DEPARTMENT OF MECHANICAL SCIENCE & ENGINEERING

department website: Mechanical Science & Engineering (http://mechse.illinois.edu)
department faculty: Mechanical Science & Engineering Faculty (https://mechse.illinois.edu/people)
college catalog page: Engineering Catalog (http://catalog.illinois.edu/engineer)
college website: https://engineering.illinois.edu/

Mechanical engineering is one of the most diverse engineering fields available, embracing many subfields and affecting all aspects of our lives. Mechanical engineers work on new machines, products, and processes that hold the promise of better lives for all of us. They are concerned with both technological and economic aspects in the design, development, and use of their products. Today, one of the challenges is to design efficient, low-cost machines and processes that use the fewest possible natural resources to improve the lives of people throughout the world.

In this ABET-accredited program, engineering design, communication, teamwork, and laboratory experiences are integrated throughout the curriculum from freshman to senior year. The technical portion of the mechanical engineering curriculum is designed as a sequence of increasingly specialized experiences. The entering student's first year is spent mastering the basics of science: math, chemistry, and physics. Building on this base, in the second year students begin to take fundamental engineering courses such as statics, dynamics, basic circuits and electronics, thermodynamics, and strength of materials. By the third year, students are taking specialized mechanical engineering courses in the subfields of fluid mechanics, heat transfer, dynamic systems and controls, materials, mechanical design, and manufacturing. Finally, during the senior year, students have the opportunity to both broaden and deepen their knowledge of the field through individually chosen technical elective courses. At the end of the curriculum, students take the capstone senior design course where the knowledge and skills they have learned are applied to projects submitted to the department by corporate or faculty sponsors, preparing Mechanical Engineering students for their next leap into industry or graduate school.

A combined B.S.-M.S. Mechanical Engineering degree program is available. Its admission and course requirements are described in the College of Engineering program information section (http://catalog.illinois.edu/undergraduate/engineer).

Engineering mechanics is a discipline devoted to the solution of engineering and mechanics problems through integrated application of mathematical, scientific, and engineering principles. Special emphasis is placed on the physical principles underlying modern engineering design.

In this ABET-accredited program, students in engineering mechanics develop a strong foundation in mathematics, physics, and chemistry. The program derives its strength from a rigorous curriculum composed of statics, dynamics, solid mechanics, fluid mechanics, and mechanics of materials courses. These topics form the basis of all engineering disciplines and have wide applicability in modern engineering. Special emphasis is placed on advanced dynamics, continuum mechanics, and the rapidly emerging field of computational mechanics. Laboratory experiments in fluid mechanics and mechanics of materials complement an integrated design sequence, which starts freshman year. Engineering design, communication, teamwork, and laboratory experiences are integrated throughout the entire curriculum. Students also have the opportunity for independent, creative work in a one-on-one or small group environment under the supervision of a faculty member.

Students in engineering mechanics also benefit from a built-in area of specialization in one of seven secondary fields within mechanics, such as biomechanics, experimental mechanics, mechanics of materials and more. Alternatively, students may fashion their own area of specialization with departmental approval. At the end of the curriculum, students take the capstone senior design course where the knowledge and skills they have learned are applied to projects submitted to the department by corporate or faculty sponsors, preparing Engineering Mechanics students for their next leap into industry or graduate school.

director of undergraduate studies: Enter Name
undergraduate office: 154 Mechanical Engineering Building
1206 West Green, Urbana, IL 61801
email: mechse-ug-advise@illinois.edu

Undergraduate Programs:
- **major: Mechanical Engineering, BS** (http://catalog.illinois.edu/undergraduate/bs_mech-engin)
- **major: Engineering Mechanics, BS** (http://catalog.illinois.edu/undergraduate/bs_engin-mech)

Mechanical engineering is one of the most diverse engineering fields available, embracing many subfields and affecting all aspects of our lives. Mechanical engineers work on new machines, products, and processes that hold the promise of better lives for all of us. They are concerned with both technological and economic aspects in the design, development, and use of their products. Today, one of the challenges is to design efficient, low-cost machines and processes that use the fewest possible natural resources to improve the lives of people throughout the world.

In this ABET-accredited program, engineering design, communication, teamwork, and laboratory experiences are integrated throughout the curriculum from freshman to senior year. The technical portion of the mechanical engineering curriculum is designed as a sequence of increasingly specialized experiences. The entering student's first year is spent mastering the basics of science: math, chemistry, and physics. Building on this base, in the second year students begin to take fundamental engineering courses such as statics, dynamics, basic circuits and electronics, thermodynamics, and strength of materials. By the third year, students are taking specialized mechanical engineering courses in the subfields of fluid mechanics, heat transfer, dynamic systems and controls, materials, mechanical design, and manufacturing. Finally, during the senior year, students have the opportunity to both broaden and deepen their knowledge of the field through individually chosen technical elective courses. At the end of the curriculum, students take the capstone senior design course where the knowledge and skills they have learned are applied to projects submitted to the department by corporate or faculty sponsors, preparing Mechanical Engineering students for their next leap into industry or graduate school.

A combined B.S.-M.S. Mechanical Engineering degree program is available. Its admission and course requirements are described in the College of Engineering program information section (http://catalog.illinois.edu/undergraduate/engineer).

Engineering mechanics is a discipline devoted to the solution of engineering and mechanics problems through integrated application of mathematical, scientific, and engineering principles. Special emphasis is placed on the physical principles underlying modern engineering design.

