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

Applicants must meet University-wide graduate admission requirements as outlined in Chapter 1, Admission, of this catalog. Applicants must also comply with general University regulations as outlined in Chapter 2, General Academic Regulations, and Chapter 4, Master’s Degree Regulations, of this catalog. Admission will be based on a combination of factors: a bachelor’s degree in engineering, science or a related field from an accredited institution of higher education or proof of equivalent education at a foreign or unaccredited institution, satisfactory performance on the Graduate Record Examination (GRE), and a satisfactory undergraduate grade point average (GPA) in engineering, science or relevant coursework.

Due to the multidisciplinary nature of the program, the Graduate Advisor of Record (GAR), in consultation with the Mechanical Engineering Graduate Program Committee and the Department Chair, will evaluate each student’s transcript and determine course deficiencies, if any, on a case-by-case 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. Applicants who have insufficient preparation for the program, or who lack certain supporting documentation, may be admitted on a conditional basis.

Degree Requirements

Thesis Option

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

A. 3 semester credit hours of a Required Mathematics Course selected from the following: 3
- EGR 5023 Numerical Techniques in Engineering Analysis
- EGR 5213 Topics in Systems Modeling
- EGR 6013 Advanced Engineering Mathematics I
- EGR 6023 Advanced Engineering Mathematics II
- EGR 6033 Linear and Mixed Integer Optimization
- MAT 5603 Numerical Analysis
- MS 5003 Quantitative Methods for Business Analysis
- STA 5093 Introduction to Statistical Inference
- STA 5103 Applied Statistics

B. 12 semester credit hours of Required Topical Courses selected from the following: 12
- 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

C. 9 semester credit hours of Prescribed Electives approved by student’s advisor (see table below) 9

D. Degree candidates must a minimum of 6 credit hours of the following course requirements for the thesis option: 6
- ME 6983 Master’s Thesis

Total Credit Hours 30

Nonthesis Option

The minimum number of semester credit hours required for the degree is 33 for the Nonthesis option.

A. 3 semester credit hours of a Required Mathematics Course selected from the following: 3
- EGR 5023 Numerical Techniques in Engineering Analysis
- EGR 5213 Topics in Systems Modeling
- EGR 6013 Advanced Engineering Mathematics I
- EGR 6023 Advanced Engineering Mathematics II
- EGR 6033 Linear and Mixed Integer Optimization
- MAT 5603 Numerical Analysis
- MS 5003 Quantitative Methods for Business Analysis
- STA 5093 Introduction to Statistical Inference
- STA 5103 Applied Statistics

B. 12 semester credit hours of Required Topical Courses selected from the following: 12
- 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

Total Credit Hours 39

*Department of Mechanical Engineering*
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 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 one semester credit hour of master’s thesis or special project for the semester in which the defense is to be taken, if they are not enrolled in any other courses. A successful thesis or project defense satisfies the university’s comprehensive examination requirement.

Students pursuing either thesis or special project must select an Advisor within the first 9 semester credit hours of coursework and form a Committee with a minimum of three faculty members (including Advisor) within the first 18 semester credit hours of coursework. Within the first 9 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.

Prescribed Electives

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ME 5643</td>
<td>Green and Sustainable Manufacturing and Enterprise Systems</td>
<td>3</td>
</tr>
<tr>
<td>ME 5703</td>
<td>Lean Product Development and Service Systems</td>
<td>3</td>
</tr>
</tbody>
</table>

C. 15 semester credit hours of Prescribed Electives approved by student’s advisor (see table below)

D. Degree candidates must complete a minimum of 3 semester credit hours of the following course requirement for the nonthesis option:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 5973</td>
<td>Special Project</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credit Hours 33

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

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 offers thesis and nonthesis options.

Program Admission Requirements

In addition to satisfying the University-wide graduate admission requirements, admission will be based on a combination of factors: a bachelor’s degree in mechanical engineering or a related field from an accredited institution of higher education or proof of equivalent education at a foreign or unaccredited institution, satisfactory performance on the Graduate Record Examination (GRE), and satisfactory undergraduate grade point average (GPA) in engineering or relevant coursework.

