# MECHANICAL AND MATERIALS ENGINEERING (MECH)

**MECH 202 Mathematical and Computational Tools for Mechanical Engineers I Units: 3.50**
This course will provide students with an introduction to vector calculus, analytical, and numerical solution methods for ordinary differential equations. The topics of the course will be presented through problems, models and applications relevant to the Mechanical Engineering Program. On completion of the course students will be able to: manipulate vectors; perform numerical integration; solve first- and higher-order ordinary differential equations analytically and numerically. Students will solve problems analytically and computationally in an active learning, tutorial environment. K3.5(Lec: Yes, Lab: No, Tut: Yes)
**Requirements:** Prerequisites: APSC 111, APSC 142 or APSC 143 or MNTC 313, APSC 171, APSC 172 and APSC 174 Corequisites: Exclusions: MTHE 225, MATH 225 and MTHE 272
**Offering Term:** F
**CEAB Units:**
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 203 Mathematical and Computational Tools for Mechanical Engineers II Units: 3.50**
This course will introduce numerical and statistical methods for the solution of engineering problems, to complement those discussed in MECH 202. The topics of the course will be presented through problems, models and applications relevant to the Mechanical Engineering Program. On completion of the course students will be able to: solve linear systems of equations; analyze random processes; perform local optimization and hypothesis testing; interpolate and fit discrete data sequences. Students will solve problems analytically and computationally in an active learning, tutorial environment. The course will include a design project. K3.5(Lec: Yes, Lab: No, Tut: Yes)
**Requirements:** Prerequisites: MECH 202 Corequisites: Exclusions: MTHE 225, MATH 225 and MTHE 272
**Offering Term:** W
**CEAB Units:**
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 11
**Offering Faculty:** Smith Engineering

**MECH 210 Electronic Circuits and Motors for Mechatronics Units: 4.50**
This introductory course for mechanical engineering students begins with a review of the concepts of resistance, capacitance, and inductance. Circuit analysis techniques are then applied to characterize the behaviour of commonly used mechatronic circuits including devices such as transformers, diodes, solenoids, DC motors and actuators. Transistors are introduced in switching applications. Selection and testing of electric motors and drivers/controllers for stationary and mobile mechanical applications. Lab activities will focus on design, construction, and testing of microcontroller based mechatronic systems for practical applications, building on skills typically developed in MECH 217. Students will solve mechatronics problems analytically and computationally in an active learning, tutorial environment.
K4.5(Lec: Yes, Lab: Yes, Tut: Yes)
**Requirements:** Prerequisites: APSC 111, APSC 112, APSC 171, APSC 172, and APSC 174 Corequisites: Exclusions: ELEC 210, ELEC 221
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 40
Engineering Design 14
**Offering Faculty:** Smith Engineering

**MECH 211 Manufacturing Methods Units: 3.50**
The objective of this course is to achieve a knowledge and understanding of a wide variety of manufacturing processes involving plastics and metals. This course forms the basis for improved product and machine design, and will assist the mechanical engineer to function in the areas of design, manufacturing and general engineering. Training in the use of machine and welding tools found in a modern job shop is a required activity practiced in the machine tool laboratory in MECH 212.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: Corequisites: Exclusions: MECH 213
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 28
Engineering Design 14
**Offering Faculty:** Smith Engineering

**MECH 212 Machine Tool Laboratory Units: 1.00**
Training in the use of machine and welding tools found in a modern job shop is a required activity practiced in the machine tool laboratory in this course.
(Lec: 0, Lab: 1, Tut: 0)
**Requirements:** Prerequisites: Corequisites: Exclusions: MECH 213
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 8
Engineering Design 4
**Offering Faculty:** Smith Engineering

**MECH 213 Manufacturing Methods Units: 4.50**
The objective of this course is to achieve a knowledge and understanding of
a wide variety of manufacturing processes involving plastics and metals.
This course forms the basis for improved product and machine design, and will assist the mechanical engineer to function in the areas of design, manufacturing and general engineering. Training in the use of machine and welding tools found in a modern job shop is a required activity practiced in the machine tool laboratory.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 1, Tut: 0.5)
**Requirements:** Prerequisites: Corequisites: Exclusions: MECH 211, MECH 212
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 18
**Offering Faculty:** Smith Engineering

**MECH 215 Instrumentation & Measurement Units: 3.50**
This course presents techniques and devices for measurements in mechanical systems of solids and fluids. On completion of the course, students will be able to: Identify and Quantify measurement objectives in practical engineering applications; Apply statistical analysis, including uncertainty for interpreting test results; Specify and Select transducers, acquisition systems, and procedures to measure temperature, pressure, stress, strain and force; position, velocity and acceleration; Apply physical principles to predict static and dynamic system performance for pressure, strain, temperature and position measurements.
COURSE DELETED 2018-2019
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisite of APSC112 and registered in a BSCE or BASC Academic Program.
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 216 Instrumentation and Measurement Labs Units: 2.00**
This course is composed of active lab modules that provide hands-on practical experience to complement the theory presented in MECH 215. On completion of the course, students will be able to: Install and test a micro controller system for data acquisition and control; Acquire and process digital and analog data; Apply transducers for temperature, pressure, stress, strain and force; position, velocity and acceleration; Formulate conclusions supported by data and comparison of results to appropriate models; Discuss the limitations of data employed, key findings, trends evident, uncertainty and error; Create graphs, tables and charts to clearly present data and support conclusions; Compose technical writing to concisely report measurement results and draw valid conclusions. Students will use experimental and numerical skills typically acquired in MTHE 272 and MECH 215.
COURSE DELETED 2018-2019
K2(Lec: Yes, Lab: Yes, Tut: No)
**Requirements:** Prerequisite: APSC112 and regi
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 16
Engineering Design 8
**Offering Faculty:** Smith Engineering

**MECH 217 Measurement in Mechatronics Units: 4.25**
This course focusses on measurement theory and Arduino programming to put that theory into practice. Active lab modules provide hands-on practical experience making measurements, doing analysis, and drawing conclusions from them. On completion of the course, students will be able to: Install and test a micro controller system for data acquisition and control; Program in C to acquire and process digital and analog data; Apply transducers, acquisition systems, and procedures to measure pressure, strain, temperature and position; Apply statistical analysis, including uncertainty, for interpreting test results; Apply physical principles to describe static and dynamic system performance for pressure, strain, temperature and position measurements; Students will be expected to use mathematical and computational skills typically acquired in first year. Previous experience with C will be an asset, but is not required.
(Lec: 3, Lab: 1.25, Tut: 0)
**Requirements:** Prerequisites: APSC 112 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 15
**Offering Faculty:** Smith Engineering

