MECHANICAL ENGINEERING

Description
Mechanical engineering is a broad field of study that significantly impacts many technologies, including those that expand our energy resources and improve medical care. Mechanical engineers are concerned with all forms of energy conversion and transmission; the flow of fluids and heat; the development, design, manufacturing, and operation of machinery and equipment; material structure and properties; solid and applied mechanics; and transportation processes. The course of study is designed to give the student fundamental preparation to enter the fields of research, design, operation, production, sales, or management.

The mechanical engineering curriculum is structured so that students are well prepared in the fundamental areas of solid mechanics, thermal-fluid sciences, systems and design engineering, and materials engineering. Students can develop an emphasis area of study by concentrating elective courses in specific interdisciplinary areas such as aerospace engineering, automotive engineering, robotics, biomedical engineering, computational methods, manufacturing, nanotechnology and others, depending upon the technical courses available and the interest of the student. Additionally, broader general education requirements are covered through the Achievement-Centered Education (ACE) program (ace.unl.edu); the mechanical engineering curriculum requirements cover ACE areas [1-4,8,10], and students may work with their academic advisor to select courses covering areas [5-7,9].

Mission and Objectives
Mission Statement
The mission of the Department of Mechanical and Materials Engineering at the University of Nebraska is to impact society locally and globally through our educational programs, research, and service, developing knowledge and sharing our expertise in the best traditions of land-grant universities. We strive for excellence in teaching and learning at both the undergraduate and graduate levels; seek to develop novel educational opportunities; grow our public and private support for research and education; and expand our scholarship, outreach, and service.

Program Educational Objectives
Within a few years of graduation, our mechanical engineering graduates are expected to:

1. Have started successful careers based on their education or have completed a professional degree or a graduate degree in engineering or related field.
2. Have begun life-long learning and development in order to remain current in their knowledge and skills and to advance in their careers.
3. Have established a record of professionalism, leadership, respect, and integrity in working to serve humanity and use resources responsibly.

Admission
Admittance to Degree Program
Students are expected to meet minimum college entrance requirements. After being admitted to the college as pre-mechanical engineering students, students wishing to pursue a degree in mechanical engineering must further be admitted to the degree program. Students who have completed 43 credit hours applicable to their mechanical engineering degree are considered for formal admission to the mechanical engineering degree program. Typically, this occurs the semester the student is enrolled in MECH 200 Engineering Thermodynamics or MATL 360 Elements of Materials Science. Those exceeding 61 credit hours must receive formal admission to the mechanical engineering degree program if they are to continue to take mechanical engineering courses. Transfer students must have at least 12 credit hours of coursework from the University of Nebraska—Lincoln on record before an application will be considered.

The requirements for admission to the degree program are a major GPA of 2.7 (that is, not counting elective courses), completion of MECH 223 Engineering Statics, no more than four withdrawals and no more than three repeated courses. Those who are not admitted to the degree program the first time are advised of the outcome and are automatically reviewed again at the end of that semester. If after two reviews a student is not admitted to the degree program, the student is advised of other majors, in engineering or elsewhere, in which they may be likely to find success.

Other
Hands-on Opportunities
One major focus of the Department is to provide students with many hands-on opportunities, both within the curriculum (through formal laboratory courses) and through extracurricular activities. Brief descriptions of some of the laboratories in the department are given below.

The Materials Laboratory is designed to study the development of microstructures during processing and to correlate the properties of materials with the observed structures. Undergraduates utilize arc melting facilities for solidification processing and alloy formation, rolling mills for deformation processing, and a variety of furnaces for thermal treatments. Characterization facilities include x-ray diffractometry and optical microscopy, while property measurements are completed using hardness testing (including microhardness), tensile testing, and impact testing facilities. Other facilities associated with the materials laboratory include rapid solidification processing facilities and electron microscopy facilities.

The Measurements Laboratory is associated with the required MECH 380 Mechanical Engineering Measurements course, which includes two hours of lecture and two hours of laboratory work each week. The course covers the fundamentals of mechanical engineering measurements including data analysis (statistics, graphing, spectral analysis); signal conditioning and data readout; and the measurement of length/displacement, rate of rotation, stress/strain, temperature, pressure, fluid velocity, fluid flow rate, vibration/acceleration, and sound. The MECH 380 lab has four workbenches. Each workbench has a set of basic measurement equipment including a digital oscilloscope, an electronic counter, a digital multimeter, a DC power supply, a function generator, and a computer-based data acquisition system consisting of a personal computer with data acquisition software and interfaced analog-to-digital converter and digital counter cards. In addition, on a week-to-week basis, specialized equipment is brought out of the cabinets and set up for each of the nine (some one week, some two week) labs.

The Kinematics and Machine Design Laboratory is a teaching laboratory for undergraduate students. The laboratory consists of equipment and instruments for conducting experiments in kinematics and machine design. One piece of major equipment is the rapid prototyping machine, which accepts design specifications from a computer and forms a prototype of the design using plastic fused deposition. This machine provides the student with experience in design integration from concept to product. Accessories in this laboratory include desktop computers, a
wide-carriage printer, and other instruments. Kawasaki also donated a retired robot that is now utilized in this laboratory.

The Thermal Fluids Laboratory involves design, execution, and evaluation of physical experiments in the areas of thermodynamics, fluid mechanics, and heat transfer. There are three major, heavily-instrumented experiments:

1. A two stage air-compressor with intercooling.
2. A versatile air conditioning unit.
3. A Ford gasoline engine with a Superflow water brake dynamometer, supported with a data acquisition system.

The course involves the design, execution, and evaluation of physical experiments in the areas of thermodynamics, fluid mechanics, and heat transfer. In addition, the facilities include "table top" instrumentation for viscosity measurement, measurement of pressure distribution on an airfoil, flow visualization, and head loss across a valve on which students conduct experiments.

The Mechatronics Laboratory is well-equipped for teaching courses in mechatronics, robotics, and controls. It is used primarily for MECH 457 Mechatronic Systems Design and MECH 450 Mechanical Engineering Control Systems Design, but is also used for other courses and by both undergraduate and graduate students working on research projects. The laboratory contains desktop computers, modular robots, digital oscilloscopes, function generators, computer controllers, soldering systems, and many other accessories.

The Department also has computational facilities available to students. The computer lab has a suite of personal computers with a full complement of computing resources available to students.

Research Laboratories. These laboratories, extensions of those described above, are equipped for research in the fields of fluid mechanics, heat transfer, thermodynamics, turbulence, flow visualization, measurements, turbomachinery and engine research, combustion, materials, mechanical design, dynamics, computational, solid and applied mechanics, biomedical engineering, and controls. Many of our undergraduate students gain valuable experience working on research projects under the guidance of professors. These are funded by research grants or the University’s UCARE program.

Some of the extracurricular opportunities for students to gain hands-on engineering experience include SAE Baja, SAE Formula (both through Husker Motorsports), NASA microgravity, AIAA competitions, and others.

College Requirements

College Admission

College Entrance Requirements

Students must have high school credit for (one unit is equal to one high school year):

1. Mathematics – 4 units: 2 of algebra, 1 of geometry, and 1 of precalculus and trigonometry
2. English – 4 units
3. Natural sciences – 3 units that must include 1 unit of physics and 1 unit of chemistry (chemistry requirement waived for students in construction management or computer science)
4. Foreign language – 2 units of a single foreign language
5. Social studies – 3 units

6. Students having a composite ACT score of 28 or greater (or equivalent SAT score) will be admitted to the College of Engineering even if they lack any one of the following: trigonometry, chemistry, or physics. Students without test scores who are missing a full unit of trigonometry/pre-calculus/calculus or chemistry or physics will be evaluated through College Review.

7. Students having an ACT score of 19 or less in English (or equivalent SAT score) or a grade lower than B in high school English, must take ENGL 150 Writing and Inquiry or ENGL 151 Writing and Argument.

A total of 16 units is required for admission.

Engineering requires that student performance meet one of the following standards: composite ACT of 24, SAT of 1180, ACT Math subscore of 24, SAT Math subscore of 580, or a 3.5 cumulative GPA.

Any domestic first-year student who does not gain admission to Engineering but does gain admission to the University of Nebraska-Lincoln (UNL) will be reviewed through College Review. College Review is conducted through the College Review Committee which considers factors beyond standardized testing. Any first-year student who is not admitted through college review is placed in Pre-Engineering (PENG) with the Exploratory and Pre-Professional Advising Center (Explore Center). Students in the Explore Center can transfer to the College of Engineering once college admission requirements are met.

