

DEPARTMENT OF MECHANICAL ENGINEERING

The Department of Mechanical Engineering offers a Bachelor of Science degree in Mechanical Engineering (ME). The program is currently accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org> (<http://www.abet.org/>). Individuals enrolling in this degree program are given the opportunity to develop a strong background in Engineering Science and to learn the analysis, design, and synthesis tools necessary to contribute in traditional and emerging areas of technology.

The department has excellent laboratory facilities where students receive hands-on instruction from faculty members. Computer-aided design (CAD) facilities, including state-of-the-art workstations, are routinely used. Some classes are taught by adjunct faculty from local industries, giving students the opportunity to interact with engineering professionals engaged in relevant engineering practice.

Because of the broad engineering training in this program, graduates may find employment in many industries, including companies or government agencies associated with aerospace, automotive, energy, petroleum, manufacturing, biomedical engineering, and research.

Direct Admission Criteria

Applicants entering UTSA as Freshmen or Freshmen Transfers (fewer than 12 transferable semester credit hours) will be directly admitted to the ME program if they:

- meet all UTSA undergraduate admission requirements,
- qualify for enrollment in MAT 1214 Calculus I, or a higher level mathematics course, and
- are ranked in the top 10 percent of their high school class (no minimum SAT or ACT scores required), *or*
- are ranked below the top 10 percent of their high school class and have a minimum 1200 SAT* or 25 ACT score.

Applicants with SAT scores below 1200 or ACT scores below 25 may undergo admission by committee review.

Transfer requirements for direct admission to the ME program for students who have earned 12 or more transferable semester credit hours:

- meet all UTSA undergraduate transfer admission requirements, and
- have completed MAT 1214 Calculus I and WRC 1013 Freshman Composition I, or the equivalents, with grades of "C-" or better, and
- meet grade point average requirements:
- applicants with a transfer grade point average of 3.00 or higher may be granted direct admission to the major, or
- applicants with a transfer grade point average below 3.00 may be granted admission to the College by committee review.

Applicants who do not meet Mechanical Engineering admission requirements will be admitted to the Engineering, Math, and Sciences Studies in the University College. Students have three semesters to complete Calculus I with a grade of "C-" or better and meet the ME Transfer Requirements.

"C-" Grade Rule

A grade of "C-" or better in any science, engineering, or mathematics course required for an engineering degree or any other course that is

a prerequisite to a required ME or Engineering (EGR) course indicates satisfactory preparation for further engineering education. Any course assigned a grade below a "C-" must be repeated before enrolling in any course for which it is a prerequisite. This requirement is subject to both the Gateway Course and Three-Attempt Limit rules.

Bachelor of Science Degree in Mechanical Engineering

The Bachelor of Science degree in Mechanical Engineering offers students the opportunity to prepare for careers in traditional, new, and emerging technologies related to the practice of Mechanical Engineering, which is a versatile and broadly-based engineering discipline. Mathematics and basic sciences, such as physics and chemistry, form the foundation of mechanical engineering, which requires an understanding of diverse subject areas, such as solid and fluid mechanics, thermal sciences, mechanical design, structures, material selection, manufacturing processes and systems, mechanical systems and control, and instrumentation.

The Mechanical Engineering curriculum provides education and basic engineering training through the required coursework. Students may develop increased specialization and depth through the selection of technical elective courses. Development of open-ended, problem-solving skills is a part of many mechanical engineering courses. Design projects with formal report writing are included in many courses. In addition, a substantial portion of technical elective courses is devoted to the design of systems and components. A capstone design sequence at the senior level provides an opportunity to apply and integrate the knowledge gained throughout the curriculum to the development of an instructor-approved project.

The laboratory requirements are designed to provide hands-on experience in basic measurement and instrumentation equipment and the application of classroom theory. Students may receive additional hands-on experiences by selecting technical elective courses with laboratory components.

Opportunities exist for students to participate in research and design projects. All students are eligible to participate in undergraduate research, through the independent study courses. Students also have an opportunity to participate in an approved co-op program and may receive up to 3 semester credit hours for their experience.

Program Educational Objectives

The Mechanical Engineering Program prepares students to attain the following program educational objectives a few years after graduation:

1. Have engineering or other careers in industry, government, and/or will pursue advanced graduate or professional degrees.
2. Apply their engineering knowledge, critical thinking, creativity, and problem solving skills in professional engineering practice or in non-engineering fields.
3. Continue to advance their knowledge, communication, and leadership skills through graduate education, professional development courses, self-directed study, and/or on-the-job training and experience.
4. Apply their understanding of societal, environmental, and ethical issues to their professional activities.

Student Outcomes

Graduates of the UTSA Mechanical Engineering Program will demonstrate the following student outcomes. Attainment of these

outcomes prepares graduates to enter the professional practice of engineering.

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

The minimum number of semester credit hours required for this degree is 128, at least 39 of which must be at the upper-division level. All candidates for this degree must fulfill the Core Curriculum requirements, the General Engineering requirements, and the degree requirements, listed below. A minimum grade of "C-" or better is required for all mathematics, science, Engineering (EGR), and Mechanical Engineering (ME) courses in the curriculum.

