# MECHANICAL ENGINEERING (MECH)

## Faculty

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The discipline of mechanical engineering is the branch of engineering that deals predominantly with the conversion, transmission, and storage of mechanical and thermal energy; the generation, transmission, and control of forces; the production and regulation of mechanical motion; and the optimal use of materials in the design and fabrication of the requisite machines and mechanisms.

## Mission Statement

The Department of Mechanical Engineering is committed to providing the best undergraduate mechanical engineering education possible within the constraints of a four-year curriculum. In accord with the College of Engineering Mission Statement, the mechanical engineering department strives to nurture the intellectual, professional, and personal development of its students. The mechanism for achieving the department's educational mission is the curriculum in mechanical engineering designed to satisfy its Program Educational Objectives. The department strives to achieve a process of continuous improvement of the curricula, to provide a faculty who are professionally current in their field, and to maintain state-of-the-art facilities.

## Program Educational Objectives

The Department of Mechanical Engineering seeks to prepare students to be successful in engineering or other careers and to be recognized for qualities associated with their Bucknell University educational experiences. These qualities include, for example, critical thinking and problem solving, consideration of global and societal concerns, leadership and effective communication, civic engagement and contributions to society, and pursuit of lifelong learning.

## Concentrations within Mechanical Engineering

Students may elect to pursue a concentration within the Mechanical Engineering program. A concentration consists of three courses from the following lists for concentration in Mechanics-Materials-Design (MMD) or in Thermo-Fluids-Energy (TFE).

### Concentration in Mechanics-Materials-Design (MMD):

Any 400-level Mechanical Engineering elective with a course number from 450 to 480. Also, MECH 445 Engineering Acoustics and Noise Control, MECH 446 Flow-induced Noise and Vibration, MECH 485 Advanced Engineering Problems (with a MMD topic) .

### Concentration in Thermo-Fluids-Energy (TFE):

Any 400-level Mechanical Engineering elective with a course number from 400 to 449. Also, MECH 485 Advanced Engineering Problems (with a TFE topic).

## Bachelor of Science in Mechanical Engineering

The **Bachelor of Science** in mechanical engineering requirements are:

| **First Year** | | | |
|---|---|---|---|
| **First Semester** | **Credits** | **Second Semester** | **Credits** |
| First-year W-1 course | 1 | MECH 220 | 1 |
| MATH 201 | 1 | MATH 202 | 1 |
| ENGR 100 | 1 | ENGR 214 | 1 |
| PHYS 211 | 1 | MECH 202 | .5 |
| | | Elective | 1 |
| | 4 | | 4.5 |
| **Sophomore** | | | |
| **First Semester** | **Credits** | **Second Semester** | **Credits** |
| MECH 222 | .5 | MATH 212 | 1 |

| | | | |
|---|---|---|---|
| MATH 211 | 1 | MECH 353 | 1 |
| ECEG 205 | 1 | ENGR 240 | 1 |
| MECH 213 | 1 | MECH 216[1] | 1 |
| Elective | 1 | | |
| | 4.5 | | 4 |

**Junior**

| First Semester | Credits | Second Semester | Credits |
|---|---|---|---|
| MECH 313 | 1 | MECH 302 | 1 |
| MECH 355[1] | 1 | MECH 312 | 1 |
| MECH 252 | 1 | MECH 392 | 1 |
| MECH 151[2] | 0 | Elective | 1 |
| Elective | 1 | | |
| | 4 | | 4 |

**Senior**

| First Semester | Credits | Second Semester | Credits |
|---|---|---|---|
| MECH 401 | .5 | MECH 402 | .5 |
| MECH 403 | 1 | Four electives | 4 |
| MECH 405 | 1 | | |
| Two electives | 2 | | |
| | 4.5 | | 4.5 |

Total Credits: 34

1 These two courses (MECH 216 Thermodynamics II and MECH 355 Manufacturing Processes) are required. Students seeking an optional concentration in the thermal fluids energy area (TFE) or in the mechanics materials design area (MMD), may replace one of these two courses with a second 400-level MECH elective.

