Department of Mechanical Engineering (MEE)

Acting Chair: Kyuil Kim

Graduate Faculty

Behrooz Fallahi, associate professor, Ph.D., P.E., Purdue University
Sengoda G. Ganesan, associate professor, Ph.D., P.E., Oklahoma State University
Abhijit Gupta, associate professor, Ph.D., P.E., Pennsylvania State University
Romualdas Kasuba, professor, Ph.D., P.E., University of Illinois
Meung J. Kim, associate professor, Ph.D., Virginia Polytechnic Institute and State University
Milivoje Kostic, associate professor, Ph.D., P.E., University of Illinois, Chicago
Pradip Majumdar, associate professor, Ph.D., Illinois Institute of Technology
Parviz Payvar, professor, Ph.D., P.E., University of California, Berkeley
Mohamed A. Seif, associate professor, Ph.D., P.E., University of Central Florida
Scott Short, assistant professor, Ph.D., P.E., University of Dayton

Master of Science in Mechanical Engineering

The Department of Mechanical Engineering offers a program leading to the M.S. in mechanical engineering. The program is designed to stimulate creativity, to provide an in-depth understanding of the basic physical phenomena involved in mechanical systems, and to provide the student with the ability to use modern techniques in the analysis and design of mechanical components and systems.

Admission to the graduate program in mechanical engineering requires a baccalaureate degree in mechanical engineering or related areas such as physics, mathematical sciences, chemistry, computer science, and engineering disciplines. NIU undergraduate majors in mechanical engineering can, however, be admitted to the integrated B.S./M.S. sequence after finishing 90 semester hours with a GPA of at least 3.00.

Thesis Option

All students admitted to the M.S. program are initially classified as thesis option students. The thesis option is designed to prepare students for graduate work at the doctoral level or advanced engineering work in industry and focuses on original research techniques. The graduate program of study must include 6 semester hours of MEE 599, Master's Thesis, on a topic approved by the student's graduate committee. The thesis must be satisfactorily defended at an oral examination. Portions of the research work required in MEE 599 may be performed in off-campus facilities if approved by the student's graduate committee.

Non-Thesis Option

Students wishing to pursue the non-thesis option are required to petition the department's graduate committee upon admission to the major. The non-thesis option is designed for practicing professionals who wish to pursue advanced study in mechanical engineering culminating in the M.S. degree and who cannot pursue the traditional research experience of a thesis option. Students pursuing a M.S. degree under this option must earn a minimum of 33 semester hours of graduate credit including 3 semester hours of MEE 597, Independent Study, for a master's project resulting in significant original work which must be defended at an oral examination and presented in a written report.

Requirements for Graduates with a B.S. in Mechanical Engineering

Students must satisfy the following departmental requirements.

Submit to the department a program of graduate study approved by the student's graduate committee or the department.

Complete at least 30 (thesis option) or 33 (non-thesis option) semester hours of graduate work, not more than 30 percent of which may be in courses numbered 400-499. All courses taken outside the Department of Mechanical Engineering must have departmental approval in advance.

Complete a minimum of 6 semester hours of applied mathematics or advanced engineering analysis selected with the advice and consent of the student's adviser.

Complete two courses from one of the following groups (6)
- Applied Mechanics–MEE 510, MEE 511, MEE 512, MEE 515
- Dynamic Systems and Control–MEE 520, MEE 521, MEE 522, MEE 526
- Materials and Manufacturing–MEE 529, MEE 531, MEE 533, MEE 534
- Thermal-Fluid Engineering–MEE 540, MEE 555, MEE 556, MEE 558

The graduate program must include 6 semester hours of MEE 599, Master's Thesis, on a topic approved by the student's graduate committee or must include 3 semester hours of MEE 597, Independent Study, for a master's project plus additional 500-level MEE course work for 6 semester hours. Employed students may use topics and facilities from their work if approved.

Requirements for Graduates with a B.S. in an Area other than Mechanical Engineering

Students are required to fulfill all the requirements mentioned in the previous section. In addition, students with a B.S. degree in an area other than mechanical engineering are required to take at least three courses from one of the following groups depending on their chosen field of study. The department will stipulate the courses to be taken. A grade of B or better must be obtained in each of these courses.