Applications may be admitted on a conditional basis as determined by the Graduate Committee of the Department. Applicants with a degree in a discipline other than mechanical engineering may be required to make up the deficiencies in the undergraduate mechanical engineering curriculum. Undergraduate courses listed as deficiencies do not count toward the graduate degree. 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 in Mechanical Engineering 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. 3 semester credit hours of a required mathematics course: 3
   EGR 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:
   Thermal and Fluid Systems
   ME 5243  Advanced Thermodynamics
   ME 5613  Advanced Fluid Mechanics
   Robotics and Control
   ME 5113  Advanced Systems Dynamics and Control
   ME 5493  Fundamentals of Robotics
   ME 5603  Advanced Manufacturing Systems Engineering
   Mechanics and Materials
   ME 5413  Elasticity
   ME 5713  Mechanical Behavior of Materials

C. 15 semester credit hours of Designated electives (with approval of the student’s committee chair) 15

D. Thesis (minimum 6 semester credit hours): 6
   ME 6983 Master's Thesis

Total Credit Hours 30

Nonthesis Option

The minimum number of semester credit hours required for the degree is 33 for the Nonthesis option.

A. 3 semester credit hours of a required mathematics course: 3
   EGR 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:
   Thermal and Fluid Systems
   ME 5243  Advanced Thermodynamics
   ME 5613  Advanced Fluid Mechanics
   Robotics and Control
   ME 5113  Advanced Systems Dynamics and Control
   ME 5493  Fundamentals of Robotics
   ME 5603  Advanced Manufacturing Systems Engineering
   Mechanics and Materials
   ME 5413  Elasticity
   ME 5713  Mechanical Behavior of Materials

C. 21 semester credit hours of Designated electives (with approval of the student’s committee chair) 21

D. Special Project (minimum 3 semester credit hours): 3
   ME 5973 Special Project

Total Credit Hours 33

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 one semester credit hour of master’s thesis or special project for the semester in which the defense is to be taken, if they are not enrolled in any other courses. A successful thesis or project defense satisfies the university’s comprehensive examination requirement.

Students pursuing either thesis or special project must select an Advisor within the first 9 semester credit hours of coursework and form a Committee with a minimum of three faculty members (including Advisor) within the first 18 semester credit hours of coursework. Within the first 9 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.

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 three concentrations: Thermal and Fluid Systems; Design and Manufacturing Systems; and Mechanics and Materials. 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 Chapter 2, General Academic Regulations, and Chapter 5, 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 admission requirements as outlined in the graduate catalog.
- Students whose native language is not English must have a satisfactory English test score to meet the University admission requirements.
- Satisfactory GRE (Graduate Record Examination) scores, as evaluated by the Graduate Program Committee of the Department of Mechanical Engineering, are required in combination with other criteria for admission to the Doctor of Philosophy in Mechanical Engineering degree program.
- Outstanding students, who do not hold a Master's degree, may enter the Doctor of Philosophy program on provisional status directly upon receiving a bachelor's degree in mechanical engineering or a closely related field, with the approval of the Graduate Studies Committee.

Degree Requirements and Program Study

The degree requires 90 semester credit hours of course and research work beyond the bachelor's degree or 60 semester credit hours beyond the master’s degree, and passing of Qualifying Examinations,

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 the Master of Science degree in engineering may, with the approval of the Graduate Program Committee, follow the 60-semester-credit-hour program of study described as follows. Students without the Master of Science degree in engineering are required to complete the 60-semester-credit-hour program of study as follows, and an additional 30 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 60 semester credit hours:

### A. Common Core Courses (6 semester credit hours):

1. **Required course:**
   - ME 6113 Experimental Techniques in Engineering (required)

2. **Choose one of the following:**
   - EGR 6013 Advanced Engineering Mathematics I
   - EGR 6023 Advanced Engineering Mathematics II
   - EGR 6033 Linear and Mixed Integer Optimization

### B. Technical Core Courses:

Among the three areas listed below, students are required to take two courses (6 semester credit hours) in their major area of study, and any one course (3 semester credit hours) from either of the remaining two areas:

#### Thermal and Fluid Systems
- ME 5243 Advanced Thermodynamics
- ME 5613 Advanced Fluid Mechanics

#### Design and Manufacturing Systems
- ME 5113 Advanced Systems Dynamics and Control
- ME 5603 Advanced Manufacturing Systems Engineering

#### Mechanics and Materials
- ME 5413 Elasticity
- ME 5713 Mechanical Behavior of Materials

### C. Technical Elective Courses (36 semester credit hours):

Students are required to take at least 12 elective courses in consultation with their Ph.D. advisor.

