

Mechanical Engineering

Faculty and Fields of Interest

Mechanical engineers are involved in a spectrum of technical activities from the design and manufacture of various products to fundamental research.

Mechanical engineers are concerned with the production, transmission, and use of power. They design and develop systems which produce power, such as steam and gas turbines, internal combustion engines, nuclear reactors, jet engines, and rocket motors. They also design, develop, and manufacture devices which consume power in order to accomplish some useful result, such as refrigeration and air conditioning equipment, machine tools, rolling mills, and elevators, to name a few.

The environmental impact of these systems forms an integral part of their analysis and design. Mechanical engineers must cope with stringent standards of air and water quality, noise abatement, and thermal pollution.

Graduates find employment in a number of areas, including private industry, government, consulting firms and education. They may be involved in one or more of the following: research, design, development, manufacturing, administration, management, sales or production supervision. Others continue studies in graduate school.

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.

A student chapter of the American Society of Mechanical Engineers permits the student to initiate professional contacts through a program of technical and social events which introduces the student to practicing engineers from industry and students from other engineering schools.

Mission Statement

The Mechanical Engineering Department at UMass Dartmouth offers two degrees, a Bachelor of Science in Mechanical Engineering and a Master of Science in Mechanical Engineering. The program provides service to meet the needs of students, industry, government, and society. The program offers excellence, access, and value through a strong commitment to teaching, scholarship, outreach, and professionalism.

Farhad Azadivar modeling and optimization of manufacturing systems, computer simulation, management of technological innovation

Sankha Bhowmick heat and mass transfer, bioengineering, MEMS

Sherif D El Wakil computer-aided manufacturing, design for manufacturing, materials science

Alex J Fowler fluid flow in porous media, heat transfer, thermodynamics, bioengineering

Peter D Friedman experimental fluid mechanics and heat transfer, thermodynamics, nuclear power plant operation

John W Hansberry solid mechanics, control theory, machine design, vibration, safety engineering

Ibrahim Kattan manufacturing engineering systems, production planning and control, engineering optimization

Raymond N Laoulache thermodynamics, multiphase flow, control systems, fluid mechanics, laser doppler anemometry, parallel computing

Tesfay Meressi (chairperson) robotics, control theory, machine design

John M Rice solid mechanics, computer-aided engineering, finite element analysis, composite materials, vibration

T K Roy machine design, solid mechanics, shell dynamics, robotics

K Srinagesh manufacturing processes, physical metallurgy, foundry engineering

Program Educational Objectives

- To educate students in the principles that underlie technological applications related to mechanical design, manufacturing, and energy systems.
- To provide a flexible curriculum, having several areas of concentration, to meet the needs of a diverse student body.
- To prepare students to be aware of the societal, economic, ethical, and political context in which engineering is done.

Program Outcomes

UMass Dartmouth Mechanical Engineering graduates will have:

- an ability to apply knowledge of mathematics, science, and engineering;
- an ability to design and conduct experiments, as well as to analyze and interpret data;
- an ability to design a system, component, or process to meet desired needs including experience in designing and building a project and ability in the area of manufacturing ;
- an ability to function on multi-disciplinary teams including an ability to work collaboratively and a broad interdisciplinary knowledge;
- an ability to identify, formulate, and solve engineering problems;
- an understanding of professional and ethical responsibility;
- an ability to communicate effectively including with written, oral, and electronic communication;
- the broad education necessary to understand the impact of engineering solutions in a global/societal context including understanding cultural, political, and economic issues;
- a recognition of the need and an ability to engage in life-long learning including being an independent learner and working in industry and/or furthering their education in graduate schools, not only in engineering but also in business, law, or medicine, depending on their future interests;
- a knowledge of contemporary issues;
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice including computers and instrumentation.

Mechanical Engineering Major
BS degree

Requirements

Throughout the program, the use of computer work stations is emphasized for the solution of complex problems and for the design and manufacture of components and systems. Hands-on design experiences occur throughout the curriculum, culminating in a senior project solving a real-life engineering program with realistic constraints of time as well as economic, aesthetic, safety, social and environmental implications. The students defend their work in an oral presentation before their class, faculty, guests and an invited panel of judges from local industries.

The first two years of the program include basic courses in the areas of mathematics, chemistry and physics, together with introductory courses in applied science such as mechanics, materials and electrical science. Specialization occurs during the last two years with courses available in the areas of thermodynamics, fluid mechanics, manufacturing processes and systems, control systems, materials behavior, energy, and mechanical design.

Areas of Concentration

Design:

MNE 441, 452, 462, 463, 480, 482, 485

Energy:

MNE 422, 423, 424, 425, 431, 432, 460, 492

Manufacturing:

MNE 472, 473, 476, 481, 482

Students should confer with advisors before selecting technical electives to assure that they meet requirements in engineering science and engineering design. Students who wish to select technical electives from other departments must receive prior approval from the mechanical engineering department.

A proposal for experiential learning must be first sponsored by a faculty member and then approved by the full department. A proposal that meets minimum standards shall normally be approved for three free elective credits. An extraordinarily meritorious proposal may be approved for three technical elective credits only if it involves significant creative technical design with a tangible product.