- Applied Mechanics–MEE 210, MEE 211, MEE 212, MEE 220, MEE 350, MEE 470
- Dynamic Systems and Control–MEE 211, MEE 321, MEE 322 or ELE 380, MEE 421, MEE 422, MEE 424, MEE 425, MEE 470
- Materials and Manufacturing–MEE 212, MEE 330, MEE 331, IENG 430 or IENG 450 or IENG 451, MEE 423, MEE 431, TECH 345 or TECH 441
- Thermal-Fluid Engineering–MEE 340, MEE 350, MEE 351, MEE 352, MEE 451, MEE 452, MEE 453

Requirements for Integrated B.S./M.S. Sequence

This integrated sequence leads to both the B.S. and M.S. degrees in mechanical engineering and is available to all undergraduate mechanical engineering majors who have finished at least 90 semester hours of undergraduate work with a GPA of at least 3.00. A minimum GPA of 3.00 must be maintained during the course of study. Failure to meet the requirements of the integrated sequence may lead to a B.S. degree only, but only after all the requirements for that degree have been met.

All students enrolled in the integrated B.S./M.S. sequence must have their schedule approved by their faculty adviser each semester. Any deviation from the approved course schedule may delay graduation.

All students enrolled in the integrated B.S./M.S. sequence are required to take the state Fundamentals of Engineering (FE/EIT) examination before graduation from the B.S. program.

Students must complete all undergraduate required courses, including 9 semester hours of technical electives, all of which must be taken for graduate credit during the student's final undergraduate term.

Students must also complete 21 (thesis option) or 24 (non-thesis option) additional graduate semester hours, as follows.

- 500-level applied mathematics or advanced engineering analysis with department approval (6)
- Course work in one of the following areas of study (6)
  - Applied Mechanics–MEE 510, MEE 511, MEE 512, MEE 515
  - Dynamic Systems and Control–MEE 520, MEE 521, MEE 522, MEE 526
  - Materials and Manufacturing–MEE 529, MEE 531, MEE 533, MEE 534
  - Thermal-Fluid Engineering–MEE 540, MEE 555, MEE 556, MEE 558
- Additional 500-level course work with department approval (3)
- MEE 599, Master's Thesis (6),
  - OR MEE 597, Independent Study for a master's project (3), and additional 500-level MEE course work with department approval (6)

Certificates of Graduate Study

In addition to offering a graduate degree program in mechanical engineering, the Department of Mechanical Engineering offers several certificates of graduate study for students interested in pursuing short-term study focused on a technical area related to mechanical engineering. The certificates are ideally suited for graduate-level students interested in lifelong learning and in the advancement of their skills in an area of mechanical engineering. Credit earned for a certificate may be applied toward the M.S. degree in mechanical engineering with the approval of the department.

Applied Mechanics (12)

This certificate emphasizes the application of engineering mechanics to design and analysis of mechanical components and products.

MEE 410, Intermediate Mechanics of Materials (3)
MEE 510, Experimental Stress Analysis (3)
MEE 512, Advanced Mechanics of Materials (3)
MEE 515, Applied Finite Element Analysis (3)

Computer-Aided Design and Computer-Aided Manufacturing (12)

Course work for this certificate unifies the methods applied to design of products simultaneous with full consideration of manufacturing methods.

MEE 430, Computer-Aided Design and Manufacturing (3)
IENG 450, Integrated Manufacturing Systems (3)
MEE 531, Computer-Aided Design of Mechanical Systems (3)
MEE 533, Computer-Aided Manufacturing (3)

Design of Thermal Systems (12)

Course work for this certificate lays the theoretical foundations of design of thermal equipment and processes with applications to such areas as refrigeration, air conditioning, thermal design of electronic equipment, and numerical modeling of thermal-fluid systems.

MEE 451, Refrigeration and Air Conditioning (3)
MEE 452, Design of Thermal Systems (3)
MEE 556, Convection Heat Transfer (3)
MEE 558, Computational Heat Transfer and Fluid Mechanics (3)

Vibration and Control System Design (12)

Course work for this certificate program focuses on laying the theoretical foundations of both vibrations and control and application to the design of components and systems.