Students for whom English is not their language of nurture must meet the minimum English proficiency requirements of the University.

Students who lack entrance units may complete precollege training by Independent Study through the University of Nebraska–Lincoln Office of On-line and Distance Education, in summer courses, or as a part of their first or second semester course loads while in the Explore Center or other colleges at UNL.

Students should consult their advisor, their department chair, or Engineering Student Services (ESS) if they have questions on current policies.

Other Admission Requirements

Students who transfer to the University of Nebraska–Lincoln from other accredited colleges or universities and wish to be admitted to the College of Engineering (COE) must meet COE first-year student entrance requirements, have a minimum cumulative GPA of 2.5, and be calculus-ready. Students not meeting either of these requirements must enroll in the Explore Center or another University college until they meet COE admission requirements. Students transferring from UNO, UNL, or UNK to the College of Engineering must be in good academic standing with their institution.

The COE accepts courses for transfer for which a C or better grade was received. Although the University of Nebraska–Lincoln accepts D grades from the University of Nebraska Kearney and the University of Nebraska Omaha, not all majors in the COE accept such low grades. Students must conform to the requirements of their intended major and, in any case, are strongly encouraged to repeat courses with a grade of C- or less.

Students who were previously admitted to COE and are returning to the College of Engineering must demonstrate a cumulative GPA of 2.5 to be readmitted to COE.
College Degree Requirements

Grade Rules

Grade Appeals

In the event of a dispute involving any college policies or grades, the student should appeal to their instructor, and appropriate department chair or school director (in that order). If a satisfactory solution is not achieved, the student may appeal their case through the College Academic Appeals Subcommittee.

Catalog Rule

Students must fulfill the requirements stated in the catalog for the academic year in which they are first admitted at the University of Nebraska–Lincoln. In consultation with advisors, a student may choose to follow a subsequent catalog for any academic year in which they are admitted to and enrolled as a degree-seeking student at Nebraska in the College of Engineering. Students must complete all degree requirements from a single catalog year. The catalog which a student follows for degree requirements may not be more than 10 years old at the time of graduation.

Students who have transferred from a community college may be eligible to fulfill the requirements as stated in the catalog for an academic year in which they were enrolled at the community college prior to attending the University of Nebraska-Lincoln. This decision should be made in consultation with the student’s College of Engineering academic advising team (e.g., ESS professional advisor and the chief faculty advisor for the student’s declared degree program). The chief faculty advisor has the final authority for this decision. Eligibility is based on a) enrollment in a community college during the catalog year the student wishes to graduate, b) maintaining continuous enrollment of at least 12 credit hours per semester at the previous institution for at least 2 semesters, and c) continuous enrollment at the University of Nebraska-Lincoln within 1 calendar year from the student’s last term at the previous institution.

Learning Outcomes

Graduates of the mechanical engineering program will have:

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 above student outcomes have been approved by the ABET Engineering Area Delegation for use beginning with the 2019-20 academic year, and have been adopted by the faculty of the Department of Mechanical and Materials Engineering.

Major Requirements

Requirements for the Degree (Lincoln Campus)

First Semester

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<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>CHEM 109A &amp; CHEM 109L</td>
<td>General Chemistry I and General Chemistry I Laboratory (ACE 4)</td>
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<tr>
<td>ENGR 10 or RAIK 10</td>
<td>Freshman Engineering Seminar or Raikes School Freshman Seminar</td>
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<td>ENGR 100 or RAIK 284H &amp; RAIK 188H</td>
<td>Interpersonal Skills for Engineering Leaders (ACE 2) or Software Engineering IV and Honors: Introductory Communication Seminar</td>
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<td>MATH 106</td>
<td>Calculus I (ACE 3)</td>
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Second Semester

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<tr>
<td>CHEM 110A &amp; CHEM 110L</td>
<td>General Chemistry II and General Chemistry II Laboratory</td>
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<tr>
<td>CSCE 155N</td>
<td>Computer Science I: Engineering and Science Focus</td>
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<tr>
<td>or RAIK 183H</td>
<td>Honors: Computer Problem Solving Essentials</td>
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<td>MATH 107</td>
<td>Calculus II</td>
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<tr>
<td>PHYS 211</td>
<td>General Physics I</td>
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<td>PHYS 221</td>
<td>General Physics Laboratory I</td>
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<tr>
<td>BSEN 206 / CONE 206</td>
<td>Engineering Economics (ACE 8)</td>
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<td>or RAIK 401H</td>
<td>Honors: RAIK Design Studio I</td>
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<td>ENGR 20 or RAIK 10</td>
<td>Sophomore Engineering Seminar or Raikes School Freshman Seminar</td>
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<td>MATH 208</td>
<td>Calculus III</td>
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<tr>
<td>MECH 130</td>
<td>Introduction to CAD</td>
<td>3</td>
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<tr>
<td>MECH 223</td>
<td>Engineering Statics</td>
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<tr>
<td>PHYS 212</td>
<td>General Physics II</td>
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Fourth Semester

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<td>Differential Equations</td>
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<tr>
<td>MATL 360</td>
<td>Elements of Materials Science</td>
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<tr>
<td>MECH 200</td>
<td>Engineering Thermodynamics</td>
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<tr>
<td>MECH 325</td>
<td>Mechanics of Elastic Bodies</td>
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<tr>
<td>MECH 373</td>
<td>Engineering Dynamics</td>
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Fifth Semester

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<tr>
<td>ECEN 211</td>
<td>Elements of Electrical Engineering I</td>
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</table>
or ECEN 215 Electronics and Circuits I
ECEN 231 Electrical Engineering Laboratory 1
or ECEN 235 Introductory Electrical Laboratory I
JGEN 200 Technical Communication I (ACE 1) 3
or JGEN 120 Basic Business Communication
or JGEN 300 Technical Communication II
or ENGL 151 Writing and Argument
or RAIK 288H Honors Business Writing
MATH 314 Linear Algebra 3
or MECH 330 Mechanical Engineering Analysis
MECH 342 Kinematics and Dynamics of Machinery 3
MECH 230 Introduction to Mechanical Engineering Design 3
or RAIK 163H Honors: Innovation Processes and Software Engineering Fundamentals
Credit Hours Subtotal: 16

### Sixth Semester
MECH 310 Fluid Mechanics 3
MECH 321 Engineering Statistics and Data Analysis 3
or RAIK 270H Statistics and Applications
MECH 343 Elements of Machine Design 3
or MECH 300 Thermal Systems and Design
MECH 350 Introduction to Dynamics and Control of Engineering Systems 3
MECH 380 Mechanical Engineering Measurements 3
Credit Hours Subtotal: 15

### Seventh Semester
MECH 370 Manufacturing Methods and Processes 3
MECH 420 Heat Transfer 3
MECH 446 Mechanical Engineering Design I (ACE 10) 2
MECH 488 Kinematics and Machine Design Laboratory 2
**Mechanical Engineering Technical Elective**
Choose from the list of approved Mechanical Engineering Technical Electives

**ACE Elective** 2
Choose one course from not yet satisfied ACE outcomes 5, 6, 7, or 9 3
Credit Hours Subtotal: 16

### Eighth Semester
ENGR 400 Professional Ethics and Social Responsibilities 1
or RAIK 372H Honors: Business Law
MECH 447 Mechanical Engineering Design II (ACE 10) 2
MECH 487 Thermal Fluids Laboratory 2
**Mechanical Engineering Design Elective**
Choose from the list of approved Mechanical Engineering Design Electives 3

**Senior Elective**
Choose from the list of approved Senior Electives 3

**ACE Electives** 2
Choose courses from not yet satisfied ACE outcomes 5, 6, 7, or 9 6
Credit Hours Subtotal: 17

**Total Credit Hours** 128

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1. Or, instead, COMM 210, COMM 283, or COMM 286 may be taken in the Third Semester.
2. ENGR 200 is recommended for ACE 6 or ACE 9 credit.
3. Or, instead, PHYS 222 (1 cr) may be taken in the Third Semester.
4. The capstone design sequence must be taken in the order shown in the curriculum and should be taken in the last full academic year (fall-spring) of the program (i.e., MECH 446 in the fall and MECH 447 in the spring).
5. If both courses are taken, one may count as the senior elective.