		Semester Credits	
		First	Second
First Year			
EGR 105, 108	Intro. Engineering through Applied Sci. I, II	2	2
EGR 131	Introduction to Design	1	
PHY 111 (or 113)	Physics for Science & Engineering I	4	
PHY 112 (or 114)	Physics for Science & Engineering II		4
MTH 113 (or 111)	Calculus for Applied Sci. and Engineering I	4	
MTH 114 (or 112)	Calculus for Applied Sci. and Engineering II		4
CHM 153	Modern/Applied Chem. for Sci./Engrg. I OR	3	
CHM 151, 161	Princ. Modern Chem. I / Applied Chem. I (4)		
CHM 152, 162	Princ. Modern Chem. II / Applied Chem. II		4
ENL 101, 102	Critical Writing and Reading I, II	3	3
		17	17
Second Year			
MNE 231	Materials Science	4	
MTH 213 (or 211)	Calculus for Applied Sci. & Engineering III	4	
MNE 102	Programming and Computer Usage	3	
EGR 241, 242	Engineering Mechanics I, II	3	3
	General Education Elective	3	
MNE 212	Math Approaches to Engineering Systems		3
MNE 201	Mechanical Engineering Laboratory I		1
MNE 220	Engineering Thermodynamics I		3
MNE 252	Mechanics of Materials		3
MNE 292	Intro. to Mechanical Design		1
		17	14
Third Year			
EGR 301	Applied Engineering Mathematics	3	
MNE 321	Engineering Thermodynamics II	3	
MNE 345	Design for Manufacturing	3	
MNE 355	Manufacturing Processes Laboratory	1	
MNE 381	Design of Machine Elements	3	
ECE 251	Electrical Measurement Laboratory I		1
ECE 211	Elements of Electrical Engineering I		3
MNE 305, 306	Mechanical Eng Lab II, III (biweekly)	0.5	0.5
MNE 332	Fluid Mechanics I		3
ENL 266	Technical Communications		3
	General Education Electives	3	3
MNE	MNE Technical Elective**		3
		16.5	16.5
Fourth Year			
MNE 491	Advanced Machine Design	4	
MNE 411	Heat Transfer	3	
ECE 212	Elements of Electrical Engineering II	3	
MNE	Technical Electives**	3	3
MNE 466	Control Theory		3
	General Education Electives		6
MNE 497, 498	Design Project I, II	2	2
		15	14
Total credits:			127

** Usually taken from approved list (shown on next page).

General Education Departmental Requirements

Students majoring in Mechanical Engineering will meet their departmentally-controlled General Education requirements as follows:

Area E: Satisfied by the sequence MNE 292, 381, 491, and 497/498

Area I, Tier 2: Satisfied by the sequence MNE 292, 305, and 306

Area W, Tier 2: Satisfied by ENL 266

Area O: Satisfied by the sequence MNE 292 and MNE 497/498

Mechanical Engineering
Option in Manufacturing Engineering

Technical Electives

MNE 422	Energy Conversion	MNE 471	Physical Metallurgy
MNE 423	Refrigeration & Air Conditioning	MNE 472	Metal Forming Operations
MNE 424	Geothermal Energy	MNE 473	Powder Metallurgy
MNE 425	Power Plant Design and Engineering	MNE 475	Principles of Foundry Engineering
MNE 431	Fluid Mechanics II	MNE 476	Manufacturing Quality Control
MNE 432	Aircraft and Rocket Propulsion Systems	MNE 480	Computer-Aided Engineering
MNE 441	Mechanical Vibrations	MNE 481	Computer-Aided Manufacturing
MNE 442	Intro. to Numerical Methods	MNE 482	Robotics
MNE 452	Mechanics of Materials II	MNE 485	Introduction to the Finite Element Method
MNE 460	Combustion Systems	MNE 490	Special Topics in Mechanical Engineering
MNE 462	Experimental Stress Analysis	MNE 492	Laser Doppler Anemometry in Fluid Flow
MNE 463	Kinematic and Dynamic Analysis of Machines		

Calculation of GPA in the Mechanical Engineering Major

Students must have a 2.000 cumulative grade point average (GPA) for all courses taken at the University in order to graduate. Students must also have a 2.000 cumulative GPA in the major. For purposes of GPA computation in the major the following are included:

- All MNE courses
- MTH, EGR, ECE courses above the 1xx level
- Any course taken as a technical elective
- ECO 231, 232 in the Manufacturing Engineering Option

Alternative Paths Program Requirements

Depending on the results of placement testing, new freshman students may be placed into one of the following first-year curricula in lieu of the standard curriculum.

		Semester Credits	
		First	Second
First Year Courses for Precalculus-Ready Freshmen			
ENL 101,102	Critical Writing and Reading I, II	3	3
CHM 153	Principles of Modern Chemistry for Engineers I		3
MTH 131	Precalculus	3	
MTH 113	Calculus for Applied Sci. and Engineering I		4
PHY 182	Introduction to the Weather	3	
PHY 111	Physics for Science and Engineering I		4
EGR 105	Intro to Engineering Through Applied Science I		2
EGR 131	Introduction to Design		1
	General Education Electives	6	
		15	17

		First	Second
First-Year Courses for Algebra-Ready Freshmen			
ENL 101, 102	Critical Writing and Reading I, II	3	3
CHM 151	Principles of Modern Chemistry I		3
CHM 161	Intro Applied Chemistry Engineers I		1
MTH 100	Basic Algebra	3*	
MTH 131	Precalculus		3
PHY 182	Introduction to the Weather	3	
EGR 131	Introduction to Design		1
	General Education Electives	6	
		15	11

* Students receive 3 administrative credits for Math 100. Administrative credits do not count towards the total credits required for graduation.