MEE 421, Dynamic Systems and Control II (3)
MEE 521, Advanced Vibrations (3)
MEE 522, Experimental Methods in Mechanical Vibrations (3)
MEE 526, Advanced Control Systems Design (3)

Course List

410. INTERMEDIATE MECHANICS OF MATERIALS (3). Buckling, unsymmetric bending, transverse loading, curved beams, thick-walled cylinders and rotating disks, torsion of thin-walled tubes, contact stresses, plastic behavior, strain energy and Castigliano's theorem, strength theories and design equations, fatigue, and fracture. PRQ: MEE 212, MATH 336, and CSCI 230, or consent of department.

421. DYNAMIC SYSTEMS AND CONTROL II (3). Concepts of linear system theory; model analysis, Lagrange's Equations, approximate numerical methods for solving vibration problems, and Root-locus and frequency response design. State-space analysis. Case studies in control system design. PRQ: MEE 322 or ELE 380, or consent of department.

422. DESIGN OF ROBOT MANIPULATORS (3). Mathematics, programming, and control in the design of robot manipulators. Includes topics on kinematics, differential relationships and dynamics, motion trajectories, and control algorithms. PRQ: MEE 211 and MATH 336, or consent of department.

423. MECHANICAL RELIABILITY (3). Basic probability, statistics, and reliability concepts applicable to mechanical systems. Probabilistic treatment of loads, stress, strength, safety indices, and fatigue. Mechanical equipment reliability; wear-out; reliability-based design, testing, and maintenance. PRQ: MEE 212 and CRQ: MEE 470; or consent of department.

424. MACHINERY VIBRATION (3). Machinery vibration analysis: signature analysis in time and frequency domains, fault detection, diagnosis, and correction; instrumentation; case studies; machine monitoring programs. PRQ: MEE 322 or consent of department. CRQ: MEE 470 or consent of department.

425. DESIGN OF MOBILE ROBOTS (3). Configuration and architecture design. Position estimation, planning, and control. Perception and learning. Group capstone project in the design and development of a mobile robot. Lecture, discussion, and case studies of mobile robot design. PRQ: MEE 211 or TECH 375, or consent of department.

430. COMPUTER-AIDED DESIGN AND MANUFACTURING (3). Computers for CAD/CAM; computer-aided design; numerical control, origin of CAM; industrial robots; group technology and process planning; computer control; computer-integrated manufacturing. PRQ: MEE 230 or CRQ: MEE 331; or consent of department.

431. COMPOSITE MATERIALS (3). Macromechanical behavior of a lamina; micromechanical behavior of a lamina; macromechanical behavior of a laminate; bending, buckling, and vibration of laminated plates. PRQ: MEE 212, MEE 330, and MEE 380, or consent of department.

451. REFRIGERATION AND AIR CONDITIONING (3). Refrigerants; vapor compression and absorption refrigeration systems; cryogenics; psychrometrics and humidity measurements; extended surface coils and transfer processes between moist air and water; solar radiation and heating and cooling loads of buildings and structures. PRQ: MEE 350 and MEE 352, or consent of department.

452. DESIGN OF THERMAL SYSTEMS (3). Application of principles of fluid mechanics, heat transfer, and thermodynamics in the component design of thermal systems. Examples drawn from power generations, environmental control, and industrial processes. Students work on group projects for integration of these components in the design of thermal systems. PRQ: MEE 350 and MEE 352, or consent of department.

453. PROPULSION (3). Aerodynamics and thermodynamics of gas turbine airbreathing and rocket engines; quasi-one-dimensional flow; ideal and real cycle analysis; component performance; engine operating off-design characteristics. PRQ: MEE 340 and MEE 350, or consent of department.

480. FINITE ELEMENT METHODS (3). Concepts of finite element methods, variational formulation and approximation; linear and quadrilateral elements; finite element formulation; error analysis; isoparametric elements; computer implementation; applications from solid mechanics, dynamics, heat transfer, and fluid mechanics. PRQ: MEE 322, MEE 352, and MEE 380, or consent of department.