### Mechanical Engineering Technical Electives

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>MATL 460</td>
<td>Mechanical Aspects of Materials</td>
<td>3</td>
</tr>
<tr>
<td>MATL 461</td>
<td>Materials Laboratory II</td>
<td>3</td>
</tr>
<tr>
<td>MATL 462</td>
<td>X-ray Diffraction</td>
<td>3</td>
</tr>
<tr>
<td>MATL 467</td>
<td>Principles of Powder Metallurgy</td>
<td>3</td>
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<tr>
<td>MATL 469</td>
<td>Physical Materials Systems</td>
<td>3</td>
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<tr>
<td>MATL 470</td>
<td>Thermodynamics of Alloys</td>
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<td>MATL 471</td>
<td>Electron Microscopy of Materials</td>
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<td>MATL 472</td>
<td>Kinetics of Alloys</td>
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<td>MATL 473</td>
<td>Corrosion</td>
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<td>MATL 474</td>
<td>Extractive Metallurgy</td>
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<td>MATL 477</td>
<td>Organic and Inorganic Electronic Materials and Devices</td>
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<tr>
<td>MATL 492</td>
<td>Special Topics</td>
<td>1-6</td>
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<tr>
<td>MECH 403</td>
<td>Internal Combustion Engines</td>
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<td>MECH 404</td>
<td>Theory of Combustion</td>
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<td>MECH 405</td>
<td>Turbomachinery</td>
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<td>MECH 408</td>
<td>Heat Exchanger Design</td>
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<td>MECH 413</td>
<td>Aerodynamics</td>
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<td>MECH 414</td>
<td>Compressible Flow</td>
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<td>MECH 415</td>
<td>Two-Phase Flow</td>
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<td>MECH 416</td>
<td>Engineering Acoustics</td>
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<td>MECH 421</td>
<td>Elements of Nuclear Engineering</td>
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<td>MECH 422</td>
<td>Industrial Quality Control</td>
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<td>MECH 424</td>
<td>Laser Material Processing with Compressible Flow Perspective</td>
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<td>MECH 425</td>
<td>Solar Energy Engineering</td>
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<td>MECH 426</td>
<td>Heat Transfer at Nanoscales and in Ultrashort Time Domains</td>
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<td>MECH 431</td>
<td>Computational Heat Transfer and Fluid Flow</td>
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<tr>
<td>MECH 436</td>
<td>Introduction to Continuum Biomechanics</td>
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<td>MECH 438</td>
<td>Mechanics of Biomaterials</td>
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<td>MECH 444</td>
<td>Intermediate Dynamics of Machinery</td>
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<td>MECH 448</td>
<td>Advanced Mechanics of Materials</td>
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<td>MECH 449</td>
<td>Advanced Dynamics</td>
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<td>MECH 451</td>
<td>Introduction to Finite Element Analysis</td>
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<td>MECH 452</td>
<td>Experimental Stress Analysis I</td>
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<td>MECH 453</td>
<td>Robotics: Kinematics and Design</td>
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<td>MECH 454</td>
<td>Introduction to Continuum Modeling</td>
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<td>MECH 455</td>
<td>Vehicle Dynamics</td>
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<tr>
<td>MECH 458</td>
<td>Digital Control of Mechanical Systems</td>
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MECH 472 Additive Manufacturing 3
MECH 475 Introduction to Mechanical Vibrations 3
MECH 480 Numerical Methods in Engineering 3
MECH 483 Engineering Analysis with Finite Elements 3
MECH 492 Special Topics 1-6

Mechanical Engineering Design Electives
MATL 465 Applied Physical Metallurgy and Design 3
MATL 466 Materials Selection for Mechanical Design 3
MATL 468 Failure Analysis: Prevention and Control 3
MECH 406 Air Conditioning Systems Design 3
MECH 407 Power Plant Systems Design 3
MECH 408 Heat Exchanger Design 3
MECH 437 Biomedical Device Design 3
MECH 442 Intermediate Kinematics 3
MECH 445 Mechanical Engineering Design Concepts 3
MECH 450 Mechanical Engineering Control Systems Design 3
MECH 456 Dynamics of Internal Combustion Engines 3
MECH 457 Mechatronic Systems Design 3

Senior Electives
MATL 460 Mechanical Aspects of Materials 3
MATL 461 Materials Laboratory II 3
MATL 462 X-ray Diffraction 3
MATL 465 Applied Physical Metallurgy and Design 3
MATL 466 Materials Selection for Mechanical Design 3
MATL 467 Principles of Powder Metallurgy 3
MATL 468 Failure Analysis: Prevention and Control 3
MATL 469 Physical Materials Systems 3
MATL 470 Thermodynamics of Alloys 3
MATL 471 Electron Microscopy of Materials 3
MATL 472 Kinetics of Alloys 3
MATL 473 Corrosion 3
MATL 474 Extractive Metallurgy 3
MATL 477 Organic and Inorganic Electronic Materials and Devices 3
MATL 492 Special Topics 1-6
MECH 300 or MECH 343 Thermal Systems and Design 3
MECH 343 Elements of Machine Design 3
MECH 403 Internal Combustion Engines 3
MECH 404 Theory of Combustion 3
MECH 405 Turbomachinery 3
MECH 406 Air Conditioning Systems Design 3
MECH 407 Power Plant Systems Design 3
MECH 408 Heat Exchanger Design 3
MECH 413 Aerodynamics 3
MECH 414 Compressible Flow 3
MECH 415 Two-Phase Flow 3
MECH 416 Engineering Acoustics 3
MECH 421 Elements of Nuclear Engineering 3
MECH 422 Industrial Quality Control 3
MECH 424 Laser Material Processing with Compressible Flow Perspective 3
MECH 425 Solar Energy Engineering 3
MECH 426 Heat Transfer at Nanoscales and in Ultrashort Time Domains 3
MECH 431 Computational Heat Transfer and Fluid Flow 3
MECH 436 Introduction to Continuum Biomechanics 3
MECH 437 Biomedical Device Design 3
MECH 438 Mechanics of Biomaterials 3
MECH 442 Intermediate Kinematics 3
MECH 444 Intermediate Dynamics of Machinery 3
MECH 445 Mechanical Engineering Design Concepts 3
MECH 448 Advanced Mechanics of Materials 3
MECH 449 Advanced Dynamics 3
MECH 450 Mechanical Engineering Control Systems Design 3
MECH 451 Introduction to Finite Element Analysis 3
MECH 452 Experimental Stress Analysis I 3
MECH 453 Robotics: Kinematics and Design 3
MECH 454 Introduction to Continuum Modeling 3
MECH 455 Vehicle Dynamics 3
MECH 456 Dynamics of Internal Combustion Engines 3
MECH 457 Mechatronic Systems Design 3
MECH 470 Theory and Practice of Materials Processing 3
MECH 472 Additive Manufacturing 3
MECH 475 Introduction to Mechanical Vibrations 3
MECH 480 Numerical Methods in Engineering 3
MECH 483 Engineering Analysis with Finite Elements 3
MECH 492 Special Topics 1-6
MECH 498 Research 0-6
MECH 499H Honors Thesis 1-3
RAIK 370H Honors: Data and Models II: Data Science Fundamentals 3

MATL 260 Elements of Materials Science
Prerequisites: CHEM 109A and 109L; PHYS 212; MECH 223 or parallel.
Description: Relation of atomic, molecular, and crystal structure to the physical, mechanical, and chemical properties of metals, alloys, polymers, and ceramics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: MATL 262

MATL 262 Materials Laboratory I
Prerequisites: MATL 260 or parallel.
Description: Engineering behavior of materials with emphasis on macroscopic properties; relationship between these properties, processing history, composition and microstructure. Introduction to the use of metallographic tools used in interpretation.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Grading Option: Graded
MATL 360 Elements of Materials Science
Prerequisites: CHEM 109A and 109L; PHYS 212; MECH 223 or parallel.
Description: Relation of atomic, molecular and crystal structure to the physical, mechanical and chemical properties of metals, alloys, polymers and ceramics. Experience in investigation of properties of engineering materials.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded
Prerequisite for: MECH 343; MECH 370
Course and Laboratory Fee: $30