### D. Seminar (1 semester credit hour):

- ME 7991 Research Seminar

### E. Doctoral Research and Dissertation (35 semester credit hours):

1. **Doctoral Research (20 semester credit hours required):**
   - ME 7951 Doctoral Research
   - ME 7952 Doctoral Research
   - ME 7953 Doctoral Research

2. **Doctoral Dissertation (after admitted for candidacy) (15 semester credit hours required):**
   - ME 7981 Doctoral Dissertation
   - ME 7982 Doctoral Dissertation
   - ME 7983 Doctoral Dissertation

**Total Credit Hours**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>ME 7951</td>
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<tr>
<td>ME 7981</td>
<td>Doctoral Dissertation</td>
</tr>
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<td>ME 7982</td>
<td>Doctoral Dissertation</td>
</tr>
<tr>
<td>ME 7983</td>
<td>Doctoral Dissertation</td>
</tr>
</tbody>
</table>

### 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 given in June and January of each year. 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 before October 31 (for January exam) and March 31 (for June exam). The written examination will be administered in the first full week of June and the second week of January each year. Normally, students who have completed the coursework listed under sections A and B of the curriculum in the course list and are in good academic standing take the written examination. The Department of Mechanical Engineering administers the written qualifying examination in the following four areas with the supporting courses:

1. Common area:
   a. Advanced Engineering Mathematics

2. Technical area:
   c. Mechanics and Materials: Elasticity, Mechanical Behavior of Materials

The written qualifying examination includes two parts: Part 1-Common Area, which is mandatory for all students, and Part 2-Major Area, which is selected by student from the three technical areas based on their fields of study.

Retaking of Written Qualifying Examination and Dismissal from the Doctoral Program

A student may be allowed to take the examination a second time either in January or June the following year, if they fail the first 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 students may apply for the Master's degree upon approval by their advisor, and may be permitted to register for doctoral dissertation. The dismissed students are eligible to retake the written examination in the following four areas with the supporting courses:

1. Common area:
   a. Advanced Engineering Mathematics

2. Technical area:
   c. Mechanics and Materials: Elasticity, Mechanical Behavior of Materials

For more information on policies and procedures, please see the Ph.D./ME Handbook online at: http://engineering.utsa.edu/me/programs/curriculum.html.

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.

ME 5113. 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 titled “Advanced Controls”).

ME 5143. Advanced Dynamics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Review of Newtonian mechanics, 3-D particle kinematics, dynamics of a system of particles, analytical mechanics, Lagrange’s equations, kinematics and rigid-body dynamics, Eulerian angles, computational analysis using a symbolic language.

ME 5153. Structural Dynamics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Matrix methods for analysis of dynamics of complex structures, computer solutions, systems identifications, and experimental modal analysis.

ME 5183. Advanced Mechanical Vibration. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Free and forced vibration of single and multi-degree-of-freedom systems; response to harmonic, periodic, and nonperiodic excitations; continuous systems; computational techniques for the response.

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.

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.

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).

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.
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.

ME 5334. Convection. (3-0) 3 Credit Hours.
Prerequisite: ME 4313. Derivation of equations of convection of mass, momentum, and energy; scale analysis; boundary layer solutions; classical, laminar convection problems; turbulent convection; natural convection.

ME 5353. Radiation. (3-0) 3 Credit Hours.
Prerequisite: ME 4313. Thermal radiation laws, geometric factors, black bodies, gray enclosures, nongray systems, combined conduction, convection, and radiation.

ME 5413. 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 EGR 5543. Credit cannot be earned for both ME 5413 and EGR 5543).

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).

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 5513).

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).

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. Credit cannot be earned for both ME 5483 and CE 5023).

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.

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.

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.

ME 5533. Advanced Machine Design. (3-0) 3 Credit Hours.
Prerequisite: ME 3823 or an equivalent. Advanced problems in machine design, including bearings, brakes, clutches, gears, shafts, springs, and advanced stress analysis.

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).

ME 5553. Advanced Design of Cams and Gears. (3-0) 3 Credit Hours.
Prerequisites: ME 3823 and ME 4543, or their equivalents. Advanced problems in design of cam follower systems, gear trains and spur, helical, bevel, and worm gears.

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.

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.

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”).

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.
ME 5613. 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.

ME 5633. Gas Dynamics. (3-0) 3 Credit Hours.  
Prerequisite: Graduate standing in engineering or consent of instructor.  
Integral and differential forms of the conservation equations, onedimensional flow, oblique shock and expansion waves, and supersonic, transonic, and hypersonic flows.

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”).

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.

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”).

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.

