Mechanical Engineering (MEEG)

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Department of Mechanical Engineering website (http://mechanical-engineering.uark.edu/)

Degrees Conferred:
M.S.M.E. (MEEG)
Ph.D. in Engineering (MEEG)

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; Energy Storage; Control Systems; Robotics; Additive Manufacturing.

M.S.M.E. in Mechanical Engineering

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/#mastersdegreestext).

Accelerated M.S.M.E. Degree

High-achieving B.S.M.E. students at the University of Arkansas who choose to pursue graduate studies in Mechanical Engineering may participate in the accelerated M.S.M.E. program (thesis option only). Eligible B.S.M.E. students can count up to 12 graduate-level credit hours of MEEG elective courses towards their M.S.M.E. degree. The 12 credit hours may include a maximum of 6 hours of 4000-level courses but the remaining hours must be that of 5000-level courses. The 4000-level courses must be approved for graduate credit in advance.

The degree requirements of the accelerated M.S.M.E. program are identical to that of the current M.S.M.E. program (thesis option). Students must complete at least 24 hours of coursework and at least 6 hours of MEEG 6000V Master's Thesis. The 24 coursework hours include up to 12 hours transferred from the B.S.M.E. degree.

B.S.M.E. undergraduate students interested in the accelerated M.S.M.E. program should apply to the program prior to starting the second-to-last semester of their undergraduate program and are strongly encouraged to identify their master's thesis advisers in their junior year. To be eligible, students must have a 3.5 cumulative GPA or higher, and submit the normal application materials required by the graduate school for the M.S.M.E. degree program.

Ph.D. in Mechanical Engineering

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/#phdandedddegreestext).

After the B.S.M.E. degree or its equivalent, the student's Schedule of Study must include 42 hours of graded coursework and 30 hours of MEEG 7000V dissertation as follows:

- At least 30 hours at 5000 level or higher and at least 12 hours must be MEEG course
- At least 6 hours of acceptable mathematics courses selected from the approved list below
- No more than 6 hours of 4000 level courses which must be taken in the first 30 hours of the program

No more than 3 hours MEEG 4920V Individual Study in Mechanical Engineering will be allowed.

Approved Math courses: MEEG 47003 Mathematical Methods in Engineering, MATH 44403 Complex Variables, MATH 45003 Differential Geometry, MEEG 57303 Advanced Numerical Methods, PHYS 50703 Mathematical Methods for Physics, STAT 51033 Introduction to Probability Theory, INEG 52603 Engineering Statistics, MATH 52103 Advanced Calculus I, MATH 52203 Advanced Calculus II, MATH 53103 Partial Differential Equations, MATH 53603 Scientific Computation and Numerical Methods, MATH 53803 Numerical Analysis, MATH 53903 Numerical Linear Algebra, MATH 54203 Introduction to Partial Differential Equations