In this ABET-accredited program, students in engineering mechanics develop a strong foundation in mathematics, physics, and chemistry. The program derives its strength from a rigorous curriculum composed of statics, dynamics, solid mechanics, fluid mechanics, and mechanics of materials courses. These topics form the basis of all engineering disciplines and have wide applicability in modern engineering. Special emphasis is placed on advanced dynamics, continuum mechanics, and the rapidly emerging field of computational mechanics. Laboratory experiments in fluid mechanics and mechanics of materials complement an integrated design sequence, which starts freshman year. Engineering design, communication, teamwork, and laboratory experiences are integrated throughout the entire curriculum. Students also have the opportunity for independent, creative work in a one-on-one or small group environment under the supervision of a faculty member.

Students in engineering mechanics also benefit from a built-in area of specialization in one of seven secondary fields within mechanics, such as biomechanics, experimental mechanics, mechanics of materials and more. Alternatively, students may fashion their own area of specialization with departmental approval. At the end of the curriculum, students take the capstone senior design course where the knowledge and skills they have learned are applied to projects submitted to the department by corporate or faculty sponsors, preparing Engineering Mechanics students for their next leap into industry or graduate school.

director of graduate studies: Taher Saif
graduate office: 168 Mechanical Engineering Building
1206 West Green Street
Urbana, IL 61801
phone: (217) 244-3416
graduate email: mechse-grad@illinois.edu

mechanics programs: Ken Christensen
mechanics office: 154 Mechanical Engineering Building
1206 West Green Street
Urbana, IL 61801
phone: (217) 333-4388
email: mechse-mechanics@illinois.edu

Graduate Programs:

- **degree: Mechanical Engineering, MEng** (http://catalog.illinois.edu/graduate/graduate-majors/mechse/me-mech-eng)
  - **concentration: Computational Engineering Concentration** (http://catalog.illinois.edu/graduate/graduate-majors/mechse/computational-eng) **(MEng degree only)**
- **degree: Mechanical Engineering, MS** (http://catalog.illinois.edu/graduate/graduate-majors/mechse/ms-mech-eng)
- **online degree: Mechanical Engineering, MS- online** (http://catalog.illinois.edu/graduate/graduate-majors/mechse/#onlinetext)
- **degree: Theoretical and Applied Mechanics, MS** (http://catalog.illinois.edu/graduate/graduate-majors/mechse/ms-theoretical-applied-mech)
- **degree: Mechanical Engineering, PhD** (http://catalog.illinois.edu/graduate/graduate-majors/mechse/dr-philo-mech-eng)
- **degree: Theoretical and Applied Mechanics, PhD** (http://catalog.illinois.edu/graduate/graduate-majors/mechse/dr-philo-theo-applied-mech)
- **concentration: Biomechanics Concentration** (http://catalog.illinois.edu/graduate/graduate-majors/bio-engin/conc-biomechanics)

Graduate Degree Programs

Building upon the longstanding strengths of programs in mechanical engineering and in mechanics, the Department of Mechanical Science and Engineering (MechSE) at the University of Illinois at Urbana-Champaign is taking a bold, new approach to research and education that will enable it to address some of the most pressing problems facing the nation and the world. A new paradigm in research is being created in the department by integrating basic sciences such as biology, chemistry, applied mathematics, and applied physics with the traditional mechanical engineering and engineering mechanics disciplines of fluid mechanics-thermal science, solid mechanics-materials, and controls-dynamics. This integration is fostering new directions and discoveries in nanomechanics, nanomanufacturing, biomechanics and computational science and engineering.

The goal of all research in the department is to address critical societal problems in the areas of health, security-defense, energy-environment, manufacturing, and transportation. While the basic function of departmental research is generation of new knowledge, a growing number of projects are prompted by current needs of the State of Illinois and of the nation.

The department offers graduate programs leading to master's and doctoral degrees with exciting research opportunities as described in the Faculty Research Interests section below. Opportunity also exists for specializing in:

1. computational science and engineering via the Computational Science and Engineering (CSE) (http://www.cse.illinois.edu) transcriptable Concentration
2. energy and sustainability engineering via the Energy and Sustainability Engineering (EaSE) Option (http://ease.illinois.edu).

The M.Eng. is a professional master's degree program for students whose primary intent is a career in industry or government. This degree differs from the Master of Science degree in that it is a terminal degree and not a pathway to a doctoral program.

Admission

An applicant for admission to the Department of Mechanical Science and Engineering must:

1. Be a graduate of an institution awarding a baccalaureate degree equivalent to that granted by the University of Illinois at Urbana-Champaign;
2. be adequately prepared for advanced study as demonstrated by his or her previous program of study and scholastic record; and
3. be recommended for admission by the Department of Mechanical Science and Engineering. A minimum grade point average of 3.25 (A = 4.00) for the last two years of undergraduate study is required and a 3.50 for any previous graduate work completed.

Scores on the Graduate Record Examination (GRE) (http://www.ets.org) general test are required of all applicants. Based upon the previous preparation of the student, prerequisite courses may be specified by the advisor, but the credit may not be applied toward a degree.

All applicants whose native language is not English must submit a minimum TOEFL (http://www.toefl.org) score of 103 (iBT), 257 (CBT), or 613 (PBT); or minimum International English Language Testing System (IELTS) (http://www.ielts.org) academic exam scores of 7.0 overall and 6.0 in all subsections. Applicants may be exempt from the TOEFL if certain criteria (http://grad.illinois.edu/admissions/instructions/04c) are met. Full admission status (http://grad.illinois.edu/admissions/instructions/04c) is granted for those meeting the minimum requirements and having taken the TOEFL or IELTS since the scores required for admission to MechSE are above the minimum scores demonstrating an acceptable level of English language proficiency.