Requirements

The Option in Manufacturing Engineering utilizes a core of courses already in the Mechanical Engineering major—MNE 231, MNE 345, and MNE 355—and a special selection of elective courses.

Students in the option in Manufacturing Engineering complete the requirements for Mechanical Engineering, at the same time making the following specific course selections:

- They must select ECO 231 and 232 within the General Education electives.
- They must select three courses—the MNE Technical Electives—from the following list: MNE 471, MNE 472, MNE 473, MNE 475, MNE 476, MNE 481, and MNE 482.

MNE Major/Business Minor Advising Path

The Department of Mechanical Engineering and the Charlton College of Business have collaborated in preparing a plan whereby students can complete concurrently the Mechanical Engineering major and the Business Administration minor. Please see an advisor in the Department of Mechanical Engineering for information.

Gen Ed note: Mechanical Engineering courses satisfy the Natural Science and Technology requirement.

BS/MS Option in Mechanical Engineering

Outstanding mechanical engineering undergraduate students will be recruited during the second semester of their junior year. The Graduate Committee will select students who satisfy the admission standards and will send them letters inviting them to participate in the combined BS/MS program. Students who wish to enroll in the program will indicate their intention to do so by filing an application for graduate school; they will not be required to take the GRE or to submit recommendation letters.

The Graduate Committee will use the following nominal criteria to select candidates.

- GPA of 3.0/4.0 or higher after the completion of 75-credit hours or more.
- Strong recommendations from faculty.

The department will follow a schedule:

- Graduate Committee identifies qualified students: February
- Graduate Committee sends invitation letters: March
- Application filing deadline: May 1

Accepted students will be classified as graduate students after successfully completing at least 105 credit hours—typically in the spring semester of their senior year.

Requirements

Undergraduate degree requirements are fulfilled as they are now, except that the BS/MS student will take three graduate courses for technical electives, as is already allowed for our undergraduates. (If a student takes a graduate course to also be counted as an undergraduate technical elective and receives a grade less than a B-, the student must take an additional graduate course in order to satisfy the minimum requirements.) A savings in credits results because the three graduate courses count toward both degrees simultaneously, resulting in a reduction in credits from 157 (degrees separately acquired) to 148 (combined BS/MS program).

Thesis Option: The student will fulfill the requirements for the MS degree exactly as they are in the existing thesis option MS program. Students will also be required to take MNE 570 Reading and Research over the summer at the end of their senior year as preparation for completing their thesis in the spring of the following year.

Coursework Option: The student will fulfill the requirements for the MS degree exactly as they are in the existing coursework option MS program.

Mechanical Engineering Courses

MNE 102 three credits

Programming and Computer Usage

3 hours lecture

Prerequisite: MTH 111 or MTH 113

Introduction to computer hardware and software. Computer mathematics; curve fitting; charting; spreadsheets. Data base management. Graphical representation; Applications in mechanical engineering.

MNE 201 one credit I

Mechanical Engineering Laboratory I

3 hours laboratory

Corequisites: MNE 220, 252

Experiments to supplement Mechanics of Materials I and Engineering Thermodynamics I. Probability and statistical analysis are applied to experimental results. Topics such as experimental uncertainty, linear regression, normal distributions, confidence intervals, calorimetry, specific heats, engine performance, strain gauges, tensile and torsion testing are typically covered.

MNE 212 three credits

Mathematical Approaches to Engineering Systems

Prerequisite: MTH 114 or MTH 112

Overview and working knowledge of linear algebra and ordinary differential equations applied to engineering problems. Topics include zero-order equations, introduction to ordinary differential equations (ODE's), first-order ODEs, second-order ODEs, second-order boundary value ODEs, and finite difference method for the solution of ODEs.

MNE 220 three credits

Engineering Thermodynamics I

3 hours lecture

Pre- or corequisites: CHM 152, MTH 211 or MTH 213

The fundamental concepts and basic principles of classical thermodynamics. The Zeroth, First and Second laws of thermodynamics are formulated with recourse to empirical observations and then expressed in precise mathematical language. These laws are applied to a wide range of engineering problems. The properties of pure substances are described using equations of state and surfaces of state. Reversible processes in gases are analyzed by means of the First and Second laws. A representative sampling of engineering applications is discussed and analyzed.

MNE 231 four credits

Material Science

3 hours lecture, 1 hour laboratory

Prerequisites: CHM 151 or CHM 153 and

CHM 152

The relation between the atomic or micro structure of engineering materials and their properties. Structures of metals, ceramics, polymers and composites are introduced. Experiments on equilibrium diagrams, metallographic structures, property changes of metals are included.

MNE 252 three credits

Mechanics of Materials I

3 hours lecture

Prerequisite: EGR 241

Material behavior and the concepts of equilibrium and compatibility of deformation are combined and initially applied to one-dimensional problems. Torsion of bars is discussed with application to problems of shaft design. Stress in beams of simple and composite shapes is considered as well as shear in beams and combined twisting and bending. Deflections of beams, shafts and structures are discussed using several calculation procedures. Stress and strain are considered in three dimensions with attention to principal directions. Buckling is considered and some attention is paid to plastic action in the various course topics.

