Mechanical engineering is a highly diversified profession. The mechanical engineer designs machines, devices, various products and control systems, and works with the generation, conversion, transmission, and utilization of mechanical and thermal power. Assignments often include analysis and synthesis of mechanical, thermal, and fluid systems. Mechanical engineers are also responsible for characterization, specification, and analysis of materials used in design and manufacturing. Manufacturing systems, robotics, electromechanical devices, and control systems are also the purview of the mechanical engineer. Graduates in mechanical engineering are among the most versatile engineers and enjoy professional employment in industry, government, consulting, and research organizations. The undergraduate program in Mechanical Engineering at Texas A&M University is accredited by the Engineering Accreditation Commission of ABET, www.abet.org.

The work of mechanical engineers varies from general engineering to numerous, narrow specialties, as required by the wide variety of employers. A general list, though not in any way exhaustive, of the areas of professional employment opportunities available to mechanical engineers includes: design, construction, controls, materials specification and evaluation, analysis of thermal systems, fluid and solid mechanics, manufacturing, plant engineering, research and development, and technical sales. Many mechanical engineers are promoted to management and administrative positions as well.

The mission of the Department of Mechanical Engineering is to serve the students of Texas A&M University, the State of Texas, and the nation by:

- providing quality education that is well-grounded in the fundamental principles of engineering, fostering innovation and preparing students for leadership positions and successful careers in industry, government, and academia;
- advancing the knowledge base of mechanical engineering to support the competitiveness of existing industry and to spawn new economic development in Texas and the nation through active involvement in basic and applied research; and
- providing professional development opportunities for practicing engineers through continuing education, service, and outreach activities.

Faculty

Allaire, Douglas, Assistant Professor
Mechanical Engineering
PhD, Massachusetts Institute of Technology, 2009

Ames, Aaron, Associate Professor
Mechanical Engineering
PhD, University of California, Berkeley, 2006

Amini, Noushin, Visiting Assistant Professor
Mechanical Engineering
PhD, Texas A&M University, 2011

Anand, Nagamangala, Professor
Mechanical Engineering
PhD, Purdue University, 1983

Annamalai, Kalyan, Professor
Mechanical Engineering
PhD, Georgia Institute of Technology, 1975

Banerjee, Debjoyoti, Professor
Mechanical Engineering
PhD, University of California, Los Angeles, 1999

Beheshti, Ali, Visiting Assistant Professor
Mechanical Engineering
DEN, Louisiana State University, 2013

Caton, Jerald, Professor
Mechanical Engineering
PhD, Massachusetts Institute of Technology, 1980

Charoenphol, Phapanin, Research Assistant Professor
Mechanical Engineering
DEN, University of Michigan, 2012

Childs, Dara, Professor
Mechanical Engineering
PhD, University of Texas, 1968

Chowdhury, Shahla, Assistant Lecturer
Mechanical Engineering
MS, University of Illinois at Urbana-Champaign, 2013

Claridge, David, Professor
Mechanical Engineering
PhD, Stanford University, 1976

Donnell, James, Professor Of The Practice
Mechanical Engineering
BS, Texas A&M University, 1982

Doron, Yuval, Lecturer
Mechanical Engineering
MS, Texas A&M University, 2009

Duggleby, Andrew, Visiting Assistant Professor
Mechanical Engineering
PhD, Virginia Tech, 2006

Felts, Jonathan, Assistant Professor
Mechanical Engineering
DEN, University of Illinois at Urbana-Champaign, 2013

Freed, Alan, Professor
Mechanical Engineering
DEN, University of Wisconsin-Madison, 1985

Fullerton, Tracy, Associate Professor Of The Practice
Mechanical Engineering
PhD, Texas A&M University, 2011

Goenezen, Sevan, Assistant Professor
Mechanical Engineering
PhD, Rensselaer Polytechnic Institute, 2011
Grunlan, Jaime, Professor
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PhD, University of Minnesota, 2001

Haglund, John, Lecturer
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PhD, Texas A&M University, 2003

