DEPARTMENT OF MECHANICAL, AEROSPACE, AND INDUSTRIAL ENGINEERING

The Department of Mechanical, Aerospace, and Industrial Engineering offers a Master of Science degree in Advanced Manufacturing and Enterprise Engineering, a Master of Science in Aerospace Engineering, and Master of Science and Doctor of Philosophy degrees in Mechanical Engineering. It also offers a Graduate Certificate in Aerospace Engineering.

Master of Science Degree in Advanced Manufacturing and Industrial Engineering

The Master of Science program in Advanced Manufacturing and Industrial Engineering (M.S. in AMIE) 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: Advanced Manufacturing, Industrial 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.
- 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, Aerospace, and Industrial 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 Industrial 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.

Code	Title	Credit Hours
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 5733	Advanced Medical Device Design and Commercialization	
ME 6033	Linear and Mixed Integer Optimization	
ME 6543	Machine Learning and Data Analytics	
ME 6553	Introduction to Deep Learning	
B. 9 semester credit hours of Prescribed Electives approved by student's advisor (see table below)		**9**
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.

Code	Title	Credit Hours
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 5733	Advanced Medical Device Design and Commercialization	
ME 6033	Linear and Mixed Integer Optimization	
ME 6543	Machine Learning and Data Analytics	
ME 6553	Introduction to Deep Learning	
B. 18 semester credit hours of Prescribed Electives approved by student's advisor (see table below)		**18**
Total Credit Hours		**33**

Prescribed Electives

Code	Title	Credit Hours
CE 5613	Environmental Chemistry	
CE 5623	Advanced Treatment Processes for Water Quality Control	
CE 5703	Special Topics in Hydraulics and Hydrology	
CE 5733	Special Topics in Environmental Engineering	
CS 5233	Artificial Intelligence	
EE 5143	Linear Systems and Control	
EE 5243	Special Topics in Control	
EE 5283	Topics in Communications and Intelligent Networks	
EE 5343	Intelligent Control and Robotics	
ES 5023	Environmental Statistics	
IS 5143	Information Technology	
IS 6433	Supervisory Control and Data Acquisition	
ME 5373	Corrosion Engineering	
ME 5493	Fundamentals of Robotics	
ME 5513	Advanced Mechanism Design	
ME 5543	Probabilistic Engineering Design	
ME 5573	Facilities Planning and Design	
ME 5673	Supply Chain Engineering	
ME 5743	Composite Materials	
ME 5773	High Performance Computing	
ME 5973	Special Project	
ME 6013	Advanced Engineering Mathematics I	
ME 6023	Advanced Engineering Mathematics II	
ME 6053	Heuristic-based Optimization	
ME 6063	Convex Optimization	
ME 6123	Advanced Systems Dynamics and Control	
ME 6953	Independent Study	
MOT 5163	Management of Technology	
MOT 5243	Essentials of Project Management	
MOT 5313	Emerging Technologies	
MS 5023	Decision Analytics for Managers	
MS 5343	Logistics Systems Management	
MS 5393	Advanced Production and Operations Management	
MS 5453	Management and Control of Quality	
STA 5093	Introduction to Statistical Inference	
STA 5103	Applied Statistics	

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 who pursue the thesis/special project option 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 AMIE program. The majority of the advisory committee members must be affiliated with the Department of Mechanical, Aerospace, and Industrial 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.

All students must select a Faculty Advisor within the first 9 credit hours of coursework and form a Committee with a minimum of three faculty members (including the Faculty Advisor) within the first 18 credit hours of coursework. Within the first 9 credit hours of coursework, students must meet with their Faculty Advisor to develop their program of study. The Graduate Advisor of Record will advise new students until a Faculty 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 UT San Antonio 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 Aerospace Engineering

The Master of Science in Aerospace Engineering program is designed to prepare degree-seeking students or degree holders in mechanical engineering or a related field with the fundamental engineering knowledge necessary for a successful career in the aerospace industry.

Program Admission Requirements

The minimum requirements for admission to the Master's in Aerospace 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.
- 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, Aerospace, and Industrial 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 Aerospace 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.

