

MECHANICAL ENGINEERING

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The second year curriculum is common to all sub-plans, but prior to or during the second year, students select from the following options (sub-plans) for their third year: General (ME1) allows students to select technical electives from a variety of specialized areas of study; Materials (ME2) includes courses in materials and metallurgical engineering; or Biomechanical (ME3) includes courses in the biomechanical field. Note that with the wide variety of courses offered, the Department cannot guarantee all courses are conflict free or offered each calendar year, particularly for students who choose to transfer or change options in their third or fourth year. Transferring programs could also result in extending the length of the program beyond the typical 4 years.

Students are encouraged to participate in one of the international design competition teams such as the Baja SAE Team, Formula SAE Team, SAE Aero Design Team, Rocket Engineering Team.

Options available:

- General Option (ME1)
- Materials Option (ME2)
- Biomechanical Option (ME3)

Programs

- Mechanical Engineering, B.A.Sc. (Class of 2026) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mechanical-engineering/mechanical-materials-engineering-basc-class-2026/>)
- Mechanical Engineering, B.A.Sc. (Class of 2027) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mechanical-engineering/mechanical-materials-engineering-basc-class-2027/>)
- Mechanical Engineering, B.A.Sc. (Class of 2028) (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mechanical-engineering/mechanical-materials-engineering-basc-class-2028/>)
- Mechanical Engineering: Technical Electives (<https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mechanical-engineering/mechanical-materials-engineering-technical-electives/>)

[sciences/academic-plans/mechanical-engineering/mechanical-materials-engineering-technical-electives/](#))

Courses

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

Course Learning Outcomes:

1. Apply vector calculus operators.
2. Perform numerical integration of sample functions and discuss the errors.
3. Solve first-order ordinary differential equations analytically.
4. Solve higher-order ordinary differential equations analytically.
5. Solve ordinary differential equations numerically, coding in Python.

**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

Course Learning Outcomes:

1. Solve systems of linear equation analytically and numerically with Python.
2. Explain random processes, including Gaussian, Poisson and binomial.
3. Analyze random processes, including Gaussian, Poisson and binomial.
4. Apply various interpolation and fitting methods using Python and discuss numerical errors.
5. Explain local optimization algorithms.
6. Apply local optimization methods, coding in Python.
7. Perform a one-independent-variable hypothesis test.

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

Course Learning Outcomes:

1. Apply low frequency and steady state analysis techniques to circuit networks.
2. Construct and test practical mechatronic circuits.
3. Select and test electric motors and drivers.
4. Program and troubleshoot microcontrollers to measure and control mechatronic systems.
5. Recommend designs for electrically powered systems in different supply environments (off-grid/on-grid).

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

Course Learning Outcomes:

1. Identify and explain the process configurations in Machining (turning, milling & drilling), Metal Forming (forging, rolling, extrusion, bending, deep drawing & shearing), Welding (fusion & solid-state welding), Casting (mold & continuous casting) and Additive Manufacturing (3D printing & laser powder deposition).
2. Explain and apply terminologies for dimensional tolerances and surface roughness in laboratory measurements and technical drawings.
3. Describe the kinematics of cutting operations, explain the mechanisms of chip formation and calculate the material removal rate in various machining operations such as turning, milling and drilling.
4. Explain fundamental aspects of stress-strain relationship in metal forming, mechanical testing, yield criteria for various engineering materials.
5. Calculate force and power requirements in metal forming operations, including: forging, extrusion, rolling, bending & shearing.
6. Identify the solidification phenomenon and development of macro- and microstructure in casting, welding and additive manufacturing.
7. Explain the effect of fluid flow and viscosity in casting and calculate the required heat input in relation to process variables in welding operations.

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

Course Learning Outcomes:

1. Identify and explain the process configurations in Machining (turning, milling and drilling), Metal Forming (bending, deep drawing and shearing), Welding (fusion and solid-state welding), and Additive Manufacturing (3D printing and laser powder deposition).
2. Explain and apply terminologies for dimensional tolerances and surface roughness in laboratory measurements and technical drawings.

**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 2025-2026

(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

Course Learning Outcomes:

1. CLOs coming soon; please refer to your course syllabus in the meantime.

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

Course Learning Outcomes:

1. Install and test a micro controller system for data acquisition and control.
2. Acquire and process digital and analog data.
3. Select and Apply transducers for temperature; pressure; stress, strain and force; position, velocity and acceleration.
4. Discuss the limitations of data employed, key findings, trends evident, uncertainty and error.
5. Formulate conclusions supported by data and comparison of results to appropriate models.
6. Estimate uncertainty for single measurements and derived quantities.
7. Model and predict time response of measurement systems.

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

Course Learning Outcomes:

1. Draw a free-body diagram with unknown external and/or internal forces, bending moments and/or torques and apply equations of equilibrium to solve for unknown external and/or internal forces, moments and/or torques.
2. Determine the shear force equations (diagrams) for a beam.
3. Determine the bending moment equations (diagrams) for a beam.
4. Calculate the 2D stress state (normal and/or shear components) at a given point from a combination of applied normal forces, shear forces, moments and/or torques.
5. Calculate the 2D strain state (normal and/or shear components) from a known amount of deformation.
6. Determine the torsional shear stress and angle of twist at a given location in a shaft with circular cross-section subject to applied torques.
7. Calculate the first and/or second moments of area for a complex cross-section.
8. Determine the slope and deflection equations for a beam.
9. Determine the state of stress at a point at any orientation relative to a given or pre-determined state of stress using the general equations for stress transformation.
10. Determine the state of stress at a point at any orientation relative to a given or pre-determined state of stress using a Mohr's circle.