Core Curriculum Requirements (42 semester credit hours)

Students seeking the Bachelor of Science degree in Mechanical Engineering must fulfill the University Core Curriculum requirements in the same manner as other students. The courses listed below satisfy both major requirements and Core Curriculum requirements; however, if these courses are taken to satisfy both requirements, then students may need to take additional courses in order to meet the minimum number of semester credit hours required for the degree.

MAT 1214 may be used to satisfy the core requirement in Mathematics, as well as one of the General Engineering requirements. PHY 1943 and PHY 1963 may be used to satisfy the core requirement in Life and Physical Sciences, as well as two of the General Engineering requirements. EGR 1403 may be used to satisfy the core requirement in the Component Area Option.

Core Curriculum Component Area Requirements (<http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degree requirements/corecurriculumcomponentarearequirements/>)

First Year Experience Requirement	3
Communication	6
Mathematics	3
Life and Physical Sciences	6
Language, Philosophy and Culture	3
Creative Arts	3
American History	6
Government-Political Science	6

Social and Behavioral Sciences	3
Component Area Option	3
Total Credit Hours	42

General Engineering Requirements

Students seeking the Bachelor of Science degree in Mechanical Engineering must complete the following 22 semester credit hours:

Code	Title	Credit Hours
CHE 1103	General Chemistry I	3
EGR 2323	Applied Engineering Analysis I	3
MAT 1214	Calculus I	4
MAT 1224 or EGR 1324	Calculus II Calculus II for Engineers	4
PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory	4
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory	4
Total Credit Hours		22

Gateway Courses

Students pursuing the Bachelor of Science degree in Mechanical Engineering must successfully complete each of the following Gateway Courses with a grade of "C-" or better in no more than two attempts. A student who is unable to successfully complete these courses within two attempts, including dropping a course with a grade of "W" or taking an equivalent course at another institution, will be required to change his or her major.

Code	Title	Credit Hours
EGR 2103	Statics	
EGR 2323	Applied Engineering Analysis I	
EGR 2513	Dynamics	
MAT 1214	Calculus I	

Degree Requirements

Students seeking the Bachelor of Science degree in Mechanical Engineering must complete the following semester credit hours, as well as the Core Curriculum requirements and General Engineering requirements:

Code	Title	Credit Hours
A. Required foundation and general mechanical engineering courses:		
EE 2213	Electric Circuits and Electronics	3
EGR 2103	Statics	3
EGR 2513	Dynamics	3
EGR 3323	Applied Engineering Analysis II	3
ME 1403	Engineering Practice and Graphics	3
ME 2173	Numerical Methods	3
ME 3113	Measurements and Instrumentation	3
ME 3241	Materials Engineering Laboratory	1
ME 3243	Materials Engineering	3

ME 3263	Manufacturing Engineering	3
ME 3293	Thermodynamics I	3
ME 3541	Dynamics and Controls Laboratory	1
ME 3543	Dynamic Systems and Control	3
ME 3663	Fluid Mechanics	3
ME 3813	Mechanics of Solids	3
ME 3823	Machine Element Design	3
ME 4293	Thermodynamics II	3
ME 4312	Thermal and Fluids Laboratory	2
ME 4313	Heat Transfer	3
ME 4543	Mechatronics	3
ME 4801	Manufacturing Practices Laboratory	1
ME 4812	Senior Design I	2
ME 4813	Senior Design II	3

B. Mechanical Engineering elective courses

Select 9 semester credit hours of Mechanical Engineering elective courses. Students are encouraged to choose courses from a specific group listed below. Students may also select courses to partially satisfy the requirements of a certificate in one of the following areas: 1) Aerospace Engineering; 2) Heating, Ventilation and Air Conditioning; 3) Industrial and Manufacturing Engineering; or 4) Oil/ Gas. For detailed requirements, see the Certificates section of the Mechanical Engineering program. 9

Aerospace

ME 3323	Mechanical Vibration
ME 4183	Compressible Flow and Propulsion Systems
ME 4603	Finite Element Analysis
ME 4723	Reliability and Quality Control in Engineering Design
ME 4953	Special Studies in Mechanical Engineering (when topic is Aerodynamics)
ME 4953	Special Studies in Mechanical Engineering (when topic is Propulsion)
ME 4953	Special Studies in Mechanical Engineering (when topic is Astrodynamics)

Design and Control of Mechanical Systems

ME 3323	Mechanical Vibration
ME 3513	Mechanism Design
ME 4553	Automotive Vehicle Dynamics
ME 4723	Reliability and Quality Control in Engineering Design
ME 4773	Robotics

Energy, Thermal and Fluid Systems

ME 4183	Compressible Flow and Propulsion Systems
ME 4323	Thermal Systems Design
ME 4343	Heating, Air Conditioning, and Refrigeration Design
ME 4593	Alternative Energy Sources
ME 4613	Power Plant System Design
ME 4623	Internal Combustion Engines

Heating, Ventilation and Air-Conditioning

EGR 3713	Engineering Economic Analysis
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ME 4323	Thermal Systems Design
ME 4343	Heating, Air Conditioning, and Refrigeration Design
ME 4593	Alternative Energy Sources
ME 4613	Power Plant System Design
ME 4953	Special Studies in Mechanical Engineering (SS in HVAC Controls)
ME 4953	Special Studies in Mechanical Engineering (SS in Refrigeration)
ME 4953	Special Studies in Mechanical Engineering (SS in Indoor Air Quality)