**MECH 221 Solid Mechanics I Units: 3.50**
Review of statics, forces and equilibrium, internal forces in simple structures and other material from first year. Further development of axial, torsion, shear and bending moment diagrams, and concepts of stress and strain. Introduction to mechanical properties of materials, centroids and moments of areas, axial stress, flexural stress, transverse shear stress, calculation of displacement by integration, combined loading, and stress transformation. This course is designed primarily for mechanical engineering students.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: APSC 111, APSC 171, and APSC 182 or permission of instructor Corequisites: Exclusions: CIVL 220, CIVL 230
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 228 Kinematics And Dynamics Units: 3.50**
This course will cover the following topics in the field of dynamics. Kinematics of particles: planar and three-dimensional motion (rectilinear, curvilinear), choosing a coordinate system, conversions between systems, space curvilinear motion using vector derivatives, free and constrained paths, relative motion between particles. Kinetics of systems of particles: generalized Newton's Second Law, work and energy, impulse and momentum, conservation of energy and momentum, impact. Students will solve dynamics problems analytically and computationally in an active learning environment.
K3.5(Lec: No, Lab: Yes, Tut: No)
**Requirements:** Prerequisites: APSC 111, APSC 171
Corequisites: Exclusions: MECH 229
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 31
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 229 Kinematics and Dynamics Units: 3.50**
This course will cover the following topics in the field of dynamics. Kinematics of particles: planar and three-dimensional motion (rectilinear, curvilinear), choosing a coordinate system, conversions between systems, space curvilinear motion using vector derivatives, free and constrained paths, relative motion between particles. Kinetics of systems of particles: generalized Newton's Second Law, work and energy, impulse and momentum, conservation of energy and momentum, impact. Students will solve dynamics problems analytically and computationally in an active learning environment.
*This course is an exact duplicate of MECH 228 but for MREN and MINE students only.
K3.5(Lec: No, Lab: Yes, Tut: No)
**Requirements:** Prerequisites: APSC 111, APSC 171
Corequisites: Exclusions: MECH 228
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 31
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 230 Applied Thermodynamics I Units: 3.50**
An introductory course in thermodynamics. Topics include: properties and behaviour of pure substances, concepts of heat, work and energy, the First and Second Laws of Thermodynamics, and the analysis of a variety of power and refrigeration cycles.
(Lec: 3, Lab: 0, Tut: 0.5)
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 12
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 241 Fluid Mechanics I Units: 3.50**
An introductory course in fluid mechanics. Topics include properties of fluids, fluids at rest, manometers and other pressure measuring devices, dimensional analysis, the laws of conservation of mass and momentum, Bernoulli's equation for incompressible flow and the energy equation, flow measurements, elementary pipe flow problems including losses, pumps, etc. On completion of the course students will be able to: Explain Bernoulli based energy equations with reference to energy and hydraulic grade lines, static and dynamic pressure; Explain control volume and control mass analysis with reference to Eulerian and Lagrangian frames, applied forces and flows; Solve simple flow systems for velocity distributions using continuity and Navier Stokes equations with appropriate boundary conditions; Solve flow and force problems in an integral framework using Bernoulli, conservation of mass and momentum; Solve piping system performance problems using Bernoulli with friction, minor losses, pump and turbine performance curves; Calculate pressures and forces on submerged surfaces in a static fluid; Solve scaling problems using dimensionless groups.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: APSC 111 Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Science 18
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 270 Materials Science and Engineering Units: 3.50**
This course provides the student with a background in the basic structural concepts of materials and the relationships between processing, structure, properties and performance. The topics will range from atomic bonding and arrangements, through micro-and macro-structures and their influence on properties, to the processing techniques required to produce the desired structures. All current types of engineering materials, including metals, ceramics, polymers, composites and semiconductors are covered.
(Lec: 3, Lab: 0, Tut: 0.5)
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 31
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 273 Materials Science and Engineering Lab Units: 1.00**
This course provides a hands-on exploration of some of the concepts introduced in MECH 270. This will include mechanical testing at room and elevated temperature as well as subsequent examination of microstructure. Results obtained will be related to the mechanisms discussed in MECH 270.
K1.0(Lec: 0, Lab: 1, Tut: 0)
**Requirements:** Prerequisites: Corequisites: MECH 270 Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 3
Complementary Studies 0
Engineering Science 9
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 302 Mathematical and Computational Tools for Mechanical Engineers III Units: 3.50**
This course will introduce advanced numerical and statistical methods for the solution of engineering problems, to complement those discussed in MECH 202 and 203. The topics of the course will be presented through problems, models and applications relevant to the Mechanical Engineering Program.
On completion of the course the students will be able to: perform spectral analysis, use Laplace transforms, perform multi-variate statistical analysis and apply machine learning methods.
K3.5 (Lec: Yes, Lab: No, Tut: Yes)
**Requirements:** Prerequisites: MECH 202 MECH 203 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 310 Digital Systems for Mechatronics Units: 4.50**
Microcontroller based operation of programmable digital sensors, servo motors, stepper motors, and activation of pneumatic and hydraulic drivers. PLC control of sequential logic operations in mechanical systems. Introduction to frequency response of systems with FFT application for machine health monitoring. Industrial communication standards for local and internet-based information transfer; Internet of Things (IOT) concepts. Off grid systems, photovoltaics, and inverters. Lab activities will focus on design, construction, and testing of microcontroller based mechatronic systems for practical applications, building on skills developed in MECH 217 and MECH 210.
K4.5(Lec: Yes, Lab: Yes, Tut: Yes)
**Requirements:** Prerequisites: MECH 210 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 40
Engineering Design 14
**Offering Faculty:** Smith Engineering

**MECH 321 Solid Mechanics II Units: 3.50**
This course continues the study of solid mechanics. On completion of the course students will be able to: Calculate the total normal and shear stress at a point and sketch the stress distributions on a cross-section of a structural component (such as a crank) experiencing 3D combined (axial, transverse and/or moment causing) loads and non-symmetric loads; Calculate the residual normal or shear stress at a point and sketch the stress distribution on a cross-section of a structural component that is experiencing axial, torsional and/or bending loads followed by unloading; Calculate the normal or shear stress at a point on a cross-section of a structural component that is under load (axial, torsional and/or bending) and is supported in a statically indeterminate configuration (using force balance equations together with compatibility equations derived from known boundary conditions); Calculate the normal or shear stress at a point on a cross-section of a structural component that is under load (axial, torsional and/or bending) and contains one or more locations of stress concentration; Calculate, using general equations and/or graphically using a Mohr's circle, the normal and shear stress and/or strain transformations at a point within a structural component under load as a function of the orientation relative to a fixed coordinate system and find the maximum in-plane normal and shear stress and/or strain; Calculate the deflections and angles of deflection at any point on a transversely loaded beam of uniform cross-section using the principle of superposition and the standard equations for single loads acting on simply supported beams; Solve for critical loads in terms of buckling for concentrically and eccentrically loaded columns; Calculate the optimum dimensions (design) for shafts and beams under combined 3D loading based on specified material failure criteria; Design mechanism or structural components to withstand all forces for given loads, maximum deflection tolerances, factor of safety and material properties.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 221 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12
**Offering Faculty:** Smith Engineering

**MECH 323 Machine Design I Units: 4.50**
This course emphasizes the application of theoretical and engineering background taught in other courses, but also relies heavily on empirical approaches and simplifications of theory. Core material includes static and fatigue failure theories and the design/specification of selected machine elements. The course is centered around a major design project which is undertaken in groups.
(Lec: 3, Lab: 1, Tut: 0.5)
**Requirements:** Prerequisites: APSC 200 or APSC 202, MECH 321 Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 27
**Offering Faculty:** Smith Engineering

**MECH 328 Dynamics And Vibration Units: 3.50**
This course covers the kinematics and dynamics of rigid bodies in two and three dimensions, as well as an introduction to vibrations. Topics in dynamics include: mathematically rigorous kinematic analysis, Newton's laws, energy methods, impulse and momentum methods, mass moments of inertia, and gyroscopic motion. Topics in vibrations include: free and forced vibration of single-degree-of-freedom systems, undamped and damped systems, equivalent single degree of freedom system of continuous elements/systems using energy equivalence and equation of motion.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 228 or ENPH 225 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 17
Engineering Design 14
**Offering Faculty:** Smith Engineering

**MECH 330 Applied Thermo II Units: 3.50**
A continuation of MECH 230 with selected topics such as gas and vapour power cycles, refrigeration, mixtures of gases and vapours, combustion and available energy.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 230 or ENPH 274 (PHYS 274) or MREN 230 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 333 Gender, Engineering and Technology Units: 3.00**
This course examines relations between gender and technology. The main topics covered are: the role of technology on the shaping of society particularly in terms of gendering of jobs and exclusion of women, gender issues in the workplace, the impact of technology on women's lives, and women's impacts on technology. Historical perspectives are presented and contemporary examples from western and developing countries are discussed.
(Lec: 3, Lab: 0, Tut: 0)
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 341 Fluid Mechanics II Units: 3.50**
A second course in fluid mechanics covering the differential form of conservation laws, boundary layer and external flows, compressible flows and the operation of rotational fluid machinery. On completion of the course students will be able to: Apply control volume analysis to mass, momentum and energy conservation; Apply differential form of mass and momentum conservation to the concept of flow field and its properties, including Navier Stokes equations; Apply stream function and velocity potential to the analysis of two-dimensional inviscid flows, and use the superposition principle to build complex flow fields from building block ingredients; Calculate drag and lift on solid bodies such as airfoils; Explain boundary layer flows, including the concept of various boundary layer thicknesses, shape factor, flow separation and the difference between laminar and turbulent boundary layers; Explain compressible flow features based on one-dimensional compressible subsonic and supersonic flows, with and without normal shock waves; Calculate design parameters of rotational fluid machinery, including centrifugal pumps and wind turbines.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 241 or MREN 241 Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 11
Natural Sciences 0
Complementary Studies 0
Engineering Science 31
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 346 Heat Transfer Units: 3.50**
An introductory course which covers conduction, convection and radiation modes of heat transfer. Both analytical and numerical analysis will be discussed, and concepts will be reinforced through tutorial and laboratory sessions. Latter topics will include combined modes of heat transfer and the design of heat exchangers.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 230 or MREN 230 or ENPH 274 (PHYS 274) and MECH 241 or MREN 241 or MECH 341 Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 350 Automatic Control Units: 3.50**
An introduction to the basic principles of modelling, analysis and control of dynamic systems. Topics include: modes of control, principles of feedback, Laplace and transfer functions, transient response of first and second order systems, stability criteria, root locus, Bode and frequency response. After completion of this course a student will be able to design a control system by classical techniques and will have an awareness of modern techniques.
(Lec: 2.75, Lab: 0.25, Tut: 0.5)
**Requirements:** Prerequisites: MECH 203 or MTHE 225 or MTHE 235 or MTHE 237, and MECH 228 or MECH 229 or ENPH 225, and registered in a BSCE or BASC Academic Program Corequisites: Exclusions:
**Offering Term:** FW
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 23
Engineering Design 19
**Offering Faculty:** Smith Engineering

