceptance of the Ph.D. dissertation.

Required coursework and the timeline for expected progress are given below. In general, undergraduate courses, general education courses, and prerequisites for graduate courses do not count towards the required number of credit hours.

Students with a prior Master of Science degree in engineering may, with the approval of the Graduate Studies Committee, have the option to follow the 42-semester-credit-hour program of study described as follows or may follow the 63-semester-credit-hour program of study, while transferring up to 21 credit hours into their PhD program. Students without the Master of Science degree in engineering are required to complete the 42-hour program of study as follows and an additional 21 semester credit hours of coursework, as determined in consultation with their Advisor and the Graduate Advisor of Record.

Degree Curriculum for Students that have Obtained a Master's Degree

Students that have obtained a master's degree must complete the following required 42 semester credit hours:

A. Common Core Courses (6 semester credit hours):		**6**
1. Required course:		
ME 6113	Experimental Techniques in Engineering (or equivalent course with prior approval by the department)	
2. Choose one of the following:		
ME 6013	Advanced Engineering Mathematics I	
ME 6033	Linear and Mixed Integer Optimization	
B. Technical Core Courses:		**6**
Among the three areas listed below, students are required to take two courses (6 semester credit hours) in their major area of study:		
Thermal and Fluid Systems		
ME 5243	Advanced Thermodynamics	
ME 6613	Advanced Fluid Mechanics	

Design and Manufacturing Systems		
ME 5603	Advanced Manufacturing Systems Engineering	
ME 6543	Machine Learning and Data Analytics (Student may substitute STA 6923: Advanced Statistical Learning/Data Mining. Credit cannot be earned for both courses.)	
Mechanics and Materials		
ME 5713	Mechanical Behavior of Materials	
ME 6413	Elasticity	
Robotics and Control		
ME 5493	Fundamentals of Robotics	
ME 6123	Advanced Systems Dynamics and Control	
C. Technical Elective Courses (6 semester credit hours):		**6**
Students are required to take at least two elective courses in consultation with their Ph.D. advisor.		
D. Doctoral Research and Dissertation (24 semester credit hours):		**24**
1. Seminar		
ME 7993	Research Seminar (3 credit hours)	
2. Doctoral Research (minimum of 9 semester credit hours required):		
ME 7951	Doctoral Research	
ME 7952	Doctoral Research	
ME 7953	Doctoral Research	
3. Doctoral Dissertation (after admitted for candidacy) (minimum of 12 semester credit hours required):		
ME 7981	Doctoral Dissertation	
ME 7982	Doctoral Dissertation	
ME 7983	Doctoral Dissertation	
Total Credit Hours		42

Degree Curriculum for Students that have Obtained a Bachelor's Degree

Students that have obtained a bachelor's degree must complete the following required 63 semester credit hours:

A. Common Core Courses (6 semester credit hours):		**6**
1. Required course:		
ME 6113	Experimental Techniques in Engineering (or equivalent course with prior approval by the department)	
2. Choose one of the following:		
ME 6013	Advanced Engineering Mathematics I	
ME 6033	Linear and Mixed Integer Optimization	
B. Technical Core Courses (6 semester credit hours):		**6**
Among the four areas listed below, students are required to take two courses (6 semester credit hours) in their major area of study:		
Thermal and Fluid Systems		
ME 5243	Advanced Thermodynamics	
ME 6613	Advanced Fluid Mechanics	
Design and Manufacturing Systems		
ME 5603	Advanced Manufacturing Systems Engineering	
ME 6543	Machine Learning and Data Analytics (Student allowed to substitute STA 6923: Advanced Statistical Learning/Data Mining. Credit cannot be earned for both courses.)	
Mechanics and Materials		
ME 5713	Mechanical Behavior of Materials	
ME 6413	Elasticity	
Robotics and Control		
ME 5493	Fundamentals of Robotics	
ME 6123	Advanced Systems Dynamics and Control	
C. Technical Elective Courses (27 semester credit hours):		**27**
Students are required to take at least 9 elective courses in consultation with their Ph.D. advisor.		
D. Doctoral Research and Dissertation (24 semester credit hours):		**24**
1. Seminar		
ME 7993	Research Seminar (3 credit hours)	
2. Doctoral Research (minimum of 9 semester credit hours required):		
ME 7951	Doctoral Research	
ME 7952	Doctoral Research	
ME 7953	Doctoral Research	
3. Doctoral Dissertation (after admitted for candidacy) (12 semester credit hours required):		
ME 7981	Doctoral Dissertation	
ME 7982	Doctoral Dissertation	
ME 7983	Doctoral Dissertation	
Total Credit Hours		63

