

## Mechanical Engineering

College of Science, Engineering & Technology

Department of Mechanical and Civil Engineering

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**Accreditation.** The Mechanical Engineering program is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>.

Mechanical Engineering (ME) is essential to a wide range of activities that include the research, design, development, manufacture, management, and control of engineering systems, subsystems, and their components. Mechanical engineers use the fundamentals of engineering mechanics, energy, thermal-fluid sciences, and material sciences to design and analyze mechanical systems that perform useful tasks required by society. For example, mechanical engineers work with the design and function of machines, devices, and structures in the areas of manufacturing, processing, power generation, and transportation (air, land, sea, and space). As a result of a rapidly expanding technology in recent years, mechanical engineers have become more versed in computer-aided design; robotics; bioengineering; environmental engineering; solar, wind, and ocean energy sources; and space exploration. The breadth of the field provides the graduate with many possibilities for a satisfying career.

Typically, mechanical engineers are employed by the manufacturing, power, aerospace, automotive, computer hardware and software, and processing industries. Careers are also available in design and development organizations as well as in many federal and state agencies. The department will make any reasonable effort to accommodate people with disabilities.

**Program Objectives.** The Mission of the Mechanical Engineering program at Minnesota State Mankato is to provide a broad-based education that will enable graduates to enter practice in the mechanical engineering profession, serving the needs of the State of Minnesota and the Nation.

Within 3-6 years of graduation, graduates of the mechanical engineering program at Minnesota State University, Mankato are expected to contribute to the profession and to society as a whole by achieving a combination of the following milestones.

1. Based on their strong technical foundation in mechanical engineering, they have advanced professionally to increased levels of responsibility, have successfully transitioned into business or management, or have successfully completed an advanced degree.
2. They have demonstrated an ability to communicate technical information through internal and external technical reports or proposals, patent applications, published papers and articles, or conference presentations.
3. They have participated in, or served as an officer of, a local, regional, or national professional engineering society, standards committee, or state/local board.
4. They have participated in continuing education or pursued additional industry certification.
5. They have become a registered professional engineer.

The program mission and educational objectives are fully compatible with the mission of Minnesota State Mankato and the College of Science, Engineering, and Technology. Program objectives are monitored by the constituencies (mechanical engineering profession through the program's Industrial Advisory Board and employers, alumni, students, and faculty of the program).

Other important features of the mechanical engineering program at Minnesota State Mankato include the following:

- Students are required to take the Fundamentals of Engineering exam in their senior year - a precursor to professional registration.
- Students are encouraged to work in engineering related areas for exposure to industrial practice. Internships are strongly recommended.
- Senior students must participate in a full academic year design experience working in a team similar to development teams in industry and government. Industrial sponsored projects are offered when available.

**Preparation.** Recommended high school preparation is one year each of precalculus (or equivalent), physics and chemistry. Engineering drafting and a computer language are also recommended. Without this background it may take longer than four years to earn the degree.

**Program Admission.** Admission to the Mechanical Engineering Program is granted by the department, and is necessary before enrolling in 300- and 400-level courses. Near the end of the sophomore year, students must submit an application for admission to the civil engineering program. Applications to the program may be obtained from the Department of Mechanical and Civil Engineering or downloaded from the department homepage.

Admission to the program is based on GPA and performance in selected courses and is subject to approval by the Department of Mechanical and Civil Engineering. Only students admitted to the program are permitted to enroll in upper-division ME courses. Generally, no transfer credits are allowed for upper-division mechanical engineering courses. For any exceptions to this policy, special written permission must be obtained and will be reviewed by the department. The department makes a special effort to accommodate transfer students. Transfer students are encouraged to contact the department as soon as possible to facilitate a smooth transition. Please feel free to write, call or visit the department.