Applicants to the M.Eng. must have a bachelor's or master's degree in engineering or a related field and will be considered for admission if they have a grade point average of at least 3.00 (A = 4.00) for the last two years of undergraduate study. Admission is possible for the spring term, but most admissions are for the fall term. The same requirements as listed above apply for all applicants whose native language is not English.

Students may apply to the Medical Scholars Program prior to beginning graduate school or while in the graduate program. Applicants to the Medical Scholars Program must meet the admissions standards for and be accepted into both Mechanical Science and Engineering and the College of Medicine. An application to the Medical Scholars Program will also serve as the application to the Mechanical Science and Engineering graduate programs. Further information on this program is available by contacting the Medical Scholars Program, (125 Medical Sciences Building, (217)-333-8146, mspo@illinois.edu).

Students interested in the joint M.S.M.E.-M.B.A. degree program must apply initially to the M.B.A. program. In the term in which 60 hours of the M.B.A. course work prescribed for the joint-degree program is expected to be completed, they become eligible to petition to transfer to the M.S.M.E. degree program and with MechSE approval, may be admitted under the joint M.S.M.E.-M.B.A. program code.

Off-Campus Programs

The department offers the M.S. in Mechanical Engineering with both a thesis and a non-thesis option as described above.

Graduate Teaching Experience

Although teaching is not a general Graduate College requirement, experience in teaching is considered an important part of the graduate experience in both the ME and TAM Ph.D. programs. The TAM Ph.D. requires that one semester of teaching assistantship be completed during the program.

Faculty Research Interests

A new paradigm in research is being created in the department by integrating basic sciences such as biology, chemistry, applied mathematics, and applied physics with the traditional mechanical engineering and engineering mechanics disciplines of fluid mechanics/thermal science, solid mechanics/materials and controls/dynamics. This integration is fostering new directions and discoveries in nanomechanics, nanomanufacturing, biomechanics and computational science and engineering.

The goal of all research in the department is to address critical societal problems in the areas of health, security/defense, energy/environment, manufacturing, and transportation. While the basic function of departmental research is generation of new knowledge, a growing number of projects are prompted by current needs of the state of Illinois and of the nation.

Faculty research interests include the following:

- Biomechanics – cell adhesion and motility, biological machines, bio-fluid mechanics, orthopedic biomechanics, musculoskeletal biomechanics, rehabilitation engineering, bone mechanics, composite biological nanomaterials, single-cell mechanics, synthetic biomaterials, failure mechanics of biomaterials, cytoskeletal biomechanics, mechanotransduction, bio-imaging of cytoskeletal structures and stress distribution in living cells, human motion analysis, human-machine systems.
- Nanomechanics/nanomanufacturing – micro/nano-fluidics, NEMS and MEMS, photonic metamaterials and devices, 3D micro/nanofabrication, process planning, programmable machines, nanotubes, nano-materials, electronic and photonic materials, metal cutting, micro/meso-machining, agile fixturing, scanning probe microscopy, micro/nano heat and mass transfer, feature-based cost analysis, rapid prototyping, interface surface science and technology, tribology, magnetic storage, friction/vibration characterization, microscale transport, electrokinetic phenomena, nano-positioning, atomic force microscopy, nanoscale actuation and robotics.
- Controls/dynamics – autonomous networked vehicle control, nonlinear mechanical systems and phenomena, distributed-parameter systems, wavelet methods, stability theory, piecewise smooth dynamics, multi-body dynamics, control of multi-rate and asynchronous systems, equi-variant (symmetric) dynamical systems, control using methods of stochastic dynamics, experimental and analytical modal analysis, and control theory (non-linear, adaptive, robust, optimal, and distributed) with application to mechanical and electromechanical systems.
- Fluid mechanics/thermal sciences – bio-fluids, combustion, propulsion, energy systems and the environment, IC engines, gas turbines, laser diagnostics, energetic materials, combustion synthesis of materials, micro- and nano-scale heat transfer, kinetics of chemical processes, two-phase flow, liquid atomization and spray, air-conditioning and refrigeration systems, micro-fluidics, computational fluid dynamics, compressible flow, fluid-structure interactions, meshless methods, detonation, deflagration-to-detonation transition,

shock propagation, reacting flows, internal ballistics of rockets and guns, continual eddies, turbulent boundary layers, turbulent wakes, stratified turbulence, turbulence simulation, instability modes, vortex dynamics, coating flows, flow separation, three-dimensional foams, direct numerical simulation, large-eddy simulation, and particle-image velocimetry.
- Solid mechanics/materials – bio-materials, composite biological nanomaterials, electronic and photonic materials, stochastic mechanics, mechanics and transport in random media, thermomechanics, composite materials, creep, fatigue, fracture, high-temperature material behavior, polymer processing, ceramic-matrix composites, thin films, deformation processes, crystal plasticity, micro-scale phenomena, non-linear dynamics, continuum mechanics, ferroelectric ceramics, shape-memory alloys, composite interfaces, woven laminates, electronic packaging, energetic materials, corn-based composites, orientable elastomers, thermoelasticity, dynamic plasticity, residual stresses, martensitic microstructure, surface crack growth, brittle-to-ductile transition, pure shear failure, shear-band measurements, damage evolution, creep resistance, hydrogen embrittlement, powder consolidation, solidification, strain-gradient plasticity, nanotubes, composite interfaces, continuum-atomistic coupling, surface waves, wave scattering, crack detection, vibration transport, diffuse waves, stochastic waves, reverberant ultrasound and casting processes.