MNE 292 one credit O, E

Introduction to Mechanical Design

1 hour lecture, 2 hours laboratory

Corequisites: EGR 242, MNE 252

Mechanical design with emphasis on microcomputers as an aid to analysis and optimization. The concept of probabilistic design and the Monte-Carlo techniques are introduced. Attention is primarily paid to the solid mechanical aspects of the subject. Stress, flexibility and minimum weight considerations are addressed through introduction to the finite element method of analysis. Proper form for technical reports and calculations is discussed. Final oral presentation in class required.

MNE 298 one to six credits

Experiential Learning

Prerequisites: At least sophomore standing; permission of the instructor, department chairperson, and college dean
Work experience at an elective level supervised for academic credit by a faculty member in an appropriate academic field. Conditions and hours to be arranged. Graded CR/NC. For specific procedures and regulations, see section of catalogue on Other Learning Experiences.

MNE 305 one-half credit I

Mechanical Engineering Laboratory II

3 hours biweekly

Corequisite: MNE 321

Extensive investigations into various commonly-encountered devices in areas of interest to the mechanical engineer. These include engines, turbines, water cooling towers, conduction, convection, radiation and refrigeration.

MNE 306 one-half credit I

Mechanical Engineering Laboratory III

3 hours laboratory biweekly

Corequisite: MNE 332

Several experiments demonstrating the concepts in the course MNE 332 Fluid Mechanics I. These include: jet impact, Venturi meter, flow under a sluice gate, friction losses in tubes, introduction to data acquisition, and calibration of valves using computer control.

MNE 321 three credits

Engineering Thermodynamics II

3 hours lecture

Prerequisite: MNE 220

Mechanical engineering applications of ideal and real compressors; gas turbine power systems; various air-standard cycles including Brayton, Ericsson, Stirling, Otto, Diesel and Wankel cycles; and several vapor cycles including Carnot, Rankine, modified Rankine, and binary cycles. An introduction is given to vapor-compression refrigeration and heat pumps. Thermochemistry and combustion are discussed with emphasis on application of the First and Second laws to chemical reactions. Chemical equilibria in homogenous gas systems are studied.

MNE 332 three credits

Fluid Mechanics I

3 hours lecture

Prerequisites: MNE 220, MTH 211 or MTH 213

Understanding the basic conservation equations in integral and differential form. The applications are concerned primarily with steady flows of inviscid, incompressible fluids. A brief discussion of similitude and modeling precedes the introduction to viscous flows. Flows in pipe systems with friction influences and including turbines and pumps are studied using the extended Bernoulli equations. The elements of incompressible potential flow are studied using real and complex potential functions.

MNE 345 three credits

Design for Manufacturing

3 hours lecture

Prerequisites: MNE 231

Discussion and comparison of manufacturing processes for economy of production;

and modifications to proposed designs to suit existing equipment. Material selection to suit production and service requirements is covered along with economics of automation and inventory control.

MNE 355 one credit

Manufacturing Processes Laboratory

3 hours laboratory

Corequisite: MNE 345

Machining operations using conventional and modern machine tools are covered. Basic principles of the statistic and probability theory as applied to quality control of machined parts are discussed and emphasized.

MNE 381 three credits E

Design of Machine Elements

3 hours lecture

Prerequisites: MNE 252, EGR 242

Comprehensive survey of the analytical design methods that are valuable to mechanical engineers. Some of the areas covered are: stress analysis, fatigue, stress concentration, design of curved beams, selection of standardized elements, and lubrication. The objective of the course is to enable the student to handle design problems with confidence and assurance.

MNE 400 variable credits

Engineering Internship

Prerequisite: Senior standing

Experiential learning in conjunction with an industrial or governmental agency project under the joint supervision of an outside sponsor and a faculty advisor. To be eligible, a student should have completed the junior-year courses. A detailed project proposal must be prepared by the student for departmental approval prior to the start of the project. Typically, three credits will be assigned. Based upon the determination of the advisor and sponsor, the learning component shall be at least 100 hours out of the total work hours. Up to six credits may be assigned for exceptional projects that extend over two semesters. MNE 400 may be used to satisfy one 3-credit technical elective course.

MNE 411 three credits

Heat Transfer

3 hours lecture

Prerequisites: MNE 220, EGR 301

Principles of heat conduction, forced and free convection and thermal radiation, and their application to various engineering problems. Mass transfer and its analogy to heat transfer phenomena are sketched. Special problems, such as boiling and

condensation, heat transfer in high speed flow, and fire propagation are introduced. Mathematical analysis motivated by physical reasoning is emphasized.

MNE 422 three credits

Energy Conversion

3 hours lecture

Prerequisites: MNE 321, 332, ECE 212, consent of instructor

An introduction to various energy resources, followed by a description of the use of chemical potential energy, nuclear energy and solar energy, the analysis and design criteria for various energy conversion devices, such as generators, transformers, motors, power distribution systems, solar cells, and so on. Understanding of working principles and essential design conditions is emphasized.

MNE 423 three credits

Refrigeration and Air Conditioning

3 hours lecture

Prerequisites: MNE 321, consent of instructor

Principles of refrigeration are presented with applications to vapor-compression, steam-jet and absorption systems, together with heat pumps. Psychrometrics and the physiological factors involved in air-conditioning are discussed along with the analysis of various processes. In particular the use and analysis of water cooling towers is emphasized.