**MECH 361 Project Based Engineering: Conceive, Design, Implement & Operate Units: 3.50**
This course provides academic credit for 3rd year students who take a lead role in design and implementation of an engineering device of substantial complexity that is part of a student project. The student has to demonstrate significant involvement with the project during the Fall term and be recommended by an academic advisor in order to qualify and be approved by the course coordinator. Students who are permitted to take this course will be required to conceive, design, implement and operate a sub-system or complete competition entry using the knowledge and skills acquired in earlier courses. Successful course completion will consist of specification of function, analysis, selection of materials and/or components, preparation of working drawings, manufactured prototype, completed with a major report and poster presentation. The evaluation will be based on joint assessment by the project academic advisor and the course coordinator.
NOT OFFERED 2023-2024
K3.5(Lec: No, Lab: Yes, Tut: No)
**Requirements:** Prerequisites: Completion of 2nd Year and permission of the course coordinator upon the recommendation by the academic advisor. Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 42
**Offering Faculty:** Smith Engineering

**MECH 370 Prin Of Materials Processing Units: 3.50**
The basic mechanisms of mass transport and phase transformations in materials are developed from thermodynamic and kinetic principles. Topics include phase equilibria, diffusion, solidification and solid-state transformations. The application of these phenomena to materials processing methods, such as casting, forming, heat treatment and sintering is described.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 270 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Science 24
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 371 Fracture Mech & Dislocation Units: 3.50**
Fracture Mechanics are developed to explain crack propagation in materials and structures. This includes development of the strain energy release rate (GIC) and the critical stress intensity factor (KIC). Emphasis will be placed on developing the correlation between microstructure control and the resistance to crack propagation which this variable produces. Dislocation theory will be evoked to analyze the stress fields of point, line and plane defects. Plasticity and fracture will be detailed, which includes the time dependent aspects of such processes as static fatigue and creep fracture.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 270 Corequisites:
Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 20
Engineering Design 11
**Offering Faculty:** Smith Engineering

**MECH 393 Biomechanical Product Development Units: 3.50**
This course focuses on design, manufacturing and product management of various assistive technology devices to be used by community members, such as gaming or communication devices for children with motor control impairments, or ileostomy guides or pill dispensers for older persons, as well as various other external devices for persons with disabilities. Some aspects, such as the determination of the geometry and different sizes are product specific, while safety criteria, regulations, rational choice of alternatives, design procedures and product management are applicable when designing a much larger variety of products. Much of the theory will be based on examples of assistive devices for persons
with disabilities.
(Lec: 3, Lab: 0, Tut: 0.5)
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 24
**Offering Faculty:** Smith Engineering

**MECH 394 Frontiers in Biomechanical Engineering Units: 3.50**
This course addresses the fundamental principles of biomechanical engineering through four introductory modules, each dedicated to one topic: biology, biomechanics, biotransport, and mechatronics. Each module introduces the background and technical principles required to understand topics in biomechanical engineering. This course content emphasizes the multidisciplinary approaches needed to understand a problem from both biology and mechanical engineering perspectives and includes guest lectures given by biomechanical engineering experts with a goal of providing students with exposure to the current biomechanical engineering research landscape.
Students are presumed to have sound background in mechanical measurement, solid mechanics, kinematics and dynamics typically acquired from MECH 217, 221, 228, 321 and 328.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 217, MECH 221, MECH 228, or permission of instructor Corequisites:
Exclusions: CHEE 340
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 30
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 396 Mechanical and Materials Engineering Laboratory I Units: 2.00**
This is the first of two laboratory courses in the third year of the Materials Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work.
K2(Lec: Yes, Lab: Yes, Tut: Yes)
**Requirements:** Prerequisites: Completion of 2nd year or permission of the instructor. Corequisites: MECH 370
Exclusions: MECH 398
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 397 Mech And Material Eng Lab II Units: 2.00**
This is the second of two laboratory courses in the third year of the Materials Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work. Approximately half of the material is common with MECH 399.
K2(Lec: Yes, Lab: Yes, Tut: Yes)
**Requirements:** Prerequisites: Completion of 2nd year or permission of the instructor Corequisites: MECH 371 Exclusions: MECH 399
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 398 Mechanical Engineering Laboratory I Units: 2.00**
This is the first of two laboratory courses in the third year of the General Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work. Lab modules from MECH 396/MECH 397/MECH 399 completed but not counted for credit may be included for credit in this course.
K2(Lec: Yes, Lab: Yes, Tut: Yes)
**Requirements:** Prerequisites: Completion of 2nd year or permission of the instructor. Corequisites: Exclusions: MECH 396
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 399 Mechanical Eng Lab II Units: 2.00**
This is the second of two laboratory courses in the third year of the General Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work. Lab modules from MECH 396/MECH 397/ MECH 398 completed but not counted for credit may be included for credit in this course.
K2(Lec: Yes, Lab: Yes, Tut: Yes)
**Requirements:** Prerequisites: Completion of 2nd year or permission of the instructor. Corequisites: Exclusions: MECH 397
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 420 Vibrations Units: 3.50**
Considers mechanical vibration, the problems it presents and the means
of dealing with it. Completes the treatment of systems with two
degrees-of-freedom (introduced in MECH 328) and proceeds to systems with higher number of degrees-of-freedom. Co-ordinate systems, types of coupling, matrix formulation, vibration absorbers and dampers, specific and hysteretic damping, Rayleigh's method, torsional vibration, Holzer method, introduction
to the finite element method, beam vibration.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 328 or ENPH 211 (PHYS 211) and ENPH 225 (PHYS 225) Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 29
Engineering Design 13
**Offering Faculty:** Smith Engineering

**MECH 423 Introduction To Microsystems Units: 3.50**
This course will deal with the practical engineering aspects of micro-machining technologies and microsystems. The contents will include: scaling issues, microfabrication technologies and production methods, classification and analysis of Microsystems (including microsensors, microactuators, RF switches, micromirrors, and other micromechanisms), the integration of devices into Microsystems (both assembly and interfacing). Micro-machining will be compared and contrasted to both micro-electronics and traditional macro-machining. The development and use of Microsystems simulation and design tools will be covered as well.
(Lec: 3, Lab: 0, Tut: 0.5)
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 25
Engineering Design 17
**Offering Faculty:** Smith Engineering

**MECH 424 Sustainable Product Design Units: 3.50**
This course deals with sustainable product design and manufacture. Topics include: product Life Cycle Analysis issues; Streamlined Life Cycle Analysis and international Life Cycle Analysis standards; Energy, Global Warming Potential, Green House Gas and carbon emission issues (including energy needs in product design and manufacturing); Carbon footprint, basic chemistry of carbon emissions, international standards for carbon emissions signatures. Design topics include: product design for manufacture and assembly, design for disassembly and design for environment. Product end-of-life considerations include: recycling, remanufacture and reuse. Students will complete several open ended projects. Guest speakers will be included where possible.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 323 or permission of the instructor Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 42
**Offering Faculty:** Smith Engineering

**MECH 430 Thermal Systems Design Units: 4.00**
This course is concerned with the technical, economic and environmental aspects of conventional and novel methods of energy supply and use.
Emphasis will be placed on the analysis and design of thermal systems.
Topics include: electric utility demand and supply; the analysis of thermal power generation systems including combined cycle and cogeneration plants; emission control; alternative energy systems. A group project related to the design of a thermal system will form a significant portion of this course.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 1)
**Requirements:** Prerequisites: MECH 330, or permission of the instructor Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 24
**Offering Faculty:** Smith Engineering

**MECH 435 Internal Combustion Engines Units: 3.50**
This course covers all aspects of the design and operation of internal combustion engines. Principles of thermodynamics and fluid mechanics are used in the analysis of internal combustion engines. Course content includes discussions on both spark ignition and compression ignition (diesel) engines with special emphasis placed on new engine technologies. Intake, in-cylinder and exhaust flows are considered along with various aspects of combustion phenomenon relevant to engines. This course includes a laboratory involving engine performance measurements made using a dynamometer.
(Lec: 3, Lab: 0.08, Tut: 0.42)
**Requirements:** Prerequisites: MECH 230 or CHEE 210 Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12
**Offering Faculty:** Smith Engineering

**MECH 437 Fuel Cell Technology Units: 3.50**
Introduction to and history of various fuel cell systems. Fuel cell fundamentals including thermodynamics, electrode kinetics, fuel cell performance and
transport issues. Systems covered include Polymer Electrolyte Membrane (PEMFC), Direct Methanol (DMFC), Alkaline (AFC), Solid Oxide (SOFC), and Molten Carbonate (MCFC). Fueling processing issues and combined heat and power systems. Overview of the current fuel cell industry.
NOT OFFERED 2023-2024
(Lec: 3.0, Lab: 0, Tut: 0.5)
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21
**Offering Faculty:** Smith Engineering

**MECH 439 Turbomachinery Units: 3.50**
Fluid mechanics and thermodynamics applied to turbomachines; dimensionless performance characteristics; momentum and energy equations; thermodynamics and efficiencies; cascade aerodynamics; compressors and turbines, reaction and stage loading; radial equilibrium; radial flow machines; application of generalized performance to choice of compressors; mechanical details and auxiliary systems.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 330, MECH 341, or permission of the instructor Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 441 Fluid Mechanics III Units: 3.50**
Topics will include: Derivation of equations of motion for incompressible fluids; exact solutions for laminar flows; stability and transition; introduction to
turbulence, including turbulent boundary layers, jets, wakes and mixing layers;
drag reduction; introduction to the modelling of turbulence.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 341 Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 444 Computational Fluid Dynamics Units: 3.50**
This course provides an overview of, and hands-on experience in, the numerical modelling of fluid flows. Finite volume, finite difference and finite elements methods are introduced. Students are expected to gain critical insight into the capabilities and limitations of fluid flow models by numerically simulating various engineering flows and by doing a term project. Topics include: comparison of numerical, experimental and analytical methods in fluid mechanics, numerical grids and their generation, flow equations and their discretization, solution techniques, turbulence modelling and data presentation. Features of commercial codes are critically reviewed.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MTHE 272 (MATH 272) or ENPH 213 (PHYS 213) or MECH 203, MECH 341 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12
**Offering Faculty:** Smith Engineering