2 There is zero credit for the course MECH 151 Machining for Manufacturing Technology.

The 11 elective courses shown above are distributed as follows:

- One course in chemistry from the following list, to be taken during the first two years:

| | | |
|---|---|---|
| CHEM 201 | General Chemistry I | 1 |
| CHEM 211 | Organic Chemistry I | 1 |
| CHEM 221 | | 1 |

- Select any TWO full-credit courses from the following:

  1. any full-credit 200-level or 300-level course in astronomy, biology, chemistry, geology or physics for which prerequisites have been satisfied; or
  2. any of the following courses:

| | | |
|---|---|---|
| BIOL 121 | Biology for Non-majors | 1 |
| BIOL 122 | Biology for Non-majors | 1 |
| GEOL 107 | Global Change - Past and Present | 1 |
| GEOL 108 | When Rocks Attack | 1 |
| GEOL 109 | Energy and Natural Resources | 1 |
| GEOL 117 | Environmental Geohazards (Any 100-level science course must be taken within the first three years) | 1 |

  Any 100-level science course must be taken within the first three years

  3. one science course may be replaced by MATH 245 Linear Algebra, MATH 280 Logic, Sets, and Proofs or any 300-level MATH course for which prerequisites have been met.

- The elective courses must include five courses selected from any of the following: social science courses, arts and humanities courses,university courses, residential college courses or foundation seminars. These courses must include one course in arts and humanities and one course in social sciences.
- Three courses in each student's program must also fulfill the University's writing requirement. One course in each student's program must also fulfill the college's global perspectives requirement.
- One 400-level or equivalent course in any department within the College of Engineering.

- One 400-level course in the Department of Mechanical Engineering or, with permission of the department, a course required for the expected fulfillment of a minor.
- One course in any department or program of the University.

**Student Outcomes**

Graduates of the program are expected to demonstrate the following learning outcomes which reflect ABET accreditation criteria:

1. An ability to apply knowledge of mathematics, science, and engineering.
2. An ability to design and conduct experiments, as well as analyze and interpret data.
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. An ability to function on multidisciplinary teams.
5. An ability to identify, formulate, and solve engineering problems.
6. An understanding of professional and ethical responsibility.
7. An ability to communicate effectively.
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
9. A recognition of the need for, and an ability to engage in lifelong learning.
10. A knowledge of contemporary issues.
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

## Courses

**MECH 151. Machining for Manufacturing Technology. 0 Credits.**
**Offered Fall Semester Only; Lecture hours:2,Other:2**
Develop an understanding of the processes needed to produce manufactured parts. Emphasis on hands-on machining and fabrication.

**MECH 202. Graphics for Design and Manufacture. .5 Credits.**
**Offered Spring Semester Only; Lecture hours:1,Lab:2**
Graphical representation techniques for visualization and communication of mechanical engineering designs and concepts. Creation, storage, and manipulation of production drawings and 3-D geometric representations using state-of-the-art software.

**MECH 213. Thermodynamics I. 1 Credit.**
**Offered Fall Semester Only; Lecture hours:4**
Thermodynamic principles including properties of substances, the first and second laws of thermodynamics, efficiencies, power and refrigeration cycles. Prerequisites: MATH 201 and ENGR 214 or permission of the department. Not open to students who have taken ENGR 200 or CHEG 310.

**MECH 216. Thermodynamics II. 1 Credit.**
**Offered Spring Semester Only; Lecture hours:3,Lab:2**
A continuation of MECH 213 with a focus on applications of thermodynamic principles including an extension of power and refrigeration cycles, psychometrics, reacting mixtures and combustion, and other selected topics. Prerequisites: MATH 211, MECH 213, MECH 222, or the permission of the department.