Code	Title	Credit Hours
A. Required Core Courses:		**9**
ME 6013	Advanced Engineering Mathematics I	
ME 5243	Advanced Thermodynamics	
ME 6613	Advanced Fluid Mechanics	
B. Designated Electives		**15**
Select 15 credits from the courses below. Selected courses must be approved by student's advisor.		
ME 5013	Topics in Mechanical Engineering (Topic: Big Data in Extreme Environments)	
ME 5013	Topics in Mechanical Engineering (Topic: Orbital Mechanics)	
ME 5033	Engineering Optics	
ME 5053	Propulsion	
ME 5263	Combustion	
ME 5463	Fracture Mechanics	
ME 5483	Finite Element Methods	
ME 5633	Advanced Compressible Flow	
ME 5653	Computational Fluid Dynamics	
ME 5693	Aircraft Performance	
ME 5753	Introduction to Turbulence	
ME 6043	Continuum Mechanics	
ME 6113	Experimental Techniques in Engineering	
ME 6123	Advanced Systems Dynamics and Control	
ME 6663	Advanced Fatigue and Fracture	
ME 6683	Hypersonics	
ME 6853	Advanced CFD and Heat Transfer	
ME 6951	Independent Study (No more than 3 credit hours of Independent Study may may count toward the degree.)	
or ME 6953	Independent Study	
C. Thesis		**6**
Degree candidates must complete a minimum of 6 credit hours of thesis coursework to complete the Thesis Option.		
ME 6981	Master's Thesis	
ME 6982	Master's Thesis	
ME 6983	Master's Thesis	
Total Credit Hours		**30**

Non-Thesis Option

The minimum number of semester credit hours required for the degree is 30 for the Non-Thesis Option.

Code	Title	Credit Hours
A. Required Core Courses		**9**
ME 6013	Advanced Engineering Mathematics I	
ME 5243	Advanced Thermodynamics	
ME 6613	Advanced Fluid Mechanics	
B. Designated Electives		**21**
Select 21 credits from the courses below. Selected courses must be approved by student's advisor.		
ME 5013	Topics in Mechanical Engineering (Topic: Big Data in Extreme Environments)	
ME 5013	Topics in Mechanical Engineering (Topic: Orbital Mechanics)	
ME 5033	Engineering Optics	
ME 5053	Propulsion	
ME 5263	Combustion	
ME 5463	Fracture Mechanics	
ME 5483	Finite Element Methods	
ME 5633	Advanced Compressible Flow	
ME 5653	Computational Fluid Dynamics	
ME 5693	Aircraft Performance	
ME 5753	Introduction to Turbulence	
ME 5973	Special Project (No more than 3 semester credit hours of Special Project may count towards the degree)	
or ME 5971	Special Project	
ME 6043	Continuum Mechanics	
ME 6113	Experimental Techniques in Engineering	
ME 6123	Advanced Systems Dynamics and Control	
ME 6663	Advanced Fatigue and Fracture	
ME 6683	Hypersonics	
ME 6853	Advanced CFD and Heat Transfer	
ME 6953	Independent Study (No more than 3 credit hours of Independent Study may count towards the degree)	
or ME 6951	Independent Study	
Total Credit Hours		**30**

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 who pursue the Thesis/Special Project Option 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, Aerospace, and Industrial 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 must select an Advisor within the first 9 credit hours of coursework, and students who are pursuing either the thesis or special project must 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 UT San Antonio 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: Materials Engineering and Mechanics, Robotics and Control, and Thermal and Fluid Systems. The program offers Thesis and Non-Thesis Options.

Program Admission Requirements

The minimum requirements for admission to the Master of Science 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.
- 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, Aerospace, and Industrial 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.

Code	Title	Credit Hours
A. Required mathematics course:		**3**
ME 6013	Advanced Engineering Mathematics I	
B. Degree candidates are required to choose a concentration and take two courses (6 semester credit hours) in their concentration listed below:		**6**
Materials Engineering and Mechanics		
ME 5713	Mechanical Behavior of Materials	
ME 6413	Elasticity	
Robotics and Control		
ME 5493	Fundamentals of Robotics	
ME 6123	Advanced Systems Dynamics and Control	
Thermal and Fluid Systems		
ME 5243	Advanced Thermodynamics	
ME 6613	Advanced Fluid Mechanics	
C. 15 semester credit hours of Prescribed Electives approved by student's advisor (see table below and refer to designated concentration)		**15**
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.

Code	Title	Credit Hours
A. Required mathematics course:		**3**
ME 6013	Advanced Engineering Mathematics I	
B. Degree candidates are required to choose a concentration and take two courses (6 semester credit hours) in their concentration listed below:		**6**
Materials Engineering and Mechanics		
ME 5713	Mechanical Behavior of Materials	
ME 6413	Elasticity	
Robotics and Control		
ME 5493	Fundamentals of Robotics	
ME 6123	Advanced Systems Dynamics and Control	
Thermal and Fluid Systems		
ME 5243	Advanced Thermodynamics	
ME 6613	Advanced Fluid Mechanics	
C. 24 semester credit hours of Prescribed Electives approved by student's advisor (see table below and refer to designated concentration)		**24**
Total Credit Hours		**33**