MATL 460 Mechanical Aspects of Materials
Crosslisted with: MATL 860
Prerequisites: MECH 325 and MATL 360, or equivalent.
Description: Emphasizes those principles at the atomistic or molecular level that relate mechanical properties and behavior of different classes of materials to their structure and environment.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: MATL 875; MATL 960; MATL 962

MATL 461 Materials Laboratory II
Crosslisted with: MATL 861
Prerequisites: MATL 360.
Description: Application of scientific principles in the laboratory to the analysis of materials problems and selection of engineering materials.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Course and Laboratory Fee: $20

MATL 462 X-ray Diffraction
Crosslisted with: MATL 862
Prerequisites: PHYS 212.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MATL 465 Applied Physical Metallurgy and Design
Crosslisted with: MATL 865
Prerequisites: MATL 360 or equivalent.
Description: Principles of alloying; alloy selection; modification of the physical properties of structural alloys by thermal, mechanical, and chemical treatment; solidification and joining phenomena.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MATL 466 Materials Selection for Mechanical Design
Crosslisted with: MATL 866
Prerequisites: MATL 360 and MECH 325.
Description: Rational selection procedure for the most suitable materials for each particular mechanical design. Introduction of materials selection charts and the concept of materials performance indices. Case studies in mechanical design, taking materials selections, shape and process into account. Projects on materials selection at the design concept and the design embodiment stages.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MATL 467 Principles of Powder Metallurgy
Crosslisted with: MATL 867
Prerequisites: MECH 200; MECH 325; MATL 360 or equivalent.
Description: Basic principles of powder metallurgy, with emphasis on methods of producing metal powders, determination of their characteristics; the mechanics of powder compaction; sintering methods and effects; and engineering applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MATL 468 Failure Analysis: Prevention and Control
Crosslisted with: MATL 868
Prerequisites: MECH 325; MATL 360 or equivalent.
Description: Metallurgical tools for analysis of failures; types and modes of failures; sources of design and manufacturing defects. Case histories utilized to illustrate modes of failures and principles and practices for analysis. Design concepts and remedial design emphasized with these case studies. Several projects involving case analyses and design by students included.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MATL 469 Physical Materials Systems
Crosslisted with: MATL 869
Prerequisites: PHYS 212 and MATL 360.
Description: Development of the principles controlling the formation of the structure of engineering materials. Phase diagrams, diffusion, interfaces and microstructures, solidification and diffusionless transformations and diffusionless transformations.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MATL 470 Thermodynamics of Alloys
Crosslisted with: MATL 870
Prerequisites: MATL 360 and MECH 200, or equivalent; MATH 208 or parallel.
Description: Materials thermodynamics of closed systems, introduction to liquid and solid solution alloys, relationship to gas phase, application to binary systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: MATL 875; MATL 960; MATL 970; MATL 972
MATL 471 Electron Microscopy of Materials  
Crosslisted with: MATL 871  
Prerequisites: PHYS 212.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

MATL 472 Kinetics of Alloys  
Crosslisted with: MATL 872  
Prerequisites: MATL 360 or equivalent; MATH 221/MATH 821.  
Description: Kinetics of gas-liquid-solid reactions in alloy systems; analysis of diffusion models applicable to such systems.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

MATL 473 Corrosion  
Crosslisted with: MATL 873  
Prerequisites: CHEM 109A and CHEM 109L or equivalent.  
Description: Fundamentals of corrosion engineering, underlying principles, corrosion control, and materials selection and environmental control.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

MATL 474 Extractive Metallurgy  
Crosslisted with: MATL 874  
Prerequisites: MATL 360 and MECH 200 or equivalent.  
Description: Unit operations and processes utilized in production of ferrous, nonferrous, and refractory metals. Examples of production techniques for metal bearing ores, scrap metals, and domestic waste. Control of impurity and alloy content and their relationship to physical properties.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

MATL 477 Organic and Inorganic Electronic Materials and Devices  
Crosslisted with: MATL 877  
Prerequisites: Permission  
Description: The course introduces the optical and electronic processes in inorganic and organic molecules and polymers that govern the behavior of practical organic electronic and optoelectronic devices.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

MATL 492 Special Topics  
Crosslisted with: MATL 892  
Description: Special topics in materials engineering and related areas.  
Credit Hours: 1-6  
Min credits per semester: 1  
Max credits per semester: 6  
Max credits per degree: 24  
Grading Option: Graded

MECH 100 Introduction to Mechanical Engineering  
Description: Overview of mechanical engineering. Introduction to problem layout, and development of basic skills required to solve mechanical engineering problems. Collection, manipulation and presentation of engineering data.  
Credit Hours: 1  
Max credits per semester: 1  
Max credits per degree: 1  
Grading Option: Graded

MECH 130 Introduction to CAD  
Description: Principles and accepted practices of geometric design. Computer generation of 2D and 3D models for mechanical systems. Introduction to engineering design practices such as specifications, dimensioning, and tolerance.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

MECH 200 Engineering Thermodynamics  
Prerequisites: MECH 223.  
Description: First and Second Laws of Thermodynamics, properties of gases and vapors, and cycles. Sources of energy and its conversion to work.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

MECH 200H Honors: Engineering Thermodynamics  
Prerequisites: Good standing in the University Honors Program or by permission; PHYS 212; MECH 223.  
Description: First and Second Laws of Thermodynamics, properties of gases and vapors, and cycles. Sources of energy and its conversion to work. Honors students will be expected to study beyond the students in the normal sections and do a special project.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

MECH 230 Introduction to Mechanical Engineering  
Description: Overview of mechanical engineering. Introduction to problem layout, and development of basic skills required to solve mechanical engineering problems. Collection, manipulation and presentation of engineering data.  
Credit Hours: 1  
Max credits per semester: 1  
Max credits per degree: 1  
Grading Option: Graded
MECH 220 Statics  
Prerequisites: MATH 106.  
Description: Fundamental concepts, equilibrium of force systems, analysis of simple frames and trusses. Centroid and moments of inertia and friction.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Prerequisite for: MECH 324  
Course and Laboratory Fee: $10

MECH 223 Engineering Statics  
Prerequisites: MATH 107 (grade of C or better), PHYS 211 (grade of C or better)  
Description: Action of forces on engineering structures and machines. Force systems, static equilibrium of frames and machines. Friction, center of gravity, moment of inertia, vector algebra.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Offered: FALL/SPR  
Prerequisite for: AGEN 324, BSEN 410; CIVE 310; CIVE 310H; CIVE 361; CIVE 371; MATL 260; MATL 360; MECH 200; MECH 200H; MECH 324; MECH 325; MECH 325H; MECH 373; MECH 373H

MECH 223H Honors: Engineering Statics  
Prerequisites: Good standing in the University Honors Program or by permission; MATH 107 and PHYS 211.  
Description: Bodies in equilibrium. Vector algebra, equivalent force systems, distributed loads, and center of gravity. Analysis of trusses, frames, and machines. Friction, wedges, crews, and belts. Area moments of inertia.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Offered: FALL/SPR  
Prerequisite for: AGEN 324, BSEN 410; CIVE 310; CIVE 310H; CIVE 361; CIVE 371; MATL 260; MATL 360; MECH 200; MECH 200H; MECH 324; MECH 325; MECH 325H; MECH 373; MECH 373H

MECH 230 Introduction to Mechanical Engineering Design  
Prerequisites: MECH 130, MECH 325  
Description: Introduction to formalized engineering design processes and methodology, selection of common mechanical components, and practice of teamwork and problem solving in the context of mechanical engineering.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Offered: FALL/SPR  
Prerequisite for: MECH 446; MECH 446H

MECH 225 Mechanics I  
Prerequisites: PHYS 211.  
Notes: Parallel: MATH 208. For electrical engineering majors.  
Description: Force actions in static coplanar systems with applications to engineering structures and machines. Resultants, moments, couples, equivalent force systems, vector algebra. Static equilibrium conditions and equations.  
Credit Hours: 2  
Max credits per semester: 2  
Max credits per degree: 2  
Grading Option: Graded  
Prerequisite for: MECH 351

MECH 300 Thermal Systems and Design  
Prerequisites: MECH 200, CSCE 155N  
Description: Applications of control-volume analysis (mass, energy, and momentum), both transient and steady; mixtures of gases and vapors; introduction to combustion; thermodynamic relations and establishment of data banks of thermal properties; applications of computer-aided engineering to processes and cycles; methodologies and case studies for thermal systems design; execution of small-scaled design projects.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Offered: SPRING

