

MEEN - MECHANICAL ENGINEERING (MEEN)

MEEN 201 Introduction to Mechanical Engineering

Credits 0. 0 Lecture Hours. 0 Lab Hours. 0 Other Hours.

Preparation for success in the mechanical engineering curriculum by learning about university, college and department resources and useful tools; development of a mechanical engineering degree plan; discussion of opportunities for leadership, professionalism, experiential learning and other high impact activities.

Prerequisite: Major in mechanical engineering.

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.

Prerequisite: Mechanical engineering major; grade of C or better in ENGR 102.

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; Grade of C or better in PHYS 206 or PHYS 218; grade of C or better in MATH 251 or MATH 253, or concurrent enrollment.

MEEN 222/MSEN 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: Grade of C or better in CHEM 107 or CHEM 119; grade of C or better in PHYS 206.

Cross Listing: MSEN 222/MEEN 222.

MEEN 223 Principles of Materials and Manufacturing

Credits 2. 2 Lecture Hours.

Structures of metals, polymers and ceramics, including structure-mechanical property relationships; defects and diffusion in materials; basic machining theory and processes, including geometric dimensioning and tolerancing (GD&T); overview of manufacturing processes for metals and polymers, including additive technologies.

Prerequisite: Grade of C or better in CHEM 120, or CHEM 107 and CHEM 117; grade of C or better in PHYS 206.

MEEN 225 Engineering Mechanics

Credits 3. 3 Lecture 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.

Prerequisite: Mechanical engineering major; grade of C or better in PHYS 206; grade of C or better in MATH 251 or MATH 253, or concurrent enrollment.

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.

Prerequisite: Grade of C or better in STAT 211; Grade of C or better in ECEN 215, MATH 308 and MEEN 315, or concurrent enrollment.

MEEN 285 Directed Studies

Credits 1 to 4. 1 to 4 Other Hours.

Directed studies in specific problem areas of mechanical engineering.

Prerequisites: MEEN classification; approval by instructor and department head or delegate.

MEEN 289 Special Topics in...

Credits 0 to 4. 0 to 4 Other 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 305 Solid Mechanics

Credits 3. 3 Lecture Hours.

Applications of stress and deformation relationships for deformable bodies and mechanical elements relevant to mechanical engineers; to include axially loaded members, stability of columns, torsional members and beams, failure theories, combined loadings; introduction to structural design.

Prerequisite: Grade of C or better in MEEN 225; grade of C or better in MEEN 210 or concurrent enrollment.

MEEN 315 Principles of Thermodynamics

Credits 3. 3 Lecture Hours.

Theory and application of energy methods in engineering; conservation of mass and energy; energy transfer by heat, work and mass; thermodynamic properties; analysis of open and closed systems; the second law of thermodynamics and entropy; gas, vapor and refrigeration cycles.

Prerequisite: Grade of a C or better in MEEN 221 or MEEN 225; grade of a C or better in MATH 251 or MATH 253.

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.

Prerequisite: Grade of C or better in MEEN 315 and MATH 308.

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: Grade of C or better in MEEN 260; grade of C or better in MEEN 344 or concurrent enrollment.

MEEN 357 Engineering Analysis for Mechanical Engineers**Credits 3. 3 Lecture Hours.**

Practical foundation for the use of numerical methods to solve engineering problems; error estimation, Taylor series, numerical solution of linear and non-linear algebraic and differential equations; introduction to engineering optimization.

Prerequisite: Grade of C or better in MATH 308.**MEEN 360 Materials and Manufacturing Selection in Design****Credits 3. 3 Lecture Hours.**

Selecting materials and manufacturing processes in design; emphasis on mechanical properties of materials; microstructure production and control; manufacturing processes for producing various classes of materials.

Prerequisite: Grade of C or better in MEEN 223 and MEEN 260.**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.

Prerequisite: Grade of C or better in MEEN 210 and MEEN 260; grade of C or better in MEEN 360 or concurrent enrollment.**MEEN 363 Dynamics and Vibrations****Credits 3. 2 Lecture Hours. 2 Lab Hours.**

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.

Prerequisite: Grade of C or better in MEEN 225 or MEEN 221, and MATH 308; grade of a C or better in MEEN 357 and MEEN 305, or concurrent enrollment.**MEEN 364 Dynamic Systems and Controls****Credits 3. 3 Lecture Hours.**

Mathematical modeling and analysis of different types of dynamic systems; introduction to feedback control, time and frequency domain analysis of control systems, stability, PID control, root locus; design of computer-based controllers.

