Mechanical Engineering (MEEG)

Faculty
David G. Albers Jr., Instructor
Rick J. Couvillion, Associate Professor
James Allen Davis, Instructor
John H. Hamilton, Instructor
Po-Hao Adam Huang, Associate Professor
David Huitink, Assistant Professor
David C. Jensen, Assistant Professor
Ing-Chang Jong, Professor
Jim Leylek, Professor, Twenty-First Century Leadership Chair in Engineering
Ajay P. Malshe, Distinguished Professor, Twenty-First Century Chair of Materials, Manufacturing and Integrated Systems
Xiangbo Meng, Assistant Professor
Paul Millett, Assistant Professor
Arun Nair, Assistant Professor
Darin W. Nutter, Professor
Larry Roe, Associate Professor, Twenty-First Century Endowed Chair
Ashok Saxena, Distinguished Professor, Twenty-First Century Endowed Chair in Materials Science and Engineering
Zhenghui Sha, Assistant Professor
Steve Tung, Professor
Uchechukwu C. Wejinya, Associate Professor
Wenchao Zhou, Assistant Professor
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Degrees Conferred:
M.S.M.E. (MEEG)
Ph.D. in Engineering (ENGR) (See Engineering (http://catalog.uark.edu/graduatecatalog/programs/study/engineeringcollegeofengr))

Areas of Study: Thermal systems, mechanical design, nano/mesoscale materials science, and engineering mechanics.

Primary Areas of Faculty Research: Micro Electromechanical Systems (MEMS); Micro and Nano Systems; Structural Dynamics and Modal Analysis; Industrial and Commercial Energy Systems and Energy Conservation; Machining, Advanced Tooling and Coatings; Thermal and Mechanical Design of Electronic Packages; Material Failure Analysis and Design of Experiments; Unsteady Aerodynamics; Computational Materials Science; Tribology; Design Theory, Complex System Design and Analysis; Cyberphysical System Fault Modeling and Simulation.

Program Goals and Student Learning Objectives for the Master of Science Degree: The program goals are broad general statements of what the Mechanical Engineering Graduate Program intends to accomplish and describes what a student will be able to do after completing the degree requirements. They prepare students:

• For independent studies in mechanical engineering.
• To contribute new knowledge of fundamental or applied importance.
• To disseminate new knowledge of fundamental or applied importance.

Student Learning Outcomes are defined in terms of the knowledge, skills, and abilities that students will know and be able to do as a result of completing a program. These student learning outcomes are directly linked to the accomplishment of the program goals listed above. They are:

1. Students will gain advanced knowledge in mechanical engineering.
2. Thesis: Students will gain a necessary understanding of their research field; non-thesis: Students will apply advanced coursework to an engineering problem.
3. Thesis: Students will contribute new knowledge of fundamental or applied importance; non-thesis: Students will demonstrate important application(s) of existing knowledge.
4. Students will be able to communicate effectively during oral presentations.
5. Students will be able to communicate effectively in writing.

Requirements for the Master of Science Degree: In addition to the requirements of the Graduate School and the graduate engineering faculty, the following departmental requirements must be satisfied by candidates for the M.S.M.E. degree.

1. Candidates who present a thesis are required to complete a minimum of 24 semester hours of course work and six semester hours of thesis.
2. Candidates who do not present a thesis are required to complete a minimum of 33 semester hours of course work, which is to include at least three hours of credit for Research or Special Problems (including a formal engineering report), completed under direction of the candidate’s major adviser.
3. All students must present a grade-point average of 3.00 or better on all courses included in their plan of study, with no more than 6 hours of “C.”

Students should also be aware of Graduate School requirements with regard to master’s degrees (http://catalog.uark.edu/graduatecatalog/degreerequirements/#mastersdegreetext).

Requirements for the Doctor of Philosophy Degree (Engineering): Students desiring to pursue a doctoral degree in engineering under the direction of a professor in the Department of Mechanical Engineering must obtain a set of guidelines from the Graduate Coordinator. Students should also be aware of Graduate School requirements with regard to doctoral degrees (http://catalog.uark.edu/graduatecatalog/degreerequirements/#phdandddegreetext).
Courses

MEEG 4003. Intermediate Dynamics (Irregular). 3 Hours.
Review of central-force motion of spacecraft, use of rotating reference frames, Coriolis acceleration. Kinematics of rigid bodies in 3-D space: velocities and accelerations in different moving reference frames, addition theorem of angular accelerations. Kinetics of rigid bodies in 3-D space: eigenvalues and eigenvectors of inertia matrices, momentum and kinetic energy of a rigid body in 3-D motion, Euler's equations of motion; precession, nutation, and spin of a gyroscope; forced steady precession, torque free steady precession, space cone, and body cone. Prerequisite: MEEG 2013.