**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 172

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

Course Learning Outcomes:

1. Write a mathematical expression that describes the rectilinear motion of a particle in 2D and 3D.
2. Draw a free body diagram of a mechanical system.
3. Write the equations of motion for a particle or system of particles using Newton's Laws of Motion.
4. Write a mathematical expression that describes the curvilinear motion of a particle in 2D and 3D.
5. Identify whether a dynamics problem is better solved with impulse-momentum or work-energy.
6. Write a computer program to visualize and evaluate the behavior of a dynamical system.
7. State assumptions and simplifications when modeling a physical system. Discuss and evaluate when the assumptions and simplifications are appropriate.

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 172

Corequisites: Exclusions: MECH 228

Offering Term: SF

CEAB Units:

Mathematics 0

Natural Sciences 11

Complementary Studies 0

Engineering Science 31

Engineering Design 0

Offering Faculty: Smith Engineering

Course Learning Outcomes:

1. Write a mathematical expression that describes the rectilinear motion of a particle in 2D and 3D.
2. Draw a free body diagram of a mechanical system.
3. Write the equations of motion for a particle or system of particles using Newton's Laws of Motion.
4. Write a mathematical expression that describes the curvilinear motion of a particle in 2D and 3D.
5. Identify whether a dynamics problem is better solved with impulse-momentum or work-energy.
6. Write a computer program to visualize and evaluate the behavior of a dynamical system.
7. State assumptions and simplifications when modeling a physical system. Discuss and evaluate when the assumptions and simplifications are appropriate.

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)

Requirements: Prerequisites: APSC 132 Corequisites:

Exclusions: MREN 230

Offering Term: F

CEAB Units:

Mathematics 0

Natural Sciences 30

Complementary Studies 0

Engineering Science 12

Engineering Design 0

Offering Faculty: Smith Engineering

Course Learning Outcomes:

1. Calculate gas properties based on real and ideal gas models.
2. Calculate two phase mixture properties using thermodynamic tables.
3. Perform an energy balance analysis on a thermodynamic system, e.g., piston/cylinder, boiler, heat exchanger.
4. Perform entropy balance and calculate turbine and compressor efficiencies knowing inlet and outlet conditions.
5. Calculate pressure or temperature changes in a closed system subject to an isentropic compression or expansion process.
6. Calculate the maximum efficiency of different thermodynamic power cycles (Rankine, Brayton, Diesel, Otto).

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: MREN 241

Offering Term: W

CEAB Units:

Mathematics 0

Natural Sciences 24

Complementary Studies 0

Engineering Science 18

Engineering Design 0

Offering Faculty: Smith Engineering

Course Learning Outcomes:

1. Solve scaling problems using dimensionless groups.
2. Explain control volume (CV) and control mass analysis with reference to Eulerian and Lagrangian frames, applied forces and flows.
3. Solve simple flow systems for velocity distributions using continuity and Navier Stokes (NS) equations with appropriate boundary conditions.
4. Calculate pressures and forces on submerged surfaces in a static fluid.
5. Solve flow and force problems in an integral framework using Bernoulli, conservation of mass and momentum.
6. Explain Bernoulli-based energy equations with reference to energy and hydraulic grade lines, static and dynamic pressure.
7. Solve piping system performance problems using Bernoulli with friction, minor losses, pump and turbine performance curves.

**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)

Requirements: Prerequisites: APSC 131 Corequisites:

Exclusions:

Offering Term: F

CEAB Units:

Mathematics 0

Natural Sciences 11

Complementary Studies 0

Engineering Science 31

Engineering Design 0

Offering Faculty: Smith Engineering

Course Learning Outcomes:

1. Explain and apply the basic mechanisms of (room temperature) elastic and plastic deformation in metals, polymers and ceramics.
2. Use phase diagrams to calculate the phases and their quantities present for a given set of conditions, and estimate the microstructures that would be found.
3. Explain how diffusion occurs in a solid, and calculate solute diffusion profiles under both steady state and non-steady state (1 dimensional bar) situations.
4. Explain the shape of a time-temperature-transformation diagram, resulting from the competition between nucleation and growth.
5. Describe and calculate the effects of the four principal mechanisms of hardening in a metal.
6. Explain the effect of changes in temperature on plasticity in metals and polymers; explain the effects of a damaging chemical environment on metals and polymers.
7. Define crystallographic planes and directions in cubic and hexagonal symmetry materials, and determine which slip system would activate in a loaded single crystal.

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(Lec: No, Lab: Yes, Tut: No)

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

Course Learning Outcomes:

1. Demonstrate proper laboratory safety practices and show confidence working in a hands on environment.
2. Perform mechanical testing of various materials and explain the differences in the mechanical properties with reference to the material's properties.
3. Process a material with various techniques, such as heat treatments and cold rolling, and explain the changes in the material's properties using materials science fundamentals.
4. Compare experimental results to theoretical models, explaining any discrepancies by referencing the limitations of the experimental method or theory.

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

Course Learning Outcomes:

1. Apply spectral analysis of signals to engineering problems.
2. Apply Laplace transforms to analyze engineering systems such as circuits and control systems.
3. Apply multivariate regression and variance analysis to data.
4. Apply machine learning methods for multi-variate regression or classification.

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

Course Learning Outcomes:

1. Select and test actuators, electric motors and drivers.
2. Program and troubleshoot microcontrollers to control mechatronic systems.
3. Explain design considerations for electrically powered systems in different supply environments: photovoltaics / on-grid / off-grid / mobile systems.
4. Apply frequency response analysis to machine health monitoring.
5. Construct and test practical mechatronic circuits.