MNE 425 three credits

Power Plant Design and Engineering

3 hours lecture

Prerequisites: MNE 321, consent of instructor

Theory as a basis for plant design and equipment selection. Practical design calculations including heat balance are carried out. Fossil- and nuclear-fueled plants as well as gas turbine and hydroelectric plants are studied. The economics of alternatives is discussed.

MNE 431 three credits

Fluid Mechanics II

3 hours lecture

Prerequisites: MNE 332, consent of instructor

Basic equations of fluid mechanics, applied to quasi one-dimensional, compressible flows, including: isentropic flows with area changes, Fanno and Rayleigh flows, and normal shock waves. Two-dimensional flow fields are studied using Prandtl-Meyer expansion and oblique shock waves. The basic concepts are applied to selected topics

such as: aircraft and rocket propulsion, combustion chambers in jets and rockets, wind tunnels and shock tubes, supersonic diffusers, and flow about supersonic airfoils.

MNE 432 three credits
Aircraft and Rocket Propulsion Systems

3 hours lecture
Prerequisites: MNE 321, 431, consent of instructor

The mechanics and thermodynamics of airborne propulsion systems. Thrust equations and efficiencies are derived from first principles and applied to a variety of systems. Airbreathing engines that are discussed include ramjets, turbojets, turbofans, and turboprops. The aero-thermodynamics of inlets and nozzles is presented. The course concludes with an introduction to rocket propulsion, including the identification and classification of types of rocket systems, fundamental definitions and derivations, and rocket dynamics.

MNE 441 three credits
Mechanical Vibrations

3 hours lecture
Prerequisites: EGR 242, 301, consent of instructor

Discussion of generalized coordinates and the Lagrangian method of determining a system's equations of motion. Normal modes and normal coordinates are introduced and the method of matrix iteration is used to find natural frequencies and modes. Free vibration of continuous systems is considered and techniques for finding natural frequencies are developed. Forced and transient responses of one degree of freedom systems are treated extensively, and forced response of multi-degree of freedom systems is discussed. Electrical analogies, use of the analog computer, and modeling of actual physical systems are discussed.

MNE 452 three credits
Mechanics of Materials II

3 hours lecture
Prerequisites: MNE 252, EGR 301, consent of instructor

After reviewing the development of the flexure formula, the stress equation is derived for unsymmetrical bending. Curved beams loaded in the plane of curvature are analyzed as are beams with combined axial and lateral loadings. The general equation for beams on elastic foundations and its applications are studied. Stresses and deflections due to dynamic loads are examined. The basic equations of elasticity are developed and two-dimensional

problems analyzed using Airy's stress function. Solutions are compared to strength of materials results. Energy methods are discussed. The Lagrange plate equation is derived and plates fabricated from modern composite materials are discussed.

MNE 460 three credits
Combustion Systems

3 hours lecture
Prerequisites: MNE 321, 332, 411, concurrently; consent of instructor
Review of fundamental aspects of combustion, with concentration on the following combustion systems: internal combustion engines, gas turbine power plant, fossil fuel power plant, modern solid waste incineration. Students will present special projects or several seminars.

MNE 463 three credits
Kinematic and Dynamic Analysis of Machines

3 hours lecture
Prerequisites: EGR 242, 301, consent of instructor
Introduction to the various types of mechanisms, their application and methods of operations. Four-bar linkages are discussed in detail with emphasis on the velocity and acceleration analysis of slider-crank, quick-return, scotch-yoke and intermittent motion mechanisms. Vector methodology is used extensively, along with graphical and complex variable methods. Different types of cams and followers are studied and profiles determined satisfying given tie-displacement requirements. Both standard and non-standard gears are treated with regard to their construction, performance, usage and geometrical features. Various types of gear trains are analyzed. Force and torque analysis of various machine parts is performed for both static and dynamic conditions. Gyroscopic devices are treated. The course concludes with the study of balance of machinery under static and dynamic conditions.

MNE 466 three credits
Control Theory

3 hours lecture
Prerequisites: ECE 212, EGR 301
Introduction to sensors used widely in control systems. Analog as well as digital control of machines and processes are discussed along with modeling of control system elements and linearization method and its applicability. Both frequency and time domain control design techniques are discussed. Algorithms for computer control

and the effect of sampling on stability are developed. Applications of analog control devices and microprocessors are included.

MNE 471 three credits
Physical Metallurgy

3 hours lecture
Prerequisites: MNE 231, consent of instructor
Structure of metals and alloys and their determination by x-ray diffraction. Structural imperfections and their influence on mechanical properties are covered. The electron theory of metal is introduced. Binary phase diagrams are studied on the basis of thermodynamic principles. Emphasis is placed on the iron-carbon system, and subjects like creep and fatigue are also considered.

MNE 472 three credits
Metal Forming Operations

3 hours lecture
Prerequisites: MNE 231, consent of instructor
Plastic deformation in terms of dislocation theory. Various methods of the failure of metals are discussed and the field of plastic working and shaping is studied. Emphasis is on metallurgical interpretation and the influence of structure on mechanical properties. Operations such as forging, rolling, extrusion, and rod, wire and tube drawing are presented in some detail.