Prescribed Electives

Code	Title	Credit Hours
Materials Engineering & Mechanics		
BME 6593	Biomaterials for Drug Delivery/ Pharmacology	
BME 6903	Biomaterials	
CHE 5653	Structure Determination Using Spectroscopic Methods	
CHE 5843	Advanced Physical Chemistry	
MATE 5103	Principles of Materials Engineering: Fundamentals of Structure, Chemistry, and Physical Properties	
MATE 5113	Functions, Evaluations and Synthesis Technology of Advanced Materials	
MATE 5213	Sensing and Sensor Materials	
MATE 5223	Structure-Chemistry-Property Relations in Materials Science and Engineering	
MATE 5243	Optic and Nonlinear Optical Materials	
MATE 5253	Magnetic Materials and Electromagnetic Engineering	
ME 5373	Corrosion Engineering	
ME 5453	Advanced Strength of Materials	

ME 5463	Fracture Mechanics
ME 5483	Finite Element Methods
ME 5743	Composite Materials
ME 5973	Special Project
PHY 5103	Classical Mechanics I
PHY 5203	Electrodynamics I
PHY 5303	Statistical Mechanics
PHY 5403	Quantum Mechanics I
PHY 6523	Computational Physics
Robotics and Control	
CS 5163	Data Science
CS 5233	Artificial Intelligence
CS 6463	Advanced Topics in Computer Science
EE 5103	Engineering Programming
EE 5143	Linear Systems and Control
EE 5243	Special Topics in Control (Network Multi-Agent System)
EE 5243	Special Topics in Control (Adaptive Control)
EE 5243	Special Topics in Control (Nonlinear Control)
EE 5243	Special Topics in Control (Opt. and Control of CPS)
EE 5243	Special Topics in Control (Control Systems)
EE 5243	Special Topics in Control (Advanced Robotics in AI)
EE 5263	Advanced Topics in Signal Processing and Machine Learning (Machine Learning)
EE 5263	Advanced Topics in Signal Processing and Machine Learning (Deep Learning)
EE 5283	Topics in Communications and Intelligent Networks (Engineering Optimization)
EE 5343	Intelligent Control and Robotics
EE 5453	Topics in Software Engineering (Engineering Programming II)
EE 5643	Advanced Robotics and Artificial Intelligence
EE 5663	Artificial Intelligence
EE 5743	Network Multi-agent Systems
EE 6363	Advanced Topics in Signal Processing
MATE 5213	Sensing and Sensor Materials
ME 5483	Finite Element Methods
ME 5513	Advanced Mechanism Design
ME 5563	Computer Integrated Manufacturing
ME 5583	Process Improvement and Variability Reduction
ME 5603	Advanced Manufacturing Systems Engineering
ME 5733	Advanced Medical Device Design and Commercialization
ME 5973	Special Project
ME 6033	Linear and Mixed Integer Optimization
ME 6113	Experimental Techniques in Engineering
ME 6543	Machine Learning and Data Analytics
ME 6953	Independent Study
ME 6973	Special Problems (Intro to Deep Learning)
Thermal & Fluid Systems	
ME 5013	Topics in Mechanical Engineering (Big Data in Extreme Environments)
ME 5053	Propulsion
ME 5263	Combustion
ME 5273	Alternative Energy Sources
ME 5303	Advanced Heat and Mass Transfer
ME 5483	Finite Element Methods
ME 5633	Advanced Compressible Flow
ME 5653	Computational Fluid Dynamics
ME 5753	Introduction to Turbulence
ME 5763	Advanced Scientific Visualization
ME 5773	High Performance Computing
ME 5963	Topics in Bioengineering
ME 5973	Special Project
ME 6023	Advanced Engineering Mathematics II
ME 6113	Experimental Techniques in Engineering
ME 6543	Machine Learning and Data Analytics
ME 6853	Advanced CFD and Heat Transfer
ME 6953	Independent Study

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 who pursue the Thesis/Special Project Option 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, Aerospace, and Industrial 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.

All students must select a Faculty Advisor within the first 9 credit hours of coursework, and form a Committee with a minimum of three faculty members (including Faculty Advisor) within the first 18 credit hours of coursework. Within the first 9 credit hours of coursework, students must meet with their Faculty Advisor to develop their program of study. The Graduate Advisor of Record will advise new students until a Faculty 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 UT San Antonio 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, Aerospace, and Industrial Engineering offers advanced coursework integrated with research leading to the Doctor of Philosophy degree in Mechanical Engineering. The program has four concentrations: Design and Manufacturing Systems, Materials Engineering and Mechanics, Robotics and Control, and Thermal and Fluid

Systems. 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.