**MECH 220. Mechanics. 1 Credit.**
**Offered Spring Semester Only; Lecture hours:4,Other:1**
Equilibrium of two- and three-dimensional force systems. Trusses and frames. Friction. Distributed force systems. Internal loads. One degree of freedom vibrations. Prerequisite: MATH 201. Not open to students who have taken ENGR 221 or ENGR 229.

**MECH 222. Introduction to Mechanical Engineering Lab Practice. .5 Credits.**
**Offered Fall Semester Only; Lecture hours:2,Lab:2**
Sensors, measurement techniques for static and dynamic measurements, data processing, statistical data analysis, propagation of error, technical report preparation. Corequisite: ECEG 205 and MECH 222L or permission of the department. Prerequisites: MATH 202 and MECH 220.

**MECH 252. Dynamics. 1 Credit.**
**Offered Fall Semester Only; Lecture hours:4**
Kinematic and kinetic analysis of rigid bodies in planar and/or three-dimensional motion. Absolute and relative analysis of displacements, velocities, and accelerations; force, energy, and momentum methods; analysis of mechanical vibrations; analytical and computer-simulated solution techniques. Prerequisites: MECH 220 and MATH 212.

**MECH 285. Independent Study for Sophomores. .5-1 Credits.**
**Offered Either Fall or Spring; Lecture hours:2,Other:3; Repeatable**
Independent investigation under the direction of a faculty member for students who have completed their first year. Sophomore standing in mechanical engineering and permission of the instructor.

**MECH 2NT. Mechanical Engineering Non-traditional Study. .25-4 Credits.**
**Offered Fall, Spring, Summer; Lecture hours:Varies,Other:3**
Non-traditional study in Mechanical Engineering. Prerequisite: permission of the instructor.

**MECH 302. Finite Elements in Analysis and Design. 1 Credit.**
**Offered Spring Semester Only; Lecture hours:3,Lab:4**
Introduction to finite element method (FEM) and commercial FEM software for design and analysis of mechanical components and thermal problems. Applications in mechanical and thermal component/system design. Co-Requisites: MECH 302L. Prerequisites: MECH 202 and MECH 353.

**MECH 312. Heat Transfer. 1 Credit.**
**Offered Spring Semester Only; Lecture hours:3,Lab:2**
Principles and engineering applications of heat transfer by conduction, convection, and radiation. Co-Requisites: MECH 312L. Prerequisite: MECH 313 or permission of the instructor.

**MECH 313. Fluid Dynamics. 1 Credit.**
**Offered Fall Semester Only; Lecture hours:3,Lab:2**
Fundamentals of fluid dynamics including integral and differential control volume analysis, conservation equations, dimensional analysis, incompressible inviscid flows, internal and external viscous flows. Prerequisites: MATH 212, MECH 213, MECH 222, or permission of the department. Not open to students who have taken ENGR 222 or ENGR 233.

**MECH 353. Solid Mechanics. 1 Credit.**
**Offered Spring Semester Only; Lecture hours:3,Lab:2**
Analysis of the stress, strain, and failure of engineering components under axial, bending, and torsional loading conditions. Provide a bridge to more advanced material in the theory of elasticity and computational solid mechanics. Co-Requisites: MECH 353L. Prerequisites: MECH 220 and concurrent prerequisite MATH 212 or permission of the department.

**MECH 355. Manufacturing Processes. 1 Credit.**
**Offered Fall Semester Only; Lecture hours:3,Lab:2**
Analytical and technological study of manufacturing processes including metal deformation, casting, and cutting. Introduction to numerical control and CAD/CAM. Laboratory fabrication project and field trips. Co-Requisite: MECH 355L. Prerequisites: ENGR 240 and MECH 202.

**MECH 385. Independent Study for Juniors. .5-1 Credits.**
**Offered Either Fall or Spring; Lecture hours:2,Other:3; Repeatable**
Independent investigation under the direction of a faculty member for students who have completed two years of study. Junior standing in mechanical engineering and permission of the instructor.

