

## **MEEM COURSES**

**MEEM 4150 - Intermediate Mechanics of Materials**  
Basic concepts of three-dimensional stress and strain. Inelastic behavior of axial members, circular shafts and symmetric beams. Deflections of indeterminate beams. Unsymmetrical bending, shear flow and shear center for open sections. Energy methods for structures made up of one-dimensional elements. Introduction to theories of failures for anisotropic materials.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Pre-Requisite(s): MEEM 2150

**MEEM 4160 - Fund of Exp Stress Analysis**  
Transmits basic understanding of purposes and uses of experimental stress analysis and makes students familiar with methods used in the field to give experience in either design or analysis of strain-gauged transducer. Credits: 3.0

Lec-Rec-Lab: (0-2-3)

Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following

Level(s): Undergraduate

Pre-Requisite(s): MEEM 2150

**MEEM 4170 - Failure of Materials in Mechanics**  
Identifies the modes of mechanical failure that are essential to prediction and prevention of mechanical failure. Discusses theories of failure in detail. Treats the topic of fatigue failure extensively and brittle fracture, impact and buckling failures at some length.

Credits: 3.0

Lec-Rec-Lab: (0-3-0) Semesters Offered: Spring Pre-

Requisite(s): MEEM 3501

**MEEM 4180 - Engineering Biomechanics**  
Engineering mechanics applied to the human body in health and disease or injury, which includes mechanics of human biological materials and engineering design in musculo-skeletal system. Also studies on mechanics of posture (occupational biomechanics) and locomotion (sports biomechanics) using mathematical models of the human body. Credit may not be received for both MEEM4180 and BE3750.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Pre-Requisite(s): MEEM 2150 and MEEM 2700

**MEEM 4200 - Principles of Energy Conversion**  
Introduces basic background, terminology, and fundamentals of energy conversion. Discusses current and emerging technologies for production of thermal, mechanical, and electrical energy. Topics include fossil and nuclear fuels, solar energy, wind turbines, fuel and solar cells. No credit for both MEEM4200 and MEEM5290.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall - Offered alternate years beginning with the 2005-2006 academic year

Pre-Requisite(s): MEEM 3230(C) or CM 3230 or ENG 3200 or MY 3100

**MEEM 4210 - Computational Fluids Engineering**  
Introduces computational methods used to solve fluid mechanics, and thermal transfer problems. Discusses theoretical and practical aspects. Modern computer-based tools are used to reinforce principles and introduce advanced topics in fluid mechanics, and thermal transport.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Pre-Requisite(s): MEEM 3230(C)

**MEEM 4220 - Internal Combustion Engines I**  
Teaches the operation and design of various types of internal combustion engines through the application of applied thermodynamics, cycle analysis, combustion, mixtures of gases, fluid dynamics, and heat transfer.

Credits: 3.0

Lec-Rec-Lab: (0-3-0) Semesters Offered: Spring Pre-

Requisite(s): MEEM 3210

**MEEM 4240 - Combustion & Air Pollution**  
Introduces sources of emissions from combustion, applies thermo-chemical principles to model the formation of pollutants, and identifies impacts of air pollutants on the environment and human health. Addresses pollution regulation and societal impacts including emissions, climate change, and air quality.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring, Summer

Restrictions: Must be enrolled in one of the following

College(s): College of Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

Pre-Requisite(s): MEEM 2200

**MEEM 4250 - Heating/Ventilation/Air Cond**

Elements of heat transfer for buildings. Thermodynamic properties of moist air, human comfort and the environment, solar energy fundamentals and applications, water vapor transmission in building structures, heating and cooling load calculations.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring - Offered alternate years beginning with the 2004-2005 academic year

Pre-Requisite(s): MEEM 3230(C)

**MEEM 4260 - Fuel Cell Technology**

In this course, after fuel cell technology basics and operating principles, fuel cell performance will be briefly described from energy and thermodynamic viewpoints. Major types of fuel cells will be discussed: Polymer Electrolyte Membrane Fuel Cell (PEMFC), Direct Methanol Fuel Cells (DMFC), Alkaline Fuel Cells (AFC), Phosphoric Acid Fuel Cell (PAFC), Molten Carbonate Fuel Cell (MCFC) and Solid Oxide Fuel Cell (SOFC). The balance of the fuel cell power plant, thermal system design and analysis will be discussed that affect the power generation. Finally, the components needed, issues related, and pertinent analysis will be covered to delivering electric power generated from the fuel cell.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following

