MECHANICAL ENGINEERING

Two undergraduate programs are offered within the Department of Mechanical Engineering (https://www.uakron.edu/engineering/ME/), leading to the Bachelor of Science in Mechanical Engineering and the Bachelor of Science in Aerospace Systems Engineering. The department also offers graduate programs leading to a Master of Science in Mechanical Engineering, and an interdisciplinary Doctor of Philosophy in Engineering.

4600: Mechanical Engineering

Mechanical engineers design and analyze physical systems and are employed in a variety of industries in different capacities. Mechanical engineers play important roles in many types of companies, including automotive, petroleum, energy generation and conversion, aerospace, tire, consulting, chemical, electronic, and manufacturing.

The Mechanical Engineering curriculum at The University of Akron is designed to give the student knowledge of fundamental principles of the

1. thermal/fluids stem,
2. structures and motion stem, and
3. controls stem of mechanical engineering, as well as the application of these principles to pertinent problems.

A significant measure of the mechanical engineering education is the degree to which it has prepared the graduate to pursue a productive engineering career that is characterized by continued professional growth.

The Mechanical Engineering program is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org/). The program educational objectives (PEOs) for the Mechanical Engineering program are that, within a few years after graduation, our Mechanical Engineering graduates:

- Practice the mechanical engineering discipline successfully within community accepted standards
- Acquire teamwork and communications skills to develop a successful career in mechanical engineering
- Fulfill professional and ethical responsibilities in the practice of mechanical engineering, including social, environmental and economic considerations
- Engage in professional service, such as participation in professional society and community service
- Engage in life-long learning activities, such as graduate studies or professional workshops
- Develop a professional career in the prevailing market that meets personal goals, objectives and desires

To meet those program educational objectives as well as the curricular requirements specified by the American Society of Mechanical Engineers (ASME) for accreditation, the Mechanical Engineering program identifies student outcomes, which are what students are expected to achieve by the time of graduation. They are:

(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

4900: Aerospace Systems Engineering

The Bachelor of Science in Aerospace Systems Engineering degree program is intended to produce engineers who possess both a broad, interdisciplinary knowledge of aerospace engineering fundamentals and who will be able to move quickly into the role of project managers, the precursor position to program managers and ultimately, senior managers. These engineers can lead multidisciplinary teams and bring about the integration of components in a variety of systems. The program includes basic engineering and aerospace courses and will also include specific non-engineering courses, selected to meet the goal of developing future senior technical leaders for our aerospace industries. The program features a mandatory co-op component that begins following the sophomore year. The co-op requirement is expected to fill out the student's technical background as well as provide a basis for broad personal growth that is part of the aim of the General Education requirement. Three fewer hours of General Education courses are required for Aerospace Systems Engineering due to the mandatory co-op.

The Aerospace Systems Engineering program is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org/). The program educational objectives (PEOs) for the Aerospace Systems Engineering program are that, within a few years after graduation, our Aerospace Systems Engineering graduates:

- Practice the aerospace systems engineering disciplines successfully within community accepted standards
- Acquire teamwork and communications skills to develop a successful career in aerospace systems engineering
- Fulfill professional and ethical responsibilities in the practice of aerospace systems engineering, including social, environmental, and economical considerations
- Engage in professional service, such as participation in professional society and community service
- Engage in life-long learning activities, such as graduate studies or professional workshops
- Develop a professional career in the prevailing market that meets personal goals, objectives and desires

To meet those program educational objectives as well as the curricular requirements specified by the American Institute of Aeronautics and Astronautics, the Aerospace Systems Engineering program identifies student outcomes, which are what students to achieve by the time of graduation. They are:

(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

Information specific to the available program options in mechanical engineering and aerospace systems engineering is available:

- Aerospace Systems Engineering, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/mechanical-engineering/aerospace-systems-engineering-co-op-bs/)
- Mechanical Engineering, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/mechanical-engineering/mechanical-engineering-bs/)
- Mechanical Engineering, Co-op Option, BS (https://bulletin.uakron.edu/undergraduate/colleges-programs/engineering-polymer-science/mechanical-engineering/mechanical-engineering-co-op-bs/)

Mechanical Engineering (4600)

4600:165 Tools for Mechanical Engineering (3 Credits)
Corequisite: 3450:149. Personal computer DOS system, word processing, spreadsheet, computer-aided drafting, math calculating package, mechanical graphics, and introduction to mechanical engineering program and curriculum.