Haims, Marla, Visiting Associate Professor
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PhD, University of Wisconsin - Madison, 1999

Hamilton, Peter, Associate Professor Of The Practice
Mechanical Engineering
DEN, The University of Texas at Austin, 1984

Han, Je, Distinguished Professor
Mechanical Engineering
PhD, Massachusetts Institute of Technology, 1977

Handler, Robert, Research Professor
Mechanical Engineering
PhD, University of Minnesota, 1980

Hogan, Harry, Professor
Mechanical Engineering
PhD, Texas A&M University, 1984

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Jacobs, Timothy, Associate Professor
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PhD, University of Michigan, 2005

Karasipahi, Sena, Lecturer
Mechanical Engineering
PHD, Universiteit Leiden, 2006

Kim, Haejune, Research Assistant Professor
Mechanical Engineering
MS, Texas A&M University, 2007

Kim, Won-Jong, Associate Professor
Mechanical Engineering
PhD, Massachusetts Institute of Technology, 1997

Kim, Yong-Joe, Associate Professor
Mechanical Engineering
PhD, Purdue University, 2003

King, Maria, Tees Research Associate Professor
Mechanical Engineering
PhD, Akademie Der Wissenschaften Der DDR, 1986

Kulatlaka, Waruna, Associate Professor
Mechanical Engineering
DEN, Purdue University, 2006

Lalk, Thomas, Associate Professor
Mechanical Engineering
PhD, University of Wisconsin-Madison, 1972

Lau, Sai, Professor
Mechanical Engineering
PhD, University of Minnesota, 1980

Lee, Sungyon, Assistant Professor
Mechanical Engineering
PhD, Massachusetts Institute of Technology, 2010

Li, Ying, Associate Professor
Mechanical Engineering
EdD, University of Florida, 2007

Liang, Hong, Professor
Mechanical Engineering
PhD, Stevens Institute of Technology, 1992

Ma, Ji, Tees Asst Research Scientist
Mechanical Engineering
PhD, Texas A&M University, 2012

Malak, Richard, Associate Professor
Mechanical Engineering
PhD, Georgia Institute of Technology, 2008

Mansoor, Bilal, Assistant Professor
Mechanical Engineering
PhD, University of Michigan, 2010

McAdams, Daniel, Professor
Mechanical Engineering
PhD, University of Texas, Austin, 1999

McFarland, Jacob, Visiting Assistant Professor
Mechanical Engineering
PhD, University of Minnesota, 2013

McGuire, Richard, Lecturer
Mechanical Engineering
MA, Texas A&M University, 1996

McVay, Matilda, Senior Lecturer
Mechanical Engineering
PHD, Texas A&M University, 1996

Monroe, James, Lecturer
Mechanical Engineering
PhD, Texas A&M University, 2013

Moreno, Michael, Assistant Professor
Mechanical Engineering
PhD, Texas A&M University, 2009

Morrison, Gerald, Professor
Mechanical Engineering
PhD, Oklahoma State University, 1977

Mukherjee, Partha, Assistant Professor
Mechanical Engineering
PhD, Pennsylvania State University, 2007

Muliana, Hanifah, Professor
Mechanical Engineering
PhD, Georgia Institute of Technology, 2004
Schwartz, Christian, Assistant Professor
Mechanical Engineering
PHD, Iowa State University, 2006

Srinivasa, Arun, Professor
Mechanical Engineering
PhD, University of California, Berkeley, 1991

Staack, David, Associate Professor
Mechanical Engineering
PhD, Drexel University, 2008

Strzelec, Andrea, Assistant Professor
Mechanical Engineering
PhD, University of Wisconsin-Madison, 2009

Suh, Chii-Der, Associate Professor
Mechanical Engineering
PHD, Texas A&M University, 1997

Swaroop, Dvahg, Professor
Mechanical Engineering
PHD, University of California, Berkeley, 1994

Tai, Li-Jung, Assistant Professor
Mechanical Engineering
PHD, University of Michigan Ann Arbor, 2011

Wen, Sy-Bor, Associate Professor
Mechanical Engineering
PHD, University of California, Berkeley, 2006