MECH 310 Fluid Mechanics  
Prerequisites: MECH 373; MATH 221  
Notes: Parallel: MECH 200, or BSEN 244 or by permission for non-ME students.  
Description: Fluid statics, equations of continuity, momentum, and energy dimensional analysis and dynamic similitude. Applications to: flow meters; fluid pumps and turbines; viscous flow and lubrication; flow in closed conduits and open channels. Two-dimensional potential flow.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Offered: FALL/SPR  
Prerequisite for: AGEN 324, BSEN 410; CIVE 310; CIVE 310H; CIVE 361; CIVE 371; MATL 260; MATL 360; MECH 200; MECH 200H; MECH 324; MECH 325; MECH 325H; MECH 373; MECH 373H

MECH 310H Honors: Fluid Mechanics  
Prerequisites: MECH 373; MATH 221  
Notes: Parallel: MECH 200, or BSEN 444 or by permission for non-ME students.  
Description: Fluid statics, equations of continuity, momentum, and energy dimensional analysis and dynamic similitude. Applications to: flow meters; fluid pumps and turbines; viscous flow and lubrication; flow in closed conduits and open channels. Two-dimensional potential flow. Advanced topics/project.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Offered: FALL/SPR  
Prerequisite for: MECH 446H
MECH 311 Fluid Mechanics Laboratory
Prerequisites: MECH/CIVE 310 or parallel.
Description: Fluid mechanics experiments and demonstrations. Conservation principles; determination of fluid properties, velocity, pressure, and flow measurements; pipe flow; open channel flow; and instrumentation techniques.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Course and Laboratory Fee: $20

MECH 318 Applied Linear Algebra and Computational Methods
Prerequisites: MATH 208; MATH 221 or parallel; CSMA 155N or equivalent.
Notes: This course is a substitute for MATH 314 for mechanical engineering students.
Description: Application-based linear algebra concepts and introduction to numerical computations using Matlab. Topics include: linear systems and numerical solvers; eigenvalue and eigenvector computations; methods for root finding and curve fitting; norms and convergence of numerical methods; numerical integration, differentiation, and initial-value ODE problems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL/SPR

MECH 321 Engineering Statistics and Data Analysis
Prerequisites: MATH 208
Description: An applications-oriented course for formulating and solving engineering statistical problems. Includes Descriptive statistics, probability distributions, variability, sampling, confidence intervals, tests of significance, basics of statistical process control, and design of experiments.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 324 Strength of Materials
Prerequisites: MECH 220 or MECH 223.
Notes: For students in architecture and construction management.
Description: Stress and strain analysis in elastic materials. Use of properties of materials in the analysis and design of welded and riveted connections, statically determinate and indeterminate flexure members, columns. Combined stresses, axial, eccentric and torsional loading. Observations of laboratory tests for axially loaded specimens. Introduction to shear and moment diagrams.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 325 Mechanics of Elastic Bodies
Prerequisites: MECH 223 (grade of C or better), MATH 208
Description: Concept of stress and strain considering axial, torsional, and bending forces. Shear and moments. Introduction to combined stresses and column theory.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: AGED 443; CIVE 331; CIVE 341; CIVE 342; CIVE 371; MECH 230; MECH 330; MECH 343; MECH 370; MECH 910

MECH 325H Honors: Mechanics of Elastic Bodies
Prerequisites: Good standing in the University Honors Program or by permission; MECH 223 or 223H; MATH 208.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: AGED 443; CIVE 331; CIVE 371; MECH 230; MECH 330; MECH 343; MECH 370

MECH 330 Mechanical Engineering Analysis
Prerequisites: MATH 221; CSMA 155N; MECH 325; MECH 373; MECH 200.
Description: Conceptual modeling of mechanical engineering systems. Analytical exploration of engineering behavior of conceptual models. Case studies drawn from mechanical engineering problems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: MECH 350

MECH 342 Kinematics and Dynamics of Machinery
Prerequisites: MECH 130 and MECH 373
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: MECH 343; MECH 488
Course and Laboratory Fee: $5

MECH 343 Elements of Machine Design
Prerequisites: MECH 325; MECH 342 or parallel; MATL 360; MECH 321 or STAT 380 or parallel.
Description: Design of machine elements under different conditions of loading. Design work includes a project of broader scope (done primarily out of class) requiring a breadth of knowledge. Failure theories for static and dynamic loading of bolts, springs, bearings, and shafts.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: SPRING
MECH 350 Introduction to Dynamics and Control of Engineering Systems
Prerequisites: MECH 373; ECEN 211; CSCE 155N; MATH 314 or parallel.
Description: Unified treatment of the dynamics and control of engineering systems. Emphasis on physical aspects, formulation of mathematical models, application of various mathematical methods, and interpretation of results in terms of the synthesis and analysis of real systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL/SPR
Prerequisite for: MECH 446; MECH 446H

MECH 351 Mechanics II
Prerequisites: MECH 250.
Notes: For electrical engineering majors.
Description: Application of Newton's laws to engineering problems involving coplanar kinematics and kinetics of particles. Work, energy, impulse, and momentum. Conservative systems. Periodic motion.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Grading Option: Graded

MECH 370 Manufacturing Methods and Processes
Prerequisites: MATL 360; and MECH 325.
Description: Introduction to traditional and modern manufacturing processes and methods to include: foundry; forming processes; welding; metal removal theory and practices; modern manufacturing systems and automation; and economics of process selection.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 373 Engineering Dynamics
Prerequisites: MECH 223 (grade of C or better), MATH 208.
Description: Force action related to displacement, velocity, and acceleration of rigid bodies. Kinematics of plane motion, kinetics of translation and rotation. Mass moment of inertia, vibration, work, energy and power, impulse and momentum.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: BSEN 410; MECH 310; MECH 310H; MECH 330; MECH 342; MECH 350

MECH 373H Honors: Engineering Dynamics
Prerequisites: Good standing in the University Honors Program or by permission; MECH 223 or 223H; MATH 208.
Description: Motion of particles and rigid bodies under the action of forces and moments. Kinematics of plane motion: displacement, velocity, and acceleration. Kinetics of translation and rotation; work, energy and power; impulse, momentum and impact. Introduction to vibration analysis.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: MECH 310; MECH 310H; MECH 330; MECH 342; MECH 350

MECH 380 Mechanical Engineering Measurements
Prerequisites: ECEN 231; JGEN 200 or JGEN 300; MECH 321 or STAT 380 or parallel; MECH 350 and MECH 310, or parallel.
Description: Theory, statistics, applications and design of mechanical engineering experiments.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL/SPR
Prerequisite for: MECH 487; MECH 488
Course and Laboratory Fee: $20

MECH 381 Elements of Computer-Aided Design
Prerequisites: MATH 221; MECH 130 or CSCE 155N
Description: Principles and techniques currently used for the computer-aided design (CAD). Applications of interactive graphics devices for drafting, design, and analysis. Modelling and analogy of engineering systems. Elementary finite element, Bode, and numerical analyses. CAD case studies and term project.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Course and Laboratory Fee: $25

MECH 399 Undergraduate Research and Thesis
Prerequisites: Permission.
Description: Engineering design or laboratory investigation that an undergraduate is qualified to undertake.
Credit Hours: 1-5
Min credits per semester: 1
Max credits per semester: 5
Max credits per degree: 6
Grading Option: Graded