Before being admitted to upper division mechanical engineering courses, a student must complete a minimum of 48 credits, including the following courses: General Physics (calculus based) 8 credits; Calculus and Differential Equations 16 credits; Introduction to Engineering 2 credits; Computer Graphics Communication 1 credit; Geometric Dimensioning and Tolerancing in Engineering Design 2 credits; Introduction to Problem Solving and Engineering Design 2 credits; Engineering Mechanics (Statics and Dynamics) 6 credits; Electrical Engineering (Circuits, including lab) 4 credits; Chemistry 3 credits; and English Composition 4 credits. Moreover, students are required to take a diagnostic test. The purpose of the test is to identify areas of weakness so that we can provide future improvement in those areas.

To be considered for admission a grade of "C" (2.00) or better must be achieved in each course listed above, and a student must have a cumulative GPA of 2.50 in the core courses. All core course grades (including those for repeated courses) will be considered in the computation of the GPA for admission to the program.

**Transfer Students.** The department makes a special effort to assist transfer students. Transfer students are encouraged to contact the department as soon as possible to facilitate a smooth transition. Please feel free to write, call, or visit the department. Generally, no transfer credits are allowed for upper division civil engineering courses. For exceptions to this policy, special written permission must be obtained from the department. Transfer students must take a minimum of 12 credits at Minnesota State Mankato prior to being considered for full admission to the program. For transfer students the distribution of credits specified for the core courses may vary, but the total credits must satisfy departmental transfer requirements. Transfer credits are not normally used in the computation of the GPA for admission to the program. Transfer students should refer to the Supplemental Information in the Undergraduate Bulletin for information about procedures to be followed when applying for admission to the University.

### POLICIES/INFORMATION

**Satisfactory Progress.** Once admitted to the mechanical engineering program, a student must maintain satisfactory progress in the upper-division Mechanical Engineering program by: (1) maintaining a cumulative GPA of 2.3 for all upper-division engineering courses (including repeated courses); and (2) achieving a GPA of at least 2.0 each semester for all courses required for the major.

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All courses, including repeated courses, will be used in the GPA calculations above. Students are required to take a department-administered diagnostic test in their junior year. The purpose of this test is to provide feedback which will be used to strengthen the curriculum and to improve the preparation of students. Students are also required to take the Fundamentals of Engineering (FE) Exam prior to graduation.

**P/N Grading Policy.** P/N credit is not allowed for any course used to meet the mechanical engineering degree requirements.

**Probation Policy.** Once admitted to the program, a student who does not maintain satisfactory progress as defined above will be placed on program probationary status for a maximum of one semester. During the probationary period, the student must achieve satisfactory progress and, in addition: (a) must complete at least 8 credits, approved by the department, of upper-division engineering courses for grade from the prescribed Mechanical Engineering curriculum; and (b) shall not receive a degree without first conforming to the satisfactory progress criteria. A student who does not maintain satisfactory progress will not be allowed to continue in the program. The student may later reapply for admission to the program. If readmitted, only probationary status will be granted, and continuation in the program will be based on performance in courses specified in a contract with the department.

**Appeals.** A student may appeal any department decision in writing. The department will consider such appeals individually.

For the most up-to-date list of Mechanical Engineering courses, please visit our website at [me.mnsu.edu](http://me.mnsu.edu).

## MECHANICAL ENGINEERING BSME

Degree completion = 128 credits

### Required General Education

Required Special General Education (23 credits)

The Bachelor of Science in Mechanical Engineering degree does not adhere to the standard general education program required by other majors. Rather, it requires a special distribution of communication, humanities, and social science courses. Courses may be chosen to satisfy the university cultural diversity requirement concurrently.

Required Humanities and Social Science Courses (minimum of 16 credits) To satisfy this requirement, the courses selected must provide both breadth and depth and not be limited to a selection of unrelated introductory courses. Each student should discuss with his/her mechanical engineering advisor the selection of courses to meet this requirement early in their academic career. A current list of acceptable courses is posted in the department office and on the department web site. Specifically, the minimum requirements consist of (a) three credits of microeconomics or macroeconomics, (b) at least 6 credits in the humanities area, and (c) at least 6 credits in the social science area; again, (a), (b), and (c) must total at least 16 credits.