Yu, Choongho, Associate Professor
Mechanical Engineering
PHD, University of Texas, Austin, 2004

Yu, Kaiyuan, Lecturer
Mechanical Engineering
PHD, Texas A&M University, 2013

Zacharia, Nicole, Tees Research Assistant Professor
Mechanical Engineering
PHD, Massachusetts Inst of Technology, 2007

Zhang, Xinghang, Professor
Mechanical Engineering
PHD, North Carolina State University, 2001

**Majors**

- Bachelor of Science in Mechanical Engineering

**Courses**

**MEEN 210 Geometric Modeling for Mechanical Design**

**Credits 2. 1 Lecture Hour. 2 Lab Hours.**

Foundations of geometric modeling as applied to mechanical design through use of modern computer-aided design (CAD) and physical prototyping tools; basics of systematic design methodology; geometric visualization concepts: multiview orthographic, isometric, oblique, perspective; three-dimensional representations, surface and solid modeling; dimensioning and tolerancing; rapid prototyping using 3D printing.

**Prerequisites:** Mechanical engineering major; ENGR 111.
MEEN 221 Statics and Particle Dynamics
Credits 3. 3 Lecture Hours.
Application of the fundamental principles of Newtonian mechanics to the
statics and dynamics of particles; equilibrium of trusses, frames, beams
and other rigid bodies.
Prerequisites: For non-mechanical engineering majors; admission to an
engineering major; MATH 251 or MATH 253 or registration therein; PHYS
218.

MEEN 222 Materials Science
Credits 3. 3 Lecture Hours.
Mechanical, optical, thermal, magnetic and electrical properties of solids;
differences in properties of metals, polymers, ceramics and composite
materials in terms of bonding and crystal structure.
Prerequisites: CHEM 102, or CHEM 104 and CHEM 114, or CHEM 107
and CHEM 117; PHYS 218.

MEEN 225 Engineering Mechanics
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Application of the laws of classical mechanics to simplified, plausibly
real world problems or interest to mechanical engineering, including the
analysis of cables, frames, trusses, beams, machines and mechanisms.
Prerequisites: Mechanical engineering major; MATH 251 or MATH 253 or
registration therein; PHYS 218.

MEEN 260 Mechanical Measurements
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Introduction to the basic principles of engineering experimentation
including: instrumentation and measurement techniques, signal processing
and data acquisition, statistical data analysis, and interpretation and
reporting of results.
Prerequisites: MEEN 225, ECEN 215, MATH 308 and MEEN 315 or
registration therein.

MEEN 289 Special Topics in...
Credits 1 to 4. 1 to 4 Lecture Hours.
Selected topics in an identified area of mechanical engineering. May be
repeated for credit.
Prerequisite: Approval of instructor.

MEEN 291 Research
Credits 1 to 4. 1 to 4 Other Hours.
Research conducted under the direction of faculty member in mechanical
engineering. May be repeated 2 times for credit.
Prerequisites: Freshman or sophomore classification and approval of
instructor.

MEEN 315 Principles of Themodynamics
Credits 3. 3 Lecture Hours.
Principles of Thermodynamics.
Prerequisites: MEEN 225; MATH 251 or MATH 253; junior or senior
classification.

MEEN 333 Project Management for Engineers
Credits 3. 3 Lecture Hours.
Basic project management for engineering undergraduates; project
development and economic justification; estimating; scheduling; network
methods; critical path analysis; earned value management; recycling
and rework; project organizational structures; project risk assessment;
resource allocation; ethics; characteristics of project managers.
Prerequisite: Junior or senior classification in Dwight Look College of
Engineering.
Cross Listing: CVEN 333 and ISEN 333.

MEEN 344 Fluid Mechanics
Credits 3. 3 Lecture Hours.
Application of laws of statics, buoyancy, stability, energy and momentum
to behavior of ideal and real fluids; dimensional analysis and similitude and
their application to flow through ducts and piping; lift and drag and related
problems.
Prerequisites: MEEN 225 and MEEN 315.

