MECHATRONICS AND ROBOTICS ENGINEERING

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The Mechatronics and Robotics Engineering (MRE) program addresses the emerging disciplines of mechatronics and robotics engineering, and integrates the traditional disciplines of computer, electrical, and mechanical engineering, with key elements of automatic control, mechanics, electronics, intelligent systems, signal processing and telecommunications systems. This multidisciplinary approach recognizes the ever-increasing complexity of engineering systems, and the societal need for skilled engineers. The MRE program addresses the need for a truly integrated approach to mechatronics and robotics across four years of study. A sequence of experiential project-based design courses will progressively build the students' foundational knowledge and culminate in a capstone design project that could lead to participation in an external design competition. Following a common two years of study (with the first year being direct-entry from high-school), in their third year students can pursue either an electrical or a mechanical stream. In their final year, students will select eight technical electives, with the option of completing one of four recommended concentrations: automation, robotics, biomedical and intelligent systems. This will give them the opportunity to tailor the curriculum to their own interests.

- Mechatronics Robotics Engineering, B.A.Sc. (Class of 2025) (https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mechatronics-robotics-engineering/mechatronics-robotics-engineering-class-of-2025/)
- Mechatronics Robotics Engineering, B.A.Sc (Class of 2026) (https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mechatronics-robotics-engineering/mechatronics-robotics-engineering-class-of-2026/)
- Mechatronics Robotics Engineering, B.A.Sc. (Class of 2027) (https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/mechatronics-robotics-engineering/mechatronics-robotics-engineering-class-of-2027/)

Courses

MREN 103 Mechatronics and Robotics Design I Units: 4.00
This course introduces students to basic engineering design methods and tools that are employed for developing mechatronic and robotic systems. The first part of the course consists of a series of laboratories and a hands-on project that introduce students to elements of mechatronic and robotic hardware and software. In the second part of the course, client-based team design projects will further develop skills that include communication, teamwork, project management and professionalism. The nature of the projects will be such that students will be required to reflect on the impact of their designs on society and the environment. The course encourages a sense of creativity and curiosity about robotics and mechatronics engineering. Students will use their knowledge of engineering graphics as acquired in APSC 162.
K4(Lec: Yes, Lab: Yes, Tut: No)
Requirements: Prerequisites: APSC 101 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 26
Engineering Science 6
Engineering Design 16
Offering Faculty: Smith Engineering

MREN 104 Mechatronics and Robotics Design Project Units: 2.00
This course introduces students to basic engineering design methods and tools that are employed for developing mechatronic and robotic systems.
The course consists of a series of laboratories and a hands-on project that introduce students to elements of mechatronic and robotic hardware and software. The course encourages a sense of creativity and curiosity about robotics and mechatronics engineering. This course covers the content and objectives of MREN 103, that are not covered by APSC 103 and is intended for transfer students into the second year of the MRE program. Students will use their knowledge of engineering graphics as acquired in APSC 162. Note: this course is only open to students transferring into year 2 of the MRE program.
K2(Lec: Yes, Lab: Yes, Tut: No)
Requirements: Prerequisites: APSC 101, APSC 151 and permission of the instructor. Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 8
Engineering Science 4
Engineering Design 12
Offering Faculty: Smith Engineering

MREN 178 Data Structures and Algorithms Units: 4.00
This course introduces fundamental structures and algorithms for storing, managing, manipulating and analyzing data. Topics covered include structures, such as multidimensional arrays, linked lists, stacks, queues, deques, asymptotic notation, hash and scatter tables, trees and search trees, heaps and priority queues, graphs, and algorithms such as recursion, branch-and-bound methods, searching, sorting, and probabilistic algorithms. Microcontroller-based laboratory exercises will explore applications of data structures and algorithms, using examples drawn from mechatronics and robotics engineering.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: APSC 143 or MNTC 313 Corequisites: Exclusions: ELEC 278 or CISC 235
Offering Term: W
CEAB Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12
Offering Faculty: Smith Engineering

MREN 203 Mechatronics and Robotics Design II Units: 4.00
This course introduces students to the engineering design process, while integrating knowledge of mechatronic and robotic equipment from MREN 103. The first part of the course will be a paper-based design project, with focus on mechatronics and robotics, that will introduce a formal engineering design process, incorporating elements of problem and scope definition, creativity and idea generation and decision making incorporating economic, societal, and environmental factors. The second part of the course will be prototype-based design project, which includes both hardware and software development, that will provide experience with the design-build-test-fail cycle in engineering design. Students will develop and apply intermediate engineering writing and speaking skills with the emphasis on professional correspondence, engineering reports, oral briefings, and formal oral presentations. Elements of professional practice such as engineering codes, standards and ethics are addressed. The connection between the environment and human activity is explored from a systems perspective.
(Lec: 2, Lab: 2, Tut: 0)
Requirements: Prerequisites: MREN 103, APSC 199 or have passed the English Proficiency Test Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 24
Engineering Science 0
Engineering Design 33
Offering Faculty: Smith Engineering

MREN 223 Signals and Systems Units: 4.00
This course covers the basic concepts and techniques for the modeling and analysis of signals and systems. Topics include signals, system properties, linear time-invariant systems, convolution, impulse response in continuous-time and discrete-time domains; Fundamentals of Fourier series; Fourier transforms, spectral analysis; Laplace transforms, and frequency response; sampling, reconstruction, and digitization; z transform and frequency response; fundamental concepts of filtering in continuous-time and discrete-time domains; Computational realizations of the analysis tools and their applications are explored in the laboratory.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: ELEC 221, and MTHE 235 or MTHE 237 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 0
Offering Faculty: Smith Engineering