Centers, Programs, and Institutes

The following research centers and programs are integral to the MechSE graduate program:

- Air Conditioning and Refrigeration Center (ACRC)
- Center for Intracellular Mechanics
- Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing systems (Nano-CEMMS)
- Continuous Casting Consortium (CCC)
- Cooperative Networked Control of Dynamical Peer-to-Peer Vehicle Systems
- Fracture Control Program
- Manufacturing Research Center
- Midwest Structural Sciences Center
- The Center for Advanced Automotive Bio-Fuel Combustion Engines
- The Center for Process Simulation and Design
- The Center of Advanced Materials for Purification of Water with Systems (The WaterCAMPWS)
- The Global Enterprise for Micro-Mechanics and Molecular Medicine (GEM4)

To learn more about the research centers and programs within the MechSE department, please visit the department's research center Web site (http://mechanical.illinois.edu/research).

Facilities and Resources

Research facilities include laboratories for advanced automation, air conditioning and refrigeration, combustion, computer-integrated manufacturing, control systems, design for manufacturing, gas dynamics, heat transfer, high-temperature materials, human factors and simulation of human-machine interaction, human dynamics and controls, intracellular mechanics, cell and molecular mechanics, internal-combustion engines, laser diagnostics for combustion, opto-electronic materials, machining and machine tool systems, mechanical behavior of materials, metrology, micromachining, microtribodynamics, polymer and composite materials processing, propulsion, rapid prototyping, robotics, short-pulse laser-ablation technology, thermal processing of materials, thermal radiation, tribology, and vehicle dynamics. Special facilities include a micro-fabrication facility with its own clean room (Class 10 and 1000) for silicon and CMOS-based micro-fabrication, test facilities for refrigeration and air-conditioning systems and components, low- and high-speed wind tunnels, and laboratories for study of combustion, quantitative visualization, complete specimen-scale mechanical testing equipment including an environmental testing chamber, thermomechanical and multiaxial loading capabilities. The department has a machine shop staffed with skilled instrument makers.

Financial Aid

Financial assistance is available to students who are admitted and includes fellowships, research and teaching assistantships, and/or waivers of tuition and fees. Assistantship stipends vary with one's entry level into the program. All applicants, regardless of U.S. citizenship, whose native language is not English and who wish to be considered for teaching assistantships must demonstrate spoken English language proficiency (http://grad.illinois.edu/admissions/taengprof.htm) by achieving a minimum score of 24 on the speaking subsection of the TOEFL iBT or 8 on the speaking subsection of the IELTS. For students who are unable to take the iBT or IELTS, a minimum score of 4CP is required on the EPI test (http://cte.illinois.edu/testing/oral_eng/epi_overview.html), offered on campus. All new teaching assistants are required to participate in the Graduate Academy for College Teaching (http://cte.illinois.edu/programs/ta_train.html) conducted prior to the start of the semester.

ME Class Schedule (https://courses.illinois.edu/schedule/DEFAULT/DEFAULT/ME)

Courses

ME 170 Computer-Aided Design credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/170)
Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; ISO and ANSI standards for coordinate dimensioning and tolerancing; geometric dimensioning and tolerancing. Use of solid-modeling software for creating associative models at the component and assembly levels with automatic blueprint creation, interference checking, and linked bill of materials. Credit is not given for both ME 170 and GE 101 or SE 101.

ME 199 Undergraduate Open Seminar credit: 1 to 5 Hours. (https://courses.illinois.edu/schedule/terms/ME/199)
May be repeated.

ME 200 Thermodynamics credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/200)
Classical thermodynamics through the second law; system and control-volume analyses of thermodynamic processes; irreversibility and availability; relations for ideal gas mixtures. Prerequisite: MATH 241.

ME 270 Design for Manufacturability credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/270)
Introduction to DFM methodologies and tools; material selection (new and traditional materials); designing for primary manufacturing processes (cutting fundamentals, casting, forming, and shaping); designing with plastics (snap-fits, integral hinges, etc.); design for assembly (DFA); geometric dimensioning and tolerancing (GD&T). Same as TAM 270. Prerequisite: ME 170. ME and EM majors only.

ME 290 Seminar credit: 0 Hours. (https://courses.illinois.edu/schedule/terms/ME/290)
Lectures by faculty and invited authorities, concerning the ethics and practices of mechanical engineering/engineering mechanics, as well as its relationship to other fields of engineering, to economics, and to society. Offered fall term only. Approved for S/U grading only.

ME 297 Introductory Independent Study credit: 1 to 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/297)
Independent study and/or individual projects related to mechanical engineering. Approved for Letter and S/U grading. May be repeated to a maximum of 6 credit hours for letter grade; no limit for S/U grade mode. Prerequisite: Consent of Instructor.

ME 310 Fundamentals of Fluid Dynamics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/310)
Fundamentals of fluid mechanics with coverage of theory and applications of incompressible viscous and inviscid flows, and compressible high speed flows. Credit is not given for both ME 310 and TAM 335. Prerequisite: MATH 285 OR MATH 286 OR MATH 441; credit or concurrent registration in ME 200.

ME 320 Heat Transfer credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/320)
Fundamentals of fluid mechanics with coverage of theory and applications of incompressible viscous and inviscid flows, and compressible high speed flows. Prerequisite: MATH 285 or MATH 286 or MATH 441; ME 310 or TAM 335; credit or concurrent registration in ME 200.