**MECH 392. Mechanical Design. 1 Credit.**
**Offered Spring Semester Only; Lecture hours:3,Lab:2**
Principles and techniques for creative design of machines in relation to specifications and user requirements. Design using a solid modeling CAD package. Co-Requisites: MECH 392L. Prerequisites: MECH 252 and MECH 353 or permission of the instructor.

**MECH 3NT. Mechanical Engineering Non-traditional Study. .25-4 Credits.**
**Offered Fall, Spring, Summer; Lecture hours:Varies**
Non-traditional study in Mechanical Engineering. Prerequisite: permission of the instructor.

**MECH 401. Senior Design I. .5 Credits.**
**Offered Fall Semester Only; Lecture hours:2,Lab:2**
Emphasis on component design in areas of advanced mechanics and thermofluids. Student teams participate in design process which includes research, design formulation, and presentation. Co-Requisites: MECH 401L Prerequisites: MECH 302, MECH 312 and MECH 392, or permission of the instructor.

**MECH 402. Senior Design II. .5 Credits.**
**Offered Spring Semester Only; Lecture hours:1,Lab:2**
Emphasis on fabrication, instrumentation, testing and presentation of mechanical or thermofluid components designed in MECH 401. Student teams will participate in presentation of their results. Co-Requisites: MECH 402L. Prerequisite: MECH 401 or permission of the instructor.

**MECH 403. Thermal Design. 1 Credit.**
**Offered Fall Semester Only; Lecture hours:3,Lab:2**
Design of thermal-fluid energy conversion systems; equipment selection; codes and standards; and economic analysis. Mini-design laboratories and group design project. Co-Requisites: MECH 403L Prerequisites: MECH 312.

**MECH 405. System Dynamics. 1 Credit.**
**Offered Fall Semester Only; Lecture hours:3,Lab:3**
Modeling and analysis of dynamic systems consisting of mechanical, electrical, fluid, and thermal elements. Frequency response methods. Sampled data systems. Experimental system identification. Co-Requisites: MECH 405L Prerequisites: MATH 212, MECH 252 and ECEG 205.

**MECH 420. Solar Energy Conversion. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:3,Other:2**
Fundamental aspects of the design and operation of solar energy conversion systems including photovoltaics, solar thermal power, solar heating and production. Prerequisite: MECH 312 or permission of the instructor. Seniors only. Crosslisted as MECH 620.

**MECH 421. Advanced Engineering Thermodynamics. 1 Credit.**
**Offered Occasionally; Lecture hours:3**
Advanced engineering thermodynamics. Prerequisite: permission of the instructor. Crosslisted as MECH 621.

**MECH 422. Renewable Energy Conversion. 1 Credit.**
**Offered Alternate Fall or Spring; Lecture hours:4**
Current energy demands, environmental effects, renewable energy resources, includes photovoltaic, thermal solar, wind, tidal, ocean thermal, wave energies; clean coal, nuclear energy, smart grid technology. Prerequisites: permission of the instructor and one of the following; CHEG 200, ENGR 200 or MECH 213. Crosslisted as MECH 622.

**MECH 423. Thermal Environmental Engineering. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Heating, ventilating and air conditioning for small commercial and residential buildings. This course uses heat transfer, solar energy, thermal design, psychometrics, economics, physiological considerations and thermal design. Prerequisite: MECH 403 and MECH 216 or permission of the instructor. Crosslisted as MECH 623.

**MECH 424. Internal Combustion Engines. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Description of internal combustion engines, methods of evaluating performance, the thermodynamics of combustion, engine testing, and design. Prerequisite: MECH 216 or permission of instructor. Crosslisted as MECH 624.

**MECH 427. Engine Generated Emissions Control. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Combustion thermochemistry, availability analysis, emission formation, emission reduction technologies, greenhouse gas reduction, emission modeling and optimization, engineering system integration for emission control. Prerequisite: MECH 216 or permission of the instructor. Crosslisted as MECH 627.