**MECH 448 Compressible Fluid Flow Units: 3.50**
Introduction and review of work done in earlier courses; basic equations for one-dimensional compressible flow; isentropic one-dimensional flow; steady and unsteady normal shock waves; oblique shock waves; steady and unsteady expansion waves; two-dimensional isentropic flow; nozzle flows; effects of friction and heat transfer; boundary layer flow; design of aircraft engine intake systems; design of supersonic wind-tunnels and shock tubes. Students are expected to have knowledge of fluid mechanics typically acquired in MECH 241/ MECH 341. Those who have not taken these or similar courses will need to prepare through self study.
(Lec: 3, Lab: 0, Tut: 0.5)
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 31
Engineering Design 11
**Offering Faculty:** Smith Engineering

**MECH 452 Mechatronics Engineering Units: 5.00**
This is a course in mechatronic systems design. Mechatronics Engineering, an integration of computer, electrical and mechanical engineering, is studied in a series of workshops that focus on electronics, microcontrollers, programmable logic controllers and mobile robots. The lectures provide the theoretical
background to the workshops, and include discussion of related industrial
and commercial applications. The knowledge and experience gained in the lectures and workshops is applied to a team design project. Students will use
their knowledge of electric circuits, microcontrollers and control systems
typically acquired in MECH 210, MECH 217 and MECH 350.
(Lec: 2, Lab: 2.5, Tut: 0.5)
**Requirements:** Prerequisites: Permission of the instructor Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 30
**Offering Faculty:** Smith Engineering

**MECH 455 Computer Integrated Manufacturing Units: 3.50**
The course focuses on the following subjects within the field of Computer Integrated Manufacturing (CIM): robot kinematics and applications in CIM, machine-vision-based inspection, virtual modelling of CIM workcells, and workcell control and scheduling. Laboratory work allows students to learn robot programming and workcell control. Students complete a course project
where they design a PLC-based control strategy for a manufacturing workcell.
(Lec: 2, Lab: 1.5, Tut: 0)
**Requirements:** Prerequisites: Must be registered in BSCE or BASC program. Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21
**Offering Faculty:** Smith Engineering

**MECH 456 Introduction To Robotics Units: 3.50**
This course will cover the following topics in the field of robotics: historical development; robot components (sensors, actuators, and end effectors, and their selection criteria); basic categories of robots (serial and parallel manipulators, mobile robots); mobility/constraint analysis; workspace analysis; rigid body kinematics (homogeneous transformation, angle and axis of rotation, Euler angles); manipulator kinematics and motion trajectories (displacement and velocity analyses, differential relations, Jacobian matrix); non-redundant and redundant sensing/ actuation of manipulators; manipulator statics (force and stiffness); singularities; and manipulator dynamics.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 350 or MTHE 332 (MATH 332) or MTHE 335 or ELEC 443 or permission of the instructor Corequisites: Exclusions: ELEC 448
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21
**Offering Faculty:** Smith Engineering

**MECH 457 Additive Manufacturing Units: 4.00**
This elective course provides a comprehensive introduction to additive manufacturing (AM), with an emphasis on a scientific/technical approach to process/product design, as well as troubleshooting, for various industrial applications. The course includes an overview of AM techniques (including process configurations, processing conditions and the common machinery/instruments), followed by part design, process design & optimization in the context of AM and AM process modelling and control. Both polymer 3D printing and metal powder-based techniques will be covered. The theoretical course material will be complemented by a group-based practical/hands-on project using the existing AM facility within the department.
(Lec: 3, Lab: 1, Tut: 0)
**Requirements:** Prerequisites: MECH 213 or (MECH 211 and MECH 212), MECH 270, MECH 203 Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 48
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 460 Team Project-Conceive & Design Units: 4.00**
Students working in teams will be required to conceive and design a product, system or process using the knowledge and skills acquired in earlier courses. Elements of the design will include: specification of function, analysis, selection of materials and/or components, preparation of working drawings, cost analysis and tenders, and preparation of preliminary design report. A research project may be accepted as an engineering design project provided it can be clearly shown that the elements of conceive and design are fulfilled in the completion of the project. Lectures and Guest Speakers will focus on related professional skills and topics including engineering ethics, professional organizations and legislation, intellectual property and information systems in support of the project.
K4(Lec: Yes, Lab: Yes, Tut: Yes)
**Requirements:** Prerequisites: MECH 321, MECH 323, MECH 328, MECH 346 and MECH 350, or in final year of MECH program. Corequisites: MECH 464 Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 48
**Offering Faculty:** Smith Engineering

**MECH 461 Research Project Units: 4.00**
This course provides an opportunity for students to work individually on an engineering research project with staff members of the Department. The topic is selected by the student in consultation with a Department supervising faculty member by the end of the Fall term. The projects are laboratory-based to be completed by the end of the Winter term with a major report and presentation of the work.
K4(Lec: No, Lab: Yes, Tut: No)
**Requirements:** Prerequisites: Completion of 3rd year and permission of the instructor. Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 48
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 462 Team Project - Implement and Operate Units: 3.50**
This course is intended to enable team projects that started in MECH 460, to continue to the implement and operate phases of the design cycle. However, new projects can be the subject of MECH 462 as long as they meet the implement and operate objectives of the course. An engineering report is prepared and defended. The presentation is normally supported by a working prototype or physical mock-up of the design. Testing a process or system can replace the building of a prototype. Choices of available projects are limited and should be discussed with the instructor.
K3.5(Lec: Yes, Lab: Yes, Tut: Yes)
**Requirements:** Prerequisites: MECH 460 Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 42
**Offering Faculty:** Smith Engineering

**MECH 463 Engineering Project for International Students Units: 2.00**
This course is for students registered at a university outside Canada who wish to do a research project at Queen's to satisfy the requirements of their home university. Projects must be initiated by a faculty supervisor at the student's home university in consultation with a Queen's professor who has agreed to act as a supervisor. The time frame and requirements for course completion will be agreed upon by the two project supervisors prior to the student arriving at Queen's. This course is NOT available or intended for typical exchange agreement students.
K2(Lec: No, Lab: Yes, Tut: No)
**Requirements:** Prerequisites: Permission of instructor. Corequisites: Exclusions:
**Offering Term:** FW
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 24
**Offering Faculty:** Smith Engineering

**MECH 464 Communications & Project Management Units: 1.50**
This course provides advanced instruction and practice in technical communication and project management for multidisciplinary engineering projects. Content includes request for proposals, project planning and proposal writing, quality function deployment, oral presentation skills, client communications and concise report writing. Course deliverables are closely tied to deliverables in Capstone design courses. Open to Mechanical and Materials Engineering students only.
(Lec: 0.75, Lab: 0, Tut: 0.75)
**Requirements:** Prerequisites: Corequisites: MECH 460 or permission of the instructor Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Science 0
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 465 Computer Aided Design Units: 3.50**
Concept of computational design including the choice of the objective function, equality and inequality constraints, and analysis methods; one-dimensional search methods, sensitivity analysis, and the steepest descent method. The principles of the finite element method and its application to stress analysis of mechanical components. The prerequisite may be waived for students with a strong background in solid mechanics from other courses.
(Lec: 3, Lab: 0.5, Tut: 0)
**Requirements:** Prerequisites: Must be registered in BSCE or BASC program. Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 31
**Offering Faculty:** Smith Engineering

**MECH 470 Deformation Processing Units: 3.50**
This course focuses on the elastic-plastic deformation of metals as it relates
to the fabrication of stock materials, the manufacture of components
and in-service material performance. Methods for describing and analyzing
elastic-plastic behaviour, at both macroscopic and microscopic length-scales,
are presented. Additional topics include the measurement and prediction
of forming limits, the effects of deformation rate and temperature on
plastic flow, and mechanisms of ductile failure. In the final portion of
the course, the concept of microstructural design is introduced and
then reinforced through a series of case studies. Material from
MECH 370/371 will be reviewed and students who have not completed those courses may require some additional reading to keep up.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 270 Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12
**Offering Faculty:** Smith Engineering

**MECH 476 Eng Of Polymers And Composite Units: 3.50**
This course introduces the microstructure-property-processing relationships needed to understand the applicability of polymers and composites to engineering design. The courses start with an introduction to the structure and properties of different polymers. The mechanics of polymers are covered including elasticity, rubber elasticity, pressure dependent yield and viscoelasticity. The mechanics of composites depend not only on the matrix, but also on the reinforcing phase.
While focusing on polymer composites, metal and ceramic-based composites will also be introduced. Topics covered will include the influence of the interface, mechanical and transport properties and design of composites. The final goal is to correlate constitutive relations describing the time-temperature dependence of mechanical properties of polymers and composites to microstructure and linking these relations to practical design. Material from MECH 370/371 will be reviewed and students who have not completed those courses may require some additional reading to keep up.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 270 Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 18
**Offering Faculty:** Smith Engineering