ME 330 Engineering Materials credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/330)
Structures of polymers, metals, and ceramics as the basis for their mechanical behavior. Manipulation of structure through such processes as heat treatment and solidification. Mechanisms of material failure in service (yielding, fracture, fatigue, creep, corrosion, and wear) and simple design techniques to avoid these failures. Strategies for materials selection in design. Credit is not given for both ME 330 and either CEE 300 or MSE 280. Prerequisite: CHEM 102 and TAM 251.

ME 340 Dynamics of Mechanical Systems credit: 3.5 Hours. (https://courses.illinois.edu/schedule/terms/ME/340)
Dynamic modeling of mechanical components and systems; time-domain and frequency-domain analyses of linear time-invariant systems; multi-degree-of-freedom systems; linearization of nonlinear systems. Credit is not given for both ME 340 and either GE 320 or AE 353. Prerequisite: MATH 285 OR MATH 286 OR MATH 441; TAM 212; credit or concurrent registration in ECE 205 and MATH 415.

ME 351 Analysis of Mfg Processes credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/351)
Mechanistic and empirical modeling of manufacturing processes including metal cutting theory, casting analysis, forging analysis, sheet metal forming, plastics molding, welding and mechanical joining assembly analysis. Also, hands-on exposure to manufacturing processes, CAD/CAM software (MasterCam), 5 axis machining (ShopBot), Wire EDM machining, statistical process control (SPC), and geometric dimensioning and tolerancing (GD&T) metrology principles using CMM. Prerequisite: ME 270.

ME 360 Signal Processing credit: 3.5 Hours. (https://courses.illinois.edu/schedule/terms/ME/360)
Basic electromechanical techniques used in modern instrumentation and control systems. Use of transducers and actuators. Signal conditioning, grounding, and shielding. Analog and digital signal processing and feedback control methods with emphasis on frequency domain techniques. Frequency response of continuous and discrete systems. Credit is not given for both ME 360 and ABE 425. Prerequisite: ME 340.

ME 370 Mechanical Design I credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/370)
Kinematics and dynamics of machinery, including introduction to user-centered design and design thinking, analytical and computer-aided design of kinematics, dynamic force analysis, principle of virtual work, cam and gear design, and balancing. Project-based learning of multi-mechanism system design, analysis, fabrication, and evaluation. Prerequisite: ME 270, TAM 212, and TAM 251.

ME 371 Mechanical Design II credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/371)
Design and analysis of machinery for load-bearing and power transmission. Consideration of material failure modes, including yielding, fracture, and fatigue. Design and selection of machine elements: threaded fasteners, springs, rolling-element bearings, fluid film lubrication, gears and friction drives. Prerequisite: ME 330 OR CEE 300; ME 370.

ME 400 Energy Conversion Systems credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/400)
Processes and systems for energy conversion, including power and refrigeration cycles, air conditioning, thermoelectrics and fuel cells; ideal-gas mixtures and psychrometrics. 3 undergraduate hours. 4 graduate hours. Prerequisite: ME 200.

ME 401 Refrigeration and Cryogenics credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/401)
Theory of operation and design of equipment for production of low temperatures, from below ambient to near absolute zero; industrial, consumer, aerospace, medical, and research applications. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: Credit or concurrent registration in ME 320.

ME 402 Design of Thermal Systems credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/402)
Selection of components in fluid- and energy-processing systems to meet system-performance requirements; computer-aided design; system simulation; optimization techniques; investment economics and statistical combinations of operating conditions. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: Credit or concurrent registration in ME 320.

ME 403 Internal Combustion Engines credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/403)
Theory and analysis of reciprocating internal-combustion engines; fuels, carburetion, combustion, exhaust emissions, detonation, fuel injection, and factors affecting performance; laboratory work on variables that affect performance. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: Credit or concurrent registration in ME 400 or ABE 466.

ME 404 Intermediate Thermodynamics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/404)
Classical thermodynamics, including the TdS equations and the Maxwell relations; development of thermodynamic property relations, behavior of real gases, thermodynamics of mixtures, phase equilibrium and chemical reactions and equilibrium with an emphasis on combustion reactions; statistical thermodynamics including the effect of molecular and atomic structure, statistical concepts and distributions, calculation of thermodynamic properties of gas-phase atoms and molecules, kinetic theory of gases, and vibrations in crystals and the electron gas in metals; selected applications. 4 undergraduate hours. 4 graduate hours. Credit is not given for both ME 404 and any of PHYS 427, CHEM 442, or CHEM 444. Prerequisite: ME 200.

ME 410 Intermediate Gas Dynamics credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/410)
Solution of internal compressible-flow problems by one-dimensional techniques, both steady and unsteady; flows with smooth and abrupt area change, with friction, with heat addition, and with mass addition; flows with weak and strong waves, multiple confined streams, and shock waves. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 200; ME 310, TAM 335 or AE 311.

ME 411 Viscous Flow & Heat Transfer credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/411)
Same as AE 412. See AE 412.

ME 412 Numerical Thermo-Fluid Mechs credit: 2 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/412)
Numerical techniques for solving the equations governing conduction and convective heat transfer in steady and unsteady fluid flows: finite-difference and finite-volume techniques, basic algorithms, and applications to real-world fluid-flow and heat-transfer problems. Same as CSE 412. 2 or 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 310 OR TAM 335; ME 320.