MEEN 345 Fluid Mechanics Laboratory
Credit 1. 3 Lab Hours.
Introduction to basic fluid mechanics instrumentation; experimental
verification and reinforcement of the analytical concepts introduced in
MEEN 344.
Prerequisites: MEEN 260; MEEN 344 or registration therein.

MEEN 357 Engineering Analysis for Mechanical Engineers
Credits 3. 3 Lecture Hours.
Practical foundation for the use of numerical methods to solve engineering
problems: Introduction to Matlab, error estimation, Taylor series, solution
of non-linear algebraic equations and linear simultaneous equations;
numerical integration and differentiation; initial value and boundary
value problems; finite difference methods for parabolic and elliptic partial
differential equations.
Prerequisites: ENGR 112 and MATH 308.

MEEN 360 Materials and Manufacturing Selection in Design
Credits 3. 3 Lecture Hours.
Selecting materials and manufacturing processes in design; emphasis
on material mechanical properties; microstructure production and control;
manufacturing processes for producing various shapes for components
and structures; use of design methodology.
Prerequisites: MEEN 222, MEEN 260; CVEN 305; junior or senior
classification; or approval of instructor.

MEEN 361 Materials and Manufacturing in Design Laboratory
Credit 1. 3 Lab Hours.
Experiments in materials characterization and manufacturing processes;
emphasis on material mechanical properties; microstructure production
and control; manufacturing processes for producing various shapes for
components and structures.
Prerequisites: MEEN 222, MEEN 260; CVEN 305; MEEN 360 or
registration therein; junior or senior classification or approval of instructor.

MEEN 363 Dynamics and Vibrations
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Dynamics and Vibration. Application of Newtonian and energy methods
to model dynamic systems (particles and rigid bodies) with ordinary
differential equations; solution of models using analytical and numerical
approaches; interpreting solutions; linear vibrations.
Prerequisites: MEEN 225; MATH 308; MEEN 357 or CVEN 302, or
registration therein; CVEN 305 or registration therein.

MEEN 364 Dynamic Systems and Controls
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Mathematical modeling, analysis, measurement and control of dynamic
systems; extensions of modeling techniques of MEEN 363 to other types
of dynamic systems; introduction to feedback control, time and frequency
domain analysis of control systems, stability, PID control, root locus;
design and implementation of computer-based controllers in the lab.
Prerequisites: MEEN 260 and MEEN 363; ECEN 215.
MEEN 368 Solid Mechanics in Mechanical Design
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Stress analysis of deformable bodies and mechanical elements; stress transformation; combined loading; failure modes; material failure theories; fracture and fatigue; deflections and instabilities; thick cylinders; curved beams; design of structural/mechanical members; design processes.
Prerequisites: CVEN 305; MEEN 357 and MEEN 360 or registration therein; junior or senior classification.

MEEN 381 Seminar
Credit 1. 2 Other Hours.
Presentations by practicing engineers and faculty addressing: effective communications, engineering practices, professional registration, ethics, career-long competence, contemporary issues, impact of technology on society and being informed; preparation of a resume, a lifelong learning plan, two papers, two oral presentations and complete an online assessment of the mechanical engineering program.
Prerequisite: Upper-level classification in mechanical engineering.

MEEN 401 Introduction to Mechanical Engineering Design
Credits 3. 2 Lecture Hours. 3 Lab Hours.
The design innovation process; need definition, functional analysis, performance requirements and evaluation criteria, conceptual design evaluation, down-selected to an embodiment; introduction to systems and concurrent engineering; parametric and risk analysis, failure mode analysis, material selection, and manufacturability; cost and life cycle issues, project management.
Prerequisites: MEEN 360, MEEN 361, MEEN 364, MEEN 368, MEEN 461.

MEEN 402 Intermediate Design
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Product detail design and development process including case studies; project management, marketing considerations, manufacturing, detailed design specifications; failure modes, application of codes and standards, selection of design margins; product (component) development guidelines; intellectual property, product liability and ethical responsibility.
Prerequisites: MEEN 401; junior or senior classification.