**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

Course Learning Outcomes:

1. 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

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

Course Learning Outcomes:

1. Learn and gain practical experience of the mechanical design process to solve real-world problems while adhering to mandated standards.
2. Develop practical experience in project and product lifecycle management.
3. Develop an understanding of machine design theories and their applications.
4. Effectively communicate and present design ideas.
5. Understanding the risks involved in design failures and implementing proper risk mitigation techniques.

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 MECH 229 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

Course Learning Outcomes:

1. Apply derivatives of vectors, constraints, ground fixed coordinates, rotating coordinates, relative and absolute motion, Coriolis acceleration, to analyze the kinematics of rigid bodies in a plane.
2. Apply free body diagrams, force balances, moment balance, moments of inertia, principles of work and energy, impulse and momentum to analyze the kinetics of rigid bodies in a plane.
3. Apply 3D kinematic analysis, 3D force balances, the inertia tensor, angular momentum vectors, 3D moment balance, gyroscopic effects to determine the three dimensional dynamics of rigid bodies.
4. Apply concepts of free vibrations, forced vibrations, damping, and energy methods to model vibration and determine time response for one degree of freedom systems.
5. Design a mechanism to meet specified 2D kinematics and dynamics requirements.

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

Course Learning Outcomes:

1. Calculate energy efficiency changes using re-heating, regeneration, use of open and closed feedwater heaters, and deaerators in vapour power systems (Vapour power).
2. Calculate energy efficiency changes associated with regenerative heating through use of heat exchangers, reheat and intercooling in gas power systems or Brayton Cycles (Gas power).
3. Use exergy analysis to calculate energy availability and effectiveness (Exergy).
4. Calculate the coefficients of performances of vapour compression and Brayton refrigeration cycles that use different working fluids with multistage compression and intercooling in refrigeration and heat pump systems (Refrigeration).
5. Calculate thermodynamic properties of ideal gas mixtures, including gases that contain water vapour and apply the Psychrometric chart (Psychrometrics).
6. Calculate the energy release from combustible mixtures, including the lower and higher heating values (Combustion).



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.

NOT OFFERED 2025-2026

(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

Course Learning Outcomes:

1. Explain selected issues on gender, engineering and technology.
2. Synthesize professional/scholarly readings and summarize them.
3. Formulate their ideas on sometimes challenging topics and discuss them in a professional way.
4. Research a topic and critically analyze the gathered information.
5. Compose synthetic documents of the researched topic.
6. Present to a group using state of the art tools.

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, potential and compressible flows.

(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

Course Learning Outcomes:

1. Understand the physical mechanisms responsible for aerodynamic forces.
2. Apply control volume analysis to mass, momentum and energy conservation (CV for Mass, Momentum, Energy).
3. 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 (Boundary Layers).
4. Apply differential form of mass and momentum conservation to the concept of flow field and its properties, including Navier Stokes equations (Apply NS).
5. 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 (Potential Flow).
6. Explain compressible flow features based on one-dimensional compressible subsonic and supersonic flows, with and without normal shock waves (Compressible Flow).
7. Calculate design parameters of rotational fluid machinery, including centrifugal pumps and wind turbines (Pumps and Turbines).

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 tutorials. By the end of the course, students will be able to solve steady and transient conduction problems, evaluate heat transfer under natural and forced convection conditions, and calculate radiation exchange rates.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MECH 230 or MREN 230 or ENPH 372 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

Course Learning Outcomes:

1. Analyze engineering problems involving the three basic modes of heat transfer, i.e. Conduction, convection, and radiation.
2. Solve problems for 1-D heat transfer processes for plane and cylindrical systems, including the enhancement of surface heat transfer by the addition of fins, using the thermal resistance method.
3. Solve both steady-state and transient heat conduction problems by analytical and numerical techniques.
4. Solve problems involving forced or natural (free) convection for a variety of typical geometries including flow over (or through) pipes and cylinders.
5. Calculate radiation emission from black-and grey-body surfaces and determine radiation heat transfer rates between discrete surfaces and in enclosures.

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

Course Learning Outcomes:

1. Simplify a block diagram to obtain the overall transfer function.
2. Create a system diagram and derive transfer function from a set of dynamic equations.
3. Determine system response of a 1st or 2nd order system.
4. Sketch Root locus and use it to determine system stability and type of system response (under-damped, or over damped).
5. Calculate steady-state error for different type of systems.
6. Determine transfer function from a given Bode plot and calculate the frequency response.
7. Identify differences between control laws for open-loop and closed-loop control.



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 2025-2026

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

Course Learning Outcomes:

1. Compose technical writing to concisely report design, fabrication and testing results.
2. Manage a design/manufacturing process.
3. Design a part which will be manufactured.
4. Test the manufactured part.

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

Course Learning Outcomes:

1. Use generalized equilibrium thermodynamics to describe materials and other natural phenomenon.
2. Understand the relationships between structure and processing.
3. Identify and describe microstructure characteristics: cubic crystallography, phase boundaries, grain boundary types.
4. Design experiments to capture kinetic information to predict rate processes in materials processes.
5. Identify boundary conditions and solve diffusion problems.
6. Read and use binary phase diagrams and TTT curves to plan heat treatments.
7. Critically read and write clearly about new scientific literature and patents regarding materials processing.