College(s): College of Engineering; Must be enrolled in one of the following Class(es): Senior

Pre-Requisite(s): MEEM 3230 or CM 3110

**MEEM 4295 - Introduction to Propulsion Systems for Hybrid Electric Vehicles**

Hybrid electric vehicle analysis will be developed and applied to examine the operation, integration, and design of powertrain components. Model based simulation and design is applied to determine vehicle performance measures in comparison to vehicle technical specifications. Power flows, losses, energy usage, and drive quality are examined over drive-cycles via application of these tools.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall, Summer

Restrictions: Must be enrolled in one of the following

College(s): College of Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore

Pre-Requisite(s): (MEEM 2200 or ENG 3200) and MEEM 4700 or EE 4261

**MEEM 4296 - Introduction to Propulsion Systems for Hybrid Electric Vehicles Laboratory**

Hybrid electric vehicles and their powertrain components will be examined from the aspects of safety, testing and analysis, energy conversion, losses, and energy storage, and vehicle technical specifications and vehicle development process. The lab will culminate with vehicle testing to perform power flow and energy analysis during a drive-cycle.

Credits: 2.0

Lec-Rec-Lab: (0-1-2)

Semesters Offered: Fall, Summer

Restrictions: Must be enrolled in one of the following

College(s): College of Engineering; May not be enrolled in one of the following Class(es): Freshman, Sophomore

Pre-Requisite(s): MEEM 4295(C) or EE 4295(C)

**MEEM 4403 - Computer-Aided Design Methods**

Students apply fundamental and advanced solid modeling techniques to construct solid models of mechanical systems, simulate the motion of the system, and document the design. Students use shared data to function in a concurrent design environment and identify major functional features of commercial CAD software.

Credits: 4.0

Lec-Rec-Lab: (3-0-2)

Semesters Offered: Fall, Spring, Summer

Restrictions: Must be enrolled in one of the following

Major(s): Mechanical Engineering, Engineering-Manufacturing, Mechanical Eng-Eng Mechanics; May not be enrolled in one of the following Class(es): Freshman, Sophomore

Pre-Requisite(s): ENG 1102

**MEEM 4404 - Mechanism Synthesis/Dynamic Modeling**

Students apply kinematic synthesis techniques in design and analysis of mechanical systems. They develop synthesis software to link to dynamic analysis packages such as ADAMS, I-DEAS, Unigraphics, etc. They investigate influences of process variation on system output and learn methods to minimize the variation influences.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall, Spring

Pre-Requisite(s): MEEM 3502(C)

**MICHIGAN TECH - Mechanical Engineering - All Approved Technical Electives**

**Semesters/Years offered subject to change. Refer to Schedule of Classes in BanWeb for current offerings.**

**Graduate level restrictions may be waived with instructor approval for qualified undergraduate students.**

**MEEM 4405 - Intro to the Finite Element Method**

Introduces the use of the finite element method in stress analysis and heat transfer. Emphasizes the modeling assumptions associated with different elements and uses the computer to solve many different types of stress analysis problems, including thermal stress analysis and introductory nonlinear analysis.

Credits: 3.0

Lec-Rec-Lab: (0-2-2)

Semesters Offered: Fall, Spring, Summer

Pre-Requisite(s): MEEM 3502 and (MA 2320 or MA 2321 or MA 2330) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**MEEM 4450 - Vehicle Dynamics**

This course will develop the necessary models to predict performance and handling and compare analytical results to selected measured data from hybrid vehicle test data. Topics to be covered include: acceleration and braking performance, hybrid electric powertrain architecture, drivetrain performance, vehicle handling, suspension modeling, tire models, steering and steering control, 2DOF dynamics model, and multi-body dynamics. This will culminate in a design project which will require the design of a hybrid vehicle to meet a given vehicle technical specification.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring

Restrictions: Must be enrolled in one of the following

College(s): College of Engineering

Pre-Requisite(s): (MEEM 3502 and MEEM 3000) or (EE 3305 and MEEM 2700)

**MEEM 4610 - Advanced Machining Processes**

Covers mechanics of 2-D and 3-D cutting and their extension to commonly used conventional processes such as turning, boring, milling, and drilling. Topics include force modeling, surface generation, heat transfer, tool life and dynamics.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring

Pre-Requisite(s): MEEM 2500

**MEEM 4615 - Metal Forming Processes**

Covers analytical and experimental study of metal forming processes, such as forging, extrusion, rolling, bending, stretch forming, and deep drawing as well as progressive die design for sheet metal stamping and design of dies for bulk forming.