MEEN 404 Engineering Laboratory
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Systematic design of experimental investigations; student teams identify topics and develop experiment designs including: establishing the need; functional decomposition; requirements; conducting the experiment; analyzing and interpreting the results and written and oral reports documenting the objectives, procedure, analysis, and results and conclusion of two or three experiments.
Prerequisites: MEEN 260, MEEN 360, MEEN 361, MEEN 364, MEEN 461; MEEN 401 or registration therein; junior or senior classification.

MEEN 408 Introduction to Robotics
Credits 3. 3 Lecture Hours.
Forward and inverse kinematics of robot manipulators, path planning, motion planning for mobile robots, dynamics of robot manipulators, control algorithms; computed torque algorithm, adaptive control algorithms and current topics in mobile robots; cooperative motion planning of mobile robots and formation control.
Prerequisites: MEEN 364 or equivalent; junior or senior classification.

MEEN 410 Internal Combustion Engines
Credits 3. 3 Lecture Hours.
Thermodynamics of cycles for internal combustion engines and gas turbines, including fuels and combustion; performance characteristics of various types of engines.
Prerequisite: MEEN 344 or equivalent or approval of instructor.

MEEN 411 Mechanical Controls
Credits 3. 3 Lecture Hours.
Application of classical and modern control theory techniques to modeling, analysis and synthesis of linear, mechanical control systems.
Prerequisite: MEEN 364.

MEEN 414 Principles of Turbomachinery
Credits 3. 3 Lecture Hours.
Aero-thermodynamic and mechanical design of turbomachinery components including steam and gas turbine stages, compressor stages, and inlet and exhaust systems, and their integration into power and thrust generation units; design and off-design behaviors of turbine and compressor stages and units; design with SolidWorks.
Prerequisites: MEEN 421 or approval of instructor; junior or senior classification.

MEEN 417/NUEN 417 Basics of Plasma Engineering and Applications
Credits 3. 3 Lecture Hours.
Basic plasma properties and confinement techniques; single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory; wave phenomena in plasmas and introduction to plasma kinetic theory; analysis of laboratory plasmas and plasma applications including fusion, electric propulsion, materials processing and plasmas enhanced chemistry.
Prerequisites: PHYS 208 or equivalent; senior classification in nuclear, mechanical or aerospace engineering, physics, or approval of instructor.
Cross Listing: NUEN 417/MEEN 417.

MEEN 421 Thermal-Fluids Analysis and Design
Credits 3. 3 Lecture Hours.
Integration of thermodynamics, fluid mechanics and heat transfer through application to the design of various thermal systems comprised of several components requiring individual analyses; analysis of the entire system; representative applications of thermal-fluids analysis with a design approach.
Prerequisites: MEEN 461; MEEN 315; junior or senior classification.

MEEN 430 Nanomaterials
Credits 3. 3 Lecture Hours.
Fundamentals of nanotechnology, including nanomaterials, types of nanomaterials, fabrication, characterization methods, and applications; explore current roles in technology and future impact on such systems on industry.
Prerequisites: Junior or senior classification and approval of instructor.

MEEN 431 Advanced System Dynamics and Controls
Credits 3. 3 Lecture Hours.
Unified framework for modeling, analysis, synthesis, design and simulation of mechanical systems with energy exchange across multiple domains; study of mechanical, electrical, hydraulic and thermal subsystems; Newtonian mechanics, rigid body dynamics, multiple degrees of freedom vibrations and control system design.
Prerequisites: MEEN 364; junior or senior classification.

MEEN 432 Automotive Engineering
Credits 3. 3 Lecture Hours.
Introduction to vehicle dynamics; application of engineering mechanics principles to analysis of acceleration and braking, cornering and handling; analysis and design of drive train, suspension, brakes, and tires to achieve desired performance.
Prerequisite: MEEN 363.
MEEN 433 Mechatronics
Credits 3.2 Lecture Hours. 3 Lab Hours.
Basic principles of digital logic and analog circuits in mechanical systems; electrical-mechanical interfacing; sensors and actuators; digital control implementation; precision design and system integration.
Prerequisite: MEEN 364 or equivalent.

