

## Mechanical Engineering

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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.

### Accreditation

The Mechanical Engineering program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: (410) 347-7700.

**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.

Graduates of the Mechanical Engineering program at Minnesota State Mankato will be prepared:

1. with a strong technical foundation to practice mechanical engineering, or to pursue graduate studies;
2. to become registered professional engineers;
3. to communicate technical information effectively with the public, their peers, customers, and employers;
4. with an understanding of the need for life-long learning and of the importance for community and professional involvement; and
5. with an awareness of cultural, societal, and professional issues.

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.

Recommended high school preparation is two years of algebra, one year of geometry, one-half year of trigonometry, one-half year of college algebra, and a year each of physics and chemistry. Engineering drafting and a computer language such as BASIC are also recommended. Without this background it may take longer than four years to earn the degree.

Admission to Program is necessary before enrolling in 300- and 400-level courses. Admission to program is granted by the department. Near the end of the sophomore year, students should submit applications for admission to the mechanical engineering program. Application 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. No transfer credits are allowed for upper-division ME 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. If local information is insufficient, please write, call or visit the department.

Before being admitted to upper division mechanical engineering courses, a student must complete a minimum of 51 credits, including the following courses: General Physics (calculus based) 10 credits; Calculus and Differential Equations 16 credits; Introduction to Engineering 2 credits; Computer Graphics Communication 1 credit; Geometric Dimensioning and Tolerancing 1 credit; Introduction to Problem Solving and Engineering Design 2 credits; Engineering Mechanics (Statics and Dynamics) 6 credits; Electrical Engineering (Circuits, including lab) 4 credits; Chemistry 5 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.

For transfer students the distribution of credits specified in the previous paragraph may vary, but the total credits must satisfy departmental transfer requirements. Transfer students should contact the department for individual evaluation.

All courses and credits shown above must be completed before enrollment in 300-level engineering courses. All of the above courses except internship credits must be taken for grade. It is not acceptable for the student to take any of these courses on a pass/no credit basis. A grade of "C" or better must be achieved in each course. To be considered for admission, the student must have a cumulative GPA of 2.5 for all science, math, ME and EE courses. Admission to the Mechanical Engineering Program is selective and subject to approval of the Mechanical Engineering Academic Standards Committee. Failure to submit an application could result in the student being denied admission to the program and registration in junior or higher level classes in the ME program. If a student is denied admission to the Mechanical Engineering Program, he/she can reapply to the program for admission in subsequent years. If the applicant has attended Minnesota State Mankato only, the application form is submitted to the Department of Mechanical and Civil Engineering along with a copy of that student's Minnesota State Mankato transcript obtained from "The Hub". Pre-engineering students at Minnesota State Mankato are not guaranteed admission to the junior-level ME Program. If the applicant has any transfer credits from another college or university, or expects to be admitted as a transfer student, all transfer courses/credits must be evaluated by the Office of Admissions at Minnesota State Mankato. The transfer student will need to refer to the Supplemental Information and/or the Minnesota State Mankato Undergraduate Bulletin

for information about procedures that need to be followed when making application for admission as a transfer student. Applicants for admission to the program must also submit a complete plan of study.

#### MECHANICAL ENGINEERING BSME

Required (Special General Education, 23 credits):

The Bachelor of Science in Mechanical Engineering degree does NOT adhere to the 44 credits of general education required by other programs. Rather, it requires a special distribution of communication, humanities and social science courses. Courses should be chosen to simultaneously satisfy the university cultural diversity requirement.

Required Communication Courses (7 credits):

ENG 101 Composition (4) AND  
SPEE 102 Public Speaking (3) OR  
SPEE 233 Public Speaking for Technical Professionals (3) OR  
ENG 271 Technical Communication (4)

Required Humanities and Social Science Courses (minimum 16 credits):

In the interest of making engineers fully aware of their social responsibilities and better able to consider related factors in the decision-making process, course work in the humanities and social sciences is required as an integral part of our mechanical engineering program. To satisfy this requirement, the course selected must provide both breadth and depth and not be limited to a selection of unrelated introductory courses. Not all courses in humanities and social sciences are acceptable, i.e. skill developing courses are not acceptable. Courses should be chosen to simultaneously satisfy the university cultural diversity requirement. Each student should discuss with his/her mechanical engineering advisor selection of courses to meet this requirement. All students are urged to discuss this plan with their mechanical engineering advisors early in their academic career. An updated list of acceptable courses is posted in the department office and on the web.

Specifically, the minimum requirements consist of (a) three credits of micro-economics 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 three credits at the 300 level or above must be included in the 16 credit requirement. At least one upper-division course must follow in the same subject area.