Credits: 4.0

Lec-Rec-Lab: (0-3-2)

Semesters Offered: Fall, Spring

Pre-Requisite(s): MEEM 2500 and MEEM 2150

**MEEM 4625 - Precision Manuf and Metrology**

Course presents theory and practice involved in manufacturing and measuring of precision components. Topics include precision machining processes, precision machine/mechanism design, and dimensional metrology. Also discusses current manufacturing challenges in the bearings, optics, and microelectronics industries.

Credits: 3.0

Lec-Rec-Lab: (0-2-2)

Semesters Offered: Fall, Spring

Pre-Requisite(s): MEEM 3700(C) and MEEM 3502(C)

**MEEM 4630 - Human Factors**

The usability of products and systems can be improved by considering human capabilities during their design. This course explores both the psychological and physical characteristics of human beings. It then presents how to apply human factors principles to the design process. Degree credit cannot be received for both MEEM4630 and SSE3400.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following

College(s): College of Engineering; May not be enrolled in one

of the following Class(es): Freshman, Sophomore, Junior

**MEEM 4635 - Design with Plastics**

Covers various complexities in design of plastic parts and design of molds for manufacturing of plastic parts.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring

Pre-Requisite(s): MY 2100 and MEEM 2150 and MEEM 3210 and MEEM 3230(C)

**MEEM 4640 - Micromanufacturing Processes**

Introduces the processes and equipment for fabricating microsystems and the methods for measuring component size and system performance. Fabrication processes include microscale milling, drilling, diamond machining, and lithography. Measurement methods include interferometry and scanning electron microscopy.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall, Spring

Pre-Requisite(s): MEEM 3502(C)

**MICHIGAN TECH - Mechanical Engineering - All Approved Technical Electives**

**Semesters/Years offered subject to change. Refer to Schedule of Classes in BanWeb for current offerings.**

**Graduate level restrictions may be waived with instructor approval for qualified undergraduate students.**

**MEEM 4650 - Quality Engineering**

Introduction to the concepts and methods of quality and productivity improvement. Topics include principles of Shewhart, Deming, Taguchi; meaning of quality; control charts for variables, individuals, and attributes; process capability analysis; variation of assemblies; and computer-based workshops. Credit may not be received for both MEEM4650 and MEEM5650.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore

Pre-Requisite(s): MA 3710 or MA 3720

**MEEM 4655 - Production Planning**

Provides current issues, such as just-in-time production and reengineering, while covering fundamental production planning topics as scheduling, job design, inventory and forecasting. Provides the fundamental essence of the firm-- how its services and products are created and how they are delivered to customers.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall, Spring

Pre-Requisite(s): MEEM 3501(C)

**MEEM 4660 - Data Based Modeling & Control**

System modeling from observed data for computer-aided design and manufacturing, providing differential equation models. Analysis of manufacturing and dynamic systems, computer routines for modeling, forecasting with accuracy assessment, and minimum mean-squared error control. Underlying system analysis, including stability and feedback interpretation, periodic and exponential trends. Illustrative applications to real- life data.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

**MEEM 4685 - Env Resp Design & Manuf**

Examines the impact of engineering and design/manufacturing, decisions on the environment. Topics include sustainability; energy and material flows; risk assessment; life cycles, manufacturing process waste streams, and product design issues, including disassembly and post-use product handling and techniques for pollution prevention.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring - Offered alternate years beginning with the 2001-2002 academic year

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

**MEEM 4701 - Analy and Exp Modal Analysis**

Combined experimental and analytical approach to mechanical vibration issues; characterization of the dynamic behavior of a structure in terms of its modal parameters; digital data acquisition and signal processing; experimental modal analysis procedures; parameter estimation for obtaining modal parameters; model validation and correlation with analytical models; structural dynamics modification.

Credits: 4.0

Lec-Rec-Lab: (0-3-2)

Semesters Offered: Fall

Pre-Requisite(s): MEEM 3000 and MEEM 3700

**MEEM 4704 - Acoustics and Noise Control**

Analysis and solution of practical environmental noise problems. Fundamental concepts of sound generation and propagation, the unwanted effects of noise, assessment of sound quality, and source-path-receiver concepts in noise control. Lecture, measurement laboratory, and team project directed at solving a real noise problem under a client's sponsorship.