**MECH 431. Boundary Layers and Convection Heat Transfer. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Hydrodynamic and thermal boundary layers, both laminar and turbulent; derivation of governing equations; stability and transition; free and forced convection in both internal and external flows. Prerequisite: MECH 312 or permission of the instructor. Crosslisted as MECH 631.

**MECH 432. Compressible Fluid Dynamics. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Compressible flow, shock wave phenomena, potential flow, two-dimensional flow, numerical methods, acoustic wave propagation. Selected laboratory exercises. Prerequisites: MECH 213, MECH 313, and ENGR 214 (or equivalent) or permission of the instructor. Crosslisted as MECH 632.

**MECH 433. Advanced Fluid Mechanics. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Ideal and viscous flow. Boundary layer theory. Turbulence and mixing. Non-Newtonian phenomena. Multiphase phenomena. Selected laboratory projects. Prerequisite: permission of the instructor. Crosslisted as MECH 633.

**MECH 434. Environmental Fluid Dynamics. 1 Credit.**
**Offered Occasionally; Lecture hours:3**
Environmental fluid flow in lakes, rivers, oceans, and the atmosphere; contaminant transport; mixing; reaction and particle dispersion processes; applications to natural and engineering systems. Prerequisite: MECH 313, ENGR 222, ENGR 233 or permission of the instructor. Crosslisted as MECH 634.

**MECH 435. Aerodynamics. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Two-dimensional flow theory; vortex and momentum theories of finite wings; viscous flows, boundary layers and drag; high lift devices. Prerequisites: MECH 313 or equivalent and permission of the instructor. Crosslisted as MECH 635.

**MECH 440. Turbomachinery. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Classification of turbomachinery; velocity triangles, dimensional analysis, centrifugal pumps and fans, centrifugal compressors, axial flow pumps, fans and compressors, radial flow turbines, axial flow turbines, steam turbines, hydraulic turbines. Prerequisite: MECH 216 or permission of the instructor. Crosslisted as MECH 640.

**MECH 441. Gas Turbines. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Ideal gas turbine cycles. Diffusers, compressors, intercoolers, burners, turbines, and nozzles are analyzed for their individual and collective performance. Prerequisite: MECH 216 and MECH 313 or permission of the instructor. Crosslisted as MECH 641.

**MECH 445. Engineering Acoustics and Noise Control. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Fundamentals of sound; instrumentation for noise measurement and analysis; sound sources; sound power, sound in enclosed areas; acoustic enclosures; muffling devices; vibration control; noise control of typical devices. Prerequisite: permission of the instructor.

**MECH 446. Flow-induced Noise and Vibration. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Classification of flow-induced vibration; turbulence excitation; gust excitation, vortex shedding, galloping and stall flutter; flutter; impinging shear layers; cylinders and tube bundle vibrations; resonators and noise generation. Prerequisites: MECH 313 and ENGR 222 or permission of the instructor. Crosslisted as MECH 646.

**MECH 447. Fundamentals of Combustion. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
The fundamentals of chemically reactive flow systems with application to jet, rocket, and other air-breathing engines and special interest paid to pollutant formation. Prerequisites: MECH 216, MECH 312, MECH 313 or permission of the instructor. Crosslisted as MECH 647.

**MECH 451. Vibration Analysis. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Damped and undamped vibrations in free and forced systems. Resonance conditions. Vibration measuring equipment. Multi-degree of freedom discrete systems. Continuous systems. Prerequisites: MECH 252 or MATH 212 or permission of the instructor. Crosslisted as MECH 651.

**MECH 452. Advanced Dynamics. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Kinematics and dynamics of particles and rigid bodies. Degrees of freedom. Partial velocities. Generalized active and inertia forces. Kane's equation. Lagrange's equation. Numerical simulation of motion. Prerequisites: MECH 252 or permission of the instructor. Crosslisted as MECH 652.