MEEN 434 Dynamics and Modeling of Mechatronic System
Credits 3.3 Lecture Hours.
Mechatronic interactions in lumped parameter and continuum systems; review of integral and differential electromagnetic laws, including motions; lumped elements and dynamic equations of motion; linear and nonlinear actuators and transducers; field transformation and moving media; electromagnetic force densities and stress tensors.
Prerequisite: MEEN 364.

MEEN 436 Principles of Heating, Ventilating and Air Conditioning
Credits 3.3 Lecture Hours.
Application of thermodynamics fluid mechanics, and heat transfer to the design of HVAC equipment; selection of equipment, piping and duct layouts.
Prerequisite: MEEN 461 or equivalent.

MEEN 437 Principles of Building Energy Analysis
Credits 3.3 Lecture Hours.
Analysis of building energy use by applying thermodynamics and heat transfer to building heating and cooling load calculations; heat balance and radiant time series calculation methods; psychometric analysis, indoor air quality, effect of solar radiation on heating and cooling of buildings. Required design project.
Prerequisites: MEEN 315 or equivalent; junior or senior classification.

MEEN 441 Design of Mechanical Components and Systems
Credits 3.3 Lecture Hours.
Design of machine elements, characteristics of prime movers, loads and power transmission elements as related to mechanical engineering design.
Prerequisite: MEEN 368 or approval of instructor.

MEEN 442 Computer Aided Engineering
Credits 3.3 Lecture Hours.
Effective and efficient use of modern computer hardware and software in modeling, design, and manufacturing; simulation of a broad spectrum of mechanical engineering problems.
Prerequisites: MEEN 363 and MEEN 368.

MEEN 444 Finite Element Analysis in Mechanical Engineering
Credits 3.3 Lecture Hours.
Introduction to basic theory and techniques; one- and two-dimensional formulations for solid mechanics applications; direct and general approaches; broader aspects for field problems; element equations, assembly and solution schemes; computer implementation, programming and projects; error sources and application consideration.
Prerequisites: MEEN 357 and 368 or equivalents.

MEEN 445 Engineering Applications of Solid Mechanics
Credits 3.3 Lecture Hours.
Mechanical and mathematical basis for modeling response of solid bodies undergoing coupled mechanical and non-mechanical effects, analysis of stress and deformation for structural members subjected to axial, torsional and bending loads, design of multifunctional systems.
Prerequisites: CVEN 305, MEEN 368.

MEEN 451 Viscoelastic Materials
Credits 3.3 Lecture Hours.
Mechanical and mathematical basis for modeling linear viscoelastic materials which focus on polymeric solid materials; characterization of viscoelastic material properties from experimental tests; applications of stress and deformation relationships for viscoelastic structural members subjected to axial, torsional, and bending loads.
Prerequisites: CVEN 305; junior or senior classification.

MEEN 455 Engineering with Plastics
Credits 3.3 Lecture Hours.
Polymer structure, processing, property characterization at the molecular, microscopic and macroscopic dimensions for thermosets, thermoplastics, elastomers, fibers and advanced fibrous nonparticle filled composites and smart multi-performance structures.
Prerequisite: MEEN 222 or approval of instructor.

MEEN 458 Processing and Characterization of Polymers
Credits 3.3 Lecture Hours.
Introduction of flow behavior in polymers; structure-property-process relationship; mixing rules for polymer blends; mechanical properties; laboratory demonstrations: injection molding, extrusion, melt mixing, and study of morphology using OM, SEM, and TEM.
Prerequisite: MEEN 222.

MEEN 459 Sound and Vibration Measurements
Credits 3.3 Lecture Hours.
Basic acoustics, review of vibration theory, wave propagation in vibrating systems, sound radiation from vibrating systems, sound and vibration sensors and instrumentation, data acquisition systems, measurement techniques, spectral analysis, spatial FFT analysis, design of experiments with vibro-acoustic systems, applications.
Prerequisites: MEEN 363; MATH 308.

