MEC

Mechanical Engineering

MEC 500: Introduction to Computer Integrated Design and Manufacturing
Topics include part design specification; Computer Aided Design (CAD); CAD-driven engineering analysis; Computer Aided Manufacturing (CAM); integration of CAD/CAM; computer integrated manufacturing industrial robotics; CAD-driven inspection and measurement; concurrent engineering; Internet-based design and manufacturing. Prerequisite: B.S. in engineering
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 501: Convective Heat Transfer and Heat Exchange
Differential and integral formulation. Exact and approximate solutions. Topics include parallel and boundary layer flows, similarity solutions, external and internal flows, laminar and turbulent convection, and forced and free convection.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 502: Conduction and Radiation Heat Transfer
Heat conduction and conservation laws; formulation of conduction equations in differential and integral forms; analytical solution techniques including Laplace transforms and separation of variables; scaling analysis; black body radiation, Kirchoff's law, analysis of heat conduction problems; analysis of radiative exchange between surfaces and radiative transport through absorbing, emitting, and scattering media.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 504: Thermal Analysis and Design of Electronic Systems
Thermal characteristics of electronic components and systems, reliability considerations, design concepts, basic modes of heat transfer and fluid flow. Topics of applied heat transfer: heat exchanger, boiling and condensation, cooling techniques, cooling at various packaging levels, thermal elastic effects, computations for electronic systems.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 505: Modeling and Simulation for Materials Processing and Manufacturing
Importance of modeling and simulation; interface between computer models and actual processes; microscopic versus macroscopic models; continuum models; thermo-fluid models, chemical transport, magnetic and electrical effects, and stress field; simulation schemes: finite difference versus finite element methods; software development; postprocessing: graphical representation, video animation; case studies; melting/solidification bulk crystal growth; thin film deposition.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 506: Energy Management in Commercial Buildings
Topics include basic heating, ventilating, and air-conditioning (HVAC) system design and selection for commercial buildings (includes both low-rise and high-rise buildings); selection of central plant components and equipment; calculation of space heating and cooling load; computer techniques for estimating annual energy consumption; design tools for reducing energy consumption; ASHRAE codes; building controls; BACnet. Prerequisite: B.S. in mechanical engineering or related field
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 507: Mathematical Methods in Engineering Analysis I
An introduction to the use of mathematical analysis techniques for the solution of engineering analysis problems and the simulation of engineering systems. Both continuous and discrete methods are covered. Initial and boundary value problems for ordinary and partial differential equations are treated.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 508: Mathematical Methods in Engineering Analysis II
A continuation of the material covered in MEC 507. Introduction to and application of numerical analysis techniques used in engineering such as finite elements and fast Fourier transforms. Determination of response characteristics of dynamic systems. Combinatoric methods and techniques for optimization of engineering design and systems/process analysis problems. Prerequisite: MEC 507
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 509: Transport Phenomena
Introduction to differential and integral formulation of mass, momentum, and energy transport in fluids and solids. Topics include viscosity, laminar flow, turbulent flows, conduction, convection, heat transfer coefficients, radiation, boundary layers, diffusion, and applications to energy technology.
Offered
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 510: Object-Oriented Programming for Scientists and Engineers
Practical introduction to C++ and object-oriented programming for a first programming course for scientists and engineers. Covers basics of application software development such as problem decomposition, structure charts, object modeling, class diagrams, incremental code building, and testing at a beginner's level. Features the concepts of abstract data types (ADT), encapsulation, inheritance, composition, polymorphism, operator and function overloading besides studying UML (Unified Modeling Language) as a graphical representational design technique. The course follows the evolution of programming ideas from the use of a single function to the use of structural charts and functions to modularize and finally to the use of object-oriented programming. Prerequisite: B.S. in science or engineering
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 511: Mechanics of Perfect Fluids
Lagrangian and Eulerian frames. Dynamical equations of momentum and energy transfer. Two-dimensional dynamics of incompressible and barotropic perfect fluids and of the compressible perfect gas. Conformal mapping applied to two-dimensional fluid dynamics. Jets and cavities. Surface waves, internal waves. Perfect shear flows.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 512: Mechanics of Viscous Fluids
The role of viscosity in the dynamics of fluid flow. The Navier-Stokes equations, low Reynolds number behavior including lubrication theory, percolation through porous media, and flow due to moving bodies. High Reynolds number behavior including steady, unsteady, and detached boundary layers, jets, free shear layers, and wakes. Phenomenological theories of turbulent shear flows are introduced.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 514: Advanced Fluid Mechanics: Introduction to Turbulence
Introductory concepts and statistical descriptions: kinematics of random velocity fields; equations of motion; experimental
techniques: isotropic turbulence, closure problem; transport processes.