Industrial and Manufacturing

EGR 3713	Engineering Economic Analysis
ME 3273	Operations Research
ME 4273	Systems Modeling and Analysis
ME 4503	Lean Manufacturing and Enterprise Engineering
ME 4563	Computer Integrated Manufacturing
ME 4573	Facilities Planning and Design
ME 4583	Enterprise Process Engineering
ME 4723	Reliability and Quality Control in Engineering Design
ME 4773	Robotics

Mechanics and Materials

ME 4243	Intermediate Materials Engineering
ME 4603	Finite Element Analysis
ME 4963	Mechanical Engineering Applications to Biomedical Systems

Oil and Gas

EGR 3713	Engineering Economic Analysis
ME 3323	Mechanical Vibration
ME 4323	Thermal Systems Design
ME 4373	Separation Processes
ME 4593	Alternative Energy Sources
ME 4603	Finite Element Analysis
ME 4643	Pressure Vessel and Piping Design
ME 4653	Oil and Gas Engineering and Reservoir Geomechanics
ME 4683	Corrosion Engineering

Additional engineering elective courses

EGR 3303	Engineering Co-op ¹
EGR 4993	Honors Research ¹
ME 3183	Python: Big Data in Engineering and Environmental Systems
ME 4173	High Performance Computing
ME 4913	Independent Study ¹
ME 4953	Special Studies in Mechanical Engineering ¹

Graduate Courses in Mechanical Engineering ²

C. 3 semester credit hours of approved mathematics or basic science elective courses, selected from the following list: 3

BIO 1233	Contemporary Biology I
BIO 1243	Contemporary Biology II
BIO 1203	Biosciences I for Science Majors

BIO 2003	Biology of Human Reproduction
CHE 1113	General Chemistry II
CHE 2603	Organic Chemistry I
ES 2013	Introduction to Environmental Science I
GEO 1123	Life Through Time
MAT 3013	Foundations of Mathematics
MAT 3103	Data Analysis and Interpretation
PHY 2103	Modern Physics
PHY 3203	Classical Mechanics I
STA 2303	Applied Probability and Statistics for Engineers
STA 3003	Applied Statistics

Total Credit Hours **73**

- With prior approval, these courses may be used as a technical elective.
- Graduate courses require approval. Forms are available from your academic advisor.

B.S. in Mechanical Engineering – Recommended Four-Year Academic Plan

First Year

		Credit Hours
Fall		
AIS 1243	AIS: Engineering, Mathematics, and Sciences	3
CHE 1103	General Chemistry I	3
MAT 1214	Calculus I (core and major)	4
ME 1403	Engineering Practice and Graphics	3
WRC 1013	Freshman Composition I (core)	3
Credit Hours		16

Spring

MAT 1224	Calculus II	4
PHY 1943	Physics for Scientists and Engineers I (core and major)	3
PHY 1951	Physics for Scientists and Engineers I Laboratory	1
POL 1013	Introduction to American Politics (core)	3
WRC 1023	Freshman Composition II (core)	3
American History (core)		3
Credit Hours		17

Second Year

		Credit Hours
Fall		
EGR 2103	Statics	3
EGR 2323	Applied Engineering Analysis I	3
PHY 1963	Physics for Scientists and Engineers II (core and major)	3
PHY 1971	Physics for Scientists and Engineers II Laboratory	1
EGR 1403	Technical Communication (or other core option)	3
Math/Science Elective		3
Credit Hours		16

Spring

EE 2213	Electric Circuits and Electronics	3
EGR 2513	Dynamics	3
EGR 3323	Applied Engineering Analysis II	3
ME 3241	Materials Engineering Laboratory	1
ME 3243	Materials Engineering	3
ME 3293	Thermodynamics I	3
Credit Hours		16

Third Year

Fall

ME 2173	Numerical Methods	3
ME 3113	Measurements and Instrumentation	3
ME 3663	Fluid Mechanics	3
ME 3813	Mechanics of Solids	3
ME 4293	Thermodynamics II	3
Language, Philosophy & Culture (core)		3
Credit Hours		18

Spring

ME 3263	Manufacturing Engineering	3
ME 3541	Dynamics and Controls Laboratory	1
ME 3543	Dynamic Systems and Control	3
ME 3823	Machine Element Design	3
ME 4313	Heat Transfer	3
Creative Arts (core)		3
Credit Hours		16

Fourth Year

Fall

ME 4312	Thermal and Fluids Laboratory	2
ME 4543	Mechatronics	3
ME 4801	Manufacturing Practices Laboratory	1
ME 4812	Senior Design I	2
POL 1133 or POL 1213	Texas Politics and Society (core) or Civil Rights in Texas and America	3
ME Technical elective		3
Credit Hours		14

Spring

ME 4813	Senior Design II	3
ME Technical elective		3
ME Technical elective		3
American History (core)		3
Social and Behavioral Sciences (core)		3
Credit Hours		15

Total Credit Hours **128**

- Certificate in Aerospace Engineering (p. 4)
- Certificate in Heating, Ventilation and Air-Conditioning (p. 5)
- Certificate in Industrial and Manufacturing Engineering (p. 5)
- Certificate in Oil/Gas (p. 6)

Certificate in Aerospace Engineering

The 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.