MECH 403 Internal Combustion Engines
Crosslisted with: MECH 803
Prerequisites: MECH 300 or equivalent.
Description: Basic cycle analysis and engine types, fundamental thermodynamics and operating characteristics of various engines are analyzed, combustion processes for spark and compression-ignition engines, fuels, testing procedures, and lubrication systems are evaluated. Emphasis on the thermodynamic evaluation of the performance and understanding the basic operation of various engine types.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 404 Theory of Combustion
Crosslisted with: MECH 804
Prerequisites: MECH 300 and MECH 420/MECH 820.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: MECH 904
<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Crosslisted with:</th>
<th>Prerequisites:</th>
<th>Description:</th>
<th>Credit Hours</th>
<th>Max credits per semester:</th>
<th>Max credits per degree:</th>
<th>Grading Option:</th>
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<tbody>
<tr>
<td>MECH 405</td>
<td>Turbomachinery</td>
<td></td>
<td>MECH 300 and MECH 310/CIVE 310</td>
<td>Thermodynamic analysis and design of axial and radial flow turbines, compressors, and pumps. Fundamentals of the operating characteristics and performance parameters of turbomachines will be evaluated. Cavitation and blade element theory.</td>
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<tr>
<td>MECH 406</td>
<td>Air Conditioning Systems Design</td>
<td></td>
<td>MECH 300 or equivalent.</td>
<td>Application of thermodynamic and fluid dynamic principles to the design of air conditioning systems. Comprehensive design project is an integral part of the course.</td>
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<tr>
<td>MECH 407</td>
<td>Power Plant Systems Design</td>
<td></td>
<td>MECH 300 or equivalent.</td>
<td>Application of thermodynamic and fluid dynamic principles to the design of Power Plants. Comprehensive design project is an integral part of the course.</td>
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<tr>
<td>MECH 408</td>
<td>Heat Exchanger Design</td>
<td></td>
<td>MECH 300 or equivalent.</td>
<td>Design methodology for various heat exchangers employed in mechanical engineering. Introduction to computer-aided design as applied to heat exchangers. Practical exercises in actual design tasks.</td>
<td>3</td>
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<td>MECH 414</td>
<td>Compressible Flow</td>
<td></td>
<td>MECH 300 and MECH 310/CIVE 310</td>
<td>Analysis of the flow of compressible fluids by means of the momentum equation, continuity equation, and the laws of thermodynamics and some application of thermodynamic laws to incompressible fluids.</td>
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<td>MECH 415</td>
<td>Two-Phase Flow</td>
<td></td>
<td>MECH 300 or equivalent.</td>
<td>Transport phenomena of homogeneous and heterogeneous types of mixtures such as solid-liquid, liquid-liquid, and liquid-gas. Properties of components and mixtures. Flow induced vibrations and parameter distributions. Optimization and design problems in multiphase systems.</td>
<td>3</td>
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<tr>
<td>MECH 416</td>
<td>Engineering Acoustics</td>
<td></td>
<td>MECH 300 and equivalent.</td>
<td>Transverse and longitudinal traveling waves. Acoustic wave equation of fluids. The reflection, transmission, radiation, reception, absorption, and attenuation of sound. Acoustic cavities and waveguides. Sound propagation in pipes, resonators and filters.</td>
<td>3</td>
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<tr>
<td>MECH 420</td>
<td>Heat Transfer</td>
<td></td>
<td>ENGR 300 or ENGR 301 or ENGR 310; MATH 208/MATH 208H; and PHYS 212/PHYS 212H</td>
<td>Heat transfer by conduction, convection, and radiation. Correlation of theory with experimental data and engineering design.</td>
<td>3</td>
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<td>Graded</td>
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<tr>
<td>MECH 421</td>
<td>Elements of Nuclear Engineering</td>
<td></td>
<td>ENGR 300 or ENGR 301 or ENGR 310; MATH 208/MATH 208H; and PHYS 212/PHYS 212H</td>
<td>Survey of nuclear engineering concepts and applications. Nuclear reactions, radioactivity, radiation interaction with matter, reactor physics, risk and dose assessment, applications in medicine, industry, agriculture, and research.</td>
<td>3</td>
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<td>3</td>
<td>Graded</td>
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MECH 422 Industrial Quality Control
Crosslisted with: MECH 822
Prerequisites: MECH 321 or STAT 380
Description: Statistical process control and quality assurance techniques in manufacturing. Control charts, acceptance sampling, and analyses and design of quality control systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL/SPR

MECH 424 Laser Material Processing with Compressible Flow
Perspective
Crosslisted with: MECH 824
Prerequisites: Permission.
Description: Fundamentals of laser material processing. Laser material interactions from the compressible flow perspective. Analytical, semi-analytical, and numerical approaches.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 425 Solar Energy Engineering
Crosslisted with: MECH 825
Prerequisites: MECH 420 or permission.
Description: Conversion of solar energy into more useful forms with emphasis on environmental heating and cooling applications. Includes solar energy availability, solar collectors and design, solar systems and their simulation and solar economics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 426 Heat Transfer at Nanoscales and in Ultrashort Time Domains
Crosslisted with: MECH 826
Prerequisites: MECH 420.
Description: Heat transfer in nanoscale and nanostructured materials. Heat transfer in ultrafast laser materials processing.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 428 Analysis of Thermal Data
Crosslisted with: MECH 828
Prerequisites: MECH 420 or parallel.
Description: Indirect measurement of thermal properties and heat flux are explored with various methods, and optimization, with examples drawn from engineering practice.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL/SPR

MECH 431 Computational Heat Transfer and Fluid Flow
Crosslisted with: MECH 831
Prerequisites: MECH 310; MATH 314; MECH 420 or parallel.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: MECH 932

MECH 433 Microscale Transport Phenomena in Biosystems
Crosslisted with: MECH 833
Prerequisites: MECH 310
Notes: Knowledge of engineering mathematics to describe physical systems, especially transport phenomena
Description: An introduction to transport phenomena with an emphasis on applying the principles of mass transfer and fluid dynamics to microscale biosystems including microorganisms. Topics include Brownian motion, diffusion-based mass transfer, cellular receptors, Taylor dispersion, bacterial diffusion, chemotaxis, low Reynolds number fluid dynamics, hydrodynamics of swimming microorganisms, surface tension and microfluidics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 434 Facility Planning and Design
Notes: introductory knowledge of ergonomics
Description: Design, analysis and layout of facilities: queuing, material handling systems, material flow analysis, systematic layout planning and design of warehouse facilities.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 435 Introduction to Cell Mechanics
Crosslisted with: MECH 835
Notes: Knowledge of calculus and basic physics to describe physical systems
Description: An introduction to cell mechanics with an emphasis on application of fundamental mechanics and various experimental methods to understanding cell mechanics. Topics include cell structure, basic solid/fluid/statistical mechanics, biopolymer mechanics, cytoskeletal network mechanics, cellular adhesion and motility, and mechanobiology.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
MECH 436 Introduction to Continuum Biomechanics
Crosslisted with: MECH 836
Prerequisites: Senior or graduate student standing
Notes: MATH 314 and MECH 325 are recommended.
Description: An introduction to continuum biomechanics with an emphasis on soft tissues. Case studies covering diverse applications of biomechanics in biology and medicine, including in the areas of mechanobiology, medical devices, and tissue engineering. Continuum mechanics concepts include kinematics, kinetics, balance laws, and constitutive relations. Includes some programming in MATLAB.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 437 Biomedical Device Design
Crosslisted with: MECH 837
Prerequisites: MECH 223, MECH 373
Notes: basic understanding of solid mechanics
Description: Design of devices intended for use in biomedical environments. Introduction to modeling of the bio-environment, biomaterials, and material selection. Overview of design methodologies and strategies used in biomedical device design from a material properties perspective. Introduction to federal regulation and other pertinent issues.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: SPRING

MECH 438 Mechanics of Biomaterials
Crosslisted with: MECH 838
Prerequisites: MECH 325 or AGEN/BSEN 324 or parallel
Notes: basic understanding of solid mechanics
Description: Theory, application, simulation, and design of biomaterials that apply mechanical principles for solving medical problems (case studies in artery, brain, bone, etc.). Tentative Topics include Mechanical characterization of biomaterials; Bio-manufacturing a tissue; Function-structure relationship; Design and analysis of medical implants; Active response of biomaterials: growth and remodeling mechanism; Cellular behavior and measurements, etc.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

MECH 439 Biomaterial Surface Patterning
Crosslisted with: MECH 839
Description: Biomaterials, biocompatibility, and biomaterial surface characteristics (chemistry, surface energy, topography, wettability, etc.). Protein adsorption on biomaterials. Microscale and nanoscale chemical patterning; anisotropic and isotropic micro/nanotopography; cell sensing and response to patterned substrates.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 442 Intermediate Kinematics
Crosslisted with: MECH 842
Prerequisites: MECH 342.
Description: Analytical cam design. Geometry of constrained plane motion and application to the design of mechanisms. Analysis and synthesis of pin-jointed linkage mechanisms.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: MECH 943