ME 420 Intermediate Heat Transfer credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/420)
Conduction heat transfer, radiation heat transfer, mass transfer, phase change, heat exchangers; numerical methods. 4 undergraduate hours. 4 graduate hours. Prerequisite: ME 310 OR TAM 335; ME 320.

ME 430 Failure of Engrg Materials credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/430)
Material anisotropy and elasto-plastic properties at the crystal level; microstructural basis for fatigue, fracture, and creep in metals, polymers, and ceramics; failure mechanisms and toughening in composites; structure and behavior of metal-matrix composites, ceramic-matrix composites, and polymer composites. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 330 OR TAM 324.

ME 431 Mechanical Component Failure credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/431)
Relationship of materials and mechanics concepts to the design of structures and components: elasticity, plasticity, thermal loading, creep, fatigue, fracture, and residual-life assessments as they relate to materials selection and design. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 330 and ME 371; Recommended: ME 430.

ME 432 Fundamentals of Photovoltaics credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/432)
In this course, we will develop a fundamental understanding of how solar cells convert light to electricity, how solar cells are made, how solar cell performance is evaluated, and the photovoltaic technologies that are currently on the market and/or under development. Using thermodynamics, materials physics, and engineering analysis we will assess and critique the potential and drawbacks of modern photovoltaic technologies, including single- and multi- crystalline silicon, tandem cells, CdTe, CIGS, PVT, bulk heterojunctions (organic), Graetzel cells, nanostructure-based, and third generation PV. 3 undergraduate hours. 4 graduate hours. Approved for Letter and S/U grading. Prerequisite: PHYS 212 and ME 330 or equivalent.

ME 440 Kinem & Dynamics of Mech Syst credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/440)
Kinematics and dynamics of constrained rigid-body mechanical systems; use of modern computer-based analysis software packages. 3 undergraduate hours. 4 graduate hours. Prerequisite: ME 370.

ME 445 Introduction to Robotics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/445)
Same as AE 482 and ECE 470. See ECE 470.

ME 446 Robot Dynamics and Control credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/446)
Same as ECE 489 and SE 422. See SE 422.

ME 450 Modeling Materials Processing credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/450)
Manufacturing processes for metals and polymers; creation of process models based on momentum, heat, and mass transfer; model simplification by estimation and scaling; applications to casting, microstructure evolution, polymer molding and extrusion, and welding. 3 undergraduate hours. 3 graduate hours. Prerequisite: ME 320 and ME 330.

ME 451 Computer-Aided Mfg Systems credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/451)
The application of computer technology and operations research to manufacturing systems. Use of microprocessors for direct numeric control of machine tools, adaptive control and optimization, and integrated manufacturing systems. Applications of industrial robots. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 270.

ME 452 Num Control of Mfg Processes credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/452)
Numerical control systems, manufacturing processes, principles and practices basic to numerical control, and programming methodology for numerical control. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 101 and ME 270.

ME 455 Micromanufacturing Process & Automation credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/455)
Scaling laws in miniaturization, Micro-machine tools design and characterization, Micromanufacturing process modeling, simulation and automation, Micro-metrology and Micro-assembly systems. 3 undergraduate hours. 4 graduate hours. Prerequisite: ME 270 or equivalent or consent of instructor.

ME 460 Industrial Control Systems credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/460)
Industrial control techniques; case studies of industrial systems; design, selection, and maintenance of industrial control systems, including electromechanical, pneumatic, thermal, and hydraulic systems. 4 undergraduate hours. 4 graduate hours. Credit is not given for both ME 460 and ECE 486. Prerequisite: ME 340 and ME 360.

ME 461 Computer Cntrl of Mech Systems credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/461)
Microcomputer control of thermal and mechanical systems: sensors and transducers, signal transmission and conversion, and regulator actuation. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: ME 360 or ABE 425.

ME 465 Optics: Theory & Applications credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/465)
Introduction to basic concepts in electromagnetic fields and waves as they pertain to measurement science and subsurface imaging. Related applications using wave-based probes, such as acoustic fields and waves with an emphasis on current phenomena and technologies. 4 undergraduate hours. 4 graduate hours. Prerequisite: PHYS 212, MATH 285 OR MATH 286 OR MATH 441. Restricted to students with Senior or Graduate standing, or instructor permission.

ME 470 Senior Design Project credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/470)
Solution of a real-world design problem: development, evaluation, and recommendation of alternative solutions subject to realistic constraints that include most of the following considerations: economics, environment, sustainability, manufacturability, ethics, health and safety, society, and politics. 3 undergraduate hours. No graduate credit. Departmental approval required. Prerequisite: Concurrent enrollment in no more than two required ME courses; completion of all required courses. This course satisfies the General Education Criteria for:
Advanced Composition

ME 471 Finite Element Analysis credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/471)
The finite element method and its application to engineering problems: truss and frame structures, heat conduction, and linear elasticity; use of application software; overview of advanced topics such as structural dynamics, fluid flow, and nonlinear structural analysis. Same as AE 420 and CSE 451. 3 or 4 undergraduate hours. 3 or 4 graduate hours. Credit is not given for both ME 471 and CEE 470. Prerequisite: CS 101 and ME 371 or TAM 470. Alternatively, AE 370 for AE students.

ME 472 Introduction to Tribology credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/472)
Friction, wear, and lubrication; engineering surfaces; surface properties and surface topography; Hertzian contacts and contact of rough surfaces; friction of surfaces in contact; wear and surface failures; boundary lubrication; fluid properties; hydrodynamic lubrication; elastohydrodynamic lubrication; bearing selection; introductory micro- and nanotribology. 3 undergraduate hours. 3 or 4 graduate hours.