Concentration in Design and Manufacturing Systems

This program provides students with the opportunity to gain essential knowledge useful to understand, analyze, and optimize the design, production, and operations in modern manufacturing systems and supply chains concerning productivity, efficiency, effectiveness, quality, reliability, scalability, and sustainability.

Concentration in Materials Engineering and Mechanics

This program provides students with the opportunity to gain fundamental knowledge useful to understand the structure, properties, and processing of materials for their design and applications in emerging fields such as structures, energy, environment, biomedical, electronic, transportation, and aerospace industries.

Concentration in Robotics and Control

This program provides students with the opportunity to gain fundamental knowledge of robotics and automation applications in manufacturing, including manipulator/mobile-robot kinematics and dynamics, actuator and end-effector design and control, and the novel field of self-powered robotics. Students will be introduced to robotics applications in industry and healthcare, and the challenges of path planning and management.

Concentration in Thermal and Fluid Systems

This program provides students with the opportunity to gain essential knowledge useful to understand heat transfer, fluid dynamics, thermodynamics, and energy systems to address challenges in thermal management, fluid systems, power conversion, renewable energy, environmental impacts, compressible flow, turbulence, engines, combustion, and propulsion technologies.

The regulations for this degree comply with the general University regulations (refer to Student Policies, General Academic Regulations (https://catalog.utsa.edu/policies/generalacademicregulations/), and the Graduate Catalog, Doctoral Degree Regulations (https://catalog.utsa.edu/graduate/doctoraldegreeregulations/)).

Admission Requirements

The minimum requirements for admission to the Doctor of Philosophy in Mechanical Engineering degree program are as follows (note that admission is competitive, and satisfying these requirements does not guarantee admission):

- Students must meet the University-Wide Admission Requirements as outlined in the Graduate Catalog.
- Official transcripts of all undergraduate and/or graduate coursework. Transcripts must be submitted from an accredited college or university in the United States or have proof of equivalent training at a foreign institution.
- Students whose native language is not English must achieve a university-wide minimum score on the Test of English as a Foreign Language (TOEFL) iBT or the International English Language Testing System (IELTS). The current university-wide minimum score for TOEFL iBT is 79, and IELTS is 6.5. Students are also encouraged to visit the Graduate Catalog on any changes in the university-wide minimum scores for TOEFL/IELTS. The test score is waived for international students from countries where English is the official language or for students who have earned an accredited bachelor's degree or higher in the United States or in countries where English is the official language, as indicated in the Graduate Catalog.
- Résumé or curriculum vitae (CV).
- A statement of research experience, interests, and goals.
- Two professional and/or academic letters of recommendation attesting to the applicant's readiness for doctoral study.
- A complete application includes the application form, official transcripts, letters of recommendation, a résumé, a statement of research experience, interests and goals, and the TOEFL or IELTS score for those applicants whose native language is not English.

Degree Requirements

The Ph.D. in Mechanical Engineering 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 Ph.D. 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 who have Obtained a Master's Degree

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

Code	Title	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 four research concentrations listed below, students are required to take the two courses (6 semester credit hours) indicated:		
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.)	
Materials Engineering and Mechanics		

ME 5713	Mechanical Behavior of Materials	
ME 6413	Elasticity	
Robotics and Control		
ME 5493	Fundamentals of Robotics	
ME 6123	Advanced Systems Dynamics and Control	
Thermal and Fluid Systems		
ME 5243	Advanced Thermodynamics	
ME 6613	Advanced Fluid Mechanics	
C. 6 semester credit hours of Prescribed Electives approved by student's advisor (see table below and refer to designated research concentration)		**6**
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 who have Obtained a Bachelor's Degree

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

Code	Title	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 research concentrations listed below, students are required to take the two courses (6 semester credit hours) indicated:		
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.)	
Materials Engineering and Mechanics		
ME 5713	Mechanical Behavior of Materials	
ME 6413	Elasticity	
Robotics and Control		
ME 5493	Fundamentals of Robotics	
ME 6123	Advanced Systems Dynamics and Control	
Thermal and Fluid Systems		
ME 5243	Advanced Thermodynamics	
ME 6613	Advanced Fluid Mechanics	
C. 27 semester credit hours of Prescribed Electives approved by student's advisor (see table below and refer to designated research concentration)		**27**
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**