To provide the measure of depth to the course of study, at least 3 credits at the 300-level or above must be included in the 16 credit requirement. At least one upper division course must follow a course in the same subject area as a course at the 100 or 200 level.

ENG 101 Composition (4)  
(choose 3-4 credits)  
CMST 102 Public Speaking (3)  
ENG 271W Technical Communication (4)

### Prerequisites to the Major

CHEM 191 Chemistry for Engineers (3)  
MATH 121 Calculus I (4)  
MATH 122 Calculus II (4)  
MATH 223 Calculus III (4)  
MATH 321 Ordinary Differential Equations (4)  
PHYS 221 General Physics I (4)

PHYS 222 General Physics II (3)  
PHYS 232 General Physics II Laboratory (1)

### Major Common Core

EE 230 Circuit Analysis I (3)  
EE 240 Evaluation of Circuits (1)  
EE 244 Introduction to Digital Systems (2)  
ME 101 Introduction to Engineering - Mechanical (2)  
ME 103 Computer Graphics Communication (1)  
ME 201 Introduction to Problem Solving and Engineering Design (2)  
ME 203 GD&T in Engineering Design (2)  
ME 206 Materials Science (3)  
ME 212 Statics (3)  
ME 214 Dynamics (3)  
ME 223 Mechanics of Materials (3)  
ME 241 Thermodynamics (3)  
ME 291 Engineering Analysis (3)  
ME 321 Fluid Mechanics (3)  
ME 324 Heat Transfer (3)  
ME 329 Applied Thermodynamics (3)  
ME 333 Manufacturing Processes (3)  
ME 336 Mechanical Engineering Experimentation I (2)  
ME 341 Linear Systems (3)  
ME 417 Design of Machine Elements (3)  
ME 420 Computer Aided Engineering (3)  
ME 428 Design Project I (3)  
ME 436W Mechanical Engineering Experimentation II (2)  
ME 438W Design Project II (3)  
ME 463 Automatic Controls (3)  
ME 466 Mechanical Engineering Experimentation III (2)  
ME 492 Mechanical Engineering Seminar (1)

### Major Restricted Electives

Consult with your advisor for selection of mechanical engineering electives.

### Mechanical Engineering Electives (choose 6 credits)

#### Science Electives (choose 4 credits)

BIOL 105 General Biology I (4)  
BIOL 105W General Biology I (4)  
CHEM 202 General Chemistry II (5)  
ENVR 101 Perspectives in Environmental Science (4)  
MATH 247 Linear Algebra I (4)  
MATH 422 Partial Differential Equations (4)  
PHYS 223 General Physics III (3)  
PHYS 233 General Physics III Laboratory (1)

### Required Minor: None.

## COURSE DESCRIPTIONS

### ME 100 (1) Explorations in Engineering

This course offers an introduction to the various disciplines of engineering and their relationship to the principles of physics and mathematics. Students are prepared for academic success and the transition into an engineering program.  
Fall  
GE-12

### ME 101 (2) Introduction to Engineering - Mechanical

To prepare students for a career in engineering with emphasis on mechanical; introduce the engineering fundamentals and the skills necessary to have a successful learning experience; and to prepare students for engineering education and profession through interactions with upper-class engineering students and practitioners.  
Pre: MATH 113 or MATH 115 or MATH 121

### ME 102 (1) Introduction to Engineering II

A continuation of ME 101 covering historical and global perspectives, engineering discipline and functions, professional aspects of engineering, ethical aspects

of engineering, creativity and innovation, basics of personal computers-word processing and spreadsheets, introduction to problem solving.

Variable

### ME 103 (1) Computer Graphics Communication

Standards of graphics communication. Orthographic projections, dimensioning, tolerancing, section views. Extensive use of modern software to create engineering drawings. Introduction to solid modeling of parts and assemblies. This course includes laboratory component.

### ME 203 (2) Geometric Dimensioning and Tolerancing in Engineering Design

This course is intended to provide the students with an understanding of the principles and methodologies of geometric dimensioning and tolerancing. Topics include: Datums, Material condition symbols, Tolerances of Form and profile, Tolerances of orientation and runout, location tolerances, and Virtual condition. This course includes laboratory component.