MECH 371 Deformation and Fracture Failure of Engineering Materials Units: 3.50

Deformation and Fracture Mechanics play pivotal roles in advancing technology across engineering disciplines, with particular significance in aerospace and automotive engineering. This comprehensive course focuses on the fundamentals of crack initiation and propagation within engineering materials, such as metals, polymers, ceramics, and composites. After introducing linear elastic fracture mechanics, the course examines the energy criterion of fracture through the analysis of strain energy release rate (GIC) and the development of the critical stress intensity factor (KIC). Emphasis is placed on establishing the correlation between microstructure control and resistance to crack propagation. It

includes a detailed study of processes including brittle and ductile fracture, addressing time-dependent static fatigue and its implications on material integrity, along with an exploration of creep fracture and an understanding of its stress-time characteristics. The course further explores the key principles of dislocation theories, which provide insights into material behavior under plastic deformation and fostering an understanding of materials strengthening mechanisms. Students complete a case study of a real-world engineering project that applies the practical significance of deformation and fracture mechanics learned in the course. (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

Course Learning Outcomes:

1. CLOs coming soon; please refer to your course syllabus in the meantime.

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

Course Learning Outcomes:

1. Use an iterative design approach to produce a prototype assistive technology solution.
2. Experience Interdisciplinary Interaction with Occupational Therapists and End-Users in the design of a device.
3. Apply design principles to meet end user needs.
4. Understand personal, ethical and social implications of building assistive technology.
5. Apply manufacturing techniques in prototyping a device.
6. Effectively communicate and present ideas.
7. Understanding the risks involved in design failures and implementing proper risk mitigation techniques.
8. Identify mechanical and electrical components of cardiac muscle activity.
9. Understand signal processing and Doppler with respect to medical devices.



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 MECH 229, 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

Course Learning Outcomes:

1. Explain and discuss what biomechanical engineers do in their professional activities.
2. Explain and discuss the basic components that constitute biological matter from molecular to organ scale and how their structure relates to mechanical properties and performance.
3. Explain mechanical transport fundamentals in the context of biological systems.
4. Apply kinematics and dynamics to model the time dependent motion of a human joint subject to muscular and external forces.
5. Construct mathematical and numerical models for the linear and non- linear mechanical properties of biological materials, including bone, cartilage, muscles, tendons, and ligaments.
6. Explain macro-scale measurement systems and processes for positions and forces in living systems.
7. Analyze and interpret biomechanical data through mechanical models.
8. Analyze a biomechanical device or process within realistic constraints (i.e., economic, environmental, ethical,

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

Course Learning Outcomes:

1. Use experimental apparatus specific to Mechanical Engineering.
2. Apply theoretical concepts to physical and simulated systems.
3. Apply critical thinking skills to solve in lab problems.
4. Efficiently write effective technical lab reports.
5. Work effectively and safely in teams.
6. Submit reports according to a deadline.

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

Course Learning Outcomes:

1. Use experimental apparatus specific to Mechanical and Materials Engineering.
2. Apply theoretical concepts to physical and simulated systems.
3. Apply critical thinking skills to solve in lab problems.
4. Efficiently write effective technical lab reports.
5. Work effectively and safely in teams.
6. Submit reports according to a deadline.

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

Course Learning Outcomes:

1. Use experimental apparatus specific to Mechanical Engineering.
2. Apply theoretical concepts to physical and simulated systems.
3. Apply critical thinking skills to solve in lab problems.
4. Efficiently write effective technical lab reports.
5. Work effectively and safely in teams.
6. Submit reports according to a deadline.

**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

Course Learning Outcomes:

1. Use experimental apparatus specific to Mechanical and Materials Engineering.
2. Apply theoretical concepts to physical and simulated systems.
3. Apply critical thinking skills to solve in lab problems.
4. Efficiently write effective technical lab reports.
5. Work effectively and safely in teams.
6. Submit reports according to a deadline.

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 2025-2026

(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

Course Learning Outcomes:

1. Explain Free and Forced Vibration of damped and undamped single DOF systems.
2. Calculate Amplitude and Phase change in single DOF systems.
3. Derive equations of motion for multi-DOF systems using Force/Moment Balances and Lagrange's Equation.
4. Determine natural frequencies and mode shapes in free vibration of undamped multi-DOF systems.
5. Calculate mode shapes for transverse vibration in beams.
6. Analyze vibration frequency spectra using Fast Fourier Transforms (FFT).

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

Course Learning Outcomes:

1. Recognize relevant physical laws and exercise them in engineering problems at microscale.
2. Recognize semiconductor materials properties and exercise them in micro device design and analysis.
3. Distinguish working principles of different micro devices testing techniques and implement these micro devices in various applications.
4. Appraise some concurrent microsystem technologies devices through literature review and identify some potential applications for them.
5. Identify limitations and benefits of existing micro devices and/or their fabrication technology and propose new design for improvement.

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 2025-2026

(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

Course Learning Outcomes:

1. CLOs coming soon; please refer to your course syllabus in the meantime.

**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 2025-2026

(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

Course Learning Outcomes:

1. CLOs coming soon; please refer to your course syllabus in the meantime.

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 MREN 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

Course Learning Outcomes:

1. Basic understanding of engine types, components, operation.
2. Calculate engine performance.
3. Perform engine thermodynamic cycle analysis.
4. Perform analysis of intake, exhaust and in-cylinder flow.
5. Understand basic combustion principles including heat of combustion, chemical reactions and kinetics.
6. Apply combustion principles for optimum engine performance and emissions.

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 2025-2026

(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

Course Learning Outcomes:

1. Describe the different types of fuel cells and their operating characteristics.
2. Quantify and compare energy systems with appropriate metrics (fuel consumption rate, energy density, power density ...).
3. Apply the laws of thermodynamics to fuel cells.
4. Explain fuel cell reaction kinetics, and calculate corresponding losses.
5. Calculate Ohmic losses (electronic and ionic) in fuel cell materials.
6. Solve coupled transport problems in operating fuel cells.
7. Apply integrated energy systems approach to fuel cell systems.
8. Explore the fuel cell industry.