Progression and Milestones

Ph.D. Advisor and Dissertation Committee

Students must select an advisor within the first 9 semester credit hours of coursework. The Ph.D. advisor must be a tenured or tenure-track faculty member of the Mechanical Engineering Department or have an adjoint affiliation with the Mechanical Engineering Department. The program of study, as well as the selection of core and elective courses, must be recommended by the student's Ph.D. advisor.

A Dissertation Committee must be created at least one month before dissertation proposal defense. The committee, with a minimum of four members, includes the Ph.D. advisor as the chair of the committee. At least 50 percent of the committee members must be Mechanical Engineering graduate faculty and one must be outside the Mechanical Engineering Department, whose suitability will be subject to approval of the Graduate School. Part-time faculty may serve as members of the dissertation committee, but not as chair.

Doctoral Candidacy

All students seeking a doctoral degree must be admitted to candidacy in order to become eligible to continue their research leading to the Doctoral degree. The requirement for admission to candidacy is passing the qualifying examination and the dissertation proposal defense.

Written Qualifying Examinations

The qualifying examination of the Ph.D. in Mechanical Engineering program consists of written questions in both common and major areas of research interest of the student. The purpose of the written qualifying examination is to ensure that students pursuing a doctoral degree in Mechanical Engineering have the essential depth and breadth of knowledge basis.

The written qualifying examination is offered twice a year, generally in January and June. Upon approval by their Ph.D. advisor, students wishing to take the examination must submit their request using the

designated form to the Graduate Advisor of Record. Normally, students who have completed the coursework listed under sections A and B of the degree curriculum are able to take the examination. The written qualifying examination includes the Common Core and Technical Core based on their fields of study.

1. Common Core (select one):
   a. Advanced Engineering Mathematics
   b. Linear and Mixed Integer Optimization
2. Technical Core (select one area):
   a. Thermal and Fluid Systems: Advanced Thermodynamics, Advanced Fluid Mechanics
   b. Design and Manufacturing Systems: Advanced Manufacturing Systems Engineering, Advanced Data Analytics
   c. Mechanics and Materials: Elasticity, Mechanical Behavior of Materials
   d. Robotics and Control: Fundamentals of Robotics, Advanced Systems Dynamics and Control

Retaking the Written Qualifying Examination

A student who failed the first attempt may be allowed to take the examination a second time. However, no more than two attempts are permitted. Should a student fail the qualifying exam for a second time, he or she will be dismissed from the doctoral program. The dismissed student may apply for the Master's degree in Mechanical Engineering by transferring the credits earned from the doctoral program upon the approval of the Graduate Studies Committee of the department.

Doctoral Dissertation Proposal

The student should first consider research topics for his/her dissertation under the supervision of his/her advisor, and then write and defend a dissertation proposal based on his/her preliminary studies. Students must pass the doctoral dissertation proposal defense before being permitted to register for doctoral dissertation.

For more information, please see the online Ph.D./ME Handbook (http://engineering.utsa.edu/mechanical/joint-graduate-program/).

Final Dissertation Defense and Graduation

Candidates must demonstrate their ability to conduct independent research by completing an original dissertation. The Dissertation Committee guides, critiques and finally approves the candidate's dissertation. All coursework in the final program of study must have been taken within eight years to include successful completion and defense of the dissertation. The format of the dissertation must follow University regulations.

Academic Probation and Dismissal

- To receive the doctoral degree, students must follow the University-wide Requirements of Doctoral Degree Regulations in the UTSA Graduate Catalog. University-wide regulations of academic probation and dismissal are defined in the Academic Standing section of the General Academic Regulations in Student Policies.
- Students who fail the qualifying exam for a second time will be dismissed from the doctoral program.

Mechanical Engineering (ME) Courses

ME 5013. Topics in Mechanical Engineering. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Current topics in mechanical engineering, such as advanced fracture mechanics, lean manufacturing, advanced manufacturing engineering and advanced energy systems. May be repeated for credit with consent of Graduate Committee as topics vary. Differential Tuition: $165.