Prerequisite: MEC 512  
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**MEC 515: Emerging Energy Technologies**

Basic physics, chemistry, and engineering of emerging energy technologies, including fuel cells, thermo-electrics, photovoltaics, batteries, hydrogen generation and storage, power electronics, and "smart" grid. Lecture, group reports, and presentation skills will be practiced and evaluated.

Offered in  
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**MEC 516: Energy Technologies Laboratory**

Students work together with instructors to develop solutions to thermal-fluids problems related to heat pumps, photovoltaics, fuel cells, solar thermal, thermo-electric power/cooling, hydrogen productions, hydrogen storage, and wind energy. Lecture, laboratory, group reports, and presentation skills will be practiced and evaluated.

Offered in  
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**MEC 517: Energy Technologies Laboratory II**

Experiments in the areas of thermoelectric power, fuel cells, photovoltaics, wind turbines, hydrogen storage, hydrogen generation, and power electronics in addition to related project work. The focus is on system efficiencies, system integration, and design for residential markets. Student groups are assigned laboratory projects to build experience applying various energy technologies to solve problems.

Offered in  
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**MEC 520: Energy Technology Thermodynamics**

Following a review of engineering thermodynamics principles, the thermodynamics of power generation, heat pumps, electro-chemical systems, chemical reactions and combustion are explored in the context of sustainable energy development lecture, group reports, and presentation skills will be practiced and evaluated.

Offered  
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

**MEC 521: Thermodynamics**

This course begins with a review of the fundamental concepts and laws of classical thermodynamics. Then the thermostat theory of equilibrium states and phase transitions is treated, followed by the thermodynamic theory of processes of simple systems and composite systems, including heat engines. Special topics may include statistical thermodynamics, irreversible thermodynamics, radiation and photovoltaic energy conversion, biological thermodynamic processes, and other topics of current interest.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**MEC 522: Building Energy Dynamics and Technology**

Building is treated as a time-dependent energy system, with its interactive components coupled through energy and mass flows under an environment defined in terms of sunlight, ambient air and wind and with its equipment which assist in meeting building-dwellers comfort requirements. Major components discussed are thermal mass (both interior mass and envelope mass) and their thermal capacities, building envelopes and their heat transfer resistances, room air including its circulation and heat exchange with thermal mass, and the transparent part of the envelope the glazing or windows and the solar system passing through it during the day and the heat loss during the night time. Major equipment include lighting, air circulation system, cooling and heating equipment, solar thermal panels and solar PV panels, and other equipment including integrated electric and control units. Of the comfort requirements only temperature-and-humidity and illumination are studied with the objective of creating, through a system-understanding of the building, buildings that in the short run meet these requirements involving minimal use of energy and in the long run are benchmarked against the environmentally regenerative capabilities of wilderness.

Offered in  
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**MEC 523: Internal Combustion Engines**


Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**MEC 524: Computational Methods for Fluid Mechanics and Heat Transfer**

Introduction of finite difference, finite volume, and finite element methods for incompressible flows and heat transfer. Topics include explicit and implicit schemes, accuracy, stability and convergence, derived and primitive-variables formulation, orthogonal and non-orthogonal coordinate systems. Selected computer assignments from heat conduction, incompressible flows, forced and free convection.

Prerequisite: MEC 507  
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

**MEC 525: Product Design Concept Development and Optimization**

This graduate course will concentrate on the design concept development of the product development cycle, from the creative phase of solution development to preliminary concept evaluation and selection. The course will then cover methods for mathematical modeling, computer simulation and optimization. The concept development component of the course will also cover intellectual property and patent issues. The course will not concentrate on the development of any particular class of products, but the focus will be mainly on mechanical and electromechanical devices and systems. As part of the course, each participant will select an appropriate project to practice the application of the material covered in the course and prepare a final report.