Graduate Faculty

Almahakeri, Mohamed, Ph.D., M.S.M.E. (Queen's University), Teaching Assistant Professor, 2020.
Campbell, Jennifer, Ph.D. (University of Virginia), Assistant Professor, 2023.
Davis, James Allen, Ph.D., M.S.M.E., B.S.M.E. (University of Arkansas), Teaching Assistant Professor, 1997, 2018.
Hamilton, John H., M.S., B.S. (University of Arkansas), Advanced Instructor, 2002, 2024.
Hu, Han, Ph.D. (Drexel University), Assistant Professor, 2019.
Huang, Po-Hao Adam, Ph.D., M.S., B.S. (University of California-Los Angeles), Associate Professor, 2006, 2012.
Huitink, David, Ph.D., M.S.M.E., B.S.M.E. (Texas A&M University), Associate Professor, 2016, 2022.
Jensen, David C., Ph.D., M.S., B.S. (Oregon State University), Associate Professor, 2012, 2018.
Leylek, Jim, Ph.D. (University of Illinois-Urbana-Champaign), M.S., B.S. (University of Illinois at Chicago), Professor, 2011.
Majumdar, Neelaskshi, Ph.D. (Purdue University), Assistant Professor, 2023.
Meng, Xiangbo, Ph.D. (University of Western Ontario), M.S.E.E. (China University of Petroleum), B.S.C.E. (Northwestern University), Associate Professor, 2016, 2022.
Millett, Paul, Ph.D., M.S. (University of Arkansas), B.E. (Vanderbilt University), Associate Professor, Twenty-First Century Professor, 2013, 2019.
Nutter, Darin W., Ph.D. (Texas A&M University), M.S.M.E., B.S.M.E. (Oklahoma State University), Professor, Twenty-First Century Leadership Chair in Engineering, 1994, 2012.
Roe, Larry, Ph.D. (University of Florida), M.S., B.S.M.E. (University of Mississippi), Associate Professor, 1994, 2000.
Shou, Wan, Ph.D. (Missouri University of Science and Technology), M.S.M.E. (University of Louisiana at Lafayette), B.E. (Tianjin Polytechnic University), Assistant Professor, 2021.
Tung, Steve, Ph.D., M.S.M.E. (University of Houston), B.S.M.E. (National Taiwan University), Professor, 2000, 2013.
Walter, Keith D., Ph.D., M.S., B.S. (Clemson University), Professor, Twenty-First Century Professorship, 2021.
Wejinya, Uchechukwu C., Ph.D., M.S., B.S. (Michigan State University), Associate Professor, Twenty-First Century Professor, 2008, 2014.
Zhou, Wenchao, Ph.D. (Georgia Institute of Technology), M.S.M.E. (Xi'an Jiaotong University, Xi'an, China), B.S.M.E. (Huazhong University of Science and Technology, Wuhan, China), Associate Professor, 2014, 2020.
Zou, Min, Ph.D., M.S.M.E. (Georgia Institute of Technology), M.S.A.E., B.S.A.E. (Northwestern Polytechnical University), Professor, Twenty-First Century Chair in Materials, Manufacturing and Integrated Systems, 2003, 2013.

Courses

MEEG 50303. Advanced Mechanics of Materials I. 3 Hours.
Combined stress, theories of failure, thick-walled cylinders, bending of unsymmetrical sections, torsion in noncircular section, plate stresses, and strain energy analysis. Prerequisite: MEEG 20103 and MEEG 30103. (Typically offered: Irregular)

MEEG 51503. Fundamentals of Mechanical Design. 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. Graduate degree credit will not be given for both MEEG 41503 and MEEG 51503. Prerequisite: MEEG 41003. (Typically offered: Fall)

MEEG 51603. Advanced Product Design. 3 Hours.
This course provides an in-depth and comparative study on the theories of engineering design and equips students to understand and utilize the tools and methodologies founded on those theories. (Typically offered: Fall)

MEEG 51703. Model-Based Systems Design and Analysis. 3 Hours.
This course provides students with an introduction into the two main approaches to understanding and designing complex engineered systems. First, the course covers the unique technical challenge of systems engineering and design of systems. Second, the course covers concepts, methods and tools related to "model-based systems design." This covers formal modeling of the information content of complex systems. The third portion of the course will focus on modeling the complex behavior of the systems. This is often described as dynamical systems modeling. Students will utilize the methods and tools presented in class to model a complex engineered system of their choice (with instructor approval). The classes will alternate between presenting modeling methods to the students and students demonstrating their system to the class utilizing those methods. Students may not receive credit for both MEEG 41703 and MEEG 51703. Prerequisite: MEEG 41003 or Instructor consent. (Typically offered: Spring Even Years)

MEEG 52003. Robot Modeling and Simulation. 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. (Typically offered: Spring)

MEEG 52503. Bio-Mems. 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 35003 or CVEG 32103 or CHEG 21303. (Typically offered: Spring)
This course is cross-listed with BENG 52503.