ME 5023. Numerical Techniques in Engineering Analysis. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Advanced methods of applied mathematics, including numerical linear algebra, initial value problems, stability, convergence, partial differential equations, and optimization. (Same as EGR 5023. Credit cannot be earned for both ME 5023 and EGR 5023.) Differential Tuition: $165.

ME 5213. Topics in Systems Modeling. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering. Systems analysis approach to formulating and solving engineering problems. Topics include operational research, mathematical modeling, optimization, linear and dynamic programming, decision analysis, and statistical quality control. Topic 1: Applied Operations Research. Application of operations research methods to practical engineering problems. Topic 2: Engineering Systems Modeling. Modeling of modern engineering systems for operational and management control. May be repeated for credit as topics vary. (Same as CE 5013 and EGR 5213. Credit can only be earned for one course:ME 5213, EGR 5213 or CE 5013.) Differential Tuition: $165.

ME 5233. Advanced Quality Control. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Methods and techniques for process control, process and gage capabilities, inspection plans, American National Standard, and recent advanced techniques. Tour of manufacturing industry. Case studies in process control, outgoing quality, and costs. A project, assigned by a manufacturing company, is required, along with a final presentation of the project. (Same as EGR 5233. Credit cannot be earned for both ME 5233 and EGR 5233.) Differential Tuition: $165.

ME 5243. Advanced Thermodynamics. (3-0) 3 Credit Hours.
Prerequisite: ME 3293. Concepts and postulates of macroscopic thermodynamics; formulation of thermodynamic principles; exergy stability of thermodynamic systems, principles of irreversible thermodynamics, chemical equilibria. Differential Tuition: $165.

ME 5263. Combustion. (3-0) 3 Credit Hours.
Prerequisite: ME 4293. Thermochemistry and transport theory applied to combustion; gas phase equilibrium; energy balances; reaction kinetics; flame temperatures, speed, ignition, and extinction; premixed and diffusion flames; combustion aerodynamics; mechanisms of air pollution. Differential Tuition: $165.

ME 5273. Alternative Energy Sources. (3-0) 3 Credit Hours.
Prerequisite: ME 3293. Solar, nuclear, wind, hydrogen, and geothermal energy sources. Resources, production, utilization, economics, sustainability, and environmental considerations. (Same as CE 5643. Credit cannot be earned for both ME 5273 and CE 5643.) Differential Tuition: $165.

ME 5283. Power Plant System Design. (3-0) 3 Credit Hours.
Prerequisites: ME 4293 and ME 4313. Application of thermodynamics and fluid mechanics to the design of vapor and gas-turbine power plant systems including boilers, condensers, turbines, pumps, compressors, cooling towers, and alternative energy power plants. Differential Tuition: $165.

ME 5303. Advanced Heat and Mass Transfer. (3-0) 3 Credit Hours.
Prerequisite: ME 4313. Derivation of energy and mass conservation equations with constitutive laws for conduction, convection, radiation, and mass diffusion. Dimensional analysis, heat exchangers, boiling and condensation, steady and transient solutions. Differential Tuition: $165.

ME 5453. Advanced Strength of Materials. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Failure theories, energy methods, advanced topics in bending, torsion, and stress concentration. (Formerly EGR 5553. Credit cannot be earned for both ME 5453 and EGR 5553.) Differential Tuition: $165.

ME 5463. Fracture Mechanics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Introduction to failure and fracture of engineering materials, Griffith's energy balance, stress intensity and strain energy release rate approaches to brittle fracture, Dugdale and Irwin approaches to ductile fracture. Application to modern engineering materials. (Formerly EGR 5313. Credit cannot be earned for both ME 5463 and EGR 5313.) Differential Tuition: $165.

ME 5473. Viscoelasticity. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Principle of fading memory, integro-differential constitutive laws, mechanical models, time and temperature superposition, and linear and nonlinear methods. Applications to polymers, composites, and adhesives. (Formerly EGR 5323. Credit cannot be earned for both ME 5473 and EGR 5323.) Differential Tuition: $165.

ME 5483. Finite Element Methods. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Derivation and computer implementation of the finite element method for the solution of boundary value problems. (Same as CE 5023 and CE 5193. Credit cannot be earned for more than one of the following: ME 5483, CE 5023 and CE 5193.) Differential Tuition: $165.