Eligibility requirements:

- Meet the prerequisite courses for the certificate program (refer to course descriptions in the *UTSA Undergraduate Catalog*)

Students pursuing an Aerospace Engineering certificate must complete 15 semester credit hours as follows:

Code	Title	Credit Hours
A. Required courses:		
ME 3663	Fluid Mechanics	3
B. ME electives. A minimum of three courses (9 semester credit hours) selected from the following list:		
ME 4183	Compressible Flow and Propulsion Systems	9-12
ME 4953	Special Studies in Mechanical Engineering (SS in Aerodynamics)	
ME 4953	Special Studies in Mechanical Engineering (SS in Propulsion)	
ME 4953	Special Studies in Mechanical Engineering (SS in Astrodynamics)	
C. Additional electives. If only three courses are selected from list B, then an additional 3 semester credit hours must be completed from the following list:		
ME 3323	Mechanical Vibration	0-3
ME 4603	Finite Element Analysis	
ME 4723	Reliability and Quality Control in Engineering Design	
Total Credit Hours		15

Certificate in Heating, Ventilation and Air-Conditioning

The Certificate in Heating, Ventilation and Air-Conditioning (HVAC) 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 design, manufacture, selection, and/or installation of mechanical equipment which controls the built environment. It certifies to employers that students awarded the certificate have completed coursework essential to success in entry-level positions in HVAC related fields.

Eligibility requirements:

- Meet the prerequisite courses for the certificate program (refer to course descriptions in the *UTSA Undergraduate Catalog*)

Students pursuing a HVAC certificate must complete 15 semester credit hours as follows:

Code	Title	Credit Hours
A. Required courses:		
ME 4313	Heat Transfer	3

B. ME electives. A minimum of three courses (9 semester credit hours) selected from the following list:

ME 4323	Thermal Systems Design
ME 4343	Heating, Air Conditioning, and Refrigeration Design
ME 4613	Power Plant System Design
ME 4953	Special Studies in Mechanical Engineering (SS in HVAC Controls)
ME 4953	Special Studies in Mechanical Engineering (SS in Refrigeration)
ME 4953	Special Studies in Mechanical Engineering (SS in Indoor Air Quality)

C. Additional electives. If only three courses are selected from list B, then an additional 3 semester credit hours must be completed from the following list:

EGR 3713	Engineering Economic Analysis
ME 4593	Alternative Energy Sources

Total Credit Hours **15**

Certificate in Industrial and Manufacturing Engineering

The Certificate in Industrial and Manufacturing 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 manufacturing industry. It certifies to employers that students awarded the certificate have completed coursework essential to success in entry-level engineering positions in manufacturing.

Eligibility requirements:

- Meet the prerequisite courses for the certificate program (refer to course descriptions in the *UTSA Undergraduate Catalog*)

Students pursuing an Industrial and Manufacturing Engineering certificate must complete 15 semester credit hours as follows:

Code	Title	Credit Hours	
A. Required courses:			
ME 3263	Manufacturing Engineering	3	
B. ME electives. A minimum of three courses (9 semester credit hours) selected from the following list:			
ME 3273	Operations Research	9-12	
ME 4503	Lean Manufacturing and Enterprise Engineering		
ME 4563	Computer Integrated Manufacturing		
ME 4573	Facilities Planning and Design		
ME 4583	Enterprise Process Engineering		
ME 4723	Reliability and Quality Control in Engineering Design		
ME 4953	Special Studies in Mechanical Engineering (SS Advanced Medical Device Design and Commercialization)		
C. Additional electives. If only three courses are selected from list B, then an additional 3 semester credit hours must be completed from the following list:			

EGR 3713	Engineering Economic Analysis
ME 4273	Systems Modeling and Analysis
ME 4773	Robotics
Total Credit Hours	15

Certificate in Oil/Gas

The Certificate in Oil/Gas is designed to prepare mechanical engineering degree-seeking students and non-degree-seeking students with mechanical engineering background with the fundamental engineering knowledge necessary for successful careers in Oil/Gas Industry. It certifies to employers that students awarded the certificate have completed coursework essential to Oil/Gas industry.

Eligibility requirements:

- Meet the prerequisite courses for the certificate program (refer to course descriptions in the *UTSA Undergraduate Catalog*)

Students pursuing an Oil/Gas certificate must complete 15 semester credit hours as follows:

Code	Title	Credit Hours
A. Required courses:		
ME 3823	Machine Element Design ¹	3
B. ME electives. A minimum of three courses (9 semester credit hours) selected from the following list:		
ME 3323	Mechanical Vibration	9-12
ME 4323	Thermal Systems Design	
ME 4373	Separation Processes	
ME 4593	Alternative Energy Sources	
ME 4603	Finite Element Analysis	
ME 4643	Pressure Vessel and Piping Design	
ME 4653	Oil and Gas Engineering and Reservoir Geomechanics	
ME 4683	Corrosion Engineering	
C. Additional electives. If only three courses are selected from list B, then an additional 3 semester credit hours must be completed from the following list:		
EGR 3713	Engineering Economic Analysis	0-3
ME 4603	Finite Element Analysis	
Total Credit Hours		15

¹ Those students who have transferred equivalent required and elective courses, as listed above, from other institutions may complete the certificate program by taking 15 semester credit hours of ME courses listed above.