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 2025-2026

(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

Course Learning Outcomes:

1. Ability to conduct control volume analysis using conservation of mass, linear momentum, angular momentum and energy in nozzles, diffusers, turbines and compressors.
2. Conduct dimensional analysis of pump, compressor or turbine including matching a compressor to a turbine in a gas turbine engine.
3. Conduct analysis of axial compressor or turbine.
4. Conduct analysis of centrifugal compressor or radial turbine.
5. Explain various concepts and details such as the difference between compressor and turbine blades, stage reaction, radial equilibrium, diffuser stall, compressor surge, slip in rotors, secondary losses, combustor design, blade cooling, etc.

**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 2025-2026

(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

Course Learning Outcomes:

1. CLOs coming soon; please refer to your course syllabus in the meantime.

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

Course Learning Outcomes:

1. Learn the principles of Computational Fluid Dynamics through a Finite Volume Method.
2. Learn to generate good mesh for numerical simulations.
3. Learn how to numerically simulate heat and mass transfer using OpenFOAM software.
4. Learn how to properly setup the problem and perform accurate and efficient numerical simulations.
5. Effectively apply postprocessing tools and communicate the results through written and graphical means.
6. Learn how to apply different turbulence models and connect turbulence model for different flow problem classes.
7. Develop self-learning skills in extracting information from the source code itself, from the on-line resources and by trial and error.
8. Develop practical experience in open-ended group project and its presentation.

MECH 448 Compressible Fluid Flow Units: 3.50

High-speed gas flows like those found in rockets, airplanes, turbomachinery, and gas handling equipment exhibit different physics compared to standard incompressible flows. This course establishes when compressibility must be accounted for, develops the key governing equations, and covers standard compressible flows such as shock waves, expansion waves, and converging/diverging nozzles. Advanced concepts such as rarefied gas dynamics, hypersonics, and high temperature gas dynamics are introduced. Emphasis is on the use of computational tools and the application of theory to devices such as rocket nozzles, aircraft intake systems, and shock tubes.

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MECH 341, MECH 330, 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

Course Learning Outcomes:

1. Recognize when compressibility effects are important
2. Develop models for stationary and moving shock and expansion waves, including normal and oblique waves.
3. Determine the effects of viscous stresses and heat transfer on compressible fluid flows (Fanno and Rayleigh flows).
4. Characterize compressible gas flow through variable-area ducts, including convergent/divergent (de Laval) nozzles.
5. Describe the basic characteristics of rarefied, hypersonic, and high temperature gas flows.
6. Apply theory to describe compressible gas flow in key applications such as rocket nozzles, engine intake systems, re-entry, shock tubes, and gas handling equipment.
7. Model compressible flows using modern computational tools.

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 labs that focus on electronics, microcontrollers, programmable logic controllers and mobile robots. The lectures provide the theoretical background to mechatronics, and include sensors and actuators, signal conditioning microprocessors and microcontrollers, bond graph modeling technique, system model and response, and mechatronics system design in robotics applications. The knowledge and experience gained in the lectures and tutorials is applied to a series of labs.

K5(Lec: Yes, Lab: Yes, Tut: Yes)

Requirements: Prerequisites: Permission of the instructor

Corequisites: Exclusions:

Offering Term: F

CEAB Units:

Mathematics 0

Natural Sciences 0

Complementary Studies 0

Engineering Science 30

Engineering Design 30

Offering Faculty: Smith Engineering

Course Learning Outcomes:

1. Work with a microcontroller software suite/editor and write programs to operate the microcontroller.
2. Write programs to read various sensors and/or control various actuators.
3. Calibrate performance of different sensors and identify their weaknesses and strengths.
4. Demonstrate tuning of a closed loop control algorithm with real hardware.
5. Write programs to enable a mobile robot to perform a complex task, with multiple sensors as inputs.
6. Demonstrate lifelong learning skills by finding and reviewing technical specifications of new controllers and/or sensors.
7. Write a technical report that succinctly summarizes the results of a laboratory.
8. Draw a flowchart given a program specification.
9. Debug a software program that fails to run as designed.
10. Debug a hardware circuit that fails to run as designed.
11. Work with a Programmable Logic Controller (PLC) software suite editor and write programs to operate the PLC.
12. Explain what mechatronics engineering is all about, with good and bad examples to illustrate your answer.



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 BASC program. Corequisites: Exclusions: MREN 320

Offering Term: W

CEAB Units:

Mathematics 0

Natural Sciences 0

Complementary Studies 0

Engineering Science 21

Engineering Design 21

Offering Faculty: Smith Engineering

Course Learning Outcomes:

1. Solve problems involving robot kinematic descriptions and frame transformations.
2. Solve problems describing motion of robot links.
3. Analyze digital images of manufacturing objects for purposes of identification and inspection.
4. Schedule jobs in a job-shop environment.
5. Control manufacturing cell equipment using Programmable Logic Controllers

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.

NOT OFFERED 2025-2026

(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, MREN 348

Offering Term: W

CEAB Units:

Mathematics 0

Natural Sciences 0

Complementary Studies 0

Engineering Science 21

Engineering Design 21

Offering Faculty: Smith Engineering

Course Learning Outcomes:

1. Discuss the robot selection requirements and robot components and use the pertinent terminology in modelling, analyzing and designing robot manipulators.
2. Analyze motion capabilities of mechanisms and robot manipulators.
3. Assess layouts of serial manipulators for the required motions.
4. Investigate the challenges in designing robot manipulators for a specific environment by defining the problem before proposing solutions.
5. Develop the models of serial manipulators (planar and spatial) and analyze their forward and inverse kinematics.
6. Apply the generalized inverses of linear systems of equations to overdetermined and under-determined problems, and analyze redundant and over-constrained manipulators.
7. Formulate relations between the actuators' forces/torques and manipulator payload (static and dynamic cases) and deflection (accuracy) of operation point.
8. Design/redesign or employ redundancy to eliminate or avoid singularity.
9. Use MATLAB to simulate and analyze motion and force/compliance performance of a manipulator for the required task.