MREN 230 Thermodynamics and Heat Transfer Units: 3.75
This course introduces fundamental thermodynamics and heat transfer concepts needed to analyze thermal systems including: ideal gas laws; work and heat; conservation of energy; thermodynamic properties of pure substances; equations of state; applications to open and closed systems; heat transfer by conduction, convection and radiation. Theory will be complemented with a series of labs that introduce temperature measurement devices and thermal circuit analysis.
(Lec: 3, Lab: 0.25, Tut: 0.5)
Requirements: Prerequisites: MREN 241 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 15
Engineering Design 0
Offering Faculty: Smith Engineering

MREN 241 Fluid Mechanics and Fluid Power Units: 3.75
An introductory course in fluid mechanics with application to fluid power systems. Topics include properties of fluids, fluids at rest, 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 due to pumps, valves etc. Laboratories will introduce students to pressure and flow measuring devices, pneumatic and hydraulic components and actuators, and circuit analysis of fluid power systems.
(Lec: 3, Lab: 0.25, Tut: 0.5)
Requirements: Prerequisites: APSC 111 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 15
Engineering Design 0
Offering Faculty: Smith Engineering

MREN 303 Mechatronics and Robotics Design III Units: 4.00
In this course, students will apply their growing technical knowledge of mechatronics and robotics, and the formal engineering design process, to solve a multi-parameter design problem. Working in teams, students will work as a small start-up company that needs to come up with a market-specific technology product, while considering the impact of that product on the society and the environment. Each team must prepare a design proposal that describes their product's market need and high-level specifications, and schedule its milestones for the 12-week term. In addition, teams are required to create a working hardware/software prototype that is demonstrated before an audience at the end of the 12 weeks. Agile project management methodologies are encouraged to iteratively execute, evaluate and correct designs in an efficient way. Teams will demonstrate advanced communication skills by documenting their design process and their product's functional specifications through an online blog and a final report. The teams must have students from both the Mechanical and Electrical streams.
(Lec: 2, Lab: 2, Tut: 0)
Requirements: Prerequisites: MREN 203 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 15
Engineering Science 0
Engineering Design 33
Offering Faculty: Smith Engineering

MREN 318 Sensors and Electric Actuators Units: 4.25
This course introduces the basic technologies, structures and operation principles of sensors and electric actuators used in mechatronic systems. The topics include methods for signal collection, conditioning and analysis; physical principles for the measurement of motion, force, torque, pressure, flow and temperature using analog and digital transducers; actuating principles and steady-state
characteristics of dc, induction, synchronous, and special motors.
Various components will be experimentally tested and analyzed.
(Lec: 3, Lab: 0.75, Tut: 0.5)
Requirements: Prerequisites: ELEC 271, ELEC 252, and MREN 223 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Science 26
Engineering Design 14
Offering Faculty: Smith Engineering

MREN 320 Introduction to Industrial Automation Units: 3.50
Industrial automation is about the design of machines used in autonomous
systems for the production of goods and services. It is an interdisciplinary subject concerning areas of machine design, sensors, actuators and control systems.
This course introduces the subject and covers central concepts of automation including hardware components for automation, mechanical actuation systems, automation design synthesis, logic design for automation processes, electro-pneumatic actuation, PLC programming and PLC-based applications of PID. Students will get hands-on experience with a PLC controlled automation
machine through a series of labs.
(Lec: 3, Lab: 0.5, Tut: 0)
Requirements: Prerequisites: MREN 318, ELEC 443 or MECH 350, or permission of the instructor. Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 16
Engineering Design 26
Offering Faculty: Smith Engineering

MREN 348 Introduction to Robotics Units: 4.00
Robotics is an interdisciplinary subject concerning areas of mechanics,
electronics, information theory, control systems and automation.
This course provides an introduction to robotics and covers fundamental
aspects of modeling and control of robot manipulators. Topics include
history and application of robotics in industry, rigid body kinematics,
manipulator forward, inverse and differential kinematics, workspace,
singularity, redundancy, manipulator dynamics, trajectory generation,
actuators, sensors, and manipulator position and contact force control
strategies. Applications studied using MATLAB/Simulink software simulation
and laboratory experiments.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: ELEC 443 or MECH 350, or permission of the instructor. Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 22
Engineering Design 26
Offering Faculty: Smith Engineering

MREN 403 Mechatronics and Robotics Design IV Units: 8.00
In this course, students culminate their learning of mechatronics and robotics, and engineering design, through a team-based capstone design project focused on solving a real-world, industry-level technical challenge, which includes a detailed design phase, as well as robust building and iterative design testing, leading to participation in and external design competition. The course is conducted over two terms. In addition to the design, build and testing of a mechatronics or robotics system, each team is required to demonstrate communication, teamwork, and management skills at a professional level by preparing a formal design proposal, which includes a management plan, providing regular progress reports, and submitting a final design report, together with a formal presentation on the project and its results. Top-placed teams in a preliminary internal design competition will be sponsored to represent Queen's University at an external design competition.
(Lec: 2, Lab: 6, Tut: 0)
Requirements: Prerequisites: Successful completion of the 3rd year of the MRE program Corequisites: Exclusions:
Offering Term: FW
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Science 0
Engineering Design 68
Offering Faculty: Smith Engineering

MREN 410 Intelligent Machines and Autonomous Systems Units: 3.50
This course provides students with a working knowledge of methods for design and analysis of robotic and intelligent machines that can think, learn and act in uncertain conditions. Topics include basic principles