Prerequisites: Undergraduate electrical or mechanical engineering and/or science training.  
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

**MEC 526: Energy Technology Fundamentals**

A practical introduction to insulation, heat pumps, lighting, solar panels, fuel cells, wind energy, transportation, and building energy codes. How they work, new products, and cost/benefit analysis are used to investigate how homeowners and small businesses can use the technologies to ‘generate’ income and improve their quality of life. This course is geared for non-MEC majors. MEC majors interested in these topics may take MEC 515 and MEC 520. MEC 523 cannot be used for MEC degree credit.

Offered Fall,  
Spring, 3 credits, Letter graded (A, A-, B+, etc.)
MEC 528: Introduction to Experimental Stress Analysis
The concepts of three-dimensional stress and strain, their transformation laws, and their mutual relationships are discussed in detail. Results from theory of elasticity as pertinent to experimental stress analysis are also presented. Experimental techniques studied include two-dimensional photoelasticity, resistance strain gauge, moire methods, holographic interferometry and speckle photography.

The application of different techniques to the measurement of stress and strain in models as well as actual structures is demonstrated. Students form small groups and each group is assigned different laboratory projects to gain experience in various experimental stress analysis methods.

3 credits, Letter graded (A, A-, B+, etc.)

MEC 529: Introduction to Robotics: Theory and Applications
Topics: robot components and mechatronic aspects of robotics (sensors, actuators, and effectors, system integration); rotation, translation, rigid-body transform; robotics foundations in kinematics and inverse kinematics, dynamics, serial and parallel manipulators and their duality, introduction to mobile robots and LEGO Robotics, control theories, motion planning, trajectory generation, grasping and manipulation, robotic programming language, industrial robotics, manufacturing automation, and societal impacts. Include hands-on projects.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 530: Applied Stress Analysis
Advanced mechanics of solids and structures. Elastic boundary value problems are analyzed with various solution techniques including finite element method. Major topics are stress and strain, FEM formulations, material behaviour, 2D elastic problems, stress function and fracture. Detailed studies of structural components are carried out with FEM with emphasis on optimal mesh design and proper interpretations of computed results.

3 credits, Letter graded (A, A-, B+, etc.)

MEC 532: Vibration and Control
Fundamentals of vibrations and control of vibrations of structures and dynamic systems. Topics include one dof systems and responses, multiple dof systems and responses, classical feedback control theory, modern state-space feedback control theory, application of control methodology in structure and systems under vibration and dynamics; introduction of optimal control theory; feedforward control; distributed transducers for active control of vibration.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 535: Engineering Stress Analysis
Provides and overview of stress analysis for practicing engineers and scientists.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 536: Mechanics of Solids
A unified introduction to the fundamental principles, equations, and notation used in finite deformation of solids, with emphasis on the physical aspects of the subject. Cartesian tensor representation of stress, principal values, finite strain, and deformation. Conservation of mass, momentum, and energy. Formulation of stress-strain relations in elasticity, and compatibility relations. The use of general orthogonal coordinate systems in the equations governing solids. Principles of virtual displacement and virtual work.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 539: Introduction to Finite Element Methods
(formerly Finite Element Methods in Structural Analyses)
Theory of finite element methods and their application to structural analysis problems. Matrix operations, force and displacement methods. Derivation of matrices for bars, beams, shear panels, membranes, plates, and solids. Use of these elements to model actual structural problems. Weighted residual techniques and extension of the finite element method into other areas such as heat flow and fluid flow. Laboratory sessions introduce use of the computer in solving finite element problems. Programs for the solution of force and displacement method problems are configured. A computer project consisting of the solution and evaluation of a structural problem is required.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 541: Elasticity

Prerequisite: MEC 536
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 543: Plasticity
Stress and deformation of solids: yield criteria and flow rules for plasticity deforming solids; the notion of a stable inelastic material; static and dynamic analysis of plastic bodies under mechanical and thermal loading; use of load bounding theorems and the calculation of collapse loads of structures; the theory of the slip-line field.

Prerequisite: MEC 541
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 550: Mechatronics
An introduction to the design, modeling, analysis and control of mechatronic systems (smart systems comprising mechanical, electrical, and software components). Fundamentals of the basic components needed for the design and control of mechatronic systems, including sensors, actuators, data acquisition systems, microprocessors, programmable logic controllers, and I/O systems, are covered. Hands-on experience in designing and building practical mechatronic systems are provided through integrated lab activities.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 552: Mechanics of Composite Materials
The course is concerned with the analysis of layered composite materials subject to mechanical loads. Cartesian tensor calculus is used. Homogeneous anisotropic media are studied first. The effect of layering is then analyzed. Applications to plates and shell are studied and analytical methods of solution are given. Numerical analysis of composite solids is also considered using finite difference and finite element methods.