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

Course Learning Outcomes:

1. Identify and explain the process configurations in various Additive Manufacturing (AM) processes.
2. Identify and explain the effect of process parameters in various AM processes.
3. Describe, analyze and design the specific function of lasers and laser optics in laser-based AM processes.
4. Analyze, design and optimize part geometry and build strategy for AM products.
5. Analyze, design and optimize process parameters/profiles for various AM processes; Calculate the required heat input in relation to process variables and material input.
6. Analyze and model heat transfer in metal AM processes.
7. Identify the solidification phenomenon and development of macro- and microstructure in metal AM processes.

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

Course Learning Outcomes:

1. Identifies problem and constraints including health and safety risks, applicable standards, economic, environmental, cultural and societal considerations.
2. Identifies key technical or scientific problems critical to achieving the design.
3. Develops detailed specifications and metrics incorporating performance requirements, constraints, assumptions, and other stated and unstated factors from all stakeholders relevant to the specific application.
4. Creates processes for solving these problems including the selection and application of suitable models and an assessment of the validity of results.
5. Uses an appropriate process to apply knowledge, ingenuity and judgement for creating and assessing design options to select an optimal design. The outcome is a feasible design.
6. Selects appropriate resources, techniques, tools and processes to realize the design.
7. Critically evaluates trade-offs among goals, criteria, functional requirements, constraints, etc., with logical well reasoned and defensible arguments (may include tools such as; Pros/Cons, WEM, QFD, etc.)
8. Identifies, critically evaluates, and incorporates relevant information regardless of format using self-determined

**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

Course Learning Outcomes:

1. Identify and formulate a focused scientific hypothesis.
2. Develop the necessary approaches to test the hypothesis.
3. Conduct simulations or experiments to test hypothesis and analyze the data.
4. Formulate succinct conclusions supported by quantitative findings.
5. Communicate findings in clear written and oral forms to the level of the audience.

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

Course Learning Outcomes:

1. Identifies problem and constraints, including health and safety risks, key technical or scientific problems, applicable standards, economic, environmental, cultural and societal considerations.
2. Develops detailed specifications and metrics incorporating performance requirements, constraints, assumptions, and other stated and unstated factors from all stakeholders relevant to the specific application.
3. Creates processes for solving these problems including the selection and application of suitable models and an assessment of the validity of results.
4. Uses an appropriate process to apply knowledge, ingenuity and judgement for creating and assessing design options to select an optimal feasible design.
5. Selects appropriate resources, techniques, tools and processes to realize the design.
6. Critically evaluates trade-offs among goals, criteria, functional requirements, constraints, etc., with logical well reasoned and defensible arguments (may include tools such as; Pros/Cons, WEM, QFD, etc.)
7. Demonstrates capacity for initiative and technical or team leadership while respecting others' roles.
8. Writes and revises documents using appropriate discipline-specific conventions.
9. Uses graphics to explain, interpret, and assess information.
10. Demonstrates accurate use of technical vocabulary.

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.

DELETED 2025-2026

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

Course Learning Outcomes:

1. CLOs coming soon; please refer to your course syllabus in the meantime.

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

Course Learning Outcomes:

1. Identifies problem and constraints including health and safety risks, applicable standards, economic, environmental, cultural and societal considerations.
2. Identifies key technical or scientific problems critical to achieving the design.
3. Develops detailed specifications and metrics incorporating performance requirements, constraints, assumptions, and other stated and unstated factors from all stakeholders relevant to the specific application.
4. Creates processes for solving these problems including the selection and application of suitable models and an assessment of the validity of results.
5. Uses an appropriate process to apply knowledge, ingenuity and judgement for creating and assessing design options to select an optimal design. The outcome is a feasible design.
6. Selects appropriate resources, techniques, tools and processes to realize the design.
7. Critically evaluates trade-offs among goals, criteria, functional requirements, constraints, etc., with logical well reasoned and defensible arguments (may include tools such as; Pros/Cons, WEM, QFD, etc.).
8. Demonstrates capacity for initiative and technical or team leadership while respecting others' roles.
9. Writes and revises documents using appropriate discipline-specific conventions and vocabulary.
10. Uses graphics to explain, interpret, and assess information.

**MECH 465 Computer Aided Design Units: 3.50**

In this course, students will learn the finite element method and design optimization. Topics in the finite element method will include fundamental principles, 1D formulation, and practical application to stress analysis. Design optimization includes the topics of mathematical problem definition, 1D search, sensitivity analysis, and integration with the finite element method. Students must have good understanding of solid mechanics.

(Lec: 3, Lab: 0.5, Tut: 0)

Requirements: Prerequisites: Permission of the instructor.

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

Course Learning Outcomes:

1. Learn the fundamental principles and practical techniques of the Finite Element Method (FEM).
2. Develop beginner to intermediate level of practical user experience with industry standard Finite Element Analysis (FEA) software packages such as ANSYS Mechanical APDL.
3. Acquire design optimization techniques and apply it to structural-related projects.
4. Effectively communicate and present design ideas.
5. Develop practical experience in project and product design management.

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.