4600:203 Dynamics (3 Credits)
Prerequisite: 3450:222, 3650:291, 4300:201. Corequisite: 3450:223. Kinematics and kinetics of particles and rigid bodies. Principles of work, energy, momentum and impulse.

4600:260 Engineering Analysis I (2 Credits)
Prerequisite: 3450:222; corequisite: 3450:223. Introduction to numerical methods in mechanical engineering; applications of computer tools (MatLab).

4600:300 Thermodynamics I (3 Credits)
Prerequisites: 3450:223 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 3650:292. Basic concepts of thermodynamics. Pure substances, closed and open systems, the first and second laws of thermodynamics. Entropy, vapor power cycles and vapor compression refrigeration.

4600:301 Thermodynamics II (2 Credits)
Prerequisites: 3450:335, 4600:300 and admission to an engineering major within the College of Engineering and Polymer Science. Absorption refrigeration. Gas cycles. Thermodynamics of state, gas mixtures and gas-vapor mixtures. Combustion.

4600:305 Thermal Science (2 Credits)
Prerequisite: 3450:223 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 3650:292. Credit not allowed for both 300 and 305. Introduction to first and second laws of thermodynamics, perfect gas relationships, equations of state, cycle analysis. Introduction to conduction, convection and radiation heat transfer.

4600:310 Fluid Mechanics I (2 Credits)
Prerequisites: 3450:223, 4600:203 and admission to an engineering major within the College of Engineering and Polymer Science. Properties and behavior of gases and liquids at rest and in motion. Energy equation. Flow in conduits. Forces on body submerged in moving fluid. Dimensional analysis and similitude.

4600:311 Fluid Mechanics II (3 Credits)
Prerequisites: 3450:335, 4600:310 and admission to an engineering major within the College of Engineering and Polymer Science. Navier-Stokes equations. The boundary layer. External viscous flows and potential flow. Fundamentals of compressible flow. Concepts of computational fluid dynamics.

4600:315 Heat Transfer (3 Credits)
Prerequisites: 4600:300, [4600:310 or 4800:360], [4600:360 or 4800:220] and admission to an engineering major within the College of Engineering and Polymer Science. Fundamentals of heat transfer by conduction, convection and radiation.

4600:321 Kinematics of Machines (2 Credits)
Prerequisites: 4600:165, 4600:203 and admission to an engineering major within the College of Engineering and Polymer Science. Displacements, velocities, accelerations and introduction to plan motion mechanisms. Introduction to design of gears, gear trains and cams.

4600:336 Analysis of Mechanical Components (3 Credits)
Prerequisites: 4300:202 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 3450:335. Analysis of stress and strain at a point. Mohr's circles, shear centers, elastic instability. Stresses in thick and thin cylinders. Fatigue analysis.

4600:337 Design of Mechanical Components (3 Credits)
Prerequisites: [4600:336 or 4900:336] and admission to an engineering major within the College of Engineering and Polymer Science. Application of stress analysis to design of fasteners, welds, springs, ball bearings and gears. Introduction to journal bearings and lubrication. Component design projects.

4600:340 Systems Dynamics & Response (3 Credits)
Prerequisites: 3450:335, 4600:203 and admission to an engineering major within the College of Engineering and Polymer Science. A unified approach to modeling, analysis, response and stability of engineering systems: analog, digital and hybrid computer simulation of interdisciplinary engineering problems are included.

4600:360 Engineering Analysis II (2 Credits)
Prerequisites: 3450:335, 4600:260 and admission to an engineering major within the College of Engineering and Polymer Science. Numerical methods of solution of mechanical engineering problems.

4600:380 Introduction to Materials Science and Engineering (2 Credits)
Prerequisites: 3150:153 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 4300:202. Introduction to metallurgy and advanced engineering materials including polymers, composites and ceramics. Topics include structure of materials, macroscopic mechanical behavior, phase change and heat treatment of metals, and theories of failure.

