Technical Specializations in Mechanical Engineering
Recommended Technical Elective Offerings

Mechanical engineering is a very broad discipline. Graduates from the ME program at NDSU find employment in a wide variety of industries, including aerospace, ground vehicles, energy, robotics and controls, biomedical, manufacturing, and defense, among others. Through the offering of the core (required) coursework, our curriculum is designed to provide students with a strong emphasis on fundamental concepts that apply to all facets of mechanical engineering. In addition to the core courses, students must select a minimum of five technical-elective course offerings. These elective courses allow students to gain a greater depth of understanding in specific technical areas, permitting students to tailor their education to meet their unique career aspirations. Through careful selection of the technical electives, students may pursue a specialization in one of the following technical focus areas. Alternatively, students can choose courses from different focus areas to gain additional insight across a range of subjects, while still maintaining a greater breadth of knowledge that is the hallmark of a mechanical engineering degree.

Automotive & Ground Vehicle Engineering

Engineering advancements made over the past century have greatly contributed to the increased mobility of our society. Engineers employed in the ground vehicle industry are involved in the design, manufacture, and operation of automobiles, motorcycles, trucks, tractors, construction equipment, and specialized vehicles for a variety of agricultural, industrial, and recreational uses. The automotive field is rapidly evolving, particularly in areas such as autonomous control, fuel economy and emissions, safety, and vehicle propulsion. Automotive/ground vehicle engineers may contribute to the design, development, fabrication, testing, and improvement of vehicles or vehicle components from concept to final production.

Recommended Technical Elective Offerings

- ME 469: Energy Storage Technology
- ME 472: Fatigue and Fracture of Metals
- ME 473: Engineering with Polymeric Materials
- ME 474: Mechanics of Composite Materials
- ME 477: ME Finite Element Analysis
- ME 479: Fluid Power Systems Design
- ME 487: Internal Combustion Engines
- ME 489: Vehicle Dynamics
- ENGR 321: Introduction to Robotics
- IME 440: Engineering Economy
- IME 460: Evaluation of Engineering Data

Aerospace Engineering

Engineers who work in the aerospace industry are primarily involved in the design and development of aircraft or spacecraft. The two main branches are aeronautical engineering (concerned with the development of flight-capable vehicles within the atmosphere) and

astronautical engineering (concerning the development of spacecraft for travel beyond Earth's atmosphere). Aerospace engineers design vehicles to operate in demanding environments subjected to high loads, using knowledge of advanced materials, aerodynamics, stress analysis, and heat transfer. They are involved in the structural design of the vehicles, modes of propulsion, and control systems for manned and unmanned flight.

Recommended Technical Elective Offerings

- ME 472: Fatigue and Fracture of Metals
- ME 474: Mechanics of Composite Materials
- ME 477: ME Finite Element Analysis
- ME 478: Advanced Flow Diagnostics
- ME 483: Introduction to Computational Fluid Dynamics
- ME 484: Gas Turbines
- ME 488: Introduction to Aerodynamics
- IME 440: Engineering Economy
- IME 460: Evaluation of Engineering Data

Robotics and Control Systems

From vehicles to manufacturing lines to surgery, robots and automated control systems are becoming more commonplace in our society. Engineers working in this field may be involved with the kinematics and kinetics of robotic motion, instrumentation and sensors, actuation systems, programming, and the design of manipulation devices. This field contains elements of mechanical, electrical, and computer engineering, as well as computer programming, autonomous control, and artificial intelligence. Students who complete specific courses in this area may obtain a minor in Robotics from the College of Engineering.