A study of fibrous composite materials with emphasis on mechanical behavior, synthesis, and application. Topics include macro- and micromechanical analysis lamina, lamina theory, failure analysis in design, and manufacturing techniques. Prerequisite: MEEG 3013.

MEEG 4153. Fundamentals of Mechanical Design (Fa). 3 Hours.
This class is designed to provide engineering students with a head start in industry as design engineers or working in an engineering related function. The course contents cover machine design and analysis experiences as related to working in industry and performing consulting work. Major topics include the design process, design procedures, fasteners, general design and numerous consulting experiences. A concept design exercise and two special design projects will be assigned to the students as homework. Prerequisite: MEEG 4104.

MEEG 4213. Control of Mechanical Systems (Irregular). 3 Hours.
Mathematical modeling for feedback control of dynamic mechanical systems with design techniques using LaPlace transforms, state variables, root locus, frequency analysis, and criteria for performance and stability. Prerequisite: MEEG 3113.

Microcomputer architectural, programming, and interfacing. Smart product design (microprocessor-based design). Control of DC and stepper motors and interfacing to sensors. Applications to robotics and real-time control. Mobile robot project. Digital and analog electronics are reviewed where required. Prerequisite: ELEG 3903.

MEEG 4303. Materials Laboratory (Irregular). 3 Hours.
A study of properties, uses, testing, and heat treatment of basic engineering materials and related analytical techniques. Corequisite: Lab component. Prerequisite: MEEG 2303.

MEEG 4413. Heat Transfer (Sp, Su). 3 Hours.
Basic thermal energy transport processes; conduction, convection, and radiation; and the mathematical analysis of systems involving these processes in both steady and time-dependent cases. Prerequisite: MEEG 3503.

MEEG 4423. Power Generation (Irregular). 3 Hours.
Study of design and operational aspects of steam, gas, and combined cycle power plants. Brief study of Nuclear and Alternative energy systems. Prerequisite: MEEG 3503.

MEEG 4433. Aerospace Propulsion (Irregular). 3 Hours.
Principles, operation, and characteristics of gas turbine and rocket engines. Brief study of novel spacecraft propulsion systems. Prerequisite: MEEG 3503.

MEEG 4453. Industrial Waste and Energy Management (Irregular). 3 Hours.
Applications of thermodynamics, heat transfer, fluid mechanics, and electric machinery to the analysis of waste streams and energy consumption for industrial facilities. Current techniques and technologies for waste minimization and energy conservation including energy-consuming systems and processes, utility rate analysis, economic analysis and auditing are taught. Prerequisite: MEEG 4413.

MEEG 4473. Indoor Environmental Control (Irregular). 3 Hours.
Gives student a thorough understanding of the fundamental theory of air conditioning design for commercial buildings, including calculating heating and cooling loads along with the proper selection and sizing of air conditioning equipment. Prerequisite: MEEG 4413.

MEEG 4483. Thermal Systems Analysis and Design (Su, Fa). 3 Hours.
Analysis design and optimization of thermal systems and components with examples from such areas as power generation, refrigeration, and propulsion. Availability loss characteristics of energy systems and availability conservation methods. Prerequisite: MEEG 4413.

MEEG 4503. Introduction to Flight (Fa). 3 Hours.
The course will provide understanding in basic aerodynamics, airfoil design and characteristics, and flight control surfaces. Prerequisite: MATH 2584, MEEG 3503.

MEEG 4523. Astronautics (Irregular). 3 Hours.
Study of spacecraft design and operations. Prerequisite: MEEG 2013 and MEEG 2403 or consent of instructor.


Combined stress, theories of failure, thick-walled cylinders, bending of unsymmetrical sections, torsion in noncircular section, plate stresses, and strain energy analysis. Prerequisite: MEEG 2013 and MEEG 3013.

MEEG 5103. Structural Dynamics (Irregular). 3 Hours.
The forced and random vibration response of complex structural systems are studied through the use of the finite element method. Computational aspects of these problems are discussed and digital computer applications undertaken. Prerequisite: MEEG 3113 and MEEG 4104 and graduate standing.