To earn any certificate in the mechanical engineering program, students must satisfy the following requirements:

1. Complete all the requirements of the certificate program.
2. Receive a grade of "C-" or better in each course used to satisfy the requirements of the certificate program.
3. Achieve at least a 2.5 grade point average (on a 4.0 scale) in all courses used to satisfy the requirements of the certificate program.

Undergraduates who are currently enrolled in the baccalaureate degree program in mechanical engineering or enrolled as non-degree-seeking

students and who wish to earn an undergraduate certificate offered by the mechanical engineering program are eligible to enroll in the certificate program, provided they satisfy the course prerequisite requirements.

Students not currently admitted to UTSA who wish to earn an undergraduate certificate offered by the mechanical engineering program will be required to apply for admission to UTSA as special (non-degree-seeking) students at the undergraduate level, and indicate in the application process their desire to pursue the requirements for specific undergraduate certificate program. Applicants will be required to meet University admission requirements for special students at the undergraduate level.

Students who are pursuing a certificate as non-degree-seeking students will not be eligible for financial aid or Veterans Administration educational benefits.

Graduate students may enroll in the undergraduate certificate programs, provided they meet the requirements for enrollment in the certificate program.

During the last semester in the certificate program, students must submit an application for the Undergraduate Certificate to the Office of the Registrar.

Mechanical Engineering (ME) Courses

ME 1403. Engineering Practice and Graphics. (2-3) 3 Credit Hours. (TCCN = ENGR 1304)

Prerequisites: MAT 1093 and completion of or concurrent enrollment in WRC 1013. Introduction to engineering practice and engineering graphics: geometric constructions, multi-view drawing, dimensioning, sections, pictorials and auxiliary views. Computer-aided design, generation of mechanical drawings, and design projects. (Formerly ME 1402. Credit cannot be earned for both ME 1402 and ME 1403.) Course Fees: LRE1 \$25; STSE \$30.

ME 2173. Numerical Methods. (2-3) 3 Credit Hours.

Prerequisite: EGR 2323. Introduction to numerical algorithms to solve science and engineering problems. Construction and derivation of numerical algorithm as well as application limits. Various numerical approaches in finding roots of linear and non-linear functions, regression analysis, interpolation, curve fitting procedures, differentiation, integration, solutions of system of linear algebraic equations, solutions of ordinary differential equations and boundary value problems. Introduction to structured programming (MATLAB), including error estimation, and stability. (Formerly ME 3173. Credit cannot be earned for both ME 3173 and ME 2173.) Generally offered: Fall, Spring, Summer. Course Fees: LRE1 \$25; STSE \$30; DL01 \$75.

ME 3113. Measurements and Instrumentation. (2-3) 3 Credit Hours.

Prerequisites: EE 2213, EGR 2513, PHY 1951, and PHY 1971. Fundamentals of measurement systems theory and laboratory practice. Descriptive statistics, probability distributions, error, uncertainty analysis, technical report writing, and data acquisition. Generally offered: Fall, Spring, Summer. Differential Tuition: \$165. Course Fees: L001 \$30; DL01 \$75.

ME 3183. Python: Big Data in Engineering and Environmental Systems. (3-0) 3 Credit Hours.

Prerequisite: ME 2173. Introduction to Python as a programming language and to several modules of Python specific to scientific computing. Understanding physical principles of engineering systems from data using Python platform. The course introduces scientific data analysis including statistical analysis of stochastic processes and numerical methods for big data. Differential Tuition: \$165.

ME 3241. Materials Engineering Laboratory. (0-3) 1 Credit Hour.

Prerequisite: Concurrent enrollment in or completion of ME 3243. Investigation of the mechanical properties of engineering materials, with emphasis on metals, sample preparation, and metallography. (Formerly ME 3244. Credit cannot be earned for both ME 3244 and ME 3241.) Differential Tuition: \$55. Course Fee: L001 \$30.

ME 3243. Materials Engineering. (3-0) 3 Credit Hours.

Prerequisites: CHE 1103, EGR 2103, and concurrent enrollment in or completion of ME 3241. Fundamentals in atomic structure, microstructures, properties, and mechanical behavior of engineering materials, such as metals, polymers, and ceramics. (Formerly ME 3244. Credit cannot be earned for both ME 3244 or ME 3243 and ME 3241. Prior completion of ME 3244 can be substituted for ME 3243 and ME 3241.) Generally offered: Fall, Spring. Differential Tuition: \$165. Course fee: DL01 \$75.

ME 3263. Manufacturing Engineering. (3-0) 3 Credit Hours.

Prerequisites: EGR 2513, ME 3241, and ME 3243 (or ME 3244 in previous catalogs). Manufacturing processes, quality assurance, statistical methods, economic analysis, planning, and communication. (Formerly titled "Materials Processing.") Generally offered: Fall, Spring, Summer. Differential Tuition: \$165.