4600:400 Thermal System Components (3 Credits)
Prerequisites: 4600:301, 4600:311, 4600:315 and admission to an engineering major within the College of Engineering and Polymer Science. Performance analysis and design of basic components of thermal energy exchange and conversion systems. Components studied include heat exchangers, pumps, compressors, turbines and expansion engines.

4600:402 Senior Seminar (1 Credit)
Prerequisite: Admission to the College of Engineering. Corequisites: 4600:400, 4600:441, 4600:460 and [4600:401 or 4600:461 or 4700:499]. Students need further education in ethics, codes and standards, intellectual property, product liability, safety issues, technical writing, diversity, and job opportunities.

4600:410 Heating & Air Conditioning (3 Credits)
Prerequisites: 4600:301 or permission. Corequisite: 4600:315 or permission. Thermodynamics of gas mixtures. Design and selection of air conditioning equipment. Control of gas mixtures, heating, cooling and humidity.

4600:411 Compressible Fluid Mechanics (3 Credits)
Prerequisites: 4600:301, 4600:311 and admission to an engineering major within the College of Engineering and Polymer Science. Subsonic and supersonic flow in nozzles, diffusers and ducts. One-dimensional reactive gas dynamics. Prandtl-Myer theory. Applications to design and analysis of compressors, turbines and propulsion devices.

4600:412 Fundamentals of Flight (3 Credits)
Prerequisites: 4600:311 and admission to an engineering major within the College of Engineering and Polymer Science. Introduction to basic aerodynamics, airplane performance, stability and control, astronautics and propulsion. Design considerations are emphasized.

4600:413 Introduction to Aerodynamics (3 Credits)
Prerequisites: 4600:311 and admission to an engineering major within the College of Engineering and Polymer Science. Introduction of aerodynamic concepts; includes conformal transformations, theory of thin airfoils, two-dimensional airfoil theory, wings of finite span, lifting line theories, lumped vortex, vortex lattice, and panel methods.

4600:414 Introduction to Aerospace Propulsion (3 Credits)
Prerequisites: 4600:311 and admission to an engineering major within the College of Engineering and Polymer Science. Introduction to propulsion systems currently used in aerospace fields; propulsion principles for turbojets, turbofans, ramjets, chemical rockets, and electrical rocket propulsion.

4600:415 Energy Conversion (3 Credits)
Prerequisites: 4600:301 or permission. Corequisite: 4600:315 or permission. Topics from fields of internal combustion engines, cycle analysis, modern conversion devices.

4600:416 Heat Transfer Processes (3 Credits)
Prerequisite: 4600:315 or permission. Analysis, design of extended surfaces. Natural convection and mixed convection, combined modes of heat transfer and heat transfer with phase changes.

4600:420 Introduction to Finite Element Method (3 Credits)
Prerequisites: 4300:202, [4600:315 or 4800:362], and admission to an engineering major within the College of Engineering and Polymer Science. Introduction to matrix and finite element methods. Stiffness and flexibility formulations in solid mechanics and thermal sciences. Basic finite element methods and its implementation.

4600:422 Experimental Stress Analysis I (3 Credits)
Prerequisite: 4600:336 or permission. Experimental methods of determining stress or strain: brittle lacquer, strain gages, photoelasticity, full field techniques.

4600:430 Machine Dynamics (3 Credits)
Prerequisite: 4600:321 or permission. Static and dynamic forces in machines, products of inertia, dynamic equivalence, flywheels. Balancing of rotating, reciprocating, cyclic plane motion. Computer simulation of transient mechanism dynamics, other topics in advanced dynamics.

4600:431 Fundamentals of Mechanical Vibrations (3 Credits)
Prerequisites: 3450:335, 4600:203 and admission to an engineering major within the College of Engineering and Polymer Science or permission. Undamped and forced vibrations of systems having one or two degrees of freedom.

4600:432 Vehicle Dynamics (3 Credits)
Prerequisites: 4600:203 or permission and 3450:335 or permission. Application of dynamic systems analysis techniques to road vehicles. Newtonian and Lagrangian methods. Tire/road interface. Ride characteristics, handling and stability. Digital simulation.

4600:440 System Dynamics & Control (4 Credits)
See department for course description.