ME 5493. Fundamentals of Robotics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Theoretical and analytic developments, Denavit-Hartenberg parameters, quaternions, state-space, linear and nonlinear analysis, classical and modern methods of mechanics, serial manipulators, parallel manipulators, and controls. Differential Tuition: $165.

ME 5503. Lean Manufacturing and Lean Enterprises. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Methodologies for transforming an enterprise into a lean enterprise. Topics include Lean Manufacturing basics and tools; Lean Implementation Guidelines; Lean Metrics and Performance Measures; Lean Extended Enterprise; and Lean Supply Chain Design and Management. Hands-on Value Stream Mapping project is required. Differential Tuition: $165.

ME 5513. Advanced Mechanism Design. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Advanced topics in kinematic synthesis of linkage, static and dynamic force analyses, and computer-aided design of mechanisms. Differential Tuition: $165.

ME 5543. Probabilistic Engineering Design. (3-0) 3 Credit Hours.
Prerequisite: STA 2303 or an equivalent. Development and application of probabilistic methods in engineering: random variable definitions, probability distributions, distribution selection, functions of random variables, numerical methods including Monte Carlo sampling, First Order Reliability Methods, and component and systems reliability. (Same as BME 6333. Credit cannot be earned for both BME 6333 and ME 5543.) Differential Tuition: $165.

ME 5563. Computer Integrated Manufacturing. (3-1) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Advanced concepts and models related to computer-aided design, manufacturing, process planning, production planning and scheduling, and manufacturing execution systems. Laboratory work includes computer-based manufacturing applications and programming of automated production equipment. Differential Tuition: $165.

ME 5573. Facilities Planning and Design. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Advanced concepts and fundamentals essential to understand, analyze, and solve problems related to manufacturing plant layout and material handling system selection. Topics include Product, Process, and Schedule Design; Flow, Space, and Activity Relationships; Material Handling; Layout Planning Models and Design Algorithms; and Warehouse Operations. The subjects included in this course are organized around integrated product, process, and manufacturing system design principles. Differential Tuition: $165.

ME 5583. Process Improvement and Variability Reduction. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Concepts, methodologies, and tools for the design, engineering and continuous improvement of manufacturing systems and enterprise operations. Topics include Six Sigma for Process Improvement and Design, Lean Systems, Performance Evaluation, and other contemporary enterprise process engineering approaches. (Formerly titled "Advanced Enterprise Process Engineering.") Differential Tuition: $165.

ME 5603. Advanced Manufacturing Systems Engineering. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Design, planning, scheduling, and control of manufacturing systems with emphasis on information flow and decision-making. After introducing students to system simulation, simulation models of manufacturing systems are developed and evaluated in terms of system performance under different production planning and control policies. Contemporary manufacturing topics and research areas are emphasized. Differential Tuition: $165.

ME 5633. Advanced Compressible Flow. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Integral and differential forms of the conservation equations, one-dimensional flow, oblique shock and expansion waves, and supersonic, transonic, and hypersonic flows. (Formerly titled "Gas Dynamics.") Differential Tuition: $165.

ME 5643. Green and Sustainable Manufacturing and Enterprise Systems. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing, ME 5503, or consent of instructor. Advanced concepts, tools and topics in eliminating wastes from the processes and operations of manufacturing firms via the perspective of the environment. Topics include identifying, measuring, and minimizing environmental wastes related to energy, water, materials, garbage, transportation, emissions, and biodiversity, as well as ways to totally eliminate these environmental wastes from green value stream mapping techniques. Readings and survey of contemporary technologies and tools enabling green and sustainable manufacturing and enterprise systems are also required. (Formerly titled "Advanced Topics in Manufacturing and Enterprise Engineering.") Differential Tuition: $165.

ME 5653. Computational Fluid Dynamics. (3-0) 3 Credit Hours.
Prerequisite: ME 3663 or an equivalent. The mathematical models for fluid-flow simulations at various levels of approximation, basic description techniques, and the nature of flow equations and their boundary conditions. Differential Tuition: $165.

ME 5703. Lean Product Development and Service Systems. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Theory and applications of lean manufacturing and six-sigma to enterprise functions beyond production shop floor, with focus on lean product and process development, lean costing, and integration of IT and ERP systems to sustain continuous improvement. (Credit cannot be earned for both ME 5703 and ME 5583 taken prior to Fall 2011.) (Formerly titled "Advanced Enterprise Systems Engineering.") Differential Tuition: $165.