ME 3273. Operations Research. (3-0) 3 Credit Hours.

Prerequisite: ME 2173. Introduction to fundamental optimization models and solution methods, including linear programs, the simplex method, duality theory, sensitivity analysis, integer programs, and network flows. Focus on formulating and solving practical operations research problems and the use of optimization software. Differential Tuition: \$165.

ME 3293. Thermodynamics I. (3-0) 3 Credit Hours.

Prerequisites: EGR 2103 and MAT 1224. Heat, work, equations of state, thermodynamics systems, control volume, first and second laws of thermodynamics, applications of the laws of thermodynamics, reversible and irreversible processes, and introduction to basic thermodynamic cycles. (Same as CME 2503. Credit cannot be earned for both ME 3293 and CME 2503.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$165. Course fee: DL01 \$75.

ME 3323. Mechanical Vibration. (3-0) 3 Credit Hours.

Prerequisites: EGR 2323 and EGR 2513. Free and forced vibrations, single and multiple degree of freedom systems, damping, matrix methods, time-domain and frequency-domain. Applications in the transmission and control of vibration. Generally offered: Spring. Differential Tuition: \$165.

ME 3513. Mechanism Design. (3-0) 3 Credit Hours.

Prerequisites: EGR 2513 and ME 1403. Introduction to mechanisms, graphical and linear analytical methods for kinematic synthesis of mechanisms; design of cam follower; gearing fundamentals, ordinary and planetary gear trains; and computer-aided design projects. Differential Tuition: \$165.

ME 3541. Dynamics and Controls Laboratory. (0-2) 1 Credit Hour.

Prerequisites: ME 3113 and concurrent enrollment in or completion of ME 3543. Investigation of the dynamics and control of physical systems. (Formerly ME 4733. Credit cannot be earned for both ME 4733 and ME 3541.) Differential Tuition: \$55.

ME 3543. Dynamic Systems and Control. (3-0) 3 Credit Hours.

Prerequisites: EGR 2513 and EGR 3323, and concurrent enrollment in or completion of ME 3113. Introduction to modeling and control of dynamic physical systems, analysis and design of control systems for mechanical, electrical, manufacturing, fluid, and thermal systems. (Formerly ME 4522 and ME 4523. Credit cannot be earned for more than one of the following: ME 3543, ME 4522, or ME 4523.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$165. Course fee: DL01 \$75.

ME 3663. Fluid Mechanics. (3-0) 3 Credit Hours.

Prerequisites: EGR 2323, EGR 2513, and completion of or concurrent enrollment in ME 3293. Fluid properties, fluid statics, integral and differential analysis of fluid flow, viscous laminar and turbulent flow in conduits, dimensional analysis, boundary layer concepts, drag and lift. Generally offered: Fall, Spring, Summer. Differential Tuition: \$165. Course fee: DL01 \$75.

ME 3813. Mechanics of Solids. (3-0) 3 Credit Hours.

Prerequisites: EGR 2103 and MAT 1224. Internal forces and deformations in solids, stress, strain and their relations, torsion, stresses and deflections in beams, and elastic behavior of columns. (Same as CE 3103. Credit cannot be earned for both ME 3813 and CE 3103.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$165. Course fee: DL01 \$75.

ME 3823. Machine Element Design. (3-0) 3 Credit Hours.

Prerequisites: ME 1403, ME 3241, ME 3243 (or ME 3244 in previous catalogs), and ME 3813. Introduction to design of machine elements, materials selection, static and fatigue failures, shafts, fasteners, springs, gears, bearings and design projects. (Formerly ME 4423. Credit cannot be earned for both ME 3823 and ME 4423.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$165. Course fee: DL01 \$75.

ME 4173. High Performance Computing. (3-0) 3 Credit Hours.

Prerequisite: ME 2173. Introduction to UNIX (login, shell scripts, editors, file permissions), visualization (software tools, data formats), Parallel programming (numerical libraries, Message Passing Interface, Trilinos, GPGPU programming). Differential Tuition: \$165.

ME 4183. Compressible Flow and Propulsion Systems. (3-0) 3 Credit Hours.

Prerequisites: ME 3293 and ME 3663. Analysis of one-dimensional steady compressible flow, isentropic flow, compressible boundary layers, transition from subsonic to supersonic flow, Fanno and Rayleigh flow, supersonic nozzle design, normal and oblique shock waves, and expansion fans. (Formerly EGR 4183. Credit cannot be earned for both ME 4183 and EGR 4183.) Differential Tuition: \$165.

ME 4243. Intermediate Materials Engineering. (3-0) 3 Credit Hours.

Prerequisites: ME 3241, ME 3243 (or ME 3244 in previous catalogs), and ME 3813. Selected topics in fabrication and processing of materials; macroscopic and microscopic aspects of the mechanical behavior of metals, ceramics, polymers and composites; Failure mode analysis in materials; optimization of material selection in the design process. Differential Tuition: \$165.

ME 4273. Systems Modeling and Analysis. (3-0) 3 Credit Hours.

Prerequisites: ME 2173 and ME 3113. Systems analysis approach to formulating and solving engineering problems. Topics include mathematical modeling, discrete event simulation, and decision analysis. Focus on applying systems modeling methods on practical industrial problems and the use of simulation software. Differential Tuition: \$165.