MNE 473 three credits
Powder Metallurgy

3 hours lecture
Prerequisites: MNE 231, consent of instructor
Characterization and production of powder. Measuring techniques and bulk properties. Powder compaction methods. Behavior of powders during compaction and green properties. Sintering. Material transport and transformations during sintering. Sintering atmospheres and furnaces. Properties of sintered materials. Engineering properties and product design applications.

MNE 475 three credits
Principles of Foundry Engineering

3 hours lecture
Prerequisites: MNE 231, consent of instructor
Principles relative to the following aspects of manufacturing metal castings: nature of cast metals; solidification of castings; need and design of risers; flow of metals and gating systems; molding materials and processes; design of castings and patterns; metal melting and refining in foundries: refractories, furnaces, reactions, inoculants.

MNE 476 three credits

Manufacturing Quality Control

3 hours lecture

Prerequisites: EGR 301, consent of instructor
Principles and procedures necessary to control processes and quality of manufactured products. Topics include: product quality, quality assurance, destructive and non-destructive tests, statistical methods in quality control, acceptance sampling, rectifying inspection, sensors, automated inspection, control charts, total quality control, quality circle, quality philosophy of Deming, Taguchi, and others.

MNE 480 three credits

Computer-Aided Engineering

3 hours lecture

Prerequisites: EGR 301, MNE 252, MNE 292, consent of the instructor
The fundamental concepts of computer-aided engineering (CAE). The topics include interactive computer graphics for 3D CAE systems; CAE hardware and software; solid modeling; and finite element analysis. Emphasis will be placed on the current state-of-the-art technology, the integration of CAE systems, and future trends. The student will also be introduced to the mathematics of computer graphics. Classroom lectures will be supplemented by laboratory demonstration of interactive graphics, and interactive finite element analysis.

MNE 481 three credits

Computer-Aided Manufacturing

3 hours lecture

Prerequisite: MNE 345; Corequisite: MNE 355, consent of instructor
Scope, principles and various applications of computer-aided manufacturing. This involves the use of computers in monitoring and controlling of machine tools and manufacturing systems. The concepts of NC, CNC, DNC, computer-assisted part programming, group technology, computer-aided process planning, FMS and FMC will be discussed.

MNE 482 three credits

Robotics

3 hours lecture, 1 hour laboratory

Prerequisites: Senior standing, consent of instructor
Introduction to the various aspects of the mechanics of robotics, its classifications and terminologies involved. Direct and inverse kinematics of a robot manipulator are treated in detail with the application of homogeneous and Denavit-Hartenberg transformation techniques. Dynamics, control and programming of a robot

manipulator are discussed with associated laboratory work.

MNE 485 three credits

Introduction to the Finite Element Method

3 hours lecture

Prerequisites: EGR 301, MNE 252, MNE 292, consent of instructor
Principles of the finite element method for solid mechanics. In addition, some fluid and heat flow problems will be covered. Topics include the direct method; energy methods; variational principles; interpolation functions; and the modeling of truss, beam, plate, and shell structures. This course is half theory and half computer modeling.

MNE 488 three credits

Operations Research

3 hours lecture

Prerequisite: EGR 301
Concepts and principles associated with operations research techniques for engineers, which are powerful tools for product design, production planning and control. Introduction to linear programming, formulation of linear programming, the Simplex Method, transportation model and its variants, network models, inventory models, forecasting models, Markovian decision process, and classical optimization theory. Students work in a team on a design project related to these topics.

MNE 490 three credits

Special Topics in Mechanical Engineering

3 hours lecture

Prerequisite: consent of instructor
Visiting professors or members of the faculty present current topics of interest in their areas of expertise.

MNE 491 four credits **E**

Advanced Machine Design

3 hours lecture, 2 hours laboratory

Prerequisite: MNE 381, senior standing
The design of machines. The complete design process is carried out from the conceptual stage through consideration of alternative designs to final creation of the device. Extensive use of the computer is made to facilitate the process. Emphasis is placed on design and automation of electro-mechanical and electro-hydraulic systems

MNE 492 three credits

Laser Doppler Anemometry in Fluid Flow

2 hours lecture, 3 hours laboratory

Prerequisites: MNE 332, consent of instructor
Introduction to laser doppler anemometry

(LDA) in fluid flow. The following topics are considered: principles of LDA; doppler effect; fringe mode LDA; seeding; frequency shifting; digital data acquisition and signal processing; time correlation; spectra; experiments on flow over a cylinder and an air foil, on turbulent jets, pipe flow and wave motion.

MNE 495 three credits

Independent Study

Prerequisites: Upper-division standing; permission of instructor, department chairperson, and college dean
A student works under the direction of a faculty member to pursue a specific line of study in an area of interest to the student. The work may deal with subject matter not normally available in the curriculum, or may involve a design project. Study under the supervision of a faculty member in an area not otherwise part of the discipline's course offerings. Conditions and hours to be arranged.

MNE 196, 296, 396, 496 three credits

Directed Study

Lecture/laboratory arranged as required
Prerequisites: Permission of the instructor, department chairperson, and college dean
Study under the supervision of a faculty member in an area covered in a regular course not currently being offered. Conditions and hours to be arranged.

MNE 497 two credits **O, E**

Mechanical Engineering Design Project I

Prerequisite: Senior standing

Professional and management activities of project engineering, first of a two course sequence. Topics covered include engineering ethics, selection of senior design project, and initial product design leading to a written and oral presentation of project proposal. Project will be completed in MNE 498, but work done in this course is evaluated and a course grade is given.