**MECH 478 Biomaterials Units: 3.50**
An introduction to the structure, properties and performance of biomaterials used for the construction of medical devices. Examples of biomaterials are bioactive ceramics, biodegradable polymers and advanced titanium-based alloys used for the construction of orthopedic implants. Topics covered will include surface and bulk properties of biomaterials and their impact on the clinical performance of implants. Discussion will focus on tissue-biomaterials interactions, biocompatibility and biodegradation. The course will also cover the current in-vitro and in-vivo testing methods for evaluating the long-term performance of biomaterials.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: Must be registered in BSCE or BASC program. Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 31
**Offering Faculty:** Smith Engineering

**MECH 479 Nano-Structured Materials Units: 3.50**
The majority of conventional materials have grain or crystallite sizes ranging from micrometers to several millimeters. Capabilities now exist to synthesize materials with grains where one or more dimension is on the nanoscale (less than 100 nm). As the grain size decreases, there is a significant increase in the volume fraction of grain boundaries or interfaces. This characteristic strongly influences the chemical and physical properties of the materials. For example, nanostructured ceramics are tougher and stronger than coarser grained ceramics, while nanostructured metals exhibit increases in yield strength and elastic modulus. It has also been shown that other properties (e.g. electrical, optical and magnetic) are influenced by a fine grain structure. The goal of this course is to introduce the student to the impact of length scale, from millimeter to nanometer, on material properties, with a primary but not exclusive focus on mechanical properties. It will include discussions on synthesis approaches as well as examples of applications. Material from MECH 370/371 will be reviewed and students who have not completed those courses may require some additional reading to keep up.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 270 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 20
Engineering Design 11
**Offering Faculty:** Smith Engineering

**MECH 480 Airplane Aerodynamics and Performance Units: 3.50**
A technical course on the principles of flight. Techniques for the quantitative prediction of the aerodynamic characteristics of the wing will be described. Extensions to account for real-world effects will be discussed. These results will be used to predict the airplane performance (range, climb rate, maximum speed, etc.) The concept aerodynamic stability will be introduced and discussed. Students are expected to know MATLAB proficiently and have fluids knowledge typically acquired in MECH 241 and MECH 341. Those who have not taken these or similar courses will need to prepare through self study.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: Must be registered in BSCE or BASC program. Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 481 Wind Energy Units: 3.50**
An introductory course on wind-turbine operation and aerodynamics.
Topics include: the Betz limit; the Blade Element Momentum method; characteristics of the atmospheric boundary layer; unsteady aerodynamic
theory; gusts and blade aeroelasticity; blade noise and health effects; and
wind-park siting and planning. Extension of some of these topics to small wind turbines, run-of-the-river water turbines and off-grid systems will also be
presented. Students are expected to have sufficient experience with fluid
dynamics equivalent to MECH 341. Those who have not taken such a
course will need to prepare through self-study.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: Must be registered in BSCE or BASC program. Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 482 Noise Control Units: 3.50**
An introduction to the principles of noise control. Topics include: basic
properties of sound and noise, the measurement of noise, effects of noise on people, description of sound fields, acoustics of rooms and enclosures,
acoustical materials and structures, and noise source identification.
A coherent approach to the solution of noise control problems is stressed throughout the course.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: Must be registered in BSCE or BASC program. Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 25
Engineering Design 17
**Offering Faculty:** Smith Engineering

**MECH 483 Nuclear Materials Units: 3.50**
A nuclear reactor presents a unique environment in which materials must perform. In addition to the high temperatures and stresses to which materials are subjected in conventional applications, nuclear materials are subjected to various kinds of radiation which affect their performance, and often this dictates a requirement for a unique property (for example, a low cross section for thermal neutron absorption) that is not relevant in conventional applications. The effects of the radiation may be direct (e.g., the displacement of atoms form their normal positions by fast neutrons or fission fragments), or indirect (e.g., a more aggressive chemical environment caused by radiolytic decomposition). This course describes materials and structures typically used in nuclear environments, their manufacture, the unique conditions to which they are subjected, the basic physical phenomena that affect their performance and the resulting design and operational requirements for reactor components. The course includes a field trips to components manufacturers and to Canada's national nuclear research laboratory. Material from MECH 370/371 will be reviewed and students who have not completed those courses may require some additional reading to keep up.
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: MECH 270 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 20
Engineering Design 11
**Offering Faculty:** Smith Engineering

**MECH 484 Introduction To Ceramics Units: 3.50**
An introduction to the processing, structure and properties of advanced ceramics used for the design of components in electronic, automotive, aerospace, energy, mining and chemical and petrochemical industries. The emphasis is placed on understanding the relationship between microstructure and mechanical, electrical and thermal properties of ceramics. Ceramic systems and related devices which are discussed include electronic and ionic conductors, capacitors, transducers, varistors, and dielectric substartes. The effect of porosity, grain size and residual stresses on strength, elastic and fracture properties of isotropic and anisotropic ceramics is also discussed. Material transport mechanism and sintering of powder ceramics materials is covered with recent examples of forming and sintering of oxides, carbides and nitrides.
COURSE DELETED 2019-2020
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** MECH 370 and MECH 371
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12
**Offering Faculty:** Smith Engineering

**MECH 492 Biological Fluid Dynamics Units: 3.50**
An introductory course on biological flows across a broad range of scales from flagellar motility to the beating heart. Topics range from the dynamics of classical biomedical flows such as the circulatory and respiratory systems. (e.g. wall compliance, pulsatility, and transition to turbulence) through to cellular-level motility and biopropulsion in general over a range of Reynolds numbers. Topics relating to comparative biology (e.g. allometry and evolutionary convergence) and common imaging techniques used for biological flows (e.g. acoustic, nuclear magnetic resonance, optical and x-ray techniques) will be covered as well. Students are expected to have sufficient experience with measurement science and fluid dynamics theory equivalent to MECH 217 and MECH 241. Those who have not taken such courses will need to prepare through self-study.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0.5)
**Requirements:** Prerequisites: Must be registered in BSCE or BASC program. Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0
**Offering Faculty:** Smith Engineering

**MECH 494 Kinematics Of Human Motion Units: 3.50**
In this course students will explore the application of classical mechanics to the analysis of human motion related to athletics, orthopaedics, and rehabilitation. The course covers the structure of human joints, including experimental and analytical techniques in the study of human joint kinematics; applications to the design of artificial joints and to clinical diagnosis and treatments. Students are introduced to the motion capabilities of the human body and how to develop and study kinematic models of the individual joints of the human body. Experimental methods used to collect kinematic data will be studied through interactive labs. Topics include defining body position and displacement, three dimensional representation of human motion, basic functional anatomy of individual joints, rigid body kinematics (homogeneous transformations, Euler angles, helical axis), intrajoint kinematics, joint modelling, articular surface motion. Three-dimensional kinematics of individual joints is emphasized from the perspective of total joint replacement design.
(Lec: 2, Lab: 1, Tut: 0.5)
**Requirements:** Prerequisites: MECH 393 and MECH 394, or permission of instructor Corequisites: Exclusions:
**Offering Term:** W
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 30
**Offering Faculty:** Smith Engineering

**MECH 495 Ergonomics And Design Units: 3.50**
This course provides an overview of ergonomic problems that are addressed in engineering design; including biomechanical, physical and physiological issues. Case studies will range from the design of vehicle cockpits to process control rooms, from industrial manual materials handling tasks to human directed robots, and from domestic tools to biomechanical devices.
(Lec: 3, Lab: 0.5, Tut: 0)
**Requirements:** Prerequisites: MECH 323 or permission of the instructor Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 42
**Offering Faculty:** Smith Engineering

**MECH 496 Musculoskeletal Biomechanics Units: 3.50**
Develops approaches to musculoskeletal biomechanics, including
experimental and analytical approaches to movement analysis, experimental instrumentation and devices, and biomechanical devices for musculoskeletal disorder rehabilitations. Analysis of the contribution of external loading, forces generated by muscles and constraints provided by other musculoskeletal
structures to predict forces and stresses in musculoskeletal joints and tissues. Numerical and modelling approaches, including inverse dynamics, and optimization, and determination of segmental inertial properties. Biomechanical devices including upper limb and lower limb orthotics and prosthetics. Applications in orthopedic engineering, movement assessment, ergonomics, joint injury and replacements, and biomechanical system design. Application of machine learning in biomechanics and human movement
analysis. Students are presumed to have had a sound introduction to biomechanics, typically acquired from MECH 394.
NOT OFFERED: 2023-2024
(Lec: 2, Lab: 1, Tut: 0.5)
**Requirements:** Prerequisites: MECH 328 Corequisites: Exclusions:
**Offering Term:** F
**CEAB Units:**
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 20
Engineering Design 22
**Offering Faculty:** Smith Engineering