ME 481 Whole-Body Musculoskel Biomech credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/481)
Exploration of the human musculoskeletal system with an emphasis on the whole-body or organism level; modeling and analysis techniques for examining human movement, such as rigid-body modeling techniques, forward and inverse dynamics, and Lagrangian mechanics; examination of current topics, such as orthopedic biomechanics, prosthetics and orthotics, postural control, and locomotion; use of computerized motion-capture equipment and software to examine, simulate, and analyze human movement. Same as BIOE 481. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: TAM 212 and TAM 251.

ME 482 Musculoskel Tissue Mechanics credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/482)
Composition-structure-function relationships for musculoskeletal tissues, including bone, tendon, ligament, cartilage, and muscle; hierarchical structure of tissues from the macro- to nano-scales; relation of composition to mechanical properties of health and diseased tissue; experimental methods used to obtain mechanical properties. Same as BIOE 482. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: TAM 251.

ME 483 Mechanobiology credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/483)
Integrative approach to mechanobiology; mechanics of cell adhesion; cytoskeletal structure and mechanics; mechanotransduction; mechanics of cell proliferation, apoptosis, cancer cells, and stem cells; aging; critical issues facing the mechanobiological sciences. 4 undergraduate hours. 4 graduate hours. Prerequisite: CHEM 102 and TAM 251.

ME 485 MEMS Devices & Systems credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/485)
Same as ECE 485. See ECE 485.

ME 487 MEMS-NEMS Theory & Fabrication credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/487)
Physical and chemical theory, design, and hands-on fabrication of micro- and nano-electromechanical systems (MEMS and NEMS); cleanroom fabrication theory, including general cleanroom safety, lithography, additive and subtractive processes, bulk and surface micromachining, deep reactive ion etching (DRIE), lithographic Galvanoformung Abformung (LIGA), packaging, scaling, actuators, and micro-nanofluids; fabrication of two take-home devices, such as piezoresistive sensors and microfluidic logic chips, that demonstrate advanced fabrication processing. 4 undergraduate hours. 4 graduate hours. Prerequisite: PHYS 212.

ME 496 Honors Project credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/496)
Special project or reading course for James Scholars in engineering. 1 to 4 undergraduate hours. No graduate credit. May be repeated. Prerequisite: Consent of instructor.

ME 497 Independent Study credit: 1 to 3 Hours. (https://courses.illinois.edu/schedule/terms/ME/497)
Independent study of advanced problems related to mechanical engineering. 1 to 3 undergraduate hours. No graduate credit. May be repeated in separate terms to a maximum of 6 hours, as topics vary. Prerequisite: Consent of Instructor. Students with Junior or Senior standing.

ME 498 Special Topics credit: 0 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/498)
Subject offerings of new and developing areas of knowledge in mechanical engineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. 0 to 4 undergraduate hours. 0 to 4 graduate hours. May be repeated in the same or separate terms if topics vary to a maximum of 9 hours.

ME 501 Combustion Fundamentals credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/501)
Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. Same as AE 538. Prerequisite: AE 311 or ME 410.

ME 502 Thermal Systems credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/502)
Steady-state simulation and optimization of thermal systems, dynamic performance, and probabilities in system design. Prerequisite: ME 402.

ME 503 Design of IC Engines credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/503)
Design of internal combustion engines, including gas forces, inertia loads, bearing analysis, torsional vibration, balance, lubrication, valve and cam design, and stress analysis of major engine components. Prerequisite: ME 403.

ME 504 Multiphase Systems & Processes credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/504)
Dynamics and thermodynamics of multiphase and multicomponent systems with special relevance to air-pollution control and energy conversion; relaxation phenomena; general motion of systems of disparate elemental masses; diffusion in gravitational and electric fields, and boundary-layer motion with mass transport; dispersion and collection of particulate matter; transport with surface reactions. Prerequisite: ME 404.

ME 510 Advanced Gas Dynamics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/510)
Theoretical gas dynamics; fundamental laws and basic equations for subsonic, transonic, and supersonic steady and unsteady flow processes. Same as AE 510. Prerequisite: ME 410.

ME 520 Heat Conduction credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/520)
Fundamentals of heat conduction in isotropic and anisotropic materials; methods of solution to steady and transient heat conduction problems in one, two, and three dimensions; internal heat sources; periodic flow of heat; problems involving phase change; approximate analytical techniques; numerical methods; study of current articles on the subject. Prerequisite: ME 420.

ME 521 Convective Heat Transfer credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/521)
Fundamentals of convective heat transfer; calculation of heat transfer within ducts and over submerged objects for laminar and turbulent flow; natural convection; film condensation and boiling; liquid metals. Prerequisite: ME 411.

ME 522 Thermal Radiation credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/522)
Fundamentals of radiant-energy transport in absorbing and nonabsorbing media; pyrometry; applications to selected problems involving combined energy-transport mechanisms. Prerequisite: ME 420.

ME 523 Nanoscale Energy Transport credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/523)
An advanced treatment of diverse transport phenomena at the nanometer scale involving solids, liquids and gases emphasizing common features in transport by molecules, electrons, phonons, photons, and other quasi-particles of interest, oriented toward applied research in the areas of nanoscale heat transfer and nanoscale energy conversion. Topics include intermolecular forces at surfaces and in the bulk, momentum and species transport in microfluidics, linear response theory, free molecular flow in gases, electron and phonon transport in crystals, Boltzmann equation and its moments, ballistic and diffusive transport, thermoelectric energy conversion, interfacial transport, energy transport in nanostructures and radiative transport in the near-field. Approved for letter and S/U grading.