Prerequisite: Grade of C or better in MEEN 260, MEEN 363, and ECEN 215.**MEEN 365 Dynamic Systems and Controls Lab****Credit 1. 0 Lecture Hours. 3 Lab Hours.**

Introduction to basic control systems instrumentation; experimental verification of control system concepts; implementation of computer-based controllers; data acquisition and analysis.

Prerequisite: Grade of C or better in MEEN 260, MEEN 363, and ECEN 215; grade of C or better in MEEN 364, or concurrent enrollment.**MEEN 368 Solid Mechanics in Mechanical Design****Credits 3. 2 Lecture Hours. 2 Lab Hours.**

Design of structural/mechanical members for stiffness, strength and stability under a variety of loading conditions; use of Static and Fatigue Failure Theories to estimate life of components.

Prerequisite: Grade of a C or better in MEEN 305; grade of C or better in MEEN 210, or concurrent enrollment.**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: Major in mechanical engineering.**MEEN 399 High Impact Experience for Mechanical Engineers****Credits 0. 0 Other Hours.**

Participation in an approved high-impact learning practice; reflection on professional outcomes from engineering body of knowledge; documentation and self-assessment of learning experience at mid-curriculum point.

Prerequisite: Junior or senior classification.**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.

Prerequisite: Grade of C or better in MEEN 360, MEEN 361; grade of C or better in MEEN 364, MEEN 365, MEEN 368, MEEN 461, and MEEN 464, or concurrent enrollment.**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.

Prerequisite: Grade of C or better in MEEN 401.**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: Grade of C or better in MEEN 360, MEEN 361, MEEN 364 and MEEN 461; grade of C or better in MEEN 401 or concurrent enrollment.**MEEN 406 Energy Management in Industry****Credits 3. 3 Lecture Hours.**

Energy systems and components frequently encountered in industrial environments; application of basic principles of thermodynamics, heat transfer, fluid mechanics and electrical machinery to the analysis and design of industrial system components and systems; improved energy utilization.

Prerequisites: Grade of C or better in MEEN 260 and MEEN 315.

MEEN 408 Mechanics of Robotic Manipulators**Credits 3. 3 Lecture Hours.**

Forward and inverse kinematics and differential kinematics of robot manipulators, path planning, motion planning, dynamics of robot manipulators and control algorithms; PD/PID control, computed torque algorithm.

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.**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; 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: Grade of C or better in PHYS 208 or equivalent; senior classification in nuclear, mechanical or aerospace engineering, or physics.

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.

Prerequisite: Grade of C or better in MEEN 461.**MEEN 423 Machine Learning for Mechanical Engineers****Credits 3. 3 Lecture Hours.**

Machine learning techniques with applications to the analysis and design of mechanical, fluid, thermal, material and multidisciplinary systems; linear and kernel support vector machines; neural networks; Bayesian techniques; decision trees and random forests; dimension reduction and model selection; data management and learner validation strategies; tools and application studies.

Prerequisite: Grade of C or better in MEEN 357.**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 435 Compressed Air Systems****Credits 3. 3 Lecture Hours.**

Basic principles, thermodynamics, and performance of compressed air systems including various components, such as compressors, reciprocating, rotary, centrifugal, and axial, prime movers, coolers, intercoolers, aftercoolers, dryers, heat recovery, receivers, separators, filters, regulators, fault detectors, controllers etc.; exploration of performance and analysis and operating principles for both systems and components, energy consumption and economic analysis for system design and operation.

Prerequisite: Grade of C or better in MEEN 315 or equivalent; junior or senior classification.

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: Grade of a C or better in MEEN 344 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 439 Solar Energy Engineering**Credits 3. 3 Lecture Hours.**

Solar energy; solar angles and radiation; solar thermal systems; solar water heating and space heating; concentrated solar power; energy storage; solar photovoltaics; solar cell manufacturing; other solar energy technologies.

Prerequisite: MEEN 315.**MEEN 440 Bio-inspired Engineering Design****Credits 3. 3 Lecture Hours.**

Expand design space available to engineering by developing and understanding of how nature solves problems; study of effective bio-inspired design and biomimetic applications to draw solutions from nature; enhance concept generation through the use of bio-inspired design; use current state of the art methods in bioinspired design; view nature's solutions to different problems from an engineering perspective.