MEEG 52603. Introduction to Micro Electro Mechanical Systems. 3 Hours.
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. (Typically offered: Fall)

MEEG 52803. Microelectronics Reliability. 3 Hours.
In this course, students will learn about common failure modes experienced in electronic packaging and devices, with special attention on mechanical and thermally driven failure mechanisms. Additionally, students will gain familiarity with accelerated testing methods and the associated governing standards associated with electronics reliability qualifications used in identifying and certifying electronics for various applications. Prerequisite: ELEG 52703 or instructor consent. (Typically offered: Fall Even Years)

MEEG 53303. Introduction to Tribology. 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 53303 and MEEG 43103. Prerequisite: Graduate standing. (Typically offered: Irregular)

MEEG 53403. Computational Material Science. 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. (Typically offered: Irregular)

MEEG 53503. Lithium-ion Batteries and Beyond: Materials, Characterization, and Performance. 3 Hours.
This course is intended to provide students an overview of various battery systems and help students establish the concepts of primary and secondary batteries. The course materials will focus on lithium-ion batteries (LIBs), covering their electrochemical mechanisms, components, materials synthesis, materials characterization, and performance evaluations. Prerequisite: CHEM 14103 and MEEG 23003. (Typically offered: Fall)

MEEG 54003. Advanced Thermodynamics. 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. (Typically offered: Spring)

MEEG 54403. Machine Learning for Mechanical Engineers. 3 Hours.
This course covers an introduction to supervised and unsupervised learning algorithms for engineering applications, such as visualization-based physical quantity predictions, dynamic signal classification, and prediction, data-driven control of dynamical systems, surrogate modeling, and dimensionality reduction, among others. The lectures cover the fundamental concepts and examples of developing machine learning models using Python and MATLAB. This course includes four homework assignments to practice the application of different machine learning algorithms in specific mechanical engineering problems and a project assignment that gives the students the flexibility of selecting their topics to study using designated machine learning tools. Students are not allowed to take both MEEG 44403 and MEEG 54403 for credits. Prerequisite: MEEG 27003 or equivalent and Graduate student standing. (Typically offered: Fall)

MEEG 54503. Advanced Heat Transfer. 3 Hours.
More in-depth study of topics covered in MEEG 44103, Heat Transfer, and coverage of some additional topics. Prerequisite: MEEG 44103 or equivalent. (Typically offered: Fall)

MEEG 54703. Radiation Heat Transfer. 3 Hours.
Spectral analysis, radiant exchange in gray and non-gray enclosures, gas radiation, and multi-mode heat transfer. Prerequisite: MEEG 54503 or equivalent. (Typically offered: Summer Even Years)

MEEG 54803. Thermal Systems Analysis and Design. 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. Graduate degree credit will not be given for both MEEG 44803 and MEEG 54803. Prerequisite: MEEG 44103. (Typically offered: Fall and Summer)

MEEG 55003. Advanced Fluid Dynamics I. 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 35003 and MATH 25804. (Typically offered: Spring)

MEEG 55103. Introduction to Flight. 3 Hours.
The course will provide understanding in basic aerodynamics, airfoil design and characteristics, and flight control surfaces. Graduate degree credit will not be given for both MEEG 45003 and MEEG 55103. Prerequisite: MATH 25804, MEEG 35003. (Typically offered: Fall)

MEEG 55203. Astronautics. 3 Hours.
Study of spacecraft design and operations. Graduate degree credit will not be give for both MEEG 45203 and MEEG 55203. Prerequisite: MEEG 20103 and MEEG 24003 or consent of instructor. (Typically offered: Irregular)

MEEG 55303. Fundamentals of Aerodynamics. 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 35003. (Typically offered: Spring)