NOT OFFERED 2025-2026

(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

Course Learning Outcomes:

1. Understand macroscopic concepts related to uniaxial stress-strain behaviour of metals, including elastic versus plastic strain, diffuse versus local necking and effective stress and strain.
2. Understand macroscopic concepts related to biaxial sheet forming behaviour, including forming limit diagrams (FLDs), diffuse versus local necking, Marciniak-Kuczinski model, anisotropy and yield functions.
3. Conduct an experiment and subsequent analysis to determine the forming limit along a uniaxial strain path for a given sheet material.
4. Derive an elastic-plastic constitutive equation using a continuum mechanics approach.
5. Explore the relationship between processing, microstructure and forming properties of new generation sheet materials designed for automotive applications, including HSLA steels, dual-phase (DP) steels, transformation-induced plasticity (TRIP) steels and 5000 series and 6000 series aluminum alloys.
6. Explore the relationship between processing, microstructure and workability during conventional forging and extrusion operations.
7. Study several examples where a continuum mechanics-based models is used to predict a specific metal forming behaviour.

MECH 472 Corrosion And Failure Analysis Units: 3.50

This course explores corrosion, and the failure of metals and alloys under both mechanical and environmental influences. Students will learn the fundamentals of corrosion science and engineering, including corrosion thermodynamics and kinetics, concepts of corrosion protection, and the fundamentals of localized corrosion. The latter includes pitting, crevice corrosion, and stress corrosion cracking. Students will learn about the mechanical failure of components including the science governing overload, fracture, fatigue, and creep. Students will be introduced to Root Cause Failure Analysis approaches. Real examples of corrosion and failure will be emphasized, including laboratory demonstrations to illustrate principles taught for several types of failures.

(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 31

Engineering Design 0

Offering Faculty: Smith Engineering

Course Learning Outcomes:

1. Explain the fundamental mechanisms of general corrosion including thermodynamics and kinetics.
2. Apply the concept of cathodic protection and passivation for corrosion inhibition of metals and alloys.
3. Explain the fundamental mechanisms of localized corrosion, including pitting, crevice corrosion, and stress corrosion cracking.
4. Describe the science of governing the general fracture and failure of metals and alloys.
5. Explain the concepts of creep failure and fatigue failure in metals and alloys.
6. Apply laboratory examples of corrosion and failure analysis to a relevant materials degradation issue.
7. Describe approaches to Root Cause Failure Analysis.

MECH 476 Engineering of Composite Materials and Polymers Units: 3.50

This course provides a strong foundation in the mechanical properties, design and fabrication of composite materials needed to understand the applicability of these in engineering design. Learners will acquire skills in designing composite fiber layouts and laminate structures for polymer-, metal- and ceramic-based composites, materials relevant to aerospace and automotive engineering. The mechanics of polymers, common matrix materials of composites, are covered in the course. The goal is to understand the time-temperature dependence of mechanical properties of composites and their polymer matrix in relation to their structure/microstructure, and linking these relations to practical design. Learners will perform computational modeling of laminates based on the knowledge acquired during the course.

NOT OFFERED 2025-2026

(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

Course Learning Outcomes:

1. Demonstrate understanding of mechanics of polymeric and composite structures.
2. Demonstrate understanding of the origin of the limitations in real polymeric and composite structures.
3. Describe the role of environment on polymer or composite materials mechanics.
4. Demonstrate basic understanding of designing structures for stiffness or strength, and selecting appropriate materials to meet this criterion.
5. Critically read science and engineering literature on polymers and/or composites, and apply this information to solve materials engineering mechanics problems, and implement into a component or system design.
6. Communicate about the engineering of polymers and/or composites at a knowledgeable level in both written and oral forms, individually and as a group.

**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.

NOT OFFERED 2025-2026

(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

Course Learning Outcomes:

1. Describe the major classes of modern biomaterials, emphasizing their physical and chemical properties.
2. Explain basic human anatomy, histology, cells and genes in the context of the design requirements for biomaterials.
3. Understand the common interactions of biomaterials with biological tissues.
4. Differentiate the various analytical methods based on their use to characterize physical, chemical and biological properties of biomaterials.
5. Understand the various applications of biomaterials.
6. Critically assess and report on the current developments in biomaterials research.

MECH 479 Nanomaterials Science and Engineering Units: 3.50

This course covers state-of-the-art developments pertaining to nanostructured materials (NSMs) and their applications. Students will learn about innovation in this space from the lens of the materials science paradigm-i.e., structure-properties-processing-performance relationships. NSMs topics covered include advanced characterization tools and computer simulations, chemical and solid-state processing routes, mechanical properties, physico-chemical properties, and economic, policy, health and environmental considerations. NSMs covered include metals and alloys, ceramics, semi-conductors, colloids and carbon-based NSMs. Students will complete critical reading exercises covering the current peer-reviewed literature on the subject. Students will also perform a case study of a NSM application of their choosing, including its materials science and engineering design considerations.

(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

Course Learning Outcomes:

1. Demonstrate understanding of nanoscopic phenomenon in materials.
2. Understand the scaling limitations of the materials theories, and determine what else is available or needed to explain these limitations.
3. Describe the main characterization methods used for nano-structured materials and explain how they work.
4. Describe both top-down and bottom-up methods for fabricating nano-structured materials.
5. Critically read new scientific literature on nanomaterials and apply this information to solve engineering problems, implement into a component or system design, and understand public policy.
6. Communicate about nanomaterials at an expert level in both written and oral forms.

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

Course Learning Outcomes:

1. Understand and explain the physics responsible for the aerodynamic forces and moments.
2. Use mathematical tools to calculate the aerodynamic forces and moments on airfoils and simple objects.
3. Use mathematical tools to calculate the aerodynamic forces and moments on finite wings.
4. Use the aerodynamic characteristics (CLO 1, 2 and 3) to predict various performance metrics of an aircraft (maximum speed, climb rate, service ceiling etc.).
5. Understand the concept of aerodynamic stability, and be able to determine the longitudinal stability of a particular wing-tail configuration.