Required for Major (Prerequisites, 47 credits):

Mathematics (16 credits):

MATH 121 Calculus I (4)  
MATH 122 Calculus II (4)  
MATH 223 Calculus III (4)  
MATH 321 Ordinary Differential Equations (4)

Physics (10 credits):

PHYS 221 General Physics I (5)  
PHYS 222 General Physics II (5)

Chemistry (5 credits):

CHEM 201 General Chemistry I (5)

Electrical Engineering (4 credits):

EE 230 Circuits Analysis I (3)  
EE 240 Evaluation of Circuits (1)

Mechanical Engineering (12 credits):

ME 101 Introduction to Engineering-Mechanical (2)  
ME 103 Computer Graphics Communication (1)  
ME 113 Geometric Dimensioning and Tolerancing (1)  
ME 201 Introduction to Problem Solving and Engineering Design (2)  
ME 212 Statics (3)  
ME 214 Dynamics (3)

Required for Major (52 credits):

EE 244 Introduction to Digital Systems (2)  
EE 253 Logic Circuits Lab (1)

ME 206 Materials Science (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 436 Mechanical Engineering Experimentation II (2)  
ME 438 Design Project II (3)  
ME 463 Automatic Controls (3)  
ME 466 Mechanical Engineering Experimentation III (2)  
ME 492 Mechanical Engineering Seminar (1)

Required for Major (Electives, 6 credits):

Consult with your advisor for selection of electives:

ME Elective  
ME Elective

Required Minor: None.

#### POLICIES/INFORMATION

**GPA Policy.** To maintain satisfactory progress in the upper-division mechanical engineering program, a student must: (1) maintain a GPA of 2.3 for all upper-division engineering courses required for the major; and (2) achieve a GPA of at least 2.0 each semester.

**P/N Grading Policy.** P/N credit may not be applied to any course in the mechanical engineering curriculum except for internship credits and courses designated as P/N only.

**Probation Policy.** A student who does not maintain satisfactory progress as defined above will be placed on academic probationary status for a maximum of one semester. During the probationary period, the student must maintain satisfactory progress and in addition: (a) must complete at least 8 credits for grade from the prescribed ME curriculum; and (b) shall not receive a degree without first conforming to the satisfactory progress criteria. A student who does not maintain satisfactory progress during the probationary period will not be allowed to continue in the program. The student may later reapply for admission to the program.

Refer to the College policies regarding required advising for students on academic probation.

**Appeals.** A student has the right to appeal a department decision in writing. The department will consider such appeals individually.

**Course Repeat Policy.** Only the first 12 semester credits of repeated classes will be exempted from GPA calculation.

#### COURSE DESCRIPTIONS

**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.

**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

## MECHANICAL ENGINEERING

### 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.

### ME 113 (1) Geometric Dimensioning and Tolerancing

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.

Co-req.: ME 103.

### 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; Co-req: ME 103, MATH 121 F, S

### 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.

F

### 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 F, S

### 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 F, S

### 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 F, S

### 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 F

### 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: ME 212, Coreq: MATH 321 F, S

### 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 222, MATH 321 S

### ME 308 (2) Design Morphology

Components of the product realization process are covered including process steps, financial analysis and project planning. Design case studies are presented.

Variable

### 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 F

### 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.

Pre: ME 241, ME 321 S

### ME 327 (3) Mechanical Engineering Design I

Applications of principles of mechanics to the design of various machine elements such as bearings, shafts, gears, clutches, brakes and springs. Design factors and fatigue. Design problems considering engineering calculations, manufacturability and safety.

Pre: ME 214, ME 223 Variable

### 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.

Pre: ME 241 S

### ME 331 (1) Materials Properties Lab

Elastic and plastic deformation of materials. Fatigue and impact. Microstructure. Structural deflections. General mechanical properties of materials related to the performance of products.

Pre: ME 206, ME 223 Variable

### 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.

Pre: ME 206, ME 223 S

### 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.

Coreq: ME 333 S

### 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 214, MATH 321, EE 230 F

### ME 357 (3) Mechanical Engineering Design II

Motion, velocity, acceleration, and dynamic forces in various mechanisms and machines. Design of selected mechanical motion devices. Optimum design.

Pre: ME 327 Variable

### ME 414 (3) Intermediate Dynamics

Two and three dimensional kinematics, multi-degree of freedom systems, Newton's equations, impulse-momentum, energy methods, Lagrange's equations.

Pre: ME 341 Variable

### ME 415 (3) Structural Analysis

Structural analysis of determinate and indeterminate beams, trusses, frames, plates shells; influence lines, moving loads, deflection analysis. Use of computer software is expected. F

Pre: ME 223

### 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 S

ME 418 (3) Mechanical Systems Design  
The application of mechanics to the design and analysis of motion and force transmitting systems. Optimum design.  
Pre: ME 417 Variable

ME 420 (3) Computer Aided Engineering  
Theoretical background in, and hand-on application of, both solid modeling and finite element methods. CAE Systems, Graphical standards, databases, solid modeling techniques. Derivation and solution of finite element equations for various types of elements and systems. Extensive use of modern software to perform both design and analysis. F  
Co-req.: senior standing in ME.