MEEG 55403. Aerospace Systems Engineering and Safety. 3 Hours.
Systems engineering fundamentals and application to the aerospace industry. Application of key concepts of systems design, including customer needs assessment and communication of solutions. Discussion of aerospace systems and vehicles. Systems safety and hazard analysis, including risk assessment and accident modeling methods. Analysis of notable aerospace accidents, their causes, and lessons learned. Prerequisite: MEEG 21003 and Graduate Standing. (Typically offered: Spring)

MEEG 56303. Additive Manufacturing. 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 46303 and MEEG 56303. Prerequisite: MEEG 21031, MEEG 23003, MEEG 30103, and MEEG 35003 or instructor consent. (Typically offered: Spring)

MEEG 57303. Advanced Numerical Methods. 3 Hours.
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. (Typically offered: Irregular)

MEEG 58303. Aerospace Propulsion. 3 Hours.
Principles, operation, and characteristics of gas turbine and rocket engines. Brief study of novel spacecraft propulsion systems. Graduate degree credit will not be given for both MEEG 44303 and MEEG 58303. Prerequisite: MEEG 35003. (Typically offered: Irregular)

MEEG 58503. Industrial Waste and Energy Management. 3 Hours.
This course in a basic application of thermodynamics, heat transfer, fluid mechanics, and electric machinery to the analysis of energy consumption and waste streams in industrial manufacturing facilities. There is also application toward energy conservation in commercial buildings. Current techniques and technologies for energy conservation and waste minimization are covered, including energy-consuming systems and processes, utility rate analysis, economic analysis and auditing. This course may be of interest to engineers in industry, consulting, facilities, environmental sustainability, and others. Prerequisite: MEEG 44103 or consent of instructor. (Typically offered: Irregular)

MEEG 58703. Indoor Environmental Control. 3 Hours.
This course is a broad use of thermal-fluid concepts toward understanding and applying fundamental theories of heating, ventilating, and air conditioning (HVAC) design. Upon completion of the course, students will be able to apply current engineering techniques and methodologies to design HVAC systems, including heating and cooling loads, and proper selection and sizing of air conditioning equipment. Moreover, through this class, students will gain a physical understanding of HVAC systems and buildings, which is needed for today's HVAC designs. This course may be of interest to engineers in industry, consulting, facilities, and others. Prerequisite: MEEG 44103 or consent of instructor. (Typically offered: Irregular)

MEEG 5910V. Special Topics in Mechanical Engineering. 1-6 Hour.
Consideration of current advanced mechanical engineering topics not covered in other courses. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer) May be repeated for up to 6 hours of degree credit.

MEEG 5920V. Individual Study in Mechanical Engineering. 1-6 Hour.
Opportunity for individual study of advanced subjects related to a graduate mechanical engineering program to suit individual requirements. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer) May be repeated for up to 6 hours of degree credit.

MEEG 59503. Fundamentals of Fracture and Fatigue in Structures. 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. (Typically offered: Fall and Spring)
This course is cross-listed with BMEG 59503, CVEG 59503.

MEEG 59603. Advanced Fracture Mechanics and Structural Integrity. 3 Hours.
This course provides an in-depth treatment of advanced topics in fracture mechanics such as stress analysis of cracks under elastic-plastic loading, crack initiation and growth under elastic-plastic and time-dependent creep and creep-fatigue conditions. The course emphasizes fundamental underpinnings of nonlinear fracture mechanics and its use in material evaluation and life prediction methodology for structural components. Micro-mechanics of fracture and crack growth processes are also covered. Prerequisite: MEEG 59503, or BMEG 59503, or CVEG 59503 or equivalent, or instructor consent. (Typically offered: Fall and Spring)

MEEG 6000V. Master's Thesis. 1-6 Hour.
Master's Thesis. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

MEEG 68000. Graduate Seminar. 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. (Typically offered: Fall and Spring)

MEEG 7000V. Doctoral Dissertation. 1-18 Hour.
Doctoral Dissertation. Prerequisite: Candidacy. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.