ME 5713. Mechanical Behavior of Materials. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Mechanical behavior of engineering materials (metals, alloys, ceramics, and polymers) elasticity, dislocation theory, strengthening mechanism, fracture, fatigue, creep, and oxidation. Differential Tuition: $165.

ME 5733. Advanced Medical Device Design and Commercialization. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Topics include classification of medical devices, medical device design and design controls, IP protection, FDA approval processes, human factors in medical device design, and medical device employment by various clinical specialties. (Formerly titled "Advanced Medical Device Design.") Differential Tuition: $165.

ME 5743. Composite Materials. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Introduction to mechanics of composites, micromechanics, macromechanics, lamination theory, design, and applications of fiber-reinforced composites and particulate composites. (Formerly EGR 5413. Credit cannot be earned for both ME 5743 and EGR 5413.) Differential Tuition: $165.

ME 5753. Introduction to Turbulence. (3-0) 3 Credit Hours.
Fundamental principles of turbulent fluid flows in natural systems with a focus on atmospheric flows, coastal flows, wind energy and physiological flows. Topics include classical and statistical theory of turbulence and energy cascading , spectral analysis of turbulence, atmospheric boundary layer, aerodynamics in diseased and normal coronary artery. Differential Tuition: $165.

ME 5763. Advanced Scientific Visualization. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Topics include 3D image display and generation techniques, visual thinking process, interaction with visualization, efficiency of visualization on sparse grid, haptic rendering and control, and immersive 3D programming. (Same as EGR 5703. Credit cannot be earned for both ME 5763 and EGR 5703.) Differential Tuition: $165.

ME 5773. High Performance Computing. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Topics include scientific computing in UNIX/LINUX environment, instruction on several import UNIX applications, various parallelization styles of computing, and application programming interfaces (APIs) in scientific applications. Same as EGR 5713. Credit cannot be earned for both EGR 5713 and ME 5773.) Differential Tuition: $165.

ME 5963. Topics in Bioengineering. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Topics may include: biomechanics, biological systems, biosolid and biofluid, transport phenomena, biomaterials, medical devices, and medical imaging. May be repeated for credit as topics vary. Differential Tuition: $165.

ME 5971. Special Project. (0-0) 1 Credit Hour.
Prerequisites: Permission in writing (form available) from the instructor and the Graduate Advisor of Record. The directed research course is offered only for nonthesis option students and may involve either a laboratory or a theoretical problem. The course requires an oral presentation of the work done at the end of the semester. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the Master's degree. Differential Tuition: $55.

ME 5973. Special Project. (0-0) 3 Credit Hours.
Prerequisites: Permission in writing (form available) from the instructor and the Graduate Advisor of Record. The directed research course is offered only for nonthesis option students and may involve either a laboratory or a theoretical problem. The course requires an oral presentation of the work done at the end of the semester. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the Master's degree. Differential Tuition: $165.

ME 6013. Advanced Engineering Mathematics I. (3-0) 3 Credit Hours.
Prerequisites: EGR 2323 and EGR 3323, or equivalent courses. Advanced methods of applied mathematics, including vector differential calculus, linear algebra, functional space and their applications to engineering problems. (Same as BME 6033 and EGR 6013. Credit can only be earned for one course: ME 6013, EGR 6013 or BME 6033.) (Formerly titled "Analytical Techniques in Engineering Analysis.") Differential Tuition: $165.

ME 6023. Advanced Engineering Mathematics II. (3-0) 3 Credit Hours.
Prerequisites: EGR 2323 and EGR 3323, or equivalent courses. Advanced methods of applied mathematics. Topics may include solution methods of partial differential equations, complex analysis, optimization theory, other topics in engineering mathematics and their applications to engineering problems. May be repeated for credit as topics vary. (Same as EGR 6023. Credit cannot be earned for both ME 6023 and EGR 6023.) Differential Tuition: $165.

ME 6033. Linear and Mixed Integer Optimization. (3-0) 3 Credit Hours.
Prerequisite: ME 2173 or equivalent. Graduate standing in engineering or consent of instructor. Introduction to the theory of linear programming and duality, algorithms for solving linear programs, network simplex, integer and mixed integer programming (e.g., simplex, branch and bound and branch and cut). This course provides an overview of optimization theory and algorithms as well as emphasizes its applications in different areas of Engineering. (Same as EGR 6033. Credit cannot be earned for both ME 6033 and EGR 6033.) Differential Tuition: $165.