MECH 444 Intermediate Dynamics of Machinery
Crosslisted with: MECH 844
Prerequisites: MECH 342 and MECH 350.
Description: Fundamentals of vibration, vibration and impact in machines, balance of rotors, flexible rotor dynamics and instabilities, parametric vibration, advanced dynamics and design of cam mechanisms, and dynamics of flywheel.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

MECH 445 Mechanical Engineering Design Concepts
Crosslisted with: MECH 845
Prerequisites: MECH 200, MECH 342, MECH 350, and MECH 310/ CIVE 310.
Description: Development of design concepts. Introduction to synthesis techniques and mathematical analysis methods. Applications of these techniques to mechanical engineering design projects.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: MECH 945
Course and Laboratory Fee: $20

MECH 446 Mechanical Engineering Design I
Prerequisites: BSEN 206, MECH 200, MECH 230, MECH 310, MECH 350, professional admission to Mechanical Engineering BS program
Notes: This course should be taken in the fall semester of the final full academic year, followed immediately by MECH 447 in the spring semester.
Description: The first of two courses in the capstone sequence. Practical application of the engineering design process in a team project focused on a mechanical engineering problem, including design reviews and reports.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Grading Option: Graded
Offered: FALL
Prerequisite for: MECH 447; MECH 447H
ACE: ACE 10 Integrated Product
Course and Laboratory Fee: $15
Experiential Learning: Student Teaching/Education Practicum
MECH 446H Honors: Mechanical Engineering Design I  
**Prerequisites:** BSEN 206, MECH 200, MECH 230, MECH 310, MECH 350, professional admission to Mechanical Engineering BS program  
**Notes:** This course should be taken in the fall semester of the final full academic year, followed immediately by MECH 447H in the spring semester.  
**Description:** The first of two courses in the capstone sequence. Practical application of the engineering design process in a team project focused on a mechanical engineering problem, including design reviews and reports.  
**Credit Hours:** 2  
**Max credits per semester:** 2  
**Max credits per degree:** 2  
**Grading Option:** Graded  
**Offered:** FALL  
**Prerequisite for:** MECH 447H  
**ACE:** 10 Integrated Product  
**Experiential Learning:** Student Teaching/Education Practicum

MECH 447 Mechanical Engineering Design II  
**Prerequisites:** MECH 446, professional admission to Mechanical Engineering BS program  
**Description:** Definition, scope, analysis, synthesis, and the design for the solution of a comprehensive engineering problem in any major area of mechanical engineering.  
**Credit Hours:** 2  
**Max credits per semester:** 2  
**Max credits per degree:** 2  
**Grading Option:** Graded  
**ACE:** 10 Integrated Product  
**Course and Laboratory Fee:** $15  
**Experiential Learning:** Student Teaching/Education Practicum

MECH 447H Honors: Mechanical Engineering Design II  
**Prerequisites:** MECH 446 or MECH 446H, professional admission to Mechanical Engineering BS program  
**Description:** Definition, scope, analysis, synthesis, and the design for the solution of a comprehensive engineering problem in any major area of mechanical engineering.  
**Credit Hours:** 2  
**Max credits per semester:** 2  
**Max credits per degree:** 2  
**Grading Option:** Graded  
**Offered:** SPRING  
**ACE:** 10 Integrated Product  
**Experiential Learning:** Student Teaching/Education Practicum

MECH 448 Advanced Mechanics of Materials  
**Crosslisted with:** MECH 848  
**Prerequisites:** MECH 373, MECH 325.  
**Description:** Stresses and strains at a point. Theories of failure. Thick-walled pressure vessels and spinning discs. Torsion of noncircular sections. Torsion of thin-walled sections, open, closed, and multicelled. Bending of unsymmetrical sections. Cross shear and shear center. Curved beams. Introduction to elastic energy methods.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded  
**Prerequisite for:** MECH 915; MECH 935; MECH 939; MECH 940; MECH 941; MECH 952

MECH 449 Advanced Dynamics  
**Crosslisted with:** MECH 849  
**Prerequisites:** MECH 373 and MATH 221/821.  
**Description:** Particle Dynamics using Newton’s laws, energy principles, momentum principles. Rigid body dynamics using Euler’s equations and Lagrange’s equations. Variable mass systems. Gyroscopic motion.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded  
**Prerequisite for:** MECH 915; MECH 935

MECH 450 Mechanical Engineering Control Systems Design  
**Crosslisted with:** MECH 850  
**Prerequisites:** MECH 350.  
**Description:** Applications of control systems analysis and synthesis for mechanical engineering equipment. Control systems for pneumatic, hydraulic, kinematic, electromechanical, and thermal systems.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded  
**Course and Laboratory Fee:** $20

MECH 451 Introduction to Finite Element Analysis  
**Prerequisites:** Open to College of Engineering Students only.  
**Description:** Matrix methods of analysis. Finite element stiffness method. Computer programs. Applications to structures and soils. Introduction to finite element analysis of fluid flow.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded  
**Course and Laboratory Fee:** $25

MECH 452 Experimental Stress Analysis I  
**Crosslisted with:** MECH 852  
**Prerequisites:** MECH 325.  
**Description:** Investigation of the basic theories and techniques associated with the analysis of stress using mechanical strain gages, electric strain gages, brittle lacquer, photoelasticity, and membrane analogy.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded  
**Prerequisite for:** MECH 935

MECH 453 Robotics: Kinematics and Design  
**Prerequisites:** MECH 350.  
**Description:** Robotics synthesize some aspects of human function by the use of mechanisms, sensors, actuators, and computers.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded
MECH 454 Introduction to Continuum Modeling  
Crosslisted with: MECH 854  
Prerequisites: MATH 221/821, MECH 325 and MECH 373  
Description: Basic concepts of continuum modeling. Development of models and solutions to various mechanical, thermal and electrical systems. Thermo-mechanical and electro-mechanical coupling effects. Differential equations, dimensional methods and similarity.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  

MECH 455 Vehicle Dynamics  
Crosslisted with: MECH 855  
Prerequisites: MECH 343 and MECH 350.  
Description: Introduction to basic mechanics governing automotive vehicle dynamic acceleration, braking, ride, handling and stability. Analytical methods, including computer simulation, in vehicle dynamics. The different components and subsystems of a vehicle that influence vehicle dynamic performance.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Course and Laboratory Fee: $20  

MECH 456 Dynamics of Internal Combustion Engines  
Crosslisted with: MECH 856  
Prerequisites: MECH 342 and MECH 343.  
Description: Basics of design of the internal combustion engines. Design of various engine parts such as pistons, connecting rods, valve trains, crankshafts, and the vibration dampers. Dynamics of the engine. The vibration of the crankshaft assembly and the valve train. Balancing of the engines.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  

MECH 457 Mechatronic Systems Design  
Crosslisted with: MECH 857  
Prerequisites: ECEN 231; MECH 350 or parallel.  
Notes: Lab sessions allow for constructing mechatronic systems. Lab time arranged. A comprehensive design project included.  
Description: Theory, application, simulation, and design of systems that integrate mechanical, computer, and electronic components.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Prerequisite for: MECH 958  

MECH 458 Digital Control of Mechanical Systems  
Crosslisted with: MECH 858  
Prerequisites: MECH 450  
Description: Introduction to digital measurement and control of mechanical systems. Applications of analysis and synthesis of discrete time systems.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Course and Laboratory Fee: $20  

MECH 470 Theory and Practice of Materials Processing  
Crosslisted with: MECH 870  
Prerequisites: MECH 370  
Description: Theory, practice and application of conventional machining, forming and non-traditional machining processes with emphasis on tool life, dynamics of machine tools and adaptive control.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Prerequisite for: MECH 970  

MECH 472 Additive Manufacturing  
Crosslisted with: MECH 872  
Prerequisites: MECH 370 or parallel  
Description: Hands-on exposure to several aspects of Additive Manufacturing (AM): (1) design and experimentation; (2) process optimization; and (3) materials testing. Coverage of a variety of AM technologies, their advantages and limitations, and how to design for AM. Discussion of both polymer and metal technologies, and exploration of recent applications of AM across multiple industries.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  

MECH 474 Manufacturing Systems I  
Crosslisted with: MECH 874  
Prerequisites: Open to College of Engineering Students only.  
Description: Principles of automated production lines; analysis of transfer lines; group technology; flexible manufacturing systems; and just-in-time; and optimization strategies for discrete parts manufacturing.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  