ME 5733. Advanced Medical Device Design. (3-0) 3 Credit Hours.  
Prerequisite: Graduate standing in engineering or consent of instructor.  
Topics include classification of medical devices, the design process, implementation, and evaluation, IP protection, FDA approval process, and human factors in medical device design.

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).

ME 5753. Fluid Dynamics in Natural Systems. (3-0) 3 Credit Hours.  
Prerequisite: ME 5613 or consent of instructor. 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 of wind turbines, flow dynamics in diseased and normal coronary artery.

ME 5803. Principles of Microfabrication. (1-6) 3 Credit Hours.  
Prerequisite: EGR 3323 or consent of instructor. Photolithography, thin film deposition, doping, wet patterning, plasma etching, thin film characterization. Students will fabricate simple microstructures such as coplanar waveguides, micro-fluidic devices and nano-powder silica films. (Same as EE 5413. Credit cannot be earned for both ME 5803 and EE 5413).

ME 5883. Introduction to Micro and Nanotechnology. (2-3) 3 Credit Hours.  
Prerequisite: Graduate standing or completion of or concurrent enrollment in EE 3323. Survey of micro-fabrication techniques, scaling laws, mechanical, optical and thermal transducers, micro-fluidic applications, and nanostructures. (Same as EE 5503. Credit cannot be earned for both ME 5883 and EE 5503).

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.

ME 5971. Special Project. (1-0) 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.

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.

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.

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.
ME 6133. Advanced Control of Mechanical Systems. (2-3) 3 Credit Hours.
Prerequisite: Graduate standing in engineering. Input-output and state space representation of discrete time mechanical systems; controllability, observability, and stability; design and analysis of digital control systems in transform and time domain; state observer; linear quadratic optimal control, stochastic state estimation, linear quadratic Gaussian problem, loop transfer recovery, adaptive control and model reference adaptive systems, self-tuning regulators, repetitive control, application to mechanical systems including hard disk drives, intelligent vehicle, motor drives, etc.

ME 6253. Bioheat Transfer. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Principles and applications of heat transfer in soft tissue. Topics may include fundamental conservation laws and governing equations of heat transfer, coupling of fluid and mass transport, and thermal activated nanoparticle transvascular transport. (Same as BME 6253. Credit can be earned for both ME 6253 and BME 6253).

ME 6333. Advanced Conduction. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. This course covers methods to calculate the distribution of temperature and heat transfer in objects. Class topics include steady-state conduction in one or more dimensions, unsteady-state conduction in one or more dimensions, exact analytic methods, approximate analytic methods, numerical techniques, nonlinear conduction in one dimension, and inverse conduction in one dimension.

ME 6563. Flexible Automation and Manufacturing Systems. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. This course focuses on major integration issues related with flexible manufacturing systems and their components. Introduces mathematical models related to design, planning, scheduling, and control of flexible manufacturing systems. Contemporary manufacturing topics and research areas are emphasized.

ME 6573. Robotics Design and Analysis. (3-0) 3 Credit Hours.
Prerequisites: ME 5113 and ME 5143. Serial manipulator design and controls; electromechanical issues at the actuator level; analytic modeling and synthesis techniques with emphasis on the influence of sensors, machine vision, and control at the actuator-level and robot system designs.

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.

ME 6813. Biomaterials. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Fundamentals in applications of material science and engineering principles and concepts to repairing, replacing, and protecting human tissues and organs. (Formerly ME 5813 and ME 6013. Same as BME 6903. Credit can be earned for only one of the following: ME 6813, ME 6013, ME 5813 or BME 6903).

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).

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.

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).

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 6 hours, regardless of discipline, will apply to the Master’s degree.

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 6 hours, regardless of discipline, will apply to the Master’s degree.

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).

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.

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.
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.

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.

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 6 hours, regardless of discipline, will apply to the Doctoral degree.

ME 7942. Independent Doctoral Study. (0-0) 2 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 6 hours, regardless of discipline, will apply to the Doctoral degree.

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 6 hours, regardless of discipline, will apply to the Doctoral degree.

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.

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.

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.

ME 7954. Doctoral Research. (0-0) 4 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.

ME 7955. Doctoral Research. (0-0) 5 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.

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.

ME 7958. Doctoral Research. (0-0) 8 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.

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).

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).

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).

ME 7991. Research Seminar. (1-0) 1 Credit Hour.
Required for all Ph.D. students to satisfy one semester of research seminar. May be repeated, but no more than one hour will be applied to the Doctoral degree requirements.