Recommended Technical Elective Offerings

- ENGR 321: Introduction to Robotics
- ME 475: Automatic Controls
- ME 476: Mechatronics
- CSCI 485: Autonomous Command and Artificial Intelligence for Robots and Other Cyber-Physical Systems

Energy Stewardship

The safe and reliable production, transmission, and storage of energy is critical to meeting the needs of society. Energy is used in manufacturing, transportation, communications, heating and cooling, etc. for domestic and commercial purposes. It is an interdisciplinary field that requires integrating various aspects of engineering. While much of the energy production in the United States and globally has traditionally been derived from fossil fuels or nuclear sources, there is a growing need to expand the development of renewable and sustainable energy sources. This transition will also require new technologies to be developed for the transmission and storage of energy, as well as a larger focus on conservation efforts and improved efficiency of end-use products. It will also require technology developments for the more efficient use of current

energy sources. Engineers employed in the energy industry may work in power plants or other facilities like wind farms, design improved systems for energy production, develop more efficient HVAC systems for energy conservation, or research new technologies for reliable energy conversion or storage, among other opportunities.

Recommended Technical Elective Offerings

- ME 353: Thermodynamics II
- ME 469: Energy Storage Technology
- ME 470: Renewable Energy Technology
- ME 475: Automatic Controls
- ME 481: Fundamentals of Energy Conversion
- ME 482: Fuel Cell Science and Engineering
- ME 484: Gas Turbines
- ME 485: Heating, Ventilation and Air Conditioning
- ME 487: Internal Combustion Engines
- ABEN 456: Biobased Energy
- IME 440: Engineering Economics

Materials Engineering

Every aspect of our daily activities is influenced by materials. This is the main reason that different eras of ancient civilization are named based on advancements in new materials or materials processing (i.e. stone age, Iron age, etc.). Materials engineering enables us with tools and knowledge to develop new materials and structures that better serve human needs in modern times. The accessibility of new technologies requires the development of advanced materials which is not possible without having a deep knowledge materials science and engineering. Several high-level courses in different topics of materials science will help our students gain a deeper understanding of specific areas in materials science. In particular, specialized courses will provide students with a better understanding regarding specific classes of materials such as biocomposites, ceramics, polymers, and composites.

Recommended Technical Elective Offerings

- ME 332: Engineering Materials II
- ME 435: Plastics and Polymer Processing in Manufacturing
- ME 436: Biopolymers and Biocomposites
- ME 437: Engineering Ceramics
- ME 473: Engineering with Polymeric Materials
- ME 474: Mechanics of Composite Materials
- ME 486: Nanotechnology and Nanomaterials
- CPM 473: Polymer Synthesis
- CPM 474: Applied Polymer Science
- CPM 475: Coatings' Materials Science
- CPM 486: Corrosion and Materials

Biomedical Engineering

Biomedical engineering is an emerging interdisciplinary field that combines a broad variety of engineering and science subjects, ranging from biomechanics, bioinstrumentation, biosensor, biomaterials, image and signal processing, measurements, data analysis, to name a few. Courses in biomedical engineering will help students to be ready to contribute to the global demand for medical technologies and innovations. NDSU College of Engineering also offers a minor in Biomedical Engineering, open to students in all disciplines.

Recommended Technical Elective Offerings

- ME 468: Introduction to Biomechanics
- ME 480: Biofluid Mechanics
- ME 486: Nanotechnology and Nanomaterials
- ECE 485: Biomedical Engineering
- ECE 487: Cardiovascular Engineering
- ECE 488: Cardiovascular Engineering II
- IME 411: Human Factors Engineering*

Thermal-Fluids Engineering

Thermal-fluids is a branch of science and engineering that deals with thermal energy and fluid flow, Thermal-fluids engineers are needed in various industrial sectors to design, build, and maintain mechanical systems and structures that function based on thermodynamics and fluid mechanics principles. Students who are interested in Thermal Fluids are encouraged to take electives from the following list, which will include more advanced topics, in-depth discussions on applications of Thermodynamics and Fluid Mechanics, and the state-of-the-art experimental and computational techniques in Thermal Fluids.