**MECH 453. Robotics. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
History, evolution, capabilities and applications of robotic devices. Introduction to robot kinematics, dynamics, and control. Research into current topics in robotics. Development and implementation of robotic operations using model and industrial robots. Prerequisites: MECH 252 or permission of the instructor. Crosslisted as MECH 653.

**MECH 454. Vehicle Dynamics and Control. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Introduction to modeling of vehicles for analysis and control. Topics include tire models, handling response, stability control, suspension design, race tuning. Prerequisites: MECH 405 or permission of the instructor. Crosslisted as MECH 654.

**MECH 455. Control Systems Design. 1 Credit.**
**Offered Alternating Spring Semester; Lecture hours:4**
Design/implementation of control systems on hardware. Sensor and actuator selection. Development of linear/nonlinear control algorithms. Performance analysis and testing. Applications in automotive, HVAC, medical, aero/astro, robotics. Prerequisites: MECH 405 or permission of the instructor. Not open to students who have taken ECEG 480. Crosslisted as MECH 655.

**MECH 457. Accident Analysis. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Vehicle crash dynamics and crashworthiness. Non motor-vehicle accidents. Mechanics of injuries. Evaluation of designs intended to reduce risk of injury. Prerequisite: permission of the instructor. Crosslisted as MECH 657.

**MECH 459. Optical Measurements Systems in Biomedical Engineering. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Course integrates basic and advanced principles of lasers, optics and optical systems and their applications in biomedical field. Analysis of laser-based characterization and processing techniques of tissues. Permission of the instructor. Crosslisted as MECH 659.

**MECH 460. Engineering Optimization. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Applied methods of linear, nonlinear, discrete, and global optimization. Numerical techniques for constrained and unconstrained problems. Emphasis on engineering applications and solution methods using Matlab. Prerequisite: permission of the instructor. Crosslisted as MECH 660.

**MECH 462. Computer Integrated Manufacturing. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Issues of integrated information in manufacturing systems. In-depth study of solid modeling. Computer control of manufacturing processes, computer-aided quality control, and computer-aided process planning. Prerequisite: MECH 355 or permission of the instructor. Crosslisted as MECH 662.

**MECH 463. Introduction to Mechatronics. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
This multidisciplinary course is the synergistic integration of mechanical engineering with electronic and computer engineering. This course will study actuators, drive systems, sensors, controllers, micro- controllers programming and interfacing, and automation systems integration. Prerequisite: permission of the instructor. Crosslisted as MECH 663 and ECEG 463 and ECEG 663.

**MECH 464. Mechanism Design. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Design of traditional and compliant mechanisms. Topics include kinematics, analytical and graphical synthesis methods, and topics in research. Prerequisites: MECH 392 or permission of the instructor. Crosslisted as MECH 664.

**MECH 465. Advanced Mechanics of Solids. 1 Credit.**
**Offered Occasionally; Lecture hours:3**
Fundamentals of the theory of elasticity and plasticity. Classical methods for solution of problems, thermal stress, plate bending torsion, residual stress, plastic collapse. Numerical analysis in plasticity. Prerequisite: permission of the instructor. Crosslisted as MECH 665.

**MECH 466. Applied Fracture Mechanics. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Fundamentals of fracture mechanics and its applications to the design of damage tolerant structures. Case studies in the fields of aerospace, pressure, vessels, rotating machinery, railroads, etc. Illustrating fracture mechanics principles in design. Prerequisite: permission of the instructor. Crosslisted as MECH 666.

**MECH 467. Finite Element Methods. 1 Credit.**
**Offered Occasionally; Lecture hours:3,Other:2**
Fundamental theory and applications for civil and mechanical engineering. Multidimensional elements, and axisymmetric elements, and their formulations; stress recovery techniques; modeling considerations; convergence criteria and error estimates, includes use of commercial and developmental finite element analysis programs. Prerequisites: CEEG 401 or MECH 302 or permission of the instructor. Crosslisted as CEEG 408 and CEEG 608 and MECH 667.