ME 6043. Continuum Mechanics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. The general purpose of the class is to introduce continuum mechanics, the equations of motion, various reference frames, and constitutive modeling. Topics covered in the class include the stress and strain tensors, equations of motion, finite elasticity, shock waves, plasticity theory, virtual displacements and nonlocal formulations. Differential Tuition: $165.

ME 6113. Experimental Techniques in Engineering. (2-3) 3 Credit Hours.
Prerequisites: Graduate standing and consent of instructor. Laboratory-based course focused on experimental testing, accounting for sources of errors, and analysis including uncertainty, graphing, and curve fitting. Modern transducers and measurement and data acquisition techniques will be discussed and utilized in the context of engineering laboratories and a course project. Differential Tuition: $165.

ME 6123. Advanced Systems Dynamics and Control. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Dynamic modeling of mechanical and multi-energy domain systems; state-space and frequency-domain analysis of dynamic systems; feedback control systems; multivariable state-feedback control; principles of controllability, observability, stability; computer-based simulation system dynamics. (Formerly ME 5113. Credit cannot be earned for both ME 6123 and ME 5113.) Differential Tuition: $165.

ME 6413. Elasticity. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Strain and stress, constitutive relations for linear elastic solids, plane problems, variational principles. (Formerly ME 5413. Credit cannot be earned for both ME 6413 and ME 5413.) Differential Tuition: $165.

ME 6543. Machine Learning and Data Analytics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Introduction to discovery and communication of meaningful patterns in data, including data description (descriptive/visualization techniques), prediction (predictive modeling using machine learning), improve performance (optimization/decision making). Differential Tuition: $165.

ME 6613. Advanced Fluid Mechanics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Dynamics of incompressible fluid mechanics viscous flow, Navier-Stokes equations, boundary layer theory, and numerical operations for incompressible fluid flow. (Formerly ME 5613. Credit cannot be earned for both ME 6613 and ME 5613.) Differential Tuition: $165.

ME 6663. Advanced Fatigue and Fracture. (3-0) 3 Credit Hours.
Prerequisites: ME 5463 and graduate standing in engineering or consent of instructor. Application of engineering concepts in fatigue and fracture mechanics to actual structural failure issues faced by various industries, such as aerospace, powerplant, oil/gas, and others. Review of concepts in fatigue, damage tolerance, and probabilistic fracture mechanics. Application of concepts to modern engineering problems. Differential Tuition: $165.

ME 6833. Biomechanics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Fundamentals in applications of engineering mechanics to modeling structures and functions of tissues, organs, joints, and human body. (Formerly ME 5833 and ME 6033. Same as BME 6803. Credit can be earned for only one of the following: ME 6833, ME 6033, ME 5833 or BME 6803.) Differential Tuition: $165.

ME 6853. Advanced CFD and Heat Transfer. (3-0) 3 Credit Hours.
Prerequisite: ME 5613 or consent of instructor. Topics include large-scale simulation tools for turbulent flows including large-eddy-simulation (LES), direct numerical simulation (DNS) and turbulence modeling for range of incompressible, buoyancy driven and compressible flows. Generalized numerical framework for numerical solution of Navier-Stokes equations. Differential Tuition: $165.

ME 6893. Topics in Biomechanics. (3-0) 3 Credit Hours.
Prerequisite: ME 6833 or BME 6803 or an equivalent. The biomechanics of biological tissues and organs. Topics may include constitutive equations, stress, and adaptation of hard and soft tissues. (Formerly ME 6023. Same as BME 6893. Credit cannot be earned for both ME 6893 and ME 6023. Credit cannot be earned for both ME 6893 and BME 6893 when the topic is the same.) Differential Tuition: $165.

ME 6951. Independent Study. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor, the student's advisor, and the Graduate Advisor of Record. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 3 hours, regardless of discipline, will apply to the Master's degree. Differential Tuition: $55.

ME 6953. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor, the student's advisor, and the Graduate Advisor of Record. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 3 hours, regardless of discipline, will apply to the Master's degree. Differential Tuition: $165.