Recommended Technical Elective Offerings

- ME 353: Thermodynamics II
- ME 478: Advanced Flow Diagnostics
- ME 479: Fluid Power Systems Design
- ME 480: Biofluid Mechanics
- ME 483: Introduction to Computational Fluid Dynamics
- ME 484: Gas Turbines
- ME 485: Heating, Ventilation and Air Conditioning
- ME 488: Introduction to Aerodynamics

Advanced Engineering Analysis

A variety of mechanical engineering software packages have been developed and used in modern industries to facilitate the design, manufacturing, operation and control of broad mechanical systems for better performance, cost-savings, and shortening the product development cycle, which form the core courses of the advanced engineering analysis category. The courses offered in this category provide students the opportunities to learn and use various cutting-edge

engineering analysis methods to understand the thermal/mechanical performance as well as sensing/control of various liquids, engineering materials, and various mechanical systems, such as ground vehicles and aircrafts. The courses also provide students the opportunities to master the fundamental skills for engineering data analysis and management. Familiar with some of the typical engineering software packages, students can seamlessly transition to various industrial practices after graduation.

Recommended Technical Elective Offerings

- ME 475: Automatic Controls
- ME 476: Mechatronics
- ME 477: ME Finite Element Analysis
- ME 479: Fluid Power Systems Design
- ME 483: Introduction to Computational Fluid Dynamics
- IME 460: Evaluation of Engineering Data

Project Engineering and Management

Whether engineers work for their own company, or at a large corporation, they assume different roles and would be involved with different aspects of a firm or a business. Some of these roles and responsibilities do not fit within the traditional definition of an engineering job description. To become a successful engineer, leader, and a manager, it is important that one understands and has an entire perspective of these aspects of a business in addition to the technical engineering knowledge. The courses offered in this field would provide help and learnings to achieve this goal. The learnings in this field ranges from forming a business, how to design and execute a process, managing a project, support a business through logistics and strategic planning etc….

Recommended Technical Elective Offerings

- ENGR 310: Entrepreneurship for Engineers and Scientists
- IME 440: Engineering Economics
- IME 430: Process Engineering
- IME 450: Systems Engineering and Management
- IME 451: Logistics Engineering and Management*
- IME 456: Program and Project Management*
- IME 460: Evaluation of Engineering Data
- IME 480: Production and Inventory Control*

Manufacturing Engineering

Manufacturing engineering is a branch of professional engineering that shares many common concepts and ideas with other fields of engineering such as mechanical, chemical, electrical, and industrial engineering. Manufacturing engineering requires the ability to plan the practices of manufacturing; to research and to develop tools, processes, machines and equipment; and to integrate the facilities and systems for producing quality products with the optimum expenditure of capital. The manufacturing engineer's primary focus is to turn raw material into an updated or new product in the most effective, efficient & economic way possible. Students who complete

specific courses in this area may obtain a minor in Manufacturing Engineering from the Industrial and Manufacturing Engineering Department.

Recommended Technical Elective Offerings

- ME 435: Plastics and Polymer Processing in Manufacturing
- IME 380: CAD/CAM for Manufacturing
- IME 430: Process Engineering
- IME 431: Production Engineering
- IME 432: Composite Materials Manufacturing
- IME 433: Additive Manufacturing*
- IME 437: Methods for Precision Manufacturing*
- IME 482: Automated Manufacturing Systems*

Test/Experimental Engineering

Experimental methods are important parts of engineering education. Studying experimental methods provides students to have a better understanding of the theory behind engineering phenomena. The students usually learn how to perform experimental tests, in order to verify their own skills and confidence, as well as their interests. They usually verify and compare the theoretical solution of any engineering problem with that of experimental one. Test and Experiment Engineering contribute to the design, development, fabrication, testing, and improvement of all fields of mechanical engineering. In the group of recommended Test/Experimental Engineering, several courses are suggested. These courses extend from experimental stress analysis, to flow diagnosis, fluid power design, fatigue and fracture of materials, control, and the evaluation of engineering data are essential parts of mechanical engineering education.

Recommended Technical Elective Offerings

- ME 471: Experimental Stress Analysis
- ME 472: Fatigue and Fracture of Metals
- ME 475: Automatic Controls
- ME 476: Mechatronics
- ME 478: Advanced Flow Diagnostics
- ME 479: Fluid Power Systems Design
- IME 460: Evaluation of Engineering Data

* Requires approval as an out-of-department technical elective