Prerequisite: MEC 536
Fall or Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 560: Advanced Control Systems
Analytical methods applied to the design of multivariable linear control systems. Introduction to linear system theory; linearization, solution of linear matrix differential equations, stability, controllability, observability, transformations to canonical forms. Formulation of control objectives. Deterministic state observer. Full-state feedback control based on pole assignment and linear quadratic optimization theory. Linear systems with stochastic inputs and measurement noise. The response of linear systems to random input; stochastic state estimator (Kalman filter); separation principle of stochastic control and estimation; system robustness.

**MEC 567: Kinematic Analysis and Synthesis of Mechanisms**

Introduction, mechanism structure, basic concepts of mechanisms, canonical representation of motion. Kinematic analysis, algebraic method, vector-loop method, complex number method, spherical and spatial polygon method, matrix method, dual-number quaternion method, screw coordinate method, line coordinate method, motor algebra method, type synthesis, numerical synthesis, coupler curves, curvature theory path generation, finite displacement theory, rigid body guidance, function generation, computer-aided mechanisms analysis and synthesis.

**MEC 572: Geometric Modeling for CAD, CAM**


An introduction to the fundamental knowledge and experience in the design and manufacture of Microsystems. Emphasis will be placed on the methodologies for design, fabrication, and packaging of Microsystems. An overview on fabrication and manufacturing technologies for producing microsystems will also be covered. Interdisciplinary nature of MEMS will be emphasized via various engineering principles ranging from mechanical and electrical to materials and chemical engineering. Introduction of the working principles of micro actuators, sensors, and transducers.

**MEC 578: Reliability and Life Prediction of Electromechanical Systems**

The modes of failure and the factors that play a role in the failure of mechanical components are presented. Failure modes and failure theories for brittle and ductile materials are introduced; special emphasis will be placed on the fatigue and fracture of materials. Distinctions will be drawn between the behavior of single crystal versus polycrystalline materials, and versus ductile and brittle materials. Reliability issues will be discussed regarding the design of series versus parallel systems.

**MEC 579: Optical Measurement**

Introduction to optical measurement and its applications to the fields of solid mechanics, design and manufacturing, and thermal and fluid systems. Topics include fundamentals of optics, lasers, and detectors, dimensional and surface metrology, machine vision, measurement of temperature, concentration, and density, and optical techniques for stress analysis and nondestructive testing.

**MEC 580: Manufacturing Processes**


**MEC 584: Quality Engineering**

**MEC 585: Total Quality Management**

Concepts of TQM and quality improvement methods to attain world-class performance in business operations. Topics include policy deployment, process improvement methodology, daily work management, quality story methodology, six sigma, poka-yoke, ISO, Deming and Baldrige Awards criteria.
MEC 591: Industrial Project in Opto Electro Mechanical Systems Engineering
A student carries out a detailed design of an industrial project in OEMS engineering. A comprehensive technical report of the project and an oral presentation are required.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MEC 596: Projects in Mechanical Engineering
Conducted jointly by graduate students and one or more members of the faculty.
1-6 credits, Letter graded (A, A-, B+, etc.)
May be repeated 1 times FOR credit.

MEC 597: Graduate Research and Study in Manufacturing
Independent research or project in the area of manufacturing processes or systems.
1-6 credits, Letter graded (A, A-, B+, etc.)

MEC 599: Research
Fall, 1-12 credits, S/U grading
May be repeated for credit.

MEC 630: Special Topics in Fluid Mechanics
The subject matter of each special topics course varies from semester to semester, depending on the interests of students and staff. Advanced topics and specialized topics will be discussed, particularly those of current interest.
3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MEC 631: Special Topics in Heat Transfer
The subject matter of each special topics course varies from semester to semester, depending on the interests of students and staff. Advanced topics and specialized topics will be discussed, particularly those of current interest.
3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MEC 632: Special Topics in Statistical Mechanics
The subject matter of each special topics course varies from semester to semester, depending on the interests of students and staff. Advanced topics and specialized topics will be discussed, particularly those of current interest.
3 credits, Letter graded (A, A-, B+, etc.)