ME 4293. Thermodynamics II. (3-0) 3 Credit Hours.

Prerequisite: ME 3293. Energy and (availability) analysis, reactive and nonreactive mixtures, moist air properties, psychrometric systems and analysis, vapor and gas power cycles, refrigeration and heat-pump cycles, and thermodynamic relations. Generally offered: Fall, Spring. Differential Tuition: \$165.

ME 4312. Thermal and Fluids Laboratory. (0-4) 2 Credit Hours.

Prerequisites: ME 3113, ME 4293, and concurrent enrollment in or completion of ME 4313. Investigation of thermal and fluid physical systems, and design of experiments. (Formerly ME 4733. Credit cannot be earned for both ME 4733 and ME 4312.) Differential Tuition: \$110.

ME 4313. Heat Transfer. (3-0) 3 Credit Hours.

Prerequisites: EGR 3323, ME 2173, ME 3293, and ME 3663. Generalized potential distribution and gradients, and heat transfer, including transient and steady state conduction, forced and free convection, radiation, and heat exchanger analysis. Generally offered: Fall, Spring. Differential Tuition: \$165.

ME 4323. Thermal Systems Design. (3-0) 3 Credit Hours.

Prerequisite: ME 4313. Application of thermodynamics, fluid mechanics, heat transfer, and computer methods to the design of thermal energy systems. Differential Tuition: \$165.

ME 4343. Heating, Air Conditioning, and Refrigeration Design. (3-0) 3 Credit Hours.

Prerequisite: ME 4293. Moist air properties, human comfort, solar radiation, heating/cooling loads, design selection, operation of air conditioning equipment, and duct design. Differential Tuition: \$165.

ME 4373. Separation Processes. (3-0) 3 Credit Hours.

Prerequisite: ME 4293. Rate- and equilibrium-controlled separation, mass transfer, phase equilibrium, distillation, and extraction. Differential Tuition: \$165.

ME 4503. Lean Manufacturing and Enterprise Engineering. (3-0) 3 Credit Hours.

Prerequisite: ME 3263. Concepts and applications of Lean Systems applied to manufacturing and non-manufacturing environments. Topics include lean fundamentals and various tools and methodologies for transformation of companies and organizations into globally competitive enterprises. Team project on Value Streaming Mapping analysis of processes in real settings is required. Differential Tuition: \$165.

ME 4543. Mechatronics. (2-3) 3 Credit Hours.

Prerequisite: ME 3113. Modeling and analysis of electrical (resistors, capacitors, inductors, diodes, transistors, operational amplifiers, combinational logic and sequential logic) and mechanical systems (spring mass damper), data acquisition and measurements, sensors, actuators, and micro-controller programming. A lab component with emphasis on building electrical circuits, data acquisition using LabVIEW, and integration of sensors, actuators, and micro-controller programming (Arduino) to create a mechatronics system. Generally offered: Fall, Spring. Differential Tuition: \$165. Course Fees: L001 \$30; DL01 \$75.

ME 4553. Automotive Vehicle Dynamics. (3-0) 3 Credit Hours.

Prerequisites: EGR 2323 and EGR 2513. Dynamics and control of automotive systems, handling, tires, suspension, steering, and aerodynamic forces. Differential Tuition: \$165.

ME 4563. Computer Integrated Manufacturing. (3-0) 3 Credit Hours.

Prerequisite: ME 3263. Fundamental concepts and models related to computer-aided design, computer-aided process planning, computer-aided manufacturing, production planning and scheduling, and manufacturing execution systems. Laboratory work includes computer-aided applications and programming of automated production equipment. Differential Tuition: \$165.

ME 4573. Facilities Planning and Design. (3-0) 3 Credit Hours.

Prerequisite: ME 3263. Product, process, and schedule design, flow, space, and activity relationships, material handling, layout planning models and design algorithms, and warehouse operations. Differential Tuition: \$165.

ME 4583. Enterprise Process Engineering. (3-0) 3 Credit Hours.

Prerequisite: ME 3263. Fundamental concepts, methodologies, and tools for the design, engineering and continuous improvement of enterprises. Topics include Six Sigma for process design and improvement, lean manufacturing fundamentals, value-stream mapping, performance evaluation, and other contemporary enterprise process engineering approaches. Generally offered: Fall. Differential Tuition: \$165. Course fee: DL01 \$75.

ME 4593. Alternative Energy Sources. (3-0) 3 Credit Hours.

Prerequisites: ME 2173, ME 3113, ME 3663, and ME 4293. Nuclear, geothermal, solar, biomass, wind, and hydrogen energy sources. Resources, production, utilization, economics, sustainability, and environmental considerations. (Formerly ME 3593. Credit cannot be earned for both ME 3593 and ME 4593.) Differential Tuition: \$165.

ME 4603. Finite Element Analysis. (3-0) 3 Credit Hours.

Prerequisites: EGR 3323, ME 2173, and ME 3823. Finite element method fundamentals, advanced geometric modeling of mechanical components and systems, and finite element modeling of components. Differential Tuition: \$165.

ME 4613. Power Plant System Design. (3-0) 3 Credit Hours.