**MECH 810 Adv. Top. In Manufacturing Eng Units: 3.00**
A topical course in manufacturing engineering which deals with some of today's research issues from both a theoretical and pragmatic approach. Research in areas such as Flexible Manufacturing Systems, Computer Integrated Manufacturing, Statistical Quality Control, Group Technology, Just in Time Concepts, Material Removal and Forming Technology, Design for Assemble, etc. are examined based on recent literature and publications. The specific topics to be addressed each year are selected to match the student's research interest and background. Three term-hours, may be given in any term. J. Jeswiet
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 811 Lasers In Manufacturing Appl. Units: 3.00**
Course presents an overview of lasers as they relate to selected manufacturing applications. Topics covered include general principles of laser operation, laser types used in manufacturing, components of laser-based processing systems and their motion programming and control. Students carry out a survey-based course project. Basic computer programming skills are required for this course. Three term-hours; lectures. (3.0 credit units)
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 812 Corrosion Units: 3.00**
This course presents the fundamental principles of corrosion with applied examples and emphasis on metals in aqueous environments. The main topics considered are: Basics of electrochemistry and charged interfaces; thermodynamics and Pourbaix diagrams; electrochemical kinetics; corrosion measurements; passivity; localized corrosion; high temperature oxidation; microscopy in corrosion analysis.
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 816 Energetics & Mechanics Locomotion Units: 3.00**
**Offering Faculty:** School of Graduate Studies

**MECH 817 Systematic Review Methodology for Product Evaluation Units: 3.00**
This course provides the skills to undertake a systematic literature review as required by the FDA when seeking approval for a device. Drawing on a clinical model, this course will enable the student to define a question using PICO (population, intervention, comparison, outcome), synthesize quantitative evidence and interpret the results. Three term hours.
**Offering Faculty:** School of Graduate Studies

**MECH 818 Functional Morphology Units: 3.00**
This course uses dynamics to understand how the musculoskeletal system allows movement and propulsion in animals. Topics include: a review of solutions for terrestrial locomotion, rigid body dynamics, implications of scaling, muscle and tendon dynamics, musculoskeletal lever systems, arthromechanics, and measurement modalities. Students interested in biomechanics, the animal
world, dynamics, and bio-inspired engineering should take this course.
Prerequisite: Permission of the instructor.
**Offering Term:** FW
**Offering Faculty:** Smith Engineering

**MECH 821 Adv Dynamics Of Mechanical Sys Units: 3.00**
Mathematical modelling of the dynamics of mechanical systems using Newton's Laws, LaGrange's Equation and Hamilton's Equations; linear and non-linear systems; time-domain and frequency-domain solutions; large systems; stability; response to random excitation. Three term-hours, lectures. R.J. Anderson.
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 823 Micro-Electro-Mech. Sys.(Mems) Units: 3.00**
This course is an overview of the research in MEMS and BioMEMS, particularly including microactuators, microsensors and their applications. Fundamentals of photolithography, wet and dry etching, and surface micromachining will be covered. Design methodologies together with fabrication processes will be emphasised through case studies. A design project will be used to enhance the understanding of the relevant theories that are covered in class. By the end of the course, students will be expected to demonstrate mastery of several different modelling techniques for microsystems and understand the mechanisms of microsystems. Three term-hours, lectures. Y. Lai
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 826 Experimental Vib./Shock Analy. Units: 3.00**
Characteristics of vibration and shock and their effects on mechanical systems and people; sensors and systems for measurement of vibratory displacement, velocity, acceleration and force; spectral analysis including applications to machinery vibration diagnostics; vibration test systems; random vibrations; modal analysis; vibration test standards; stress screening; shock testing. Three term-hours, lectures and laboratory. C. Mechefske.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 828 Biomechanics Of Human Gait Units: 3.00**
An overview of the research in biomechanics of human motion with particular focus on gait analysis. Topics include measuring and analysis techniques, biomechanical modelling, and data analysis techniques. Applications include the study of normal, able-bodied gait, and the evaluation of gait pattern changes associated with osteoarthritis, and total knee replacements. The course has a laboratory component that is used to give the student the opportunity to apply the theory covered in class. Three term -hours. K. Deluzio.
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 829 Tissue Mechanics Units: 3.00**
Methods of characterizing biological tissues for the Mechanical Engineer with no previous biology background. Histology of ligament, tendon, cartilage and bone. Viscoelasticity and classical elasticity. Current models of ligament and tendon (Fung's quasi-linear model). Linear anisotropic elastic model for bone and cartilage. Theories for strength and failure mechanisms. Three term-hours, lectures. J.T. Bryant
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 830 Experimental Fluid Dynamics Units: 3.00**
A review of measurement theory including: static and dynamic characteristics of signals, spectral analysis with filtering methodologies, response of systems, and statistical/uncertainty analyses. Subsequently the course then provides insight into traditional as well as contemporary measurement techniques in fluid dynamics ranging from single-point scalar/vector measurements through to spatially resolved volumetric reconstructions. To conclude, post-processing and data-manipulation strategies for such contemporary data sets along with a discussion of future concepts will be presented.
**Offering Term:** FW
**Offering Faculty:** Smith Engineering

**MECH 831 Convective Heat Transfer Units: 3.00**
Convective Heat Transfer
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 832 Combustion Dynamics Units: 3.00**
This course begins with a thorough review of the fundamental principles of combustion such as heat of reaction, chemical equilibrium, and chemical kinetics. Combustion aspects related to explosion phenomena such as flame acceleration, detonation wave and blast wave propagation are then covered. Finally, the single degree-of-freedom response of mechanical structures to blast wave loading will be discussed, and explosion damage mitigation techniques will be presented. Three term-hours, lectures. G. Ciccarelli
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 833 Topics in Single Phase Convective Heat Transfer Units: 3.00**
This course deals with aspects of Convective Heat Transfer not considered in course MECH-831. The main topics considered are: Introduction to Convective Heat Transfer, Natural Convection, Mixed Convection, Convective Heat Transfer in Porous Media, Enhanced Convective Heat Transfer, Nano Heat Transfer, Convective Heat Transfer in High Speed Flows, Interaction of Convection with Other Modes of Heat Transfer. Three term hours.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 834 Fundamentals Of Solar Energy Units: 3.00**
This course presents the fundamental principles of solar energy conversion, storage and distribution. Both photovoltaic and thermal energy conversion systems will be introduced; however the primary focus of the course will be on solar thermal systems for heating and cooling applications. Topics covered include the nature and prediction of the solar resource, solar collector design and performance, thermal storage, heat transport and distribution. The modeling and design of complete solar heating and cooling systems will be studied and exercises completed. Students will be required to complete a major project related to one of the above topics. Course lecture material will be augmented with laboratory exercises. S.J. Harrison.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 835 Introduction to Computational Fluid Dynamics Units: 3.00**
Objective of this course is to give students a basic understanding of the potential and limitations of Computational Fluid Dynamics (CFD), learn the fundamentals of CFD codes, find solutions for test problems, and run commercial software in a competent and critical manner. Three term hours; lectures. Prerequisites: Permission of instructor.
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 836 Radiative Heat Transfer Units: 3.00**
This course covers the following topics related to heat transfer by thermal radiation: fundamentals of thermal radiation, blackbody thermal radiation, radiative properties of real materials, surface to surface exchange of diffuse radiation, numerical solution of diffuse radiation problems, radiation with conduction and convection, radiation in absorbing, emitting and scattering media, gas volume radiation, surface-volume radiation selected applications.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 837 Trans & Kin. In Fuel Cells Units: 3.00**
The fundamentals of transport phenomena and reaction kinetics are considered and applied to fuel cells, with a view to a mechanistic understanding of fuel cell operation and limitations. Material covered includes the basic axioms of mechanics (conservation of mass, momentum, energy and charge) presented in indicial notation and applied to porous media. Emphasis is placed on the description of porous materials and the implications of porous media on transport, including the notion of effective transport coefficients. Ion transport in solid and polymer electrolytes due to electrochemical potential differences is considered. Diffusion models covered include Fick¿s law, Stefan Maxwell and Knudsen. Electrochemical reaction kinetics and mechanism are covered including rate-limiting steps, exchange current density and the fundamental definition of overpotential. The course will include individual projects. J. Pharoah
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 838 Civil Aviation & Environment Units: 3.00**
**Offering Faculty:** Smith Engineering

**MECH 839 Introduction to Turbulence Units: 3.00**
This course is an introduction to the study of turbulence, covering its mathematical description, its physical features and the modelling of turbulent flows. The course is suitable for MASc and PhD students with a background in advanced fluid dynamics and numerical methods. Three term-hours; lectures. Taught in alternate years. PREREQUISITE: Permission of the instructor.
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 840 Selected Topics in Thermal Fluid Systems Units: 3.00**
This course is limited to Master¿s students who already have a good background in the fundamental topics related to their areas of study and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of heat transfer, fluid mechanics and thermodynamics. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering
Exclusions: MECH-842*, MECH-843*, MECH-844*
**Offering Faculty:** Smith Engineering