Prescribed Electives

Code	Title	Credit Hours
Design & Manufacturing		
CE 5613	Environmental Chemistry	
CE 5623	Advanced Treatment Processes for Water Quality Control	
CE 5703	Special Topics in Hydraulics and Hydrology	
CE 5733	Special Topics in Environmental Engineering	
CS 5233	Artificial Intelligence	
EE 5143	Linear Systems and Control	
EE 5243	Special Topics in Control (Systems and Control)	
EE 5283	Topics in Communications and Intelligent Networks (Engineering Optimization)	
EE 5343	Intelligent Control and Robotics	
ES 5023	Environmental Statistics	
IS 5143	Information Technology	
IS 6433	Supervisory Control and Data Acquisition	
ME 5373	Corrosion Engineering	
ME 5493	Fundamentals of Robotics	
ME 5513	Advanced Mechanism Design	
ME 5543	Probabilistic Engineering Design	
ME 5573	Facilities Planning and Design	
ME 5673	Supply Chain Engineering	
ME 5743	Composite Materials	
ME 5773	High Performance Computing	
ME 6013	Advanced Engineering Mathematics I	
ME 6023	Advanced Engineering Mathematics II	
ME 6053	Heuristic-based Optimization	

ME 6063	Convex Optimization
ME 6123	Advanced Systems Dynamics and Control
ME 6953	Independent Study
MOT 5163	Management of Technology
MOT 5243	Essentials of Project Management
MOT 5313	Emerging Technologies
MS 5023	Decision Analytics for Managers
MS 5343	Logistics Systems Management
MS 5393	Advanced Production and Operations Management
MS 5453	Management and Control of Quality
STA 5093	Introduction to Statistical Inference
STA 5103	Applied Statistics
Materials Engineering & Mechanics	
BME 6593	Biomaterials for Drug Delivery/ Pharmacology
BME 6903	Biomaterials
CHE 5653	Structure Determination Using Spectroscopic Methods
CHE 5843	Advanced Physical Chemistry
MATE 5103	Principles of Materials Engineering: Fundamentals of Structure, Chemistry, and Physical Properties
MATE 5113	Functions, Evaluations and Synthesis Technology of Advanced Materials
MATE 5213	Sensing and Sensor Materials
MATE 5223	Structure-Chemistry-Property Relations in Materials Science and Engineering
MATE 5243	Optic and Nonlinear Optical Materials
MATE 5253	Magnetic Materials and Electromagnetic Engineering
ME 5373	Corrosion Engineering
ME 5453	Advanced Strength of Materials
ME 5463	Fracture Mechanics
ME 5483	Finite Element Methods
ME 5743	Composite Materials
PHY 5103	Classical Mechanics I
PHY 5203	Electrodynamics I
PHY 5303	Statistical Mechanics
PHY 5403	Quantum Mechanics I
PHY 6523	Computational Physics
Robotics and Control	
CS 5163	Data Science
CS 5233	Artificial Intelligence
CS 6463	Advanced Topics in Computer Science
EE 5103	Engineering Programming
EE 5143	Linear Systems and Control
EE 5243	Special Topics in Control (Network Multi-Agent System)
EE 5243	Special Topics in Control (Adaptive Control)
EE 5243	Special Topics in Control (Nonlinear Control)
EE 5243	Special Topics in Control (Opt. and Control of CPS)
EE 5243	Special Topics in Control (Control Systems)
EE 5243	Special Topics in Control (Advanced Robotics in AI)
EE 5263	Advanced Topics in Signal Processing and Machine Learning (Machine Learning)
EE 5263	Advanced Topics in Signal Processing and Machine Learning (Deep Learning)
EE 5283	Topics in Communications and Intelligent Networks (Engineering Optimization)
EE 5343	Intelligent Control and Robotics
EE 5453	Topics in Software Engineering (Engineering Programming II)
EE 5643	Advanced Robotics and Artificial Intelligence
EE 5663	Artificial Intelligence
EE 5743	Network Multi-agent Systems
EE 6363	Advanced Topics in Signal Processing
MATE 5213	Sensing and Sensor Materials
ME 5483	Finite Element Methods
ME 5513	Advanced Mechanism Design
ME 5563	Computer Integrated Manufacturing
ME 5583	Process Improvement and Variability Reduction
ME 5603	Advanced Manufacturing Systems Engineering
ME 5733	Advanced Medical Device Design and Commercialization
ME 6033	Linear and Mixed Integer Optimization
ME 6113	Experimental Techniques in Engineering
ME 6543	Machine Learning and Data Analytics
ME 6953	Independent Study
ME 6973	Special Problems (Intro to Deep Learning)
Thermal & Fluid Systems	
ME 5013	Topics in Mechanical Engineering (Big Data in Extreme Environments)
ME 5053	Propulsion
ME 5263	Combustion
ME 5273	Alternative Energy Sources
ME 5303	Advanced Heat and Mass Transfer
ME 5483	Finite Element Methods
ME 5633	Advanced Compressible Flow
ME 5653	Computational Fluid Dynamics
ME 5753	Introduction to Turbulence
ME 5763	Advanced Scientific Visualization
ME 5773	High Performance Computing
ME 5963	Topics in Bioengineering
ME 6023	Advanced Engineering Mathematics II
ME 6113	Experimental Techniques in Engineering
ME 6543	Machine Learning and Data Analytics
ME 6853	Advanced CFD and Heat Transfer
ME 6953	Independent Study

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, Aerospace, and Industrial Engineering Department or have an adjoining affiliation with the department. The program of study, as well as the selection of core and prescribed elective courses, must be recommended by the student's Ph.D. advisor.