510. EXPERIMENTAL STRESS ANALYSIS (3). Elementary elasticity; brittle-coating methods; strain meaurement methods and related instrumentation; photoelasticity; Moire methods; residual stress analysis. PRQ: MEE 490 or consent of department.

511. CONTINUUM MECHANICS (3). Vectors and tensors; stress; deformation; Eulerian and Lagrangian strain; physical laws; constitutive equations; solid mechanics; fluid mechanics. PRQ: Consent of department.

512. ADVANCED MECHANICS OF MATERIALS (3). Stress-strain-temperature relations; failure criteria; energy methods; torsion; nonsymmetrical bending; curved beams; flat plates; beams and elastic foundations; rotating discs; contact stresses. PRQ: MEE 470 or consent of department.

513. FATIGUE AND FRACTURE MECHANICS (3). Yielding; brittle fracture mechanics; plasticity induced fracture; fracture toughness; fatigue testing and analysis; stress concentration and notch sensitivity; low-cycle, corrosion, acoustic, and thermal fatigues. PRQ: MEE 512 or consent of department.

514. THEORY OF ELASTICITY AND APPLICATIONS (3). Plane stress and plane strain in rectangular, polar, and curvilinear coordinates; analysis of stress and strain in three dimensions; torsion of bars; bending of bars and plates; axisymmetric problems; thermal stress; propagation of waves in elastic solid media. PRQ: MEE 511 or consent of department.

515. APPLIED FINITE ELEMENT ANALYSIS FOR MECHANICAL ENGINEERS (3). Implementation of analysis and interpretation of results for discrete and continuous systems; computational techniques; available computer software; selection of model parameters; model evaluation and determination of accuracy; applications in mechanical engineering problems. PRQ: MEE 480 or consent of department.

516. MECHANICAL BEHAVIOR OF COMPOSITES (3). Comprehensive treatment of laminated beams, plates, and tubes. Bending, buckling, and vibration analysis. Various orders of theory and their range of parametric applications with respect to designing with composites. Hygrothermal and residual stresses. PRQ: MEE 431 or consent of department.

520. ADVANCED DYNAMICS (3). Newtonian mechanics; analytical mechanics; rotating reference frames; rigid body dynamics; geometric theory; stability of autonomous and nonautonomous systems; perturbation techniques; transformation theory; gyroscope. PRQ: MEE 421 or consent of department.

521. ADVANCED VIBRATIONS (3). Advanced principles of dynamics; discrete and continuous systems; free and forced vibrations; damped and undamped system reponse; approximate methods; wave solutions for continuous systems; random vibrations. PRQ: MEE 421 or consent of department.

522. EXPERIMENTAL METHODS IN MECHANICAL VIBRATIONS (3). Random vibrations; vibration pick-ups; dynamic strain measurements; beam vibrations; response analysis; modal analysis. PRQ: MEE 521 or consent of department.

523. ROBOT VISION CONTROL (3). Generalized images; segmented images; geometrical structures; relational structures; robot machine vision systems. PRQ: MEE 422 or consent of department.

524. ROBOT DYNAMICS AND CONTROL (3). Motion trajectories; principles of rigid body dynamics; robot dynamics; digital control systems; control of multiple link manipulators. PRQ: MEE 422 or consent of department.

525. ROBOT PROGRAMMING AND CONTROL (3). Task descriptions; structured programming; teaching; compliance and control; high level of robot language. PRQ: MEE 422 or consent of department.

526. ADVANCED CONTROL SYSTEMS DESIGN (3). Review of conventional and modern control design using block-diagram-transfer function, state-variable method, pole placement technique, estimation, and robust control schemes; digital control system analysis and design; z-transform theory and digitization process; nonlinear control system design; describing functions, phase plane and Liapunav's stability criterion; control system design problems and case studies including open-ended hands-on design projects from current research topics. PRQ: MEE 421 or consent of department.

529. MATERIALS ENGINEERING IN MECHANICAL DESIGN (3). The engineering design process, engineering materials and their properties, materials selection charts, case studies, selection of material and shape, and aesthetics of designs. PRQ: Consent of department.

530. STRUCTURE AND PROPERTIES OF POLYMERS (3). Molecular structure of amorphous, crystalline, and network polymers; theories of the glassy state; transition and melt temperatures; model prediction of viscoelastic properties; time-temperature superposition principle; theory of rubber elasticity. PRQ: MEE 430 or consent of department.