MEEN 460 Corrosion Engineering
Credits 3.3 Lecture Hours.
Basic corrosion phenomena are described, including mixed potential theory, types of corrosion, experimental methods, and prevention techniques.
Prerequisite: MEEN 360 and MEEN 361, or equivalent.

MEEN 461 Heat Transfer
Credits 3.3 Lecture Hours.
Heat transfer by conduction, convection and radiation: steady and transient conduction, forced and natural convection, and blackbody and gray body radiation; multi-mode heat transfer; boiling and condensation; heat exchangers.
Prerequisites: MEEN 344; MATH 308.

MEEN 463 Cogeneration Systems
Credits 3.3 Lecture Hours.
Design and analysis of cogeneration system; selection of the prime mover, matching power and thermal needs, institutional factors, economic evaluations, financial options and the study of actual and hypothetical systems.
Prerequisite: MEEN 421 or equivalent.

MEEN 464 Heat Transfer Laboratory
Credit 1.3 Lab Hours.
Basic measurement techniques in conduction, convection, and radiation heat transfer; experimental verification of theoretical and semi-empirical results; uncertainty analysis.
Prerequisite: MEEN 345, MEEN 461 or registration therein.
MEEN 467 Mechanical Behavior of Materials  
Credits 3.3 Lecture Hours.  
Fundamentals of flow and fracture in metals, emphasizing safe design by anticipating response of materials to complex stress and environmental service conditions; micromechanisms of flow, fatigue, creep and fracture; fracture mechanics approach to design. Special emphasis given to microstructure-mechanical property relationship and damage tolerant design.  
Prerequisite: MEEN 360 and MEEN 361.

MEEN 471 Elements of Composite Materials  
Credits 3.3 Lecture Hours.  
Fundamentals concerned with relating structure of multiphase materials to physical properties; plastic, metallic and ceramic matrices reinforced with continuous and discontinuous fibers, whiskers and particulates.  
Prerequisites: MEEN 360, MEEN 361, and MEEN 368 or approval of instructor.

MEEN 472 Gas Dynamics  
Credits 3.3 Lecture Hours.  
Fundamental analysis of compressible flows and its application to supersonic airfoils/projectiles, jet and rocket nozzles, normal and oblique shock waves, explosion waves, shock tubes, supersonic wind tunnels, and compressible pipe flows.  
Prerequisite: MEEN 344.

MEEN 475 Materials in Design  
Credits 3.3 Lecture Hours.  
The heuristics of synthesis of material properties, configuration and processing in the optimization of material selection in the design process; product design and development overview, failure mode effects analysis, design margin establishment; role of the generic failure modes and codes and standards; fundamental characteristics of process methods.  
Prerequisites: MEEN 360 and MEEN 361; CVEN 305.

MEEN 476 Nanoscale Issues in Manufacturing  
Credits 3.3 Lecture Hours.  
Fundamentals of manufacturing techniques at the nanoscale and larger length scales; design approaches and issues; direct fabrication of nanostructures; nanomanufacturing as a building block to larger objects; fabrication of composites and devices utilizing nanoscale components.  
Prerequisites: MEEN 222 or approval of instructor; junior or senior classification.

MEEN 477 Air Pollution Engineering  
Credits 3.3 Lecture Hours.  
Design of air pollution abatement equipment and systems to include cyclones, bag filters, and scrubbers; air pollution regulations; permitting; dispersion modeling; National Ambient Air Quality Standards.  
Prerequisite: ENGR 214 or equivalent.  
Cross Listing: BAEN 477 and SENG 477.

MEEN 485 Directed Studies  
Credits 1 to 6.1 to 6 Other Hours.  
Special problems relating to a specific project in some phase of mechanical engineering. A commitment of two semesters with 6 hours 485 credit is required.  
Prerequisites: Approval of department head and senior classification.

MEEN 489 Special Topics in...  
Credits 1 to 4.1 to 4 Lecture Hours.  
Selected topics in an identified area of mechanical engineering.  
Prerequisite: Approval of instructor.