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 2025-2026

(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

Course Learning Outcomes:

1. Solve problems involving the aerodynamic and structural performance of wind-turbine blades.
2. Determine the technical, economic, environmental and societal compromises necessary towards specific wind-turbine designs and their siting.
3. Conduct blade design optimization using a custom MATLAB code and subsequently perform validation of these designs with related laboratory experiments.
4. Identify challenges and potential solutions to both technical and non-technical hurdles for wind-turbine integration.
5. Apply qualitative and quantitative reasoning to convincingly support specific wind turbine designs.



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 2025-2026

(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 25

Engineering Design 17

Offering Faculty: Smith Engineering

Course Learning Outcomes:

1. Calculate the basic parameters that define acoustic noise such as the speed of sound in different media sound pressure sound pressure level acoustic impedance sound power sound power level sound intensity sound intensity level and loudness.
2. Calculate the various noise criteria associated with rooms and human hearing such as noise rating criteria and equivalent noise weightings over a range of frequencies or over a given time period.
3. Demonstrate an understanding of different acoustic noise measurement instruments and analysis equipment such as microphones sound level meters sound intensity probes dosimeters and spectrum analyzers.
4. Calculate sound radiation and propagation parameters such as sound radiation through air sound reflection coefficients sound transmission through and around objects sound transmission loss insertion loss outdoor sound sources meteorological effects room acoustics near field effects and reverberation effects.
5. Calculate the acoustic noise that is likely to be generated by typical industrial machinery such as fan noise electric motor noise pump noise compressor noise gear noise valve noise HVAC noise traffic noise and train noise.
6. Calculate the effects of various noise control techniques such as sound absorbing materials sound absorbers noise partitions noise enclosures sound barriers in rooms and outdoors silencers vibration isolation and active noise control.
7. Calculate design the optimum dimensions of different surface treatments with given or estimated material properties for a room of known dimensions that is

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 radiation which affects their performance, and often this dictates a requirement for a unique property. 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 field trips to components manufacturers and to Canada's national nuclear research laboratory.

(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

Course Learning Outcomes:

1. Explain and apply a basic knowledge of crystal structure defects texture phase transformation creep fatigue fracture residual stresses in nuclear metals.
2. Use nuclear fission and absorption cross-section diagrams to determine materials selection in nuclear reactors and understand their influence on different reactor designs.
3. Explain how atomic displacement occurs in a solid under energetic neutron irradiation and demonstrate understanding of defect clustering microstructure evolution as a function of dose accumulation as well as their effects on material performance.
4. Describe CANDU reactor design and its major components understand the design principles of CANDU Demonstrate understanding of radiation effects on CANDU major components in particular the pressure boundary and the consequence of pressure tube deformation induced by neutron irradiation resulting from growth and creep.
5. Explain the mechanism of growth and creep of pressure tubes under neutron irradiation as functions of material texture grain structure temperature stress and dose rate Understand how SLAR is used in repositioning of spacers with calculation of deformation of fuel channels.
6. Explain concept of delayed hydride cracking of pressure tubes Determine factors causing such issues in the nuclear reactor and describe feasible mitigation methods

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 substrates. 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 pericellular fluid flow 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. Students will learn to quantify these biofluidic mechanics problems using key equations from fluid mechanics (mass conservation, Bernoulli, and generalized Bernoulli) and heat and mass transfer (convection-diffusion equation).

(Lec: 3, Lab: 0, Tut: 0.5)

Requirements: Prerequisites: MECH 241 or MREN 241, and MECH 346 or MREN 230, 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

Course Learning Outcomes:

1. Solve problems involving pressure-driven internal flows with curvature, bifurcations and pulsatility.
2. Construct mathematical models of fluid flow in biological systems.
3. Apply the Bernoulli's equation for fluid flow in biological system.
4. Apply the Navier-Stokes equation for quasi-steady and unsteady flow.
5. Identify biological fluid dynamics research applied to bio propulsion systems
6. Apply qualitative and quantitative reasoning to support real-world biomedical or biologically-inspired designs.

**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

Course Learning Outcomes:

1. Understand the anatomical and mechanical analysis of human movement.
2. Appreciate the complexity of living species with regard to the motion they produce.
3. Evaluate the design of total joint replacements with respect to their kinematics.
4. Perform an analysis of three dimensional, six degree of freedom rigid body motion, expressing the results in terms of Euler angles, homogeneous matrices, or helical axis parameters.
5. Quantify the motion of articulating joints in terms of the centres and axes of rotation, and the behaviour of the contact kinematics.
6. Carry out a motion capture experiment, and convert marker coordinate data into meaningful measurements of body position and orientation.
7. Describe the function of a human joint in terms of the articulating bones, major ligaments and muscles.

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.

NOT OFFERED 2025-2026

(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

Course Learning Outcomes:

1. Identify and describe ergonomic issues associated with systems and devices involving human interfaces, with attention to the range of abilities expected in the population.
2. Design and describe practical user-centred designs of devices and systems that incorporate current best practices in the application of ergonomic design principles, including the use of universal design methods.
3. Understanding risks involved in workplace environments from the physiological and biomechanical perspectives.
4. Experience Interdisciplinary Interaction between kinesiology and engineering students in assessment of risk for manual materials handling.
5. Effectively communicate and present ideas.

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.

(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

Course Learning Outcomes:

1. Solve static biomechanics problem for musculoskeletal systems.
2. Determine muscle force distribution using optimization method.
3. Determine body segment parameters.
4. Perform inverse dynamic analysis of musculoskeletal systems during dynamic movement.
5. Perform segmental energy analysis based on kinematics and kinetic measurements.
6. Analyze accelerometers to obtain kinematics variables.