531. COMPUTER-AIDED DESIGN OF MECHANICAL SYSTEMS (3). Finite element methods in structural analysis; computer-aided design of symmetric and asymmetric machine elements under dynamic, impulsive, and thermal loadings; computer graphics; computer analysis and animation of kinematics of linkages. PRQ: MEE 480 or consent of department.

532. TRIBOLOGY (3). Surface topography and integrity; sliding and rolling friction; temperature in sliding contact; types, mechanisms, and theories of wear; antifriction and wear resistant material; boundary, hydrodynamic, and elastohydrodynamic lubrication; high pressure and wear resistant additives; solid lubricant; examples of tribology applied engineering design. PRQ: Consent of department.

533. COMPUTER-AIDED MANUFACTURING (3). Manufacture of parts and assemblies; design for manufacturability; numerically controlled machine tools; robotics. PRQ: MEE 430 or consent of department.

534. EXPERIMENTAL METHODS IN MATERIALS SCIENCE (3). Structural evaluation of materials with X-ray techniques; scanning electron microscopy for image formation and use of column related techniques to characterize bulk specimens; transmission microscopy for image formation and defect analysis in materials science applications. PRQ: Consent of department.

540. ADVANCED FLUID MECHANICS (3). Kinematics of fluid flow; plane irrotational and incompressible fluid flows; Navier-Stokes equations; hydrodynamic stability; turbulence; two-dimensional boundary layers in incompressible flow; flow separation. PRQ: Consent of department.

542. DYNAMICS OF VISCOUS FLUIDS (3). Fundamentals of viscous fluid; Navier-Stokes equations; exact solutions, boundary layer equations and their physical interpretations; mathematical techniques of similarity transformations, integral methods, perturbation methods and numerical solutions. PRQ: MEE 540 or consent of department.

550. ADVANCED THERMODYNAMICS (3). Thermodynamic postulates and conditions of equilibrium; the Euler equation and the Gibbs-Duhem relations; Legendre transformations and the extreme principle; Maxwell relations; stability of thermodynamic systems; the Nernst Postulate; chemical reactions and combustion; chemical equilibrium; irreversible thermodynamics. PRQ: Consent of department.

555. CONDUCTION HEAT TRANSFER (3). Fundamentals of heat conduction; approximate and exact analytical methods; finite and semi-infinite bodies; one-dimensional composite media; phase change problems; nonlinear problems; heat transfer in anisotropic solids. PRQ: Consent of department.

556. CONVECTION HEAT TRANSFER (3). Conservation principles; laminar internal and external flows; natural convection; turbulent flow; heat transfer at high velocities; heat transfer through porous media; numerical methods in convection heat transfer. PRQ: Consent of department.

558. COMPUTATIONAL HEAT TRANSFER AND FLUID MECHANICS (3). Application of partial differential equations, finite difference methods, and finite element methods in heat transfer and fluid mechanics; stability analysis, convergence criteria, and accuracy of computational techniques. PRQ: Consent of department.

592. ADVANCED MECHANICAL ENGINEERING ANALYSIS (3). Calculus of variations for deformable bodies; Sturm-Liouville problems; LaGrange's equations and generalized dynamical entities; integral equations in mechanical engineering; Green's functions; theory of distributions; one dimensional boundary value problems; partial differential equations in mechanical engineering. Applications of heat, conduction and convection, fluid dynamics, and structural mechanics. PRQ: Consent of department.

597. INDEPENDENT STUDY (1-3). Independent pursuit of advanced problems in mechanical engineering under faculty supervision. A written report is required. May be repeated to a maximum of 3 semester hours. Combined credit in MEE 597 and MEE 598 may not exceed 3 semester hours. PRQ: Consent of department.

598. SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) Advanced study of mechanical engineering topics. May be repeated to a maximum of 3 semester hours. Combined credit in MEE 597 and MEE 598 may not exceed 3 semester hours. PRQ: Consent of department.

599. MASTER'S THESIS (1-6). May be repeated to a maximum of 6 semester hours. PRQ: Consent of department.