4600:441 Control Systems Design (3 Credits)
Prerequisites: 4600:340 and admission to an engineering major within the College of Engineering and Polymer Science or permission. Methods of feedback control design such as minimized error, root-locus, frequency domain. Compensation techniques. Multivariable and nonlinear design methods and computer-aided control design.

4600:442 Industrial Automatic Control (3 Credits)
Prerequisite: 4600:441 or permission. Operation of basic control mechanisms. Study of mechanical, hydraulic, pneumatic, fluidic control systems, including application areas. Tuning of control devices for optimum performance of system. Case studies on control applications from industry, e.g. boilers, furnaces, process heaters.

4600:443 Optimization Methods in Mechanical Engineering (3 Credits)
Prerequisite: 4600:360 or permission. Development and method of solution of optimization problems in mechanical engineering. The use of dynamic programming and operational research methods for optimization including computer utilization and applications.

4600:444 Robot Design, Control & Application (3 Credits)
Prerequisites: [4600:321 or 4600:441] or permission. Robot design and control. Kinematic transformations, velocities and accelerations, path trajectories and dynamics, control and sensing in robotics. The automated factory with robot applications.

4600:450 Introduction to Computational Fluid Flow & Convection (3 Credits)
Prerequisites: 4600:315 or permission, 4600:360 or permission. Numerical modeling of fluid/thermal systems; numerical solution of the momentum and thermal boundary layer equations; flow simulation using advanced heat transfer/fluid/graphics packages.

4600:460 Concepts of Design (3 Credits)
Prerequisites: 4600:337 and admission to an engineering major within the College of Engineering and Polymer Science. Design process. Creativity and inventiveness. Tools of decision making, engineering economics, reliability, optimization. Case studies.

4600:461 ME Senior Design Project I (2 Credits)
Prerequisite: Admission to an engineering major within the College of Engineering and Polymer Science. Corequisites: 4600:400, 4600:441 and 4600:460. Detailed senior design project. Design, feasibility, and cost analysis.
Gen Ed: Tier 3 - Complex Systems

4600:462 Pressure Vessel Design (3 Credits)
Prerequisite: 4600:336 or permission. Introduction to modern pressure vessel technology. Topics include basic structural considerations, materials and their environment and design-construction features.

4600:463 Computer Aided Design & Manufacturing (3 Credits)
Prerequisites: 4600:165 or permission, 4600:360 or permission. The use of computer systems to assist in the creation, modification, analysis, or optimization of engineering designs, and to plan, manage, and control manufacturing plants.

4600:465 Technology Based Startups: Ideate, Invent and Innovate (3 Credits)
Prerequisite: Permission of the department. This course will provide students with the opportunity to extend their fundamental knowledge of entrepreneurship within the specific interdisciplinary context of technology commercialization. Working in interdisciplinary groups the student teams/groups will be taught design thinking approaches that put the customer at the center of the creative process. Brainstorming exercises will be held to solve open ended problems on special topics (e.g. biomimicry, software, medical devices, sensors etc.) so that teams can ideate and conceptualize product, process or service based ideas that solve real problems. In some cases, students can be assigned known research technologies and learn how to come up with applications that have commercialization potential. The evaluation will include, but not be limited to, evaluation of the underlying technology, determination of potential customer value proposition(s), determination of market feasibility, examination of licensing/spin-off options, identification of potential licensees, estimation of potential market size and value, and development of recommendations for further funding, growth (or abandonment). By working in teams, students will learn how to create/invent a product prototype, learn how to listen to potential customers and come back to describe the value proposition that will make the startup successful.

4600:471 ME Senior Design Project II (2 Credits)
Prerequisites: 4600:461 and admission to an engineering major within the College of Engineering and Polymer Science. Detailed senior design project. Final design and implementation.

4600:480 Materials Selection in Design (3 Credits)
Prerequisites: [4200:305 or 4600:380] and admission to an engineering major within the College of Engineering and Polymer Science or permission. Materials selection from the perspective of design including material properties, processing approaches, shape considerations, hybrid materials, and tradeoffs including environmental and cost.

4600:482 Fundamentals of Composite Processing and Mechanics (3 Credits)
Prerequisites: 3450:335, 4300:202, and admission to an engineering major within the College of Engineering and Polymer Science. Polymer-matrix composite processing, manufacturing, and mechanics. The emphasis is on discontinuous fiber reinforcements.