Credits: 3.0

Lec-Rec-Lab: (0-2-2)

Semesters Offered: Spring

Pre-Requisite(s): MA 3160 and MEEM 2700

**MEEM 4705 - Introduction to Robotics and Mechatronics**  
Cross-discipline system integration of sensors, actuators, and microprocessors to achieve high-level design requirements, including robotic systems. A variety of sensor and actuation types are introduced, from both a practical and a mathematical perspective. Embedded microprocessor applications are developed using the C programming language.

Credits: 4.0

Lec-Rec-Lab: (0-3-3)

Semesters Offered: Fall, Spring

Pre-Requisite(s): MEEM 4700(C)

**MICHIGAN TECH - Mechanical Engineering - All Approved Technical Electives**

**Semesters/Years offered subject to change. Refer to Schedule of Classes in BanWeb for current offerings.**

**Graduate level restrictions may be waived with instructor approval for qualified undergraduate students.**

**MEEM 4720 - Space Mechanics**

This course presents the vector-based solution of the two-body problem and the solution for Kepler's equations. The course will also cover basic orbit determination techniques, impulsive orbit transfer maneuvers, interplanetary trajectories, ground tracks, and rendezvous problems.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Pre-Requisite(s): MEEM 2700

**MEEM 4750 - Distributed Embedded Control Systems**

This course will develop an understanding for the design and application of embedded control systems. Topics to be covered include: embedded system architecture, model-based embedded system design, real-time control, communication protocols, signal processing, and human machine interface. Embedded applications in advanced hybrid electric vehicles will also be introduced.

Credits: 3.0

Lec-Rec-Lab: (0-2-2)

Semesters Offered: Spring

Restrictions: Must be enrolled in one of the following

College(s): College of Engineering

Pre-Requisite(s): MEEM 4700 or EE 4261

**MEEM 5110 - Continuum Mechanics/Elasticity**

Covers development of Cartesian tensors and indicial notation applied to vector analysis; analysis of stress, principal stresses, invariants, strain tensors, material derivatives, and continuity equations; basic conservation laws and constitutive relationships; the theory of elasticity, including 2-D problems in plane stress/strain, stress functions, and 3-D problems with polar symmetry.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

Pre-Requisite(s): MEEM 2150 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**MEEM 5130 - Nanoscale Science and Technology**

The course covers fundamentals of nanoscience (synthesis, properties, characterization) and recent technological advances in renewable energy, biotechnology, and nanodevices. This course is appropriate for students with backgrounds in mechanical engineering, materials science, chemistry, chemical engineering, civil engineering, and physics.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

**MEEM 5150 - Advanced Mechanics of Matls**

A critical study of the basic concepts of stress, strain, and constitutive laws of solids, the physical significance of principle stresses, stress deviator and octahedral stress. Covers failure theories; two-dimensional elasticity theory; mechanics of sub-micron structures; torsion of prismatic bars, thick pressure vessels; special topics in beam theory; elements of elastic stability.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall, Spring

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

Pre-Requisite(s): MEEM 2150

**MEEM 5160 - Experimental Stress Analysis**

Review of elastic stress-strain relationships. Covers theory and use of resistive strain gages, strain gage circuits, rosette analysis, static and dynamic strain measurement; discusses other current strain measuring techniques; introduces photoelasticity, Moire, and other optical techniques.

Credits: 3.0

Lec-Rec-Lab: (0-2-2)

Semesters Offered: Fall

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

Pre-Requisite(s): MEEM 2150

**MEEM 5170 - Finite Element and Variational Methods in Engineering**

Presents fundamental concepts of variational methods including Rayleigh-Ritz technique. Introduces foundations of finite element modeling through direct method, variational method, and weighted residual method. Reviews elements commonly used in static structural analysis and heat transfer problems. Advanced topics such as nonlinearity and time-dependent problems may also be discussed.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

**MEEM 5180 - Mechanics of Composite Matls**

Introduces engineering properties and advantages of fibrous composites, the governing equations of mechanics of anisotropic, laminated materials. Develops micromechanics methods for predicting the elastic properties of the composite and classical lamination theory, including hygrothermal effects, and applies them to stress and failure analysis of composite structures.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring - Offered alternate years beginning with the 2009-2010 academic year