Pre: ME 103, ME 201

### ME 201 (2) Introduction to Problem Solving and Engineering Design

This course has two main parts. Part one covers problem solving and fundamentals of programming including data types, decision making, repetitive loops, and arrays. Engineering applications requiring programming are included. Part two covers engineering design philosophy and methodology, communication skills, and teamwork. A design project is also included.

Pre: ME 101

Coreq: ME 103, MATH 121

Fall, Spring

### ME 206 (3) Materials Science

Physical principles of elastic and plastic deformation of materials. Dislocation theory. Fatigue, creep, fracture, hardness, phase diagrams and other mechanical phenomena in materials. Ceramics and composite materials. Residual stresses. Lecture and lab demonstrations.

Pre: ME 223

Fall

### ME 212 (3) Statics

Resultants of force systems, equilibrium, analysis of forces acting on structural and machine elements, friction, second moments, virtual work.

Pre: PHYS 221

Fall, Spring

### ME 214 (3) Dynamics

Kinematics and kinetics of particles, systems of particles and rigid bodies, work-energy, linear and angular impulse momentum, vibrations.

Pre: ME 212

Fall, Spring

### ME 223 (3) Mechanics of Materials

Load deformation, stress, strain, stress-strain relationship, buckling, energy concepts, stress analysis of structural and machine elements.

Pre: ME 212

Fall, Spring

### ME 241 (3) Thermodynamics

Fundamental concepts of thermodynamics. Thermal properties of substances and state equations. Conservation of mass, first and second laws. Examples of applications to different engineering systems.

Pre: PHYS 221

Fall

### ME 291 (3) Engineering Analysis

Probability and statistics. Uncertainty, distributions. Numerical solution of algebraic, transcendental and differential equations. Numerical integration and differentiation. Structured programming language required.

Pre: CIVE 201 or ME 201

Fall, Spring

### ME 293 (1) MAX Scholar Seminar

This class provides MAX scholars with an opportunity to explore a set of topics related to achieving success in academic, professional and personal realms. Speakers will include faculty, graduate students, visiting researchers and industry members as well as student participants. Students will be required to participate in mentoring of lower division MAX scholarship recipients and provide written and oral presentations of various topics during the semester. This course may be repeated and will not count towards graduation requirements.

Pre: Recipient of a MAX scholarship or instructor consent.

Fall, Spring

### ME 299 (2) Thermal Analysis

Basic principles of thermodynamics, fluid mechanics, and heat transfer. First and second laws of thermodynamics and application to engineering systems and their design. Not for mechanical engineering major.

Pre: PHYS 221, MATH 321

Spring

### ME 321 (3) Fluid Mechanics

Introduction to fluid flow, fluid properties, fluid statics, the integral and differential approach to basic flow equations. Bernoulli's equation, similitude and dimensional analysis, viscous internal and external flows, one dimensional compressible flow.

Pre: ME 214

Coreq: ME 241 or ME 299

Fall

### ME 324 (3) Heat Transfer

Steady and unsteady conduction. Free and forced convection. Heat transfer by radiation. Combined modes of heat transfer. Elements of heat exchangers design. Includes significant design component.

Pre: ME 241, ME 321

Spring

### ME 329 (3) Applied Thermodynamics

Energy analysis and design of thermodynamic systems including power and refrigeration cycles. Thermodynamic relations. Application of thermodynamics to mixtures and solutions. Psychometrics. Introduction to chemical thermodynamics. Third law of thermodynamics. Includes significant design component.

Pre: ME 241

Spring

### ME 333 (3) Manufacturing Processes

Introduction to manufacturing, tribology, casting, bulk deformation, sheet metal forming, material removal, joining, polymers, powder metals, ceramics, automation, integrated systems. Design for manufacture. Includes significant design component.