ME 6961. Comprehensive Examination. (0-0) 1 Credit Hour.
Prerequisite: Approval of the Mechanical Engineering Graduate Program Committee to take the Comprehensive Examination. Independent study for the purpose of taking the Comprehensive Examination. May be repeated for credit as many times as approved by the Mechanical Engineering Graduate Program Committee. Enrollment is required each term in which the Comprehensive Examination is taken if no other courses are being taken that term. The grade report for the course is either "CR" (satisfactory performance on the Comprehensive Examination) or "NC" (unsatisfactory performance on the Comprehensive Examination). Differential Tuition: $55.

ME 6973. Special Problems. (3-0) 3 Credit Hours.
Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized studies not normally available as part of the regular course offerings. Special Problems courses may be repeated for credit when topics vary, but not more than 6 hours, regardless of discipline, may be applied to the Master's degree. Differential Tuition: $165.

ME 6981. Master's Thesis. (0-0) 1 Credit Hour.
Prerequisites: Consent of the Graduate Advisor of Record and primary thesis advisor. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. Differential Tuition: $55.

ME 6982. Master's Thesis. (0-0) 2 Credit Hours.
Prerequisites: Consent of the Graduate Advisor of Record and primary thesis advisor. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. Differential Tuition: $110.

ME 6983. Master's Thesis. (0-0) 3 Credit Hours.
Prerequisites: Consent of the Graduate Advisor of Record and primary thesis advisor. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. Differential Tuition: $165.

ME 7941. Independent Doctoral Study. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing in Ph.D. in Mechanical Engineering program and permission in writing (form available) of the student's advisor. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For Ph.D. students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 3 hours, regardless of discipline, will apply to the Doctoral degree. Differential Tuition: $55.

ME 7943. Independent Doctoral Study. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing in Ph.D. in Mechanical Engineering program and permission in writing (form available) of the student's advisor. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For Ph.D. students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 3 hours, regardless of discipline, will apply to the Doctoral degree. Differential Tuition: $165.

ME 7951. Doctoral Research. (0-0) 1 Credit Hour.
Prerequisites: Consent of the Graduate Advisor of Record and primary thesis advisor. May be repeated for credit. A minimum of 18 credit hours of Doctoral Research is required. Differential Tuition: $55.

ME 7952. Doctoral Research. (0-0) 2 Credit Hours.
Prerequisites: Consent of the Graduate Advisor of Record and primary thesis advisor. May be repeated for credit. A minimum of 18 credit hours of Doctoral Research is required. Differential Tuition: $110.

ME 7953. Doctoral Research. (0-0) 3 Credit Hours.
Prerequisites: Consent of the Graduate Advisor of Record and primary thesis advisor. May be repeated for credit. A minimum of 18 credit hours of Doctoral Research is required. Differential Tuition: $165.

ME 7956. Doctoral Research. (0-0) 6 Credit Hours.
Prerequisites: Consent of the Graduate Advisor of Record and primary thesis advisor. May be repeated for credit. A minimum of 18 credit hours of Doctoral Research is required. Differential Tuition: $330.

ME 7981. Doctoral Dissertation. (0-0) 1 Credit Hour.
Prerequisites: Consent of the Graduate Advisor of Record and primary thesis advisor, after being admitted for Ph.D. candidacy. May be repeated for credit. A minimum of 15 credit hours of Doctoral Dissertation is required. (Formerly ME 7993-8.) Differential Tuition: $55.

ME 7982. Doctoral Dissertation. (0-0) 2 Credit Hours.
Prerequisites: Consent of the Graduate Advisor of Record and primary thesis advisor, after being admitted for Ph.D. candidacy. May be repeated for credit. A minimum of 15 credit hours of Doctoral Dissertation is required. (Formerly ME 7993-8.) Differential Tuition: $110.

ME 7983. Doctoral Dissertation. (0-0) 3 Credit Hours.
Prerequisites: Consent of the Graduate Advisor of Record and primary thesis advisor, after being admitted for Ph.D. candidacy. May be repeated for credit. A minimum of 15 credit hours of Doctoral Dissertation is required. (Formerly ME 7993-8.) Differential Tuition: $165.

ME 7993. Research Seminar. (3-0) 3 Credit Hours.
Organized lectures and seminar presentations to facilitate the development of doctoral students' research skills and knowledge of current and emerging research. Required for all Ph.D. students in Mechanical Engineering. The grade report for the course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance). Differential Tuition: $165.