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

**MEEM 5200 - Advanced Thermodynamics**

A study of the principles of thermodynamics, including fundamental concepts and introduction of the analytical treatments of the first, second and combined first and second laws of thermodynamics. Topics include irreversibility, availability (exergy), thermodynamic relations, mixtures, chemical reactions, and chemical equilibrium.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall, Summer

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

Pre-Requisite(s): MEEM 2200

**MEEM 5210 - Advanced Fluid Mechanics**

Develops control volume forms of balance laws governing fluid motion and applies to problems involving rockets, pumps, sprinklers, etc. Derives and studies differential forms of governing equations for incompressible viscous flows. Some analytical solutions are obtained and students are exposed to rationale behind computational solution in conjunction with CFD software demonstration. Also covers qualitative aspects of lift and drag, loss of stability of laminar flows, turbulence, and vortex shedding.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

Pre-Requisite(s): MEEM 3210

**MEEM 5230 - Advanced Heat Transfer**

Advanced topics on conduction, convection, radiation, and heat exchangers are covered. Emphasis is on problem formulation, exact solutions, some coverage of empirical results, and computational techniques.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

Pre-Requisite(s): MEEM 3230

**MEEM 5240 - Comp Fluid Dynamics for Engg**

Introduces finite-difference and finite-volume methods used in solving fluid dynamics and heat transfer problems. Covers numerical grid generation, turbulence modeling, and application to some selected problems.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring - Offered alternate years beginning with the 2001-2002 academic year

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

Pre-Requisite(s): MEEM 5210

**MEEM 5250 - Internal Combustion Engines II**

Advanced topics in internal combustion engines with emphasis on CI operation, modeling of engines, modeling of combustion processes, tribology, second law applications, and other topics of current interest.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall - Offered alternate years beginning with the 2001-2002 academic year

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

Pre-Requisite(s): MEEM 4220 and MEEM 5200(C)

**MEEM 5255 - Advanced Powertrain Instrumentation and Experimental Methods**

Students will be exposed to unique instrumentation used in modern powertrain research and development. Through hands-on experimentation students will learn techniques for installation, usage, and calibration. Students will also be exposed to data quality checks and techniques to mitigate experimental variation.

Credits: 2.0

Lec-Rec-Lab: (0-1-2)

Semesters Offered: Spring

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

Pre-Requisite(s): MEEM 4220(C)

**MEEM 5270 - Advanced Combustion**

The objective is to understand basic combustion processes through detailed chemical reaction step analysis. Introduces both analytical and modern experimental methods.

Emphasizes gas liquid fuel combustion, flame propagation, and critical phenomena of ignition and extinction.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring

Restrictions: Must be enrolled in one of the following

Level(s): Graduate; Must be enrolled in one of the following

College(s): College of Engineering

Pre-Requisite(s): MEEM 4240 or MEEM 5200

**MEEM 5280 - Phase-Change & Two-Phase Flows**

Considers two-phase flow patterns for air-water, condensing, and boiling flows in the context of interface conditions (surface tension, etc.) and interfacial instabilities that lead to interfacial waves, droplet formation, etc. The course

emphasizes development of model equations. Relevant experimental data leading to pressure drop correlations, interfacial shear models, etc., are discussed. The model equations and empirical correlations are used to estimate solutions of problems.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: On Demand

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

Pre-Requisite(s): MEEM 3230

**MEEM 5295 - Advanced Propulsion Systems for Hybrid Electric Vehicles**

Hybrid electric vehicles (HEV) will be studied and simulated using advanced powertrain component analysis and modeling. An in-depth analysis and study of power flows, losses and energy usage are examined for isolated powertrain components and HEV configurations. Simulation tools will be developed and applied to specify powertrain and vehicle components and to develop control and calibration for a constrained optimization to vehicle technical specifications.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring

Restrictions: Must be enrolled in one of the following

Level(s): Graduate; Must be enrolled in one of the following

College(s): College of Engineering

Pre-Requisite(s): MEEM 4295 or EE 4295

**MEEM 5296 - Advanced Propulsion Systems for Hybrid Electric Vehicles Laboratory**

Hybrid electric vehicles (HEV) and their components will be examined in a series of laboratories. This includes quantification of power flows and losses in components, calibration of component models based upon experimental data, measurement and quantification of drive quality, failure Mode & Effects Analysis, calibration practices and trade-offs. A HEV model will be tuned and validated through analysis and fitting to vehicle test data.