MECH 475 Introduction to Mechanical Vibrations  
Crosslisted with: MECH 875  
Prerequisites: MECH 373 and MATH 221  
Description: Review of rigid body dynamics; equations of motion, free vibration, damping; linear response of one, two, and multi-degree of freedom systems; forced vibrations, harmonic, periodic, impulse, and general responses; resonance and vibration isolation; rotating imbalance; Fourier transforms, digitization and analysis of experimental data.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Prerequisite for: MECH 975  
Course and Laboratory Fee: $25  

MECH 476 Manufacturing Information Systems  
Crosslisted with: MECH 876  
Prerequisites: Senior standing; CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, or CSCE 155T or equivalent  
Description: An exploration of information systems and their impact in a manufacturing environment. Software, hardware, database systems, enterprise resource planning, networking, and the Internet.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded
MECH 480 Numerical Methods in Engineering
Crosslisted with: MECH 880
Prerequisites: MATH 221/MATH 821; CSCE 155N.
Notes: MATH 314 recommended. Credit towards the degree cannot be earned in both CSCE/MATH 440/840 and MECH 480/880.
Description: Numerical algorithms and their convergence properties in: solving nonlinear equations; direct and iterative schemes for linear systems of equations; eigenvalue problems; polynomial and spline interpolation; curve fitting; numerical integration and differentiation; initial and boundary values problems for Ordinary Differential Equations (ODEs) and systems of ODEs with applications to engineering; finite difference methods for partial differential equations (potential problems, heat-equation, wave-equation).
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: CHME 496, CHME 896; MECH 851; MECH 888
Course and Laboratory Fee: $25

MECH 483 Engineering Analysis with Finite Elements
Crosslisted with: MECH 883
Prerequisites: MECH 310; MECH 343; MECH 350; MECH 420 or parallel
Description: Analysis of engineering systems using finite elements; a critical and challenging task performed during the design process for many engineering systems. Four very distinct domains are studied: Structural stress analysis, heat transfer, fluid flow, and modal analysis.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
MECH 487 Thermal Fluids Laboratory
Prerequisites: MECH 200 and MECH 380; MECH 420/820 or parallel
Description: Design, execution, and evaluation of physical experiments in the areas of thermodynamics, fluid mechanics, and heat transfer.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Grading Option: Graded with Option
Course and Laboratory Fee: $30

MECH 488 Kinematics and Machine Design Laboratory
Prerequisites: MECH 342; MECH 380 or parallel.
Description: Design projects and physical experiments in the area of machine design and kinematics.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Grading Option: Graded
Course and Laboratory Fee: $30

MECH 491 Special Topics in Engineering Mechanics
Crosslisted with: MECH 891
Prerequisites: Permission.
Description: Treatment of special topics in engineering mechanics by experimental, computational and/or theoretical methods. Topics vary from term to term.
Credit Hours: 1-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 6
Grading Option: Graded
Course and Laboratory Fee: $25

MECH 492 Special Topics
Crosslisted with: MECH 892
Description: Special topics in mechanical engineering and related areas.
Credit Hours: 1-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 24
Grading Option: Graded

MECH 494 Independent Study
Crosslisted with: MECH 894
Prerequisites: Permission
Description: Faculty-supervised independent study.
Credit Hours: 1-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 24
Grading Option: Graded

MECH 498 Research
Crosslisted with: MECH 898
Description: Faculty-supervised research.
Credit Hours: 0-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 6
Grading Option: Graded

MECH 499H Honors Thesis
Prerequisites: Senior standing in mechanical engineering; admission to the University Honors Program.
Description: Honors thesis research project meeting the requirements of the University Honors Program. Independent research project executed under the guidance of a member of the faculty of the Department of Mechanical Engineering which contributes to the advancement of knowledge in the field. Culminates in the presentation of an honors thesis to the department and college.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

PLEASE NOTE
This document represents a sample 4-year plan for degree completion with this major. Actual course selection and sequence may vary and should be discussed individually with your college or department academic advisor. Advisors also can help you plan other experiences to enrich your undergraduate education such as internships, education abroad, undergraduate research, learning communities, and service learning and community-based learning.

Career Information
The following represents a sample of the internships, jobs and graduate school programs that current students and recent graduates have reported.

Jobs of Recent Graduates
- Weapon Systems Operation & Sustainment Team, The Boeing Company - Huntsville, AL
- Production Engineer, Kawasaki Motors - Lincoln, NE
- Aerospace Engineer, NASA - Houston, TX
- Power Supply Engineer, Lincoln Electric System - Lincoln, NE
Internships

- Operations Management Training Program, Union Pacific - Kansas City, KS
- Airframe Engineer, Textron Aviation - Wichita, KS
- Mechanical Engineer, Schlumberger - Houston, TX
- Design Engineer - Airframe, Cessna Aircraft Company - Wichita, KS
- Field Engineer, Kiewit - Englewood, CO
- Nuclear Officer, United States Navy - Washington, DC
- Engineering Leadership Program - Entry Level Engineer, National Instruments - Austin, TX
- Operations Advanced Development Program, Schneider Electric - Lincoln, NE
- Assistant Mechanical Engineer, Burns and McDonnell - Kansas City, MO
- Infotainment Design Engineer, Honda Research & Development - Columbus, OH
- Research & Development Engineer, Stark Industries - Manhattan, NY
- Consulting Engineer, Black & Veatch - Kansas City, MO
- Project Engineer, Hexagon Lincoln - Lincoln, NE
- Mechanical Engineer, Advanced Aircraft Company - Lincoln, NE
- Machine Design Engineer, Vishay Dale Electronics Inc. - Columbus, NE
- Seating Engineer, Tesla Motors Inc. - Palo Alto, CA
- Design Engineer, Molex Inc. - Lincoln, NE
- Assistant Mechanical Engineer, Burns and McDonnell - Kansas City, MO
- Nuclear Engineer, Omaha Public Power District - Blair, NE
- Product Engineering Development Program, John Deere - Coffeyville, KS
- Mechanical Engineer 1, Honeywell - Kansas City, MO

Graduate & Professional Schools

- Master's in Mechanical Engineering, Stanford University - Stanford, CA
- Ph.D., Mechanical Engineering, University of Nebraska-Lincoln - Lincoln, NE
- Ph.D., Aerospace Engineering, University of Michigan - Ann Arbor, MI
- Ph.D., Aeronautics & Astronautics, Stanford University - Stanford, CA
- Ph.D., Biomechanics, University of Nebraska Medical Center - Omaha, NE
- Ph.D., Robotics, Carnegie Mellon University - Pittsburgh, PA
- Master’s in Mechanical Engineering, Georgia Institute of Technology - Atlanta, GA
- Master’s in Biomedical Engineering, University of Nebraska-Lincoln - Lincoln, NE
- Master’s in Mechanical Engineering, University of California-Berkeley - Berkeley, CA
- Ph.D., Aerospace Engineering, University of Texas at Austin - Austin, TX
- Master’s in Business Administration, University of Nebraska-Lincoln - Lincoln, NE
- Doctor of Medicine, University of Nebraska Medical Center - Omaha, NE
- Master’s in Mechanical Engineering, Texas A&M University - College Station, TX
- Ph.D., Computational Methods, University of Nebraska-Lincoln - Lincoln, NE
- Master’s in Mechanical Engineering, University of Utah - Salt Lake City, UT
- Ph.D., Mechanical Engineering, Colorado School of Mines - Golden, CO
- Ph.D., Mechanical Engineering, University of Washington - Seattle, WA
- Ph.D., Material Science and Engineering, University of Illinois - Champaign, IL
- Ph.D., Medical Engineering, University of California - Santa Barbara, CA
- Ph.D., Materials Science and Engineering, Iowa State University - Ames, IA
- Ph.D., Aeronautics and Astronautics, Purdue University - West Lafayette, IN
- Master’s in Financial Mathematics, Rutgers University - Piscataway, NJ
- Master’s in Mechanical Engineering, University of Illinois Urbana-Champaign - Urbana, IL
- Ph.D., Mechanical Engineering, State University of New York - Binghamton, NY
- Master’s in Mechanical Engineering, Stanford University - Stanford, CA
• Master’s in Aerospace Engineering, University of Michigan - Ann Arbor, MI