MEEG 5113. Modal Analysis Methods (Irregular). 3 Hours.
Fundamental concepts of both analytical and experimental modal analysis methods are examined and applied to the study of complex structural systems. Computational aspects of these problems are discussed, and digital computer applications undertaken with experimental verification. Prerequisite: MEEG 5103 and graduate standing.

MEEG 5123. Finite Elements Methods II (Irregular). 3 Hours.
Development and application of finite element (FE) methods used to solve transient and two-dimensional boundary value problems. Applications are taken from solid and fluid mechanics, heat transfer, and acoustics. Emphasis is placed on the FE methodology in order to make accessible the research literature and commercial software manuals, and to encourage responsible use and interpretation of FE analysis. Prerequisite: MEEG 4123 and graduate standing or consent.

Application of advanced topics such as probability theory, fracture mechanics, and computer methods to the design and analysis of complex mechanical systems. Prerequisite: MEEG 4104 and graduate standing.
MEEG 5203. Robot Modeling and Simulation (Sp). 3 Hours.
This is a graduate level course in Robotics dealing with the behavioral study of robots. Topics covered in this course will include but not limited to the following: mathematical modeling of robots, rigid motions and homogeneous transformation, forward/inverse kinematics of robots, velocity kinematics, path and trajectory planning, robot dynamics, joint control, PD/PID control, and multivariable control. Advanced topics may include passivity-based motion control, geometric nonlinear control, computer vision, vision-based control, and sensor fusion. Prerequisite: Graduate standing in MEEG or ELEG and consent of the instructor.

MEEG 5253. Bio-Mems (Sp). 3 Hours.
Topics include the fundamental principles of microfluidics, Navier-Stokes Equation, bio/abio interfacing technology, bio/abio hybrid integration of microfabrication technology, and various biomedical and biological problems that can be addressed with microfabrication technology and the engineering challenges associated with it. Lecture 3 hours per week. Prerequisite: MEEG 3503 or CVEG 3213 or CHEG 2133. This course is cross-listed with BENG 5253.

A study of mechanics and devices on the micro scale. Course topics will include: introduction to micro scales, fundamentals of microfabrication, surface and bulk micromachining, device packaging, device reliability, examples of micro sensors and actuators. Recitation three hours per week.

MEEG 5273. Electronic Packaging (Irregular). 3 Hours.
An introductory treatment of electronic packaging from single chip to multichip including materials, electrical design, thermal design, mechanical design, package modeling and simulation, processing considerations, reliability, and testing. Credit cannot be earned for both MEEG 5273 and ELEG 5273. Prerequisite: (ELEG 3214 or ELEG 3933) and MATH 2584. This course is cross-listed with ELEG 5273.

MEEG 5303. Physical Metallurgy (Irregular). 3 Hours.
Physical and chemical properties of solids and the application of materials in commerce. Prerequisite: MEEG 2303.

MEEG 5323. Physical and Chemical Vapor Deposition Processes (Irregular). 3 Hours.
Fundamental principles of materials behavior in the deposition of films by PVD/CVD. Topics include kinetic theory of gases, statistical mechanics, plasmas, diagnostics, reaction rate theory, nucleation and growth, crystal structures and defects in thin films, advanced characterization techniques for thin films, and applications in microelectronics, tribology, corrosion, bio- and nano-materials. Prerequisite: Graduate standing in Engineering or consent of instructor.

MEEG 5333. Introduction to Tribology (Irregular). 3 Hours.
A study of science and technology of interacting surfaces in relative motion. Topics include solid surface characterization, contact between solid surfaces, adhesion, friction, wear, lubrication, micro/nanotribology, friction and wear screening test methods, and tribological components and applications. Students may not earn credit for both MEEG 5333 and MEEG 4313. Prerequisite: Graduate standing.

MEEG 5343. Computational Material Science (Irregular). 3 Hours.
This course provides students with an overview of different modeling techniques in material science. Applications will be presented on a broad range of modeling techniques including atomistic simulation methods, Monte Carlo techniques, molecular mechanics, and molecular dynamics. Prerequisite: Graduate standing.

MEEG 5403. Advanced Thermodynamics (Sp). 3 Hours.
An in-depth review of classical thermodynamics, including availability analysis, combustion, and equilibrium, with an introduction to quantum mechanics and statistical thermodynamics. Prerequisite: Graduate standing in Engineering or consent of instructor.