**MECH 841 Net-Zero Energy Buildings and Communities Units: 3.00**
An introduction to what is meant by net-zero energy building or community, to how the net-zero energy state can be achieved, and to the considerations that need to be taken into account in planning and designing a net-zero energy building or community is provided. Building envelopes, building integrated photo-voltaic systems, bore-hole energy systems, day-lighting, ventilation, solar air-conditioning, energy storage, and social and economic factors are considered. Three term hours; lectures.
**Offering Faculty:** Smith Engineering

**MECH 842 Topics in Manufacturing and Design Units: 3.00**
This course is limited to Master's students who already have a good background in the fundamental topics related to their areas of study and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of dynamics, manufacturing and design. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering
Exclusions: MECH-840*, MECH-843*, MECH-844*
**Offering Faculty:** Smith Engineering

**MECH 843 Selected Topics in Biomechanical Engineering Units: 3.00**
This course is limited to Master's students who already have a good background in the fundamental topics related to their areas of study and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of biomechanical engineering. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering
Exclusions: MECH-840*, MECH-842*, MECH-844*
**Offering Faculty:** Smith Engineering

**MECH 844 Selected Topics in Materials Engineering Units: 3.00**
This course is limited to Master's students who already have a good background in the fundamental topics related to their areas of study and are interested in other areas not offered in existing graduate courses. Topics will be related to the structure, properties, processing and/or performance of materials. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering
Exclusions: MECH-840*, MECH-842*, MECH-843*
**Offering Faculty:** Smith Engineering

**MECH 846 Fluid Systems Analysis Units: 3.00**
This course provides an introduction to analysis of fluid flows at the masters level. Derivation of the transport equations is completed for arbitrary control volumes in both vector and tensor forms. Inviscid flows are explored to illustrate the separate effects of inertial and viscous forces, including development of Joukowski airfoil models. Exact and approximate solutions are developed for steady and unsteady laminar flows. Boundary Layer solutions are developed by differential and integral analysis. The similarity of transport equations for thermal energy and concentration are illustrated. On completion of the course, students will be well prepared for specialized courses in convective heat transfer, turbulence, and computational fluid mechanics.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 847 Energy & Society Units: 3.00**
This course is a discussion course focused on fundamental ideas in energy and the social context of energy. It will feature an introduction to Energy Systems and fundamental thermodynamic tools to analyze these systems. Of particular emphasis will be the social context of energy: how societies emerge, organize and thrive or fail according to their energy supply. Factors which contribute to societal responses to changing contexts will also be discussed. In class participation is an essential element of this course.
PREREQUISITE: Permission of the instructor
**Offering Faculty:** Smith Engineering

**MECH 848 Measurement Systems I Units: 3.00**
This course focusses on practical measurement systems for Masters student's in mechanical engineering. On completing this course students will be able to: Select, install, test, and program a micro controller system for data acquisition and control; Select, analyze the performance of, and apply transducers for temperature; pressure; stress, strain and force; position, velocity and acceleration; Apply basic signal conditioning in analog and digital domains; Analyze data to draw conclusions from measurements and uncertainty analysis. Conceive, Design, Implement and Operate a complete measurement system as part of a course project. The course will require a small equipment expenditure (< $100 / student) for components that will be reusable in subsequent years.
**Offering Faculty:** Smith Engineering

**MECH 851 Materials Characterization Units: 3.00**
This course covers the theory and practice of materials characterization by X-ray and electron microscopy techniques. Theory includes interaction of materials with X-rays and electrons, diffraction and image formation. The following topics are discussed and illustrated by laboratory investigations: determination of crystal structure, microchemical analysis, characterization of lattice defects, determination of texture and measurement of residual stresses. Three term-hours, lecture and laboratory; R. Holt.
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 852 Mechatronics for Automation Units: 3.00**
This course covers the tools and techniques needed to design and control assembly automation machines and their machine vision-based inspection systems. The issues that arise when interfacing different components to form complex mechatronic systems are studied. Course content will be reinforced with an individual project and group laboratories.
**Offering Faculty:** Smith Engineering

**MECH 853 From Science-Fiction to Science-Fact through Robotics Engineering Research and Design Units: 3.00**
Drawing from current examples of new technology and real ongoing or past research (i.e. official literature), students will seek to contextualize specific examples of fiction in terms of feasibility and fact. Through lectures and labs, this course will provide an overview of the following topics related to engineering and robotics: soft robotics actuator and system design, origami-inspired robotics, novel fabrication techniques (layer assembly), modular robotic systems, smart material actuators (Electrostatic/HASEL-type and Shape Memory Alloy), and embedded electronic circuits and controllers. Students will work in small groups on a final hands-on project to develop a working prototype mechatronic or robotic system inspired by their choice of ¿fiction¿. Permission of the Instructor required. (3.0 credit units).
**Offering Faculty:** Smith Engineering

**MECH 855 Bio-inspired Robot Locomotion Units: 3.00**
This course covers the design and fabrication of robots with a focus on bio-inspiration and locomotion. Students will be introduced to bio-inspired robotics, biological movement, prototyping and fabrication techniques, and mechatronics. Learning will take place with a combination of lectures, hands-on labs, and peer presentations. Course deliverables include quizzes, a paper presentation, lab reports, and a final project. (3.0 credit units.)
PREREQUISITE: Permission of instructor required.
**Offering Faculty:** Smith Engineering

**MECH 857 Robotics Units: 3.00**
This course will cover kinematics of serial and parallel architecture robots; as well as the geometric, kinematic, static and dynamic criteria required for designing robot manipulators. The course will also include projects on advanced robotics topics and will conclude with the presentation of these projects, at least two presentations per student. Three term-hours, lectures and seminars. L. Notash.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 858 System Dynamics and Control Units: 3.00**
The course will include ¿a review of important key topics from undergrad plus the introduction of advanced topics at the graduate level¿. The topics include Laplace Transformation; Vibration and Time Response; Linear Graph Representation of Mechanical Systems; Matrix Algebra; State Space Representation; Transfer Functions and System Response; Controllability, Observability, Stability and Pole Placement.
**Offering Faculty:** Smith Engineering

**MECH 861 Principles Of Metal Forming Units: 3.00**
This course examines experimental, analytical and numerical methods employed for evaluating and predicting forming limits in a variety of industrial metal forming operations. The concept of a forming limit diagram (FLD) is introduced and related to classical theories for plastic instability and failure. Constitutive equations of elastic-plastic flow are derived using a continuum mechanics approach, with additional discussion regarding issues of plastic anisotropy, damage accumulation, localization and material length scales. Three term-hours. K. Pilkey.
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 863 Materials Selection in Design Units: 3.00**
This course presents the concept of materials selection as an integral part of the mechanical engineering design process. Materials selection addresses a number of issues: the choice of material; the method of part manufacture; potential modes/mechanisms of failure; as well as the tailoring of material microstructure to obtain optimal properties and in-service performance. Background topics will include mechanical engineering design, solid mechanics, engineering component design, and materials science and engineering. Material selection methodologies will range from conventional, holistic approaches to the deterministic method of Ashby. Course content will be reinforced through case studies that consider a variety of material classes.
**Offering Faculty:** School of Graduate Studies

**MECH 864 Engineering Analysis Units: 3.00**
Methods for formulating mathematical models for engineering problems; examples drawn from dynamics, elasticity, fluid mechanics, heat transfer, and electro-mechanics; lumped-parameter and continuum models; variational techniques; boundary conditions and their effects on the character of the model; techniques for obtaining approximate solutions; methods for casting models into forms appropriate for solution on digital computers. Three term-hours, lectures. R.J. Anderson.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 866 Advanced Phase Transformations Units: 3.00**
This course focuses on the practical aspects and the relevant fundamentals of phase transformations in advanced manufacturing of metal alloys. The course offers a deep theoretical insight into solidification and solid-state diffusional transformations, along with an effective utilization of relevant analytical models to explore/explain the effect of material and processing variables on the evolution (i.e., types and kinetics) of phase transformations.
**Offering Faculty:** Smith Engineering

**MECH 868 Introduction to Computational Materials Science Units: 3.00**
This course focuses in atom-scale modelling of materials using computational methods. Covered topics include electronic density functional theory, molecular dynamics, Metropolis Monte Carlo, and transition state theory. The course will cover fundamental theoretical aspects and hands-on application of the methods. It will include a short, open-ended, end-of-semester simulation project.
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 878 Dislocation Theory Units: 3.00**
This course attempts to cover the basic derivations from elasticity theory, the properties of dislocations in crystalline materials, and their role in inelastic material behaviour. This introduction should enable one to comprehend, examine, and criticize current literature on the mechanical behaviour of materials. Topics include: a brief introduction to applied elasticity theory; elastic stress fields of dislocations and their interactions with external ones; the role of a particular crystal structure on the properties and motion of dislocations. The use of dislocation mechanics in the theories of creep, fracture, and yield points will be discussed along with other topics as time permits. Three term-hours. B. J. Diak.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 883 Advanced Nuclear Materials Units: 3.00**
A nuclear reactor presents a unique environment in which materials must perform. In addition to the high temperatures, stresses and corrosive environments to which materials are subjected in conventional applications, nuclear materials are subjected to various kinds of radiation that affect their deformation, corrosion, aging and failure. This course considers materials typically used in nuclear environments and those proposed for next generation reactors, the unusual conditions to which these materials are subjected, the physical phenomena that affect their performance and the resulting design criteria for reactor components. Approaches to modelling nuclear materials, and the use of ion irradiation as a surrogate for neutron irradiation is discussed. This course builds on the material covered in MECH-483 Nuclear Materials. Three term-hours, lectures.
PREREQUISITE: MECH 483
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 884 Topics In Materials Engr. Units: 3.00**
A timely topic of interest to materials engineers will be presented. The topics will vary from year to year. Three term-hours, lectures. A.K. Pilkey, Visiting Lecturers
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 891 Design Of Biomechanical Device Units: 3.00**
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 892 Industry-Linked Project (Part 1) Units: 3.00**
Students work on individual one-term research or development projects. Each project is defined by the academic project supervisor. The project is linked to a supporting company partner. Course evaluation is based on a final written report (typically 30-40 pages) and an end of term seminar presentation. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. Exclusions: MECH-898 - Project, CMAS-898 ¿ Project
**Requirements:** Anti Requisits for MECH 892
**Offering Faculty:** Smith Engineering