MEC 633: Special Topics in Thermodynamics
The subject matter of each special topics course varies from semester to semester, depending on the interests of students and staff. Advanced topics and specialized topics will be discussed, particularly those of current interest.
3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MEC 634: Advanced Topics in Kinematics and Dynamics of Machines
The subject matter of each special topics course varies from semester to semester, depending on the interests of students and staff. Advanced topics and specialized topics will be discussed, particularly those of current interest.
3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MEC 635: Advanced Topics in Nonlinear Dynamic Systems
The subject matter of each special topics course varies from semester to semester, depending on the interests of students and staff. Advanced topics and specialized topics will be discussed, particularly those of current interest.
3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MEC 636: Advanced Topics in Mechanical Vibration
The subject matter of each special topics course varies from semester to semester, depending on the interests of students and staff. Advanced topics and specialized topics will be discussed, particularly those of current interest.
3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MEC 637: Special Topics in Precision Engineering
The subject matter of each special topics course varies from semester to semester, depending on the interests of students and staff. Advanced topics and specialized topics will be discussed, particularly those of current interest.
3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MEC 641: Fracture Mechanics
The mechanics of brittle and ductile fracture in engineering materials are studied. Major subjects are linear elastic fracture, elastic-plastic fracture, and fatigue crack analysis. Topics also include stress intensity factor, energy release rate, J-integ.
Prerequisite: MEC 536, Fall or Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 651: Advanced Finite Element Analysis
Prerequisites: MEC 541, MEC 539
Fall or Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 662: Advanced Vibration and Analysis
Principle and techniques of vibration analysis of structures and machines. Includes free and forced vibration responses of linear limped-parameter, multiple dof systems; model analysis of distributed, continuous systems; non-linear vibration analysis; random vibrations.
3 credits, Letter graded (A, A-, B+, etc.)

MEC 671: Optical Methods for Experimental Stress Analysis
Theory and applications of moire methods (in-plane, shadow, reflection, projection, and refraction moire techniques) for measuring static and dynamic deformation of 2D and 3D models, bending of plates and shells, and temperature distribution or refraction index change in fluids. Other topics: holographic interferometry, laser speckle interferometry, digital speckle photography, and current research activities of the field.
Fall or Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MEC 691: Mechanical Engineering Seminar
This course is designed to expose students to cutting-edge research and development activities in mechanical engineering. Speakers are invited from both on and off campus. Fall and spring. 0 credits, S/U grading. May be repeated.
S/U grading
May be repeated for credit.
MEC 695: Mechanical Engineering Internship
Participation in off-campus engineering practice in private corporations, public agencies, or non-profit institutions. Students will be required to have faculty coordinator as well as a contact in outside organization, to participate with them in regular consultations on the project, and to submit a final report to both. A maximum of 3 credits can be accepted toward the M.S. degree.
Fall, 1 credit, S/U grading
May be repeated 3 times FOR credit.

MEC 696: Special Problems in Mechanical Engineering
Conducted jointly by graduate students and one or more members of the faculty.
1-6 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MEC 697: Practicum in Teaching I
Every TA must register for the course
Fall, S/U grading
May be repeated for credit.

MEC 698: Practicum in Teaching II
Practicum in teaching under faculty supervision
1-3 credits, S/U grading
May be repeated for credit.

MEC 699: Dissertation Research on Campus
Prerequisite: Advancement to candidacy (G5).
Major portion of research must take place on SBU campus, at Cold Spring Harbor, or at the Brookhaven National Lab.
Fall, 1-9 credits, S/U grading
May be repeated for credit.

MEC 700: Dissertation Research off Campus - Domestic
Prerequisite: Must be advanced to candidacy (G5). Major portion of research will take place off-campus, but in the United States and/or U.S. provinces. Domestic students have the option of the health plan and may also enroll in MEDEX. International students who are in their home country are not covered by mandatory health plan and must contact the Insurance Office for the insurance charge to be removed. International students who are not in their home country are charged for the mandatory health insurance. If they are to be covered by another insurance plan they must file a waiver be second week of classes. The charge will only be removed if other plan is deemed comparable.
All international students must received clearance from an International Advisor.
Fall, 1-9 credits, S/U grading
May be repeated for credit.

MEC 800: Full Time Summer Research
May be repeated for credit.