Prerequisite: ME 4293. Application of thermodynamics and fluid mechanics to the design of vapor and gas-turbine power plant systems including boilers, condensers, turbines, pumps, compressors, and cooling towers. Differential Tuition: \$165.

ME 4623. Internal Combustion Engines. (3-0) 3 Credit Hours.

Prerequisite: ME 4293. Application of thermodynamic cycles in design, analysis, and modeling of internal combustion engines including spark-ignition and compression-ignition cycles, thermochemistry, fuels, combustion, emissions, and pollution. Differential Tuition: \$165.

ME 4643. Pressure Vessel and Piping Design. (3-0) 3 Credit Hours.

Prerequisites: ME 3663 and ME 3813. ASME Section XIII Boiler and Pressure Vessel code, inspection, maintenance, repair, and modification of pressure vessels. Piping design and construction. Differential Tuition: \$165.

ME 4653. Oil and Gas Engineering and Reservoir Geomechanics. (3-0) 3 Credit Hours.

Prerequisites: ME 3663 and ME 3813. Introduction to the oil and gas industry, Measurement; deformation mechanisms in rock; rock fracture description and analysis; wellbore stresses and failure; wellbore stability analysis; fault stability analysis; depletion-induced reservoir deformation; and hydraulic fracturing. Differential Tuition: \$165.

ME 4683. Corrosion Engineering. (3-0) 3 Credit Hours.

Prerequisites: ME 3241 and ME 3243 (or ME 3244 in previous catalogs). Principles of electrochemistry, fundamentals of the environmental degradation of materials, corrosion thermodynamics and kinetics, corrosion phenomenology, and corrosion control and prevention. Differential Tuition: \$165. Course fee: DL01 \$75.

ME 4723. Reliability and Quality Control in Engineering Design. (3-0) 3 Credit Hours.

Prerequisite: ME 3113. Introduction to statistical methods in reliability and probabilistic engineering design methodology, statistical quality control and inspection, life prediction and testing, and design optimization. Generally offered: Fall. Differential Tuition: \$165. Course fee: DL01 \$75.

ME 4773. Robotics. (3-0) 3 Credit Hours.

Prerequisites: EGR 2513 and ME 2173. Kinematics, dynamics, planning and control of mobile robots and manipulators. Special topics may include legged robots, soft robots, climbing robots, advanced control methods, image processing, computer vision, estimation. A LEGO-based laboratory with emphasis on prototyping robotic systems for practical applications. Differential Tuition: \$165.

ME 4801. Manufacturing Practices Laboratory. (0-2) 1 Credit Hour.

Prerequisite: Concurrent enrollment in, or completion of, ME 3263. Use of measurement tools, saw, drill, mill, lathe, and welder. Differential Tuition: \$55.

ME 4812. Senior Design I. (2-0) 2 Credit Hours.

Prerequisites: ME 3113, ME 3263, ME 3543, ME 3663, ME 3823, and ME 4293; completion of or concurrent enrollment in ME 4313, ME 4543 (or ME 3513 in previous catalogs), ME 4801, and ME 4312 required. Design project proposals, computer-aided synthesis, analysis, and modeling of an open-ended problem development and presentation of conceptual designs. Industrial cooperation is encouraged. This course, as well as ME 4313, ME 4543, ME 4801, and ME 3541, must be completed with a grade of "C-" or better to serve as prerequisites for ME 4813. (Formerly ME 4811 and ME 4803. Credit cannot be earned for more than one of the following: ME 4812, ME 4803, or ME 4811.) Differential Tuition: \$110. Course fee: DL01 \$50.

ME 4813. Senior Design II. (2-3) 3 Credit Hours.

Prerequisites: ME 3541, ME 4312, ME 4313, ME 4543, ME 4801, and ME 4812. Development of a working design of an instructor-approved design project using computer-aided synthesis, analysis, modeling, and optimization methods. Industrial cooperation encouraged. Considerations of safety, reliability, environmental, and economic constraints, and ethical and social impacts. Generally offered: Fall, Spring. Differential Tuition: \$165. Course Fees: L001 \$30; DL01 \$75.

ME 4911. Independent Study. (0-0) 1 Credit Hour.

Prerequisite: Permission in writing (form available) from the instructor, the Department Chair, and Dean of the College. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours of independent study, regardless of discipline, will apply to a bachelor's degree. Differential Tuition: \$55.

ME 4913. Independent Study. (0-0) 3 Credit Hours.

Prerequisite: Permission in writing (form available) from the instructor, the Department Chair, and Dean of the College. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours of independent study, regardless of discipline, will apply to a bachelor's degree. Differential Tuition: \$165.

ME 4953. Special Studies in Mechanical Engineering. (3-0) 3 Credit Hours.

Prerequisite: Will depend on the topic. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when topics vary, but not more than 9 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Generally offered: Fall, Spring. Differential Tuition: \$165. Course fee: DL01 \$75.

ME 4963. Mechanical Engineering Applications to Biomedical Systems. (3-0) 3 Credit Hours.

Prerequisites: EGR 2513, ME 3663, and ME 3813. Applications of dynamics, solid mechanics and fluid mechanics to biomedical systems. (Formerly titled Bioengineering.) Differential Tuition: \$165.