Credits: 2.0

Lec-Rec-Lab: (0-1-2)

Semesters Offered: Spring, Summer

Restrictions: Must be enrolled in one of the following

Level(s): Graduate; Must be enrolled in one of the following

College(s): College of Engineering  
Pre-Requisite(s): (MEEM 5295(C) or EE 5295(C)) and (MEEM 4296 or EE 4296)

**MEEM 5401 - Design for Reliability**

Emphasizes the importance of reliability in design, covering basic concepts of series, parallel, standby and mixed systems. Uses conditional probability and multimodefunctions as methods for problem solution. Considers derating and reliability testing.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

Pre-Requisite(s): MEEM 3501

**MEEM 5453 - Discover. Design. Delight 1**

Familiarizes students with the principles and techniques of design thinking through a two-semester real project development sequence: awareness, understanding, discovery, iteration, prioritization, prototyping, art, shipping, and delighting. Students will work with real client/communities and aim to transform ideas to opportunities.

Credits: 2.0

Lec-Rec-Lab: (0-1-3)

Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

**MEEM 5454 - Discover. Design. Delight 2**

Continuation of MEEM5453. This course extends the techniques of design thinking through a two-semester real project development sequence: awareness, understanding, discovery, iteration, prioritization, prototype, art, ship, and delight, this course focusing on the latter half. Students will work with real client/communities and aim to transform ideas to opportunities.

Credits: 2.0

Lec-Rec-Lab: (0-1-3)

Semesters Offered: Spring

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

Pre-Requisite(s): MEEM 5453 or ENVE 5453

**MEEM 5645 - Numerical Analy Manuf Proc**

Nonlinear FEM and BEM analyses, modeling of bulk forming processes, sheet forming processes, machining processes, casting processes, grinding of ceramics.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: On Demand

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

Pre-Requisite(s): MEEM 2500

**MEEM 5655 - Introduction to Lean Manufacturing**

Lean manufacturing is emerging globally as a paradigm by which business units must function to be globally competitive. Quality, cost, and delivery have become critical measures that impact profits and, in turn, the success of an organization. Significant improvements in all these three measures come from the continuous elimination of waste, or non-value added activities, in manufacturing. Numerous tools are available for the elimination of waste and making businesses lean. This course is intended to familiarize students with this new philosophy of lean manufacturing and arm them with a basic toolset that enables the identification, measurement, and elimination of non-value added activities.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring - Offered alternate years beginning with the 2007-2008 academic year

Restrictions: Must be enrolled in one of the following

Level(s): Graduate; Must be enrolled in one of the following

College(s): School of Business & Economics, College of Engineering

**MEEM 5660 - Data Based Modeling & Control**

System modeling and analysis from observed data for computer-aided design and manufacturing, providing differential equation models. Computer routines for modeling, forecasting with accuracy assessment and minimum mean-squared error control. Underlying system analysis, including stability and feedback interpretation, periodic and exponential trends. Uses illustrative applications to real-life data, including team projects.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

**MEEM 5670 - Experimental Design in Engg**

Review of basic statistical concepts. Models for testing significance of one or many factors. Reducing experimental effort by incomplete blocks, and Latin squares. Factorial and fractional factorial designs. Response surface analysis for optimal response.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall, Summer

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

**MEEM 5680 - Optimization I**

Provides introductory concepts to optimization methods and theory. Covers the fundamentals of optimization, which is central to any problem involving engineering decision making. Provides the tools to select the best alternative for specific objectives.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall, Spring

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

**MEEM 5700 - Dynamic Measurement/Signal Analysis**

Assessment of measurement system requirements: transducers, conditioners, and displays of dynamic measurands. Time-, frequency-, probabilistic-, and correlative-domain approaches to dynamic signal analysis: sampled data, discrete Fourier transforms, digital filtering, estimation errors, system identification, calibration, recording. Introduction to wavelet analysis. All concepts reinforced in laboratory and simulation exercises.