ME 421 (3) Intermediate Fluid Mechanics  
Potential flow, boundary layer flow, turbomachinery. Design aspects in fluid-flow systems. Formulation of continuity, momentum and energy equations, applications to control volumes, two-dimensional and axially symmetric potential flows.  
Pre: ME 321 Variable

ME 423 (3) Intermediate Mechanics of Materials  
Stresses and deformation of curved beams, beams on elastic foundations, indeterminate problems, torsion of noncircular bars, introduction to plates and shells, thick walled cylinders, failure theories.  
Pre: ME 417 Variable

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.  
Pre: ME 324 Variable

ME 425 (3) Thermal Analysis & Control of Electronic Equipment  
Thermal consideration in the design of heat-exchange equipment. Review of heat transfer modes; contact resistance; air handling. Numerical methods. Cooling techniques; fins, extended surfaces, cold plates, heat pipes, immersion cooling, thermoelectric coolers. Enhanced heat transfer.  
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 427 (3) Kinematics & Dynamics of Mechanisms  
Computer-oriented methods of synthesis. Dynamics of mechanisms. Force and moment balancing of mechanisms; shaking forces. Term design projects.  
Pre: ME 417 Variable

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 438.  
Pre: Senior standing in mechanical engineering F

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 430 (3) Dynamics of Machinery  
Force transmissibility, bearing reactions, applications to cams, flywheels, gear linkages, shaking forces, balancing, isolators, critical speeds. Term design problems.  
Pre: ME 417 Variable

ME 433 (3) Design for Manufacture and Assembly  
Current design for assembly (DFA) techniques are discussed. Both "manual" and software approaches are utilized, and enforced with numerous examples. Design for manufacturability (DFM) is addressed for many common manufacturing processes including: sheet metal, casting, forging, plastics, machining, snap fits, elastomers, surface finishes/protective finishes, powdered metal, and extrusions. Recent DFM software is utilized. Class project required.  
Variable

ME 434 (3) Computer Control of Manufacturing Systems  
A study of the principles, techniques, and applications of computer numerically controlled machine tools. The planning, use, expansion, and updating of computerized systems to meet the needs of industry. An introduction to Computer Aided Manufacturing (CAM) systems.  
Pre: Senior standing in Engineering Variable

ME 436 (2) Mechanical Engineering Experimentation II  
Experimental and analytical studies of phenomena and performance of fluid flow, heat transfer, thermodynamics, refrigeration and mechanical power systems.  
Pre: ME 324, ME 329 F

ME 438 (3) Design Project II  
The second course of a two semester sequence, taken the semester in which the student expects to graduate. These two courses provide a complete design experience. This course includes: completion of the design project, design presentations, design report, design evaluations and manuals.  
Pre: ME 428 S

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.  
Pre: ME 324, ME 329 Variable

ME 441 (3) Vehicle Dynamics  
The dynamics of ground vehicles is studied, including pneumatic tires, vehicle handling, vehicle performance (including transmissions), modeling & simulation, and current research topics such as ITS/AVCS (Intelligent Transportation Systems Program/Advanced Vehicle Control Systems). Emphasis is on fundamentals, simulation, and limited experimentation. Class project required.  
Pre: Senior standing in Mechanical Engineering Variable

ME 443 (3) Theory of Elasticity  
Fundamental equations of elasticity in three dimensions, plane stress and plane strain, flexure and torsion of bars of various shapes.  
Pre: ME 223 Variable

ME 446 (1) Senior Mechanical Engineering Laboratory  
Application of the engineering sciences and the principles of measurement to the evaluation of operating characteristics of mechanical equipment and systems. Design of measurement systems. Collection, analysis, and interpretation of the data and the presentation of the results.  
Pre: Senior standing in Mechanical Engineering Variable

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.

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## MECHANICAL ENGINEERING

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Pre: ME 223 and ME 324 or instructor consent Variable

### ME 462 (3) Vibrations

Free and forced vibration in linear single degree of freedom systems, design and analysis of multiple degree of freedom systems with and without damping, vibration of coupled systems.

Pre: ME 341 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.

Pre: ME 341 F

### 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.

Pre: ME 417, ME 463 S

### ME 466 (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.

Pre: ME 463 S

### ME 471 (3) Production Tool Design

Classroom discussions and actual design projects are combined to gain knowledge and experience necessary to design tools commonly used in modern manufacturing processes. Course consists of designing tools, gages, simple jigs, fixtures, punches and dies as employed in mass production processes.

Pre: Senior standing in Engineering Variable

### 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 S

### ME 497 (1-6) Internship

Variable

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

Variable