4600:483 Measurements Laboratory (2 Credits)
Prerequisites: 4600:300, 4600:310 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 4600:340. Development of methods to measure temperature, pressure, flow rate, viscosity and motion. Includes both lecture and laboratory experience and emphasizes calibration and accuracy of appropriate instruments.

4600:484 Mechanical Engineering Laboratory (2 Credits)
Prerequisite: 4600:301, 4600:311, 4600:315, 4600:380, 4600:431, 4600:483 and admission to an engineering major within the College of Engineering and Polymer Science. Corequisite: 4600:441. Laboratory experiments in area of dynamics, vibrations, thermodynamics, fluids, heat transfer and controls.

4600:485 3D Printing and Additive Manufacturing (3 Credits)
Prerequisites: 4600:165, 4600:360, and junior or greater standing or permission. Introduction to 3D Printing and Additive Manufacturing including various processes, materials, and applications; Hands-on practice and design/manufacturing project; State of the art of 3D Printing.

4600:486 Special Topics: Mechanical Engineering (1-3 Credits)
Prerequisite: Permission. Brief description of current content to be announced in schedule of classes.

4600:497 Honors Project in Mechanical Engineering (4 Credits)
Prerequisite: senior standing in Honors Program. Individual creative project in thermal science, mechanics or design relevant to mechanical engineering, supervised by faculty member of the department.
Gen Ed: Tier 3 - Complex Systems

4600:498 Experimental Investigation in Mechanical Engineering (1-2 Credits)
Individual independent laboratory investigations in areas relevant to mechanical engineering. Student suggests a project and makes appropriate arrangements with faculty for supervision.

Aerospace Systems Engineering (4900)

1500:113 Heritage and Values I (1 Credit)
Survey course introducing the U.S. Air Force and ROTC. Officership and military customs and courtesies are discussed. Foundations of Air Force communication are covered.

1500:114 Heritage and Values II (1 Credit)
Survey course covering the origin and organization of the Air Force. Selected topics contributing to an understanding of the Air Force are covered.

1500:115 Leadership Laboratory (1 Credit)
Prepares an individual to undertake a broad range of technical tasks. Optional for academic credit; Mandatory for Air Force ROTC credit for scholarship/commissioning.

1500:253 Team & Leadership Fundamentals I (1 Credit)
Survey course examining air and space power from an historical perspective. Course covers early flight and World War I to the Korean War and ICBMS.

1500:254 Team & Leadership Fundamentals II (1 Credit)
Survey course examining air and space power from the Vietnam War to the Gulf War plus a look at the Air Force of the future.

1500:255 Leadership Laboratory (1 Credit)
Prepares an individual to undertake a broad range of technical tasks. Optional for academic credit; Mandatory for Air Force ROTC credit for scholarship/commissioning.

1500:303 Leading People/Effective Communication I (3 Credits)
Prerequisite: Permission of instructor. Study of leadership, professional knowledge and communication skills required for an Air Force officer. The roles of a leader as supervisor and counselor are discussed.

1500:304 Leading People/Effective Communication II (3 Credits)
Prerequisite: Permission of instructor. Study of quality management fundamentals and communication skills for the Air Force officer. The Air Force personnel evaluation system and military ethics are discussed.

1500:305 Leadership Laboratory (1 Credit)
Prepares an individual to undertake a broad range of technical tasks. Optional for academic credit; Mandatory for Air Force ROTC credit for scholarship/commissioning.

1500:453 Leading National Security/Leadership Responsibilities I (3 Credits)
Prerequisite: Permission of instructor. Examines political, economic and social constraints on national security and defense structure. The role of the military, including joint operations and regional defense, are discussed.

1500:454 Leading National Security/Leadership Responsibilities II (3 Credits)
Prerequisite: Permission of instructor. Roles of the military, regional defense, current Air Force issues, and other topics relevant to preparing an Air Force officer for active duty are covered.

1500:455 Leadership Laboratory (1 Credit)
Prepares an individual to undertake a broad range of technical tasks. Optional for academic credit; Mandatory for Air Force ROTC credit for scholarship/commissioning.