ME 530 Fatigue Analysis credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/530)
Fatigue analysis methods for the design of structures and components: stress-life, strain-life, and crack-propagation approaches; multiaxial and high-temperature fatigue; interrelationship among material properties, geometry, and design methodology appropriate for a wide range of mechanical engineering components. Prerequisite: ME 430.

ME 531 Inelastic Design Methods credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/531)
Material deformation under combined mechanical and thermal loading; constitutive equations and their application in engineering design and in inelastic finite element methods; material and structural degradation under fatigue and creep conditions. Prerequisite: ME 471 and ME 430.

ME 532 Fracture Resistant Design credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/532)
Application of fracture mechanics and microstructural behavior to materials selection for design; practical approximation of linear and inelastic fracture parameters for evaluation of complex components; destructive and nondestructive tests for control of toughness in manufacture; residual life assessment involving time-dependent fracture (creep, fatigue, stress, corrosion); case studies; design project. Prerequisite: ME 430.

ME 533 Physical Basis for Plasticity credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/533)
Physical and mathematical foundation for plasticity in crystalline materials, with application to deformation processes. Metal forming; deformation processes in other materials, such as slip in geological materials and polymers; rate dependence of plastic flow, with underlying physical mechanisms; kinetics of dislocation motion, mechanisms of work hardening, and crystallographic texture; theoretical framework for modeling the constitutive response of rate-dependent materials undergoing crystallographic slip, and allied computational procedures. Prerequisite: TAM 445.

ME 540 Control System Theory & Design credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/540)
Same as ECE 515. See ECE 515.

ME 541 Control of Machine Systems credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/541)
Modeling machining processes and machine tools. Mechanistic modeling of machining processes, machine-tool errors, characterization of machined surfaces, machine-tool system dynamics and stability, and topics in motion control. 4 graduate hours. No professional credit. Prerequisite: ME 340 and ME 270.

ME 544 Dyanmic System Reliability credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/544)
Same as ECE 554. See ECE 554.

ME 546 Analysis of Nonlinear Systems credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/546)
Same as ECE 528 and SE 520. See ECE 528.

ME 550 Solidification Processing credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/550)
Principles of control of structure, properties, and shape in processes involving liquid-solid transformations; stresses, heat flow, mass transport, solute redistribution, and nucleation and growth kinetics; relationship between process variables and structures and properties in the resultant material; examples are drawn from existing commercial and new developing processes. Prerequisite: ME 450.

ME 554 Computational Process Modeling credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/554)
Development and application of computer models to solve practical problems involving fluid flow, heat transfer, and deformation phenomena. Advanced topics in computational methods for materials process modeling; case studies. Same as CSE 561. Prerequisite: ME 412 or ME 471; ME 450.

ME 561 Convex Methods in Control credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/561)
Use of convex optimization in analysis and control of dynamical systems; robust control methods and the use of semidefinite programming; linear matrix inequalities, operator theory, model reduction, H-2 and H-infinity optimal control, S-procedure and integral quadratic constraints, structured singular value and mu-synthesis, and Markovian jump systems; applications in control design. Prerequisite: ECE 515.

ME 562 Robust Adaptive Control credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/562)
Mathematical foundation for synthesis and analysis of adaptive control systems: Lyapunov stability theory; methods of direct and indirect model reference adaptive control; recent methods, such as L1 adaptive control, that enable adaptive control with desired transient and steady-stage performance specifications. Prerequisite: Any of ECE 486, ECE 515, ECE 528, GE 424, ME 460.

ME 570 Nonlinear Solid Mech Design credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/570)
Optimality conditions; finite element methods; design sensitivity analysis; nonlinear analysis; transient analysis; thermo-mechanical solid mechanics. Same as AE 524. 4 graduate hours. No professional credit. Prerequisite: One of AE 420, CEE 470, ME 471, TAM 470; TAM 445, TAM 551.

ME 586 Mechanics of MEMS credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/586)
Mechanics and dynamics of microelectromechanical systems (MEMS); scaling laws in electrostatics, magnetics, and fluidics; analytical models for thin-film growth and etching; effect of surface tension in small dimensions in relations to stability of MEMS during web fabrication; size effects on mechanical properties of MEMS materials; equations of motion for MEMS, involving coupled elastic and electric fields that give rise to nonlinear dynamical behavior; Mathieu behavior and chaotic systems. Prerequisite: ME 485.

ME 590 Seminar credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/ME/590)
Presentation and discussion of significant developments in mechanical engineering. Approved for S/U grading only. May be repeated.

ME 591 Interest Group Seminar credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/ME/591)
Seminars on current topics in mechanical science and engineering. May be repeated in the same term if topics vary. May be repeated in separate terms.

ME 597 Independent Study credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/597)
Independent study of advanced problems related to mechanical engineering. May be repeated in the same term or in separate terms if topics vary to a maximum of 12 hours. Prerequisite: Consent of instructor.

ME 598 Special Topics credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ME/598)
Subject offerings of new and developing areas of knowledge in mechanical engineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. May be repeated in the same or separate terms if topics vary.

ME 599 Thesis Research credit: 0 to 16 Hours. (https://courses.illinois.edu/schedule/terms/ME/599)
Approved for S/U grading only. May be repeated.