MNE 498 two credits **O, E**

Mechanical Engineering Design Project II

Prerequisite: MNE 497

Application of knowledge gained in various courses to the synthesis, analysis, and design of a system in a particular field of interest selected by student. This is the second of a two-course sequence. Design project proposed in MNE 497 will be completed, and a final report and oral presentation will be made before a panel of judges.

Note: Some graduate courses may be open to undergraduates. Please consult your department chairperson. See the Graduate Catalogue for graduate general and program requirements.

Graduate Courses in Mechanical Engineering

MNE 501 three credits

Advanced Engineering Mathematics

Prerequisite: EGR 301 or equivalent
Ordinary differential equations: power series solutions; solutions to Legendre, Bessel, Hermite, associated Legendre, and Mathieu equations. Partial differential equations: separation of variables; transform methods; eigenvalues; Green's function; solutions to elliptic, parabolic and hyperbolic equations.

MNE 502 three credits

Applied Numerical Methods

Prerequisite: EGR 301 or equivalent
An introduction to the tools of numerical analysis used in all areas of engineering study. Solution of linear systems and non-linear systems of equations. Numerical integration of functions ODE's and PDE's: differentiation, error control, stability and accuracy. Extensive programming in C is required.

MNE 503 three credits

Continuum Mechanics

Prerequisites: EGR 301 and MNE 252 or equivalents
A comprehensive study of the fundamental principles of Continuum Mechanics. The following topics are covered: stress, strain, and strain rate tensors; Lagrangian and Eulerian descriptions; conservation laws; constitutive relations; Navier-Cauchy and Navier Stokes equations; Newtonian fluids.

MNE 504 three credits

Advanced Mechanics of Fluids

Prerequisite: MNE 332 or equivalent
Integral Transformation: Divergence Theorem; Stokes Theorem. Reynolds Transport Theorem. Navier-Stokes equations. Kelvin's theorem. Vorticity Transport. Crocco's Theorem. Viscous flow: boundary layers, buoyancy-driven flows.

MNE 511 three credits

Theory of Elasticity

Prerequisite: MNE 503 or equivalent
Basic field equations. Generalized Hooke's law. General concepts of stress and strain. Equilibrium equations. Plane problems. Stress functions. Saint Venant torsion and flexure. Introduction to three-dimensional problems. Thermoelasticity. Anisotropic solutions.

MNE 512 three credits

Plasticity and Metal Forming Theory

Prerequisite: MNE 503 or equivalent
Tresca and von Mises yield criteria and their associated flow rules. Slip-line field theory and Geiringer velocity equations. Upper bound and lower bound theories. Application of the plasticity theories to rigid, perfectly-plastic bodies undergoing large plastic deformation in various metal forming processes such as wire drawing, extrusion, forging, deep drawing, etc.

MNE 513 three credits

Theory of Plates and Shells

Prerequisite: EGR 242, Pre or corequisite: MNE 503
Basic plate and shell equations; solutions of different shape plates. Application of cylindrical and spherical shell equations. Linear and non-linear situations. Plates on elastic foundations. Numerical solutions of plates and shells. Membrane theory.

MNE 515 three credits

Finite Element Analysis

Prerequisite: MNE 485 or equivalent
A broad study of the principles of Finite Element Analysis. The following topics are covered: energy methods; variational principles; element formulation; coordinate transformation; problems in dynamics, solids, and heat transfer; non-linear problems; numerical errors and convergence; computer modeling.

MNE 518 three credits

Advanced Physical Metallurgy

Prerequisites: EGR 231, EGR 221 or equivalents
Extending understanding of the effect of structure on the properties of metals and alloys. Deviation in various forms from perfect crystallinity will be analyzed. Metallurgical processes of typical ferrous and nonferrous alloys will be explored.

MNE 519 three credits

Metal Casting Principles

Prerequisites: EGR 231, MNE 345, MNE 411 or equivalents
Advanced concepts in solidification of alloys. Mutually dependent topics are: flow of liquid metals, transient heat transfer, phase and state change. Consequence of these in the design of sound castings will be presented.

MNE 521 three credits

Classical Thermodynamics

Prerequisite: EGR 232 or equivalent
An in-depth study of the fundamental principles of classical thermodynamics. The following topics are covered: equilibrium;

temperature; equations of state; fundamental equations; First Law for steady, unsteady and continuous systems; Born-Caratheodory formulation of the Second Law; Third Law.

MNE 522 three credits

Statistical Thermodynamics

Prerequisite: EGR 232 or equivalent
The principles of thermodynamics based on a microscopic approach. The following topics are covered: statistical concepts, Kinetic Theory, Gibb'sian ensembles, partition function, Liouville's theorem, Boltzmann equation and the Chapman-Enskog solution, calculation of equilibrium and transport properties.

MNE 525 three credits

Bioengineering Fundamentals

Applications of thermodynamics, fluid mechanics, and transport study to biological systems. An introduction to chemical kinetics, intercellular interactions, and basic biomechanics is also included. Emphasis is on engineering with relevance to clinical and research medical applications.