**MECH 468. Applied Finite Element for Mechanical Design. 1 Credit.**
**Offered Occasionally; Lecture hours:2,Other:3**
Practical uses of finite element software for problems common in research and mechanical design. Applications include sub-structure modeling, contact problems, stress concentrations and crack defects, elastic-plastic problems, and problems with dynamic loading. Prerequisites: MECH 302 or permission of the instructor. Crosslisted as MECH 668.

**MECH 469. Computer-Aided Design. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Fundamentals of geometric modeling and computational geometry. Topics include geometric representation of surfaces, mesh generation, and design optimization. Prerequisite: MECH 302 or permission of the instructor. Crosslisted as MECH 669.

**MECH 470. Engineering Composite Materials. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Fundamental composite mechanics, including micromechanics and laminated plate theory. Design and analysis of composite structures; composite manufacturing techniques; current research topics in composite area. Prerequisites: MECH 353 or permission of the instructor. Crosslisted as MECH 670.

**MECH 472. Atomic Arrangement and Defects. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
The structure of crystalline and non-crystalline materials and the relationship between structure, defects, and mechanical properties. Prerequisite: ENGR 240 or permission of the instructor. Crosslisted as MECH 672.

**MECH 474. Bulk Metallic Glasses. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:3,Other:2**
Thermodynamics and kinetics of metallic glasses; deformation, fatigue and fracture behavior; and metallic glass composites. Alloy design, casting, and mechanical testing. Prerequisite: ENGR 240 or permission of the instructor. Crosslisted as MECH 674.

**MECH 476. Biomechanics. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Principles of mechanics applied to biological systems. Background in anatomy, physiology, and cell biology will be presented. Mechanical behavior of hard and soft biological materials. Topics in cellular, cardiovascular, musculoskeletal, implant, and sport/motion biomechanics. Prerequisite: permission of the instructor. Crosslisted as MECH 676.

**MECH 480. Impact! Exploring Innovation. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
The goal of innovation is POSITIVE CHANGE, to make someone or something better. This class will examine innovation from an interdisciplinary and integrative perspective. We will explore both what makes something innovative and how innovation happens. Prerequisite: Permission of the instructor. Crosslisted as MIDE 387 and UNIV 380.

**MECH 482. Computational Statistics for Engineers. 1 Credit.**
**Offered Occasionally; Lecture hours:4**
Hypothesis testing, Multivariate Regression, Time Series Analysis, Engineering System Optimization, Statistical Design of Experiments, and other Computational tools for engineers (e.g. PCA, RSM, FFT). MATLAB Based. Prerequisites: ENGR 214 or permission of the instructor. Crosslisted as MECH 682.

**MECH 484. Artificial Intelligence for Engineering Systems. 1 Credit.**
**Offered Either Fall or Spring; Lecture hours:4**
Engineering system modeling and optimization using artificial intelligence methods such as neural networks and genetic algorithms. MATLAB based. Prerequisites: ENGR 214 or equivalent or permission of the instructor. Crosslisted as MECH 684.

**MECH 485. Advanced Engineering Problems. .5-1 Credits.**
**Offered Either Fall or Spring; Lecture hours:2,Other:3; Repeatable**
An investigation under the direction of a staff member. Topics not covered in other courses may be studied in this course. Prerequisite: permission of the instructor. Crosslisted as MECH 685.

**MECH 495. Advanced Topics in Engineering Mathematics. 1 Credit.**
**Offered Fall Semester Only; Lecture hours:4**
Linear algebra and analytical/computational techniques for solving ordinary and partial differential equations relevant to engineering applications. Crosslisted as CEEG 495 and CHEG 495 and MECH 495 and ENGR 695 and ECEG 495 and ECEG 695. Prerequisite: permission of the instructor.