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

1. Common Core (select one):
   a. Engineering Mathematics
   b. Linear and Mixed Integer Optimization
2. Technical Core (select one):
   a. Design and Manufacturing Systems: 1) Manufacturing Engineering and 2) Machine Learning & Data Analytics
   b. Materials Engineering and Mechanics: 1) Solid Mechanics and 2) Mechanical Behavior of Materials
   c. Robotics and Control: 1) Robotics and 2) Systems Dynamics and Control
   d. Thermal and Fluid Systems: 1) Thermodynamics & Heat Transfer and 2) Fluid Mechanics

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 of Science 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, including 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 UT San Antonio 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.

- Graduate Certificate in Aerospace Engineering (p. 9)
- Graduate Certificate in (p. 10)Career Technology and Engineering Teaching

Graduate Certificate in Aerospace Engineering

The Graduate Certificate in Aerospace Engineering is designed to prepare degree-seeking students or degree holders in Mechanical Engineering or related fields with the fundamental engineering knowledge necessary for successful careers in the aerospace industry. It certifies to employers that students awarded the certificate have completed coursework essential to successful in entry-level positions in aerospace.

Admission Requirements

Applicants may apply for admission to the certificate as a special (non-degree-seeking) graduate student according to UTSA's admission requirements for certificate programs (see Certificate Program Regulations in this catalog). Additionally, applicants will be required to submit a résumé detailing their experience.

Currently enrolled graduate students who wish to pursue the certificate should fill out the UTSA Graduate Certificate Form (http://cacp.utsa.edu/images/uploads/Construction_Engineering,_Science_and_Management_certificate_INTENT_FORM.pd send it to the Mechanical, Aerospace, and Industrial Engineering department.

Certificate Program Requirements

Students must first meet the prerequisite course requirements for the certificate program (refer to course descriptions in the UTSA Graduate Catalog).

Students pursuing an Aerospace Engineering Graduate Certificate must complete 12 semester credit hours as follows:

Code	Title	Credit Hours
A. Required Core Courses		**6**
Complete 6 semester credit hours of courses from below.		
ME 5053	Propulsion	
ME 5633	Advanced Compressible Flow	
B. Prescribed Elective Courses		**6**
Select 6 semester credit hours of prescribed electives. One course (3 semester credit hours) towards the prescribed electives may be substituted with approval from the Mechanical, Aerospace, and Industrial Engineering Department Graduate Studies Committee.		
ME 5023	Numerical Techniques in Engineering Analysis	
ME 5033	Engineering Optics	
ME 5263	Combustion	
ME 5303	Advanced Heat and Mass Transfer	
ME 5453	Advanced Strength of Materials	
ME 5653	Computational Fluid Dynamics	
ME 5693	Aircraft Performance	
ME 6043	Continuum Mechanics	
ME 6113	Experimental Techniques in Engineering	
ME 6613	Advanced Fluid Mechanics	
ME 6683	Hypersonics	
Total Credit Hours		**12**

Graduate Certificate in Career Technology and Engineering Teaching

The Graduate Certificate in Career Technology and Engineering Teaching (CTET) is designed for teachers and instructors who wish to teach dual-credit STEM courses in high schools or community colleges. The certificate also helps instructors improve their teaching skills and marketability.

Admission Requirements

Applicants may apply for admission to the certificate as a special (non-degree-seeking) graduate student according to UTSA's admission requirements for certificate programs (see Certificate Program Regulations (https://catalog.utsa.edu/graduate/certificateprograms/) in this catalog). Additionally, applicants will be required to submit a résumé detailing their experience.

This certificate requires students initially to complete UTSA's Graduate Certificate in Engineering Education (https://catalog.utsa.edu/graduate/engineeringintegrateddesign/biomedicalengineering/#certificatestext) as a prerequisite. Applicants must have successfully passed Engineering Education with a minimum grade point average of 3.00.

Certificate Program Requirements

After the completion of the Graduate Certificate in Engineering Education (https://catalog.utsa.edu/graduate/engineeringintegrateddesign/biomedicalengineering/#certificatestext), students are required to complete a total of 9 credit hours of graduate-level engineering courses with a minimum grade point average of 3.00. The selection of courses is based on the applicant's area of interest and consultation with an Engineering professor.