**MECH 893 Industry-Linked Project (Part 2) Units: 3.00**
Students work on individual one-term research or development projects that are the natural progression of projects started in MECH-892*. The project is linked to a supporting company partner. Course evaluation is based on a final written report (typically 50-60 pages) and an end of term seminar presentation. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. Exclusions: MECH-898 - Project, CMAS-898 ¿ Project. Prerequisites: MECH 892 ¿ Industry-Linked Project (Part 1)
**Requirements:** Anti Requisite for MECH 893
**Offering Faculty:** Smith Engineering

**MECH 894 Intership Units: 3.00**
Students work on a one-term (typically summer) internship at a sponsoring company site. The internship involves the student continuing with the same project work started in MECH-892 and continued throughout MECH-893*. The work will typically be conducted exclusively at the supporting partner company site. Course evaluation is based on a final written report (typically 40-50 pages) and an end of term project seminar presentation. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. Prerequisites: MECH-893* ¿ Industry-Linked Project (Part 2)
**Requirements:** Prerequisite for MECH 894
**Offering Faculty:** Smith Engineering

**MECH 895 Industrial Internship for M.Eng. Units: 3.00**
The industrial internship involves spending 4 months in a paid industrial internship position in industry, or government. Successful completion of the course requires submission of a report on the industrial project to be submitted on the last day of the internship. Each project must be approved by the academic supervisor. Career Services manages the non-academic aspects of the course. This course is open only to Materials and Mechanical Engineering (MME) M.Eng. students. Permission of MME M.Eng. Coordinator is required for registration. This course is graded on a Pass/Fail basis. Exclusions: MECH-892,* MECH-893*, MECH-894*
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 896 Professional Development for MEng Students Units: 3.00**
This course is designed to develop professional skills that expand on a student's existing technical and non- technical skills, as relevant to a future career in engineering. The topics covered will encompass aspects of project management; leadership and crisis management; written and oral communication; engineering integrity and ethics; and social responsibility. A key feature of the course will be the use of a simulation game in project management for both instruction and assessment. This course is open only to MEng students. PREREQUISITE: Permission of the instructor.
**Offering Faculty:** Smith Engineering

**MECH 897 Graduate Seminar Units: 3.00**
Each research full-time graduate student is required to regularly attend the graduate seminar program and to give at least one seminar during their program at Queen's. M.Sc./M.Sc.(Eng.) students are required to take MECH-897 and Ph.D. students are required to take MECH-997. The content of the seminar is to be developed in cooperation with the student's supervisor. The seminar will be evaluated by assigned faculty and a pass/referred decision will be recorded. The student must obtain a pass grade to clear this course requirement. The evaluation process for the seminar is defined in the departmental procedures. This course carries no course credit but is a degree requirement in the Department of Mechanical and Materials Engineering.
**Offering Term:** FWS
**Offering Faculty:** Smith Engineering

**MECH 898 Master's Project (Non-Res.) Units: 3.00**
weight= 0.50.
**Offering Term:** FW
**Offering Faculty:** Smith Engineering

**MECH 899 Master' Thesis Research Units: 6.00**
**Offering Term:** FWS
**Offering Faculty:** Smith Engineering

**MECH 924 Finite Element Analysis Units: 3.00**
This course presents the formulation and use of finite element models for the analysis of a broad range of non-linear solid materials (plastics, metals, elastomers) subject to large deformations. Basic concepts from continuum mechanics (suffix notation, large strain theory, constitutive relations) are covered in order to provide a basis for the formulation of these models and for the interpretation of results. Testing procedures for the determination of non-linear material properties, required for model input, are also covered. Example analyses are conducted with commercial non-linear finite element code. Three term-hours; lectures. I. Y. Kim.
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 932 Adv Top. In Convect Heat Trans Units: 3.00**
This course is, basically, a continuation of MECH-931* but may be taken by any student who has had adequate preparation. Among the main topics considered are: Analysis of laminar and turbulent free convective flows; local similarity methods in heat transfer; heat transfer with film condensation; prediction of turbulent Prandtl numbers; mixed (or combined) convection; combined heat and mass transfer; heat transfer in compressible flows. Three term hours, lectures. P.H. Oosthuizen
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 934 Comp. Fluid Dyns. II Units: 3.00**
The objective of this course is to teach students to understand the potential and limitations of Computational Fluid Dynamics (CFD), develop advanced solution methods for fluid-dynamics problems, and run commercial software in a critical manner. The course begins by presenting various forms of numerical approximations of the governing equations. An in-depth analysis of iterative methods to solve linear systems will follow. Numerical methods for the solution of the Navier-Stokes equations will be presented, with emphasis on numerical stability and on conservation properties. Three term-hours lectures.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 935 Turbulence Simulations Units: 3.00**
The objective of this course is to analyze numerical techniques for the simulation of turbulent flows. Emphasis will be placed on the understanding of the role of modeling and numerical errors, and on the development of "best practices" to validate and establish confidence in the numerical results. The course begins with a review of the governing equations for turbulent flows, of the role of turbulent eddies, and of the statistical quantities used to characterize turbulent flows. The important features of numerical methods will then be examined.An extensive review of the potential, requirements, achievements and limitations of direct simulation, large-eddy simulation and solution of the Reynolds-Averaged Navier-Stokes equations will form the core of the course. Time permitting, additional topics such as Lagrangian particle tracking, or applications to compressible flows will be covered. U. Piomelli.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 936 Radiative Heat Transfer Units: 3.00**
This course covers the following topics related to heat transfer by thermal radiation: fundamentals of thermal radiation, blackbody thermal radiation, radiative properties of real materials, surface to surface exchange of diffuse radiation, numerical solution of diffuse radiation problems, non-diffuse and specular radiation from surfaces, spectral radiation, radiation with conduction and convection, radiation in absorbing, emitting and scattering media, gas volume radiation, surface-volume radiation, selected applications. Three term hours, lectures. A.M. Birk.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 940 Selected Topics in Thermal-Fluids Engineering Units: 3.00**
This course is limited to those PhD students who already have a good background in the fundamental and advanced topics related to their research and are interested in other areas not offered in existing graduate courses. Topics can be selected from the general areas of heat transfer, fluid mechanics and thermodynamics. The course will include lectures, open discussion and directed study. The course content for a student or group must specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. EXCLUSIONS: MECH-942*, MECH-943*, MECH-944*
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 941 Turbulent Flow- Theory Units: 3.00**
Introduction; Reynolds averaging; turbulent transport equations; turbulence modelling; statistics and dynamics of turbulence; turbulent diffusion; structure of turbulent flows; numerical and experimental methods. Three term-hours; lectures. A. Pollard.
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 942 Selected Topics in Dynamics, Manufacturing and Design Units: 3.00**
This course is limited to PhD students who already have a good background in the fundamental and advanced topics related to their research and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of dynamics, manufacturing and design. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. EXCLUSIONS: MECH-940*, MECH-943*, MECH-944*
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 943 Selected Topics in Biomechanical Engineering Units: 3.00**
This course is limited to PhD students who already have a good background in the fundamental and advanced topics related to their research and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of biomechanical engineering. The course will include lectures, open discussions and directed study. The course content for a student or group must specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. EXCLUSIONS: MECH-940*, MECH-942*, MECH-944*
**Offering Term:** W
**Offering Faculty:** Smith Engineering

**MECH 944 Selected Topics in Materials Engineering Units: 3.00**
This course is limited to PhD students who already have a good background in the fundamental and advanced topics related to their research and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of materials engineering. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. EXCLUSIONS: MECH-940*, MECH-942*, MECH-943*
**Offering Faculty:** Smith Engineering

**MECH 956 Nonlinear Control Systems Units: 6.00**
**Offering Term:** F
**Offering Faculty:** Smith Engineering

**MECH 997 Graduate Seminar Units: 0.00**
**Offering Term:** FWS
**Offering Faculty:** Smith Engineering

**MECH 999 Ph.D. Thesis Research Units: 6.00**
**Offering Term:** FWS
**Offering Faculty:** Smith Engineering