Credits: 4.0

Lec-Rec-Lab: (0-3-3)

Semesters Offered: Fall, Summer

Restrictions: Must be enrolled in one of the following

Level(s): Graduate; Must be enrolled in one of the following

College(s): College of Engineering



**MEEM 5701 - Intermediate Dynamics**

Intermediate study of several topics in engineering dynamics, including three-dimensional kinematics and kinetics, generalized coordinates, Lagrange's equation, and Hamilton's principle. Uses computer-aided dynamic simulation tools for analyzing dynamic systems.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore, Junior

Pre-Requisite(s): MEEM 2700

**MEEM 5702 - Analytical Vibroacoustics**

First in a series of two courses on vibro-acoustics to provide a unified approach to study noise and vibration. Emphasizes interaction between sound waves and structures. Presents advanced vibration concepts with computational tools. Discusses wave-modal duality.

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Fall

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

Pre-Requisite(s): MEEM 3700

**MEEM 5703 - Exp Methods Vibro-Acoustics**

Covers operating data measurement and analysis, including multisource ODS. Includes signature analysis and order tracking; modal theory, modal scaling. FRF estimators; multiple input excitation techniques; parameter estimation methods; sound measurements and acoustic intensity; sound quality; field data acquisition, DAT; binaural recording and playback with equalization.

Credits: 4.0

Lec-Rec-Lab: (0-3-3)

Semesters Offered: Spring

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

Pre-Requisite(s): MEEM 5700 and MEEM 5702

**MEEM 5715 - Linear Systems Theory and Design**

Overview of linear algebra, modern control; state-based design of linear systems, observability, controllability, pole placement, observer design, stability theory of linear time-varying systems, Lyapunov stability, optimal control, linear quadratic regulator, Kalman filter,

Credits: 3.0

Lec-Rec-Lab: (0-3-0)

Semesters Offered: Spring

Restrictions: Must be enrolled in one of the following

Level(s): Graduate

Pre-Requisite(s): MEEM 4700 or EE 4261 or MA 4330

## **INTERDISCIPLINARY COURSES**

### **BE 4660 - Active Implantable Devices**

Implantable devices that are actively delivering therapy and acting as monitoring tools will be covered. Emphasis will be on the technology and its application. Devices include electrical stimulators, pumps & diagnostic instrumentations.

Credits: 3.0

Lec-Rec-Lab: (3-0-0)

Semesters Offered: Fall - Offered alternate years beginning with the 2010-2011 academic year

Pre-Requisite(s): BE 3600

### **CE 4404 - Railroad Engineering**

Overview of basic elements and roles of rail transportation, history, organizations and economics, safety, intercity and urban passenger rail, freight operations, track-train dynamics, signals and communications, motive power and equipment, track components, construction and maintenance.

Credits: 3.0

Lec-Rec-Lab: (3-0-0)

Semesters Offered: Fall

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore

### **CE 4405 - International Railroad Engineering**

Overview of basic elements and roles of rail transportation, history, organizations and economics, safety, intercity and passenger rail, freight operations, track-train dynamics, signals and communications, motive power and equipment, track components, construction and maintenance.

Incorporates technical field visits in the United States and Europe.

Credits: 3.0

Lec-Rec-Lab: (3-0-0)

Semesters Offered: Summer

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore

### **MY 4130 - Principles of Metal Casting**

Principles of metal casting, including melting practice, casting design, mold design, heat transfer and solidification, fluid flow and gating design. Introduction to computer simulation techniques for mold filling, solidification, and development of residual stress. Structure-property relations in cast metals. Recycling and environmental issues of the cast metals industry.

Credits: 3.0

Lec-Rec-Lab: (2-0-3)

Semesters Offered: Fall

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore

Pre-Requisite(s): MY 2100

### **MY 4155 - Composite Materials**

Mechanistic aspects of property development in metal, ceramic, and polymeric composites. The role of composite architecture, processing, and microstructure on properties.

Credits: 3.0

Lec-Rec-Lab: (3-0-0)

Semesters Offered: Spring

Restrictions: May not be enrolled in one of the following

Class(es): Freshman, Sophomore

Pre-Requisite(s): MY 2100

### **MY 4800 - Material and Process Selection in Design**

The principles of materials selection for engineering design. Topics include selection based on strength, stiffness, thermal properties, high temperature behavior, corrosion resistance, formability, joinability, manufacturability, recyclability, etc. Considers ethics and economics. Presents numerous case studies and examples.

Credits: 3.0

Lec-Rec-Lab: (3-0-0) Semesters Offered: Spring

Pre-Requisite(s): MY 2100