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. This course has Differential Tuition.

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.) This course has Differential Tuition.

ME 5033. Engineering Optics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Overview of the principles of light, key definitions, and units. Key concepts of linear geometric optics and optical components (e.g., simple lenses, mirrors, diffraction gratings, prisms, coatings, and camera lenses), detectors (PMTs, photodiodes, CCDs, etc.), and lasers. Design of modern optical experiments with an introduction to the current state-of-the-art in optical diagnostics used in aerospace and mechanical engineering. This course has Differential Tuition.

ME 5053. Propulsion. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Application of thermodynamics and fluid mechanics to the analysis of problems related to the propulsion of aerospace vehicles. Development of control volume analysis techniques for compressible flow problems, with applications in the design and analysis of rocket nozzles and state-of-the-art propulsion systems like ramjets, scramjets, and detonation cycle systems. This course has Differential Tuition.

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.) This course has Differential Tuition. Course Fee: L001 $25.

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.) This course has Differential Tuition.

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. This course has Differential Tuition.

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. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

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.) This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

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. This course has Differential Tuition.

ME 5373. Corrosion Engineering. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Application of thermodynamics and kinetics to the analysis of problems related to Corrosion. Introduction of techniques for corrosion assessment and corrosion control methods. Inspection of corrosion cases and development of corrosion control strategies to mitigate corrosion problems. This course has Differential Tuition.

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.) This course has Differential Tuition.

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.) This course has Differential Tuition.

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.) This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

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. (Formerly CE 5023. Same as CE 5193. Credit cannot be earned for more than one of the following: ME 5483, CE 5023, and CE 5193.) This course has Differential Tuition.

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. This course has Differential Tuition.

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. This course has Differential Tuition.

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. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

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.) This course has Differential Tuition.

ME 5563. Computer Integrated Manufacturing. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Concepts and modern methods for computer-integrated manufacturing, planning and execution, shopfloor automation and controls, and emerging technologies. Includes hands-on practices on numerical controls and programmable controls. This course has Differential Tuition.

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. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

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 analyzing and improving manufacturing systems and enterprise operations. Topics include systems capability evaluation, Six Sigma and DMAIC, root-cause analysis, statistical process control, and other contemporary process engineering approaches. This course has Differential Tuition.

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. Analytical models and discrete-event simulation will be introduced to evaluate system performance under different production planning and control strategies. Contemporary manufacturing topics and research areas are emphasized. This course has Differential Tuition.

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.") This course has Differential Tuition.

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.") This course has Differential Tuition.

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. This course has Differential Tuition.

ME 5673. Supply Chain Engineering. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. This course addresses critical issues faced in modern supply chains. Students will review essential information, constraints, and existing methodologies for problem-solving. Covered topics encompass production scheduling, inventory systems, package-courier systems, ground transportation, container shipping, railroad operations, and air cargo. Additionally, the course examines technologies supporting efficient supply chain operations. This course has Differential Tuition.

ME 5693. Aircraft Performance. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Study of aircraft performance using the governing equations of fluid dynamics, atmospheric properties, and the concepts of lift and drag. Analysis of level flight performance, rates of climb, service and absolute ceilings, range, takeoff and landing, and turn performance. Study of longitudinal and lateral stability applied to aircraft. This course has Differential Tuition.

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.") This course has Differential Tuition.

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. This course has Differential Tuition.

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.") This course has Differential Tuition.

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.) This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

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. This course has Differential Tuition.

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.) This course has Differential Tuition.

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. (Formerly EGR 5713. Credit cannot be earned for both EGR 5713 and ME 5773.) This course has Differential Tuition.

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. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

ME 5971. Special Project. (0-0) 1 Credit Hour.
Prerequisite: 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. This course has Differential Tuition.

ME 5973. Special Project. (0-0) 3 Credit Hours.
Prerequisite: 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. This course has Differential Tuition.

ME 6013. Advanced Engineering Mathematics I. (3-0) 3 Credit Hours.
Prerequisite: 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.") This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

ME 6023. Advanced Engineering Mathematics II. (3-0) 3 Credit Hours.
Prerequisite: 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.) This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

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.) This course has Differential Tuition.

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. This course has Differential Tuition.

ME 6053. Heuristic-based Optimization. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. This course provides an overview of modern heuristic-based optimization methods including single-solution and population-based algorithms. Students will gain hands-on experience in problem representation, algorithm implementation, parameter optimization, and performance analysis. This course has Differential Tuition.