MNE 530 three credits

Simulation Modeling

Prerequisites: Advanced mathematics (EGR 301) and computer programming (EGR 102) or equivalents
Concepts and principles associated with systems simulation and modeling using contemporary software such as Simulation with Arena. Topics include probability and statistics, discrete event simulation, statistical techniques in simulation modeling. Statistical analysis is integrated for the most part into the simulation modeling, reflecting the joint nature of these activities in good simulation studies, and continuous simulation of industrial and manufacturing systems using SIMAN language. The student will work in a team producing a design project relating to these topics.

MNE 531 three credits

Advanced Dynamics

Prerequisites: EGR 242, EGR 301 or equivalents
A course of study of technologically useful topics from dynamics, such as: three dimensional motion of rigid bodies; dynamics of flexible rotors and linkages; balancing of machinery and non-linear forces and stability. Variational methods and numerical techniques will be introduced.

MNE 532 three credits

Advanced Robotics

Prerequisite: MNE 482 or equivalent

Advanced course in kinematics, dynamics and control of robots. Topics covered include: trajectory generation, position and force control of open chain and closed chain manipulators, kinematic redundancy, link flexibility, artificial intelligence and integration of industrial robots in integrated manufacturing systems.

MNE 533 three credits
Manufacturing Automation

Prerequisite: MNE 345 or equivalent
A study of the different components of an automated manufacturing system. Design of the hardware and software used in the different manufacturing systems. Analysis, modeling, performance and economics of flexible manufacturing systems and flexible manufacturing cells. Design of parts to facilitate automatic assembly.

MNE 534 three credits
Advanced Vibrations

Prerequisites: EGR 242, EGR 301, or equivalent
Vibration of structures and machine components, free and forced vibrations, damped vibrations, normal modes, critical speeds, non-linear systems techniques, phase plane and function description methods.

MNE 536 three credits
Advanced Control Theory

Prerequisite: MNE 466 or equivalent
Advanced course in design of control systems. Topics covered include: input-output and state space description; controllability and observability of multi-input multi-output systems; pole placement; observer design and separation principle; linear quadratic optimal control; non-linear systems and linearization; Lyapunov stability theory; application to electromechanical systems.

MNE 537 three credits
Manufacturing Systems Design

Prerequisite: MNE 345 or equivalent
Advanced topics in manufacturing systems design and analysis with emphasis on modeling and integration methodologies. Specific topics include production flow analysis, group technology, manufacturing cell design, facilities location and work design, material handling systems and automated guided vehicles, flexible manufacturing systems, and systems evaluation. Term design projects are required using computer and software tools.

MNE 538 three credits
Manufacturing Planning and Control

Prerequisite: EGR 301 or equivalent
Advanced topics in manufacturing production planning and control with emphasis on design and resource utilization. Specific topics include operations planning and control, linear programming, capacity planning, resource material planning, inventory control, project scheduling, and manufacturing cost analysis. Term design projects are required using computer and software tools.

MNE 539 three credits
Engineering Optimization

Prerequisite: EGR 301 or equivalent
Advanced topics in engineering optimization with emphasis on the algorithm and applications. Specific topics include linear and nonlinear optimization, mathematical modeling, constrained optimality criteria, transformation methods, constrained direct search, quadratic approximation methods for constrained problems, and comparison of constrained optimization methods. Term design projects are required using computer and software tools.

MNE 542 three credits
Convective Heat Transfer

Prerequisite: MNE 411 or equivalent
Boundary layer flow problems: laminar and turbulent plows. Thermal boundary layer plows. Dimensional analysis. Forced convection problems. Free convection problems. Duct flows. Boiling and Condensation. Special convection problems. Heat Exchange Design. Applications.

MNE 551 three credits
Compressible Fluid Flow

Prerequisite: MNE 431 or equivalent
Conservation laws. Wave propagation in compressible media. Isentropic flow. Normal and oblique shock waves. Prandtl-Meyer flow. Converging-diverging nozzles and supersonic diffusers. Supersonic oblique shock diffusers. Exit flow for underexpanded and overexpanded supersonic nozzles. Fanne line flow. Rayleigh line flow.

MNE 552 three credits
Computational Fluid Mechanics

Prerequisite: MNE 504
Solutions to Navier-Stokes equations. Finite difference methods: Lax-Wendroff, MacCormack, Rusanov, implicit, forward-time and centered-method, leap-frog/ Dufort-Frankel, ADI, predictor-corrector methods. Grid generation. Accuracy and convergence.

MNE 560 three credits
Methods of Experimental Research

Prerequisite: Graduate standing
The need and subject matter of research. Laws, truths, analogy and hypothesis. Identifying and clustering parameters. Use of models. Experimental setup. Induction, deduction, statistics, and conclusions. Presentation and use of finding.

MNE 570 three credits
Reading and Research

Prerequisite: Graduate standing and approval of student's graduate committee
Independent study under faculty supervision. Intensive literature search culminating in a technical report. Oral presentation at the option of the faculty.

MNE 580 six credits
Masters Thesis

Prerequisites: Graduate standing, Thesis Option, and approval of the student's Graduate Committee
Thesis research on an experimental or theoretical project in mechanical engineering under a faculty advisor. A formal thesis must be submitted to fulfill the course requirements.

MNE 590 six credits
Masters Project

Prerequisites: Graduate standing, Project Option, and approval of the student's Graduate Committee
Project research in conjunction with industry under a faculty advisor. A formal report must be submitted to fulfill the course requirements.