Prerequisite: MEEN 368, BMEN 361, or BAEN 375.**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.**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: Grade of C or better in 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 Mechanics of Compliant Materials****Credits 3. 3 Lecture Hours.**

Study of mechanics; three-dimensional analysis tools and techniques needed to model linear behavior of fluids and solids in response to imposed loads and deformations.

Prerequisite: Grade of C or better in MEEN 344.**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: Grade of C or better in MEEN 368.**MEEN 453 Additive and Subtractive Processes in Custom Manufacturing**
Credits 3. 3 Lecture Hours.

Machining theory; traditional and non-traditional machining processes; CNC machines and tools; geometric dimensioning and tolerance (GD&T); additive manufacturing systems and processes; materials in additive manufacturing.

Prerequisites: Grade of C or better in MEEN 360 and MEEN 361, or equivalent.**MEEN 454 Tribology-Mechanical Interface Design****Credits 3. 3 Lecture Hours.**

History and significance of tribology, rough surfaces, hertzian contact, rough surfaces in contact, friction of surfaces in contact, surface failures/wear, boundary lubrication, fluid properties, thick film lubrication, thin film lubrication, micro- and nano-tribology.

Prerequisites: Grade of C or better in MEEN 344 and MEEN 368.**MEEN 455 Engineering with Plastics****Credits 3. 3 Lecture Hours.**

Polymer structure, processing, property characterization at the molecular, microscopic and macroscopic dimensional levels for thermosets, thermoplastics, elastomers, fibers and advanced fibrous nonparticle filled composites and smart multi-performance structures.

Prerequisite: MEEN 222/MSEN 222; junior or senior classification.**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/MSEN 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.

Prerequisite: Grade of C or better in MEEN 344.**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.

Prerequisites: Grade of C or better in MEEN 345; grade of C or better or MEEN 461 or concurrent enrollment.

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 469 Alternative Energy Conversion****Credits 3. 3 Lecture Hours.**

Design and analysis of alternative energy conversion processes and systems that are based on converting energy directly (e.g., fuel cells, photovoltaics), utilizing non-combustible heat sources (e.g., geothermal, ocean gradients, solar and nuclear fission and fusion) and obtaining energy from the environment (e.g., wind, hydroelectric, ocean tides and waves).

Prerequisite: MEEN 315.**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: Grade of C or better in MEEN 360, MEEN 361, and MEEN 368.**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: Grade of C or better in MEEN 360 and MEEN 361.**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: Grade of C or better in BAEN 340, CVEN 311/EVEN 311, or MEEN 344.**Cross Listing:** BAEN 477 and SENG 477.**MEEN 480 Research Methods and Experiences****Credits 3. 3 Lecture Hours.**

Application of various methodologies used in engineering research, including literature review, study design, data collection, statistical analysis, uncertainty quantification through the Kline-McClintock approach, quality assurance techniques; development of understanding of adviser-advisee relationship fundamentals, personal responsibilities and initiatives, responsive and effective communication; topics include all sub disciplines of mechanical engineering; activities include peer evaluation, relationship building, and collaboration across disciplines.

Prerequisites: Junior or senior classification and approval of instructor; Qatar campus.**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 Other Hours.**

Selected topics in an identified area of mechanical engineering.

Prerequisite: Approval of instructor.**MEEN 490 Entrepreneurship in Nano and Energy Systems****Credits 3. 3 Lecture Hours.**

Exploration of the various aspects of entrepreneurship, from discovery to commercialization, with a focus on nanotechnology and the energy sector; exposure to idea generation incorporating technical design and comparative analysis to existing technologies, raising early stage capital, staffing the enterprise, developing the business plan and selling the product.

Prerequisite: Grade of C or better in MEEN 344, CVEN 311/EVEN 311, CHEN 304, PETE 310, ECEN 322, or MSEN 325.**MEEN 491 Research****Credits 0 to 4. 0 to 4 Other Hours.**

Research conducted under the direction of faculty member in mechanical engineering. May be repeated 2 times for credit. Registration in multiple sections of this course is possible within a given semester provided that the per semester credit hour limit is not exceeded.

Prerequisites: Junior or senior classification and approval of instructor.**MEEN 497 Innovation Mindset for Design and Research****Credits 3. 3 Lecture Hours.**

Exploration of the key behaviors of innovators and how to increase innovativeness in one's work; exploration of additional learning orientations, including Design Thinking and Lean experimentation, and Leadership practices to increase innovation in teams.

Prerequisite: Junior or senior classification.