MEEG 5423. Statistical Thermodynamics (Irregular). 3 Hours.
Concepts and techniques for describing high temperature and chemically reactive gases from a molecular point of view. Introductory kinetic theory, chemical thermodynamics, and statistical mechanics applied. Prerequisite: MEEG 2403 and MATH 2574.

MEEG 5433. Combustion (Irregular). 3 Hours.
Introduction to combustion of solid, liquid, and gaseous fuels. Equilibrium and kinetics of hydrocarbon oxidation, laminar and turbulent flames, premixed and non-premixed combustion processes, ignition, quenching, stability, emissions and diagnostics. Prerequisite: Graduate standing in Engineering or consent of instructor.

MEEG 5453. Advanced Heat Transfer (Fa). 3 Hours.
More in-depth study of topics covered in MEEG 4413, Heat Transfer, and coverage of some additional topics. Prerequisite: MEEG 4413 or equivalent.

MEEG 5473. Radiation Heat Transfer (Even years, Su). 3 Hours.
Spectral analysis, radiant exchange in gray and non-gray enclosures, gas radiation, and multi-mode heat transfer. Prerequisite: MEEG 5453 or equivalent.

MEEG 5503. Advanced Fluid Dynamics I (Sp). 3 Hours.
A basic survey of the characteristics of fluid flow under a variety of conditions with examples. Begins with a derivation of the Navier-Stokes equations and an evaluation of the dimensionless groups found from these equations. Topics to be covered include viscous laminar and turbulent boundary layers, jets and wakes, Stokes flow, inviscid flows with and without free surfaces and turbulence. Prerequisite: MEEG 3503 and MATH 2584.

MEEG 5533. Fundamentals of Aerodynamics (Irregular). 3 Hours.
A study of external-flow fluid mechanics applied to Aerodynamics. Topics include integral and differential forms of the basic fluid equations (continuity, momentum, and energy), potential flow, and supersonic flow. Prerequisite: MEEG 3503 and MEEG 4503.

MEEG 5563. Additive Manufacturing (Sp). 3 Hours.
This course provides an overview of developing opportunities and critical challenges of additive manufacturing (AM, also known as 3-D printing). It covers existing and emerging additive manufacturing processes in the context of product design, materials selection and processing, and industrial and consumer applications. Students may not receive credit for both MEEG 4633 and MEEG 5633. Prerequisite: MEEG 2100, MEEG 2303, MEEG 3013, and MEEG 3503 or instructor consent.

Numerical methods for the solution of linear and non-linear ordinary and partial differential equations; initial and boundary value problems; one-step and multi-step methods; predominantly finite difference but also finite element and control volume techniques; and computer applications. Graduate standing in Engineering or consent of instructor.

MEEG 590V. Master’s Research Topic and Report (Sp, Su, Fa). 1-3 Hour.
Fundamental or applied research project required course for students electing the report option. Prerequisite: Graduate standing.

MEEG 591V. Special Topics in Mechanical Engineering (Sp, Su, Fa). 1-6 Hour.
Consideration of current advanced mechanical engineering topics not covered in other courses. Prerequisite: Graduate standing. May be repeated for up to 6 hours of degree credit.

MEEG 592V. Individual Study in Mechanical Engineering (Sp, Su, Fa). 1-3 Hour.
Opportunity for individual study of advanced subjects related to a graduate mechanical engineering program to suit individual requirements. Prerequisite: Graduate standing. May be repeated for up to 6 hours of degree credit.
MEEG 5953. Fundamentals of Fracture and Fatigue in Structures (Sp, Fa). 3 Hours.
The course will cover the concepts of linear-elastic, elastic-plastic and time-dependent Fracture Mechanics as applied to fracture in a variety of materials, structures, and operating conditions. The examples will include fracture in large components such as aircraft, bridges and pressure vessels and also in bones and in soft materials and human tissue. Prerequisite: Graduate standing in Civil, Mechanical or Biomedical Engineering or consent of the instructor. This course is cross-listed with BMEG 5953, CVEG 5953.

MEEG 600V. Master’s Thesis (Sp, Su, Fa). 1-6 Hour.
Master’s Thesis. Prerequisite: Graduate standing. May be repeated for degree credit.

MEEG 6800. Graduate Seminar (Sp, Fa). 0 Hours.
A periodic seminar devoted to mechanical engineering research topics. Course includes letter grades A, B, C, D, and F as well as CR.

MEEG 700V. Doctoral Dissertation (Sp, Su, Fa). 1-18 Hour.
Doctoral Dissertation. Prerequisite: Candidacy. May be repeated for degree credit.