Pre: ME 206, ME 223

Spring

### ME 336 (2) Mechanical Engineering Experimentation I

Experiments in Mechanical Engineering, load-deformation, load-failure, fatigue, impact, hardness. Introduction to traditional machining and material processing. This course includes laboratory.

Coreq: ME 333

Spring

### ME 341 (3) Linear Systems

Analysis of linear systems in the time and frequency domains. Physical systems modeled and analyzed using time domain techniques. Fourier and Laplace Transforms.

Pre: ME 291

Fall

### ME 398 (0) CPT: CO-Operative Experience

Curricular Practical Training: Co-Operative Experience is a zero-credit full-time practical training experience for one summer and on adjacent fall or spring term. Special rules apply to preserve full-time student status. Please contact an advisor in your program for complete information.

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Pre: ME 201. At least 60 credits earned; in good standing; instructor permission; co-op contract; other prerequisites may also apply.  
Fall, Spring, Summer

### ME 415 (3) Structural Analysis

Minimum design loads for buildings using ASCE 7 guidelines and load distribution. Analysis of determinate structural systems including the case of moving loads. Analysis of indeterminate structures using the flexibility and moment distribution methods. Use of software to enhance the analysis.

Pre: ME 223  
Fall

### ME 416 (3) Thermal/Fluid Systems Design

The application of the principles of thermodynamics, fluid mechanics, and heat transfer to the design and analysis of selected energy systems of current interest, such as nuclear, solar, geothermal, and also conventional systems. Lecture and design projects.

Pre: ME 324, ME 329  
Variable

### ME 417 (3) Design of Machine Elements

Application of principles of mechanics to the design of various machine elements such as gears, bearings, springs, rivets, welding. Stresses in mechanical elements. Design factors, fatigue, manufacturability. Lectures and design projects.

Pre: ME 214, ME 223  
Spring

### ME 418 (3) Mechanical Systems Design

The application of mechanics to the design and analysis of motion and force transmitting systems. Optimum design. Includes significant design component.

Pre: ME 417  
Variable

### ME 420 (3) Computer Aided Engineering

This course provides the students with sound understanding of both solid modeling techniques and finite element analysis. It covers the major features as well as feature manipulation techniques. It also provides a background in deriving, understanding and applying the stiffness matrices and finite element equations for various types of finite elements and systems. Static stress analyses, sensitivity studies and optimization studies are covered. Includes significant design component.

Pre: ME 417, ME 324  
Coreq: Senior standing in ME.  
Fall

### ME 422 (3) Mechanics of Composite Materials

Introduce anisotropic mechanics theories, engineering application of various composite materials, mechanical behaviors and fabrication of composites, experimental and theoretical approach for composite designs, contemporary issues such as nano/microcomposites. Includes significant design component.

Pre: ME 223

### ME 424 (3) Analysis and Design of Heat Transfer Equipment

Analysis of heat and mass flow, design of heat exchangers and accompanying piping system. Methods of heat transfer enhancement, heat pipes. Includes significant design component.

Pre: ME 324  
Variable

### ME 426 (3) Aerosol Theory and Technology

Introduction to the theory of aerosols and particulate systems. Properties, behavior, and physical principles of aerosols; including particle size statistics, Brownian motion and diffusion, and coagulation. Application in areas such as environmental systems, respiratory deposition, bioterrorism, and materials processing.

### ME 428 (3) Design Project I

The first course in a two semester sequence that provides a complete design experience under professional guidance. The course covers: the product realization process, financial analysis, quality, patents, ethics and case studies. The students

initiate a design project early in the semester to be completed in ME 438W.  
Pre: ME 324, ME 329, ME 333, ME 336, ME 341, ME 417  
Fall

### ME 429 (3) Energy Conversion

Methods of energy conversion. Topics may include hydroelectric, geothermal, wind and solar power generation, as well as unconventional methods of energy conversion. Term design problems.

Pre: ME 324, ME 329  
Variable

### ME 436W (2) Mechanical Engineering Experimentation II

Experimental and analytical studies of phenomena and performance of fluid flow, heat transfer, thermodynamics, refrigeration and mechanical power systems. This course includes laboratory component. Extensive writing component.