ME 6063. Convex Optimization. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. This course introduces the theory of convex optimization and provides practical tools to identify and solve related problems. Convex optimization has applications in diverse fields, including control systems, machine learning, supply networks, and robotics. This course covers foundational concepts, including convex sets and functions, modeling aspects, and practical results. Also, this course includes a review of convex analysis, least squares, linear and quadratic programs, optimality conditions, duality theory, interior-point methods, and convex relaxation. This course has Differential Tuition.

ME 6113. Experimental Techniques in Engineering. (2-3) 3 Credit Hours.
Prerequisite: 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. This course has Differential Tuition.

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.) This course has Differential Tuition.

ME 6413. Elasticity. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. Index notation and tensors, deformation and strain analysis, stress and equilibrium, material symmetry, constitutive relations for linear elastic solids, plane problems, boundary value problems in elasticity, strain energy, and related principles. This course has Differential Tuition.

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). This course has Differential Tuition.

ME 6553. Introduction to Deep Learning. (3-0) 3 Credit Hours.
Introduction to the theory and application of deep learning, a branch of machine learning for the development and application of modern neural networks. This course covers a range of topics including basic neural networks, convolutional and recurrent network structures, generative adversarial networks, and deep reinforcement learning. This course has Differential Tuition.

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.) This course has Differential Tuition.

ME 6663. Advanced Fatigue and Fracture. (3-0) 3 Credit Hours.
Prerequisite: ME 5463 and graduate standing in engineering or consent of instructor. This course reviews concepts in fatigue, damage tolerance, and probabilistic fracture mechanics. It will also discuss fatigue life prediction and application for structural components, crack initiation and propagation, low and high cycle fatigue, notch strain analysis, and cumulative damage and apply these concepts to modern engineering problems. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

ME 6673. Combustion. (3-0) 3 Credit Hours.
Prerequisite: ME 4293. This course will cover 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, and mechanisms of air pollution. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

ME 6683. Hypersonics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in engineering or consent of instructor. This is an introduction to hypersonics, including shock/expansion theory, Newtonian theory, 3D flows, entropy, viscous effects, high-temperature and real gas effects, and testing and modeling considerations. This course has Differential Tuition.

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.) This course has Differential Tuition.

ME 6853. Advanced CFD and Heat Transfer. (3-0) 3 Credit Hours.
Prerequisite: ME 6613 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. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

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.) This course has Differential Tuition. Course fees: LRE1 $25; STSE $30.

ME 6951. Independent Study. (0-0) 1 Credit Hour.
Prerequisite: Graduate standing and permission in writing (form available) from 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. This course has Differential Tuition.

ME 6953. Independent Study. (0-0) 3 Credit Hours.
Prerequisite: Graduate standing and permission in writing (form available) from 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. This course has Differential Tuition.

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). This course has Differential Tuition.

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. This course has Differential Tuition.

ME 6981. Master's Thesis. (0-0) 1 Credit Hour.
Prerequisite: 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. This course has Differential Tuition.

ME 6982. Master's Thesis. (0-0) 2 Credit Hours.
Prerequisite: 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. This course has Differential Tuition.

ME 6983. Master's Thesis. (0-0) 3 Credit Hours.
Prerequisite: 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. This course has Differential Tuition.

ME 7941. Independent Doctoral Study. (0-0) 1 Credit Hour.
Prerequisite: Graduate standing in Ph.D. in Mechanical Engineering program and permission in writing (form available) from 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. This course has Differential Tuition.

ME 7943. Independent Doctoral Study. (0-0) 3 Credit Hours.
Prerequisite: Graduate standing in Ph.D. in Mechanical Engineering program and permission in writing (form available) from 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. This course has Differential Tuition.

ME 7951. Doctoral Research. (0-0) 1 Credit Hour.
Prerequisite: 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. This course has Differential Tuition.

ME 7952. Doctoral Research. (0-0) 2 Credit Hours.
Prerequisite: 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. This course has Differential Tuition.

ME 7953. Doctoral Research. (0-0) 3 Credit Hours.
Prerequisite: 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. This course has Differential Tuition.

ME 7956. Doctoral Research. (0-0) 6 Credit Hours.
Prerequisite: 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. This course has Differential Tuition.

ME 7981. Doctoral Dissertation. (0-0) 1 Credit Hour.
Prerequisite: 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.) This course has Differential Tuition.

ME 7982. Doctoral Dissertation. (0-0) 2 Credit Hours.
Prerequisite: 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.) This course has Differential Tuition.

ME 7983. Doctoral Dissertation. (0-0) 3 Credit Hours.
Prerequisite: 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.) This course has Differential Tuition.

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 and recommended to complete in the first year of the Ph.D. program. The grade report for the course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance). This course has Differential Tuition.