Pre: ME 291, ME 324, ME 329  
Fall  
WI

### ME 438W (3) Design Project II

The second course of a two semester sequence providing a complete design experience and introduction to professional practice. This course includes: completion of the design project, design presentations, and the final design report. Students will prepare for and complete the Fundamentals of Engineering exam.

Pre: ME 428  
Spring  
WI

### ME 439 (3) Air Conditioning & Refrigeration

Refrigeration cycles and equipment, refrigerant properties, heating and cooling loads, psychometric analysis of air conditioning. Distribution of air conditioning medium and air quality as applied to design. Includes significant design component.

Pre: ME 324, ME 329  
Variable

### ME 447 (3) Design of Machine Elements II

Application of principles of mechanics of materials and of material failure theories to the design and analysis of shafts, journal bearings, helical, bevel and worm gears, clutches, brakes, couplings, and flexible mechanical elements. Statistical consideration.

Pre: ME 417  
Spring

### ME 450 (3) Finite Element Method

Energy and residual methods, 2D and 3D problems in stress analysis. Application of steady and transient heat flow, hydrodynamics, creeping flow. Includes significant design component.

Pre: ME 223 and ME 324 or instructor consent  
Variable

### ME 463 (3) Automatic Controls

Analysis of control systems using the methods of Evans, Nyquist and Bode. Improvement of system performance by feedback compensation. Introduction to digital control. Includes significant design component.

Pre: ME 341  
Fall

### ME 464 (3) Mechatronics

Synergistic combination of mechanical engineering, electronics, controls and programming in the design of mechatronic systems. Sensors, actuators and microcontrollers. Survey of the contemporary use of embedded microcontrollers in mechanical systems, case studies. Includes significant design component.

Pre: ME 417, ME 463  
Spring

### ME 466 (2) Mechanical Engineering Experimentation III

Experiments in vibrations: Motion measurement, force measurement, free vibra-

tion, frequency response, impact response, noise, signal processing. Experiments in control: system modelling and characterization in the time and frequency domains, feedback and compensation, PID control, control of velocity and position. This course includes laboratory. Extensive writing component.

Pre: ME 463

Spring

**ME 466W (2) Mechanical Engineering Experimentation III**

Experiments in vibrations: Motion measurement, force measurement, free vibration, frequency response, impact response, noise, signal processing. Experiments in control: system modelling and characterization in the time and frequency domains, feedback and compensation, PID control, control of velocity and position. This course includes laboratory. Extensive writing component.

Pre: ME 463

Spring

WI

**ME 491 (1-4) In-Service**

Variable

**ME 492 (1) Mechanical Engineering Seminar**

To acquaint students with various engineering careers, various industries, and various societal and ethical problems.

Pre: Senior standing in Mechanical Engineering

Coreq: ME 428

Spring

**ME 493 (1) MAX Scholar Seminar**

This class provides MAX scholars with an opportunity to explore a set of topics related to achieving success in academic, professional and personal realms. Speakers will include faculty, graduate students, visiting researchers and industry members as well as student participants. Students will be required to participate in mentoring of lower division MAX scholarship recipients and provide written and oral presentations of various topics during the semester. This course may be repeated and will not count towards graduation requirements.

Pre: Recipient of a MAX scholarship or instructor consent.

Fall, Spring

**ME 494 (1) Global Experience in Engineering and Technology**

This class provides students pursuing a minor in "Global Solutions in Engineering and Technology" with an opportunity to explore a set of topics related to achieving success in advance of and following an international experience (internship, study abroad, etc.). Speakers will include faculty, graduate students, visiting researchers and industry members as well as student participants. Returning students will be required to participate in mentoring of students preparing for their international experience and provide written and/or oral presentations of various topics during the semester. This course is required both before and after participation in the international experience (min. 2 cr.)

Variable

**ME 497 (1-6) Internship**

Variable

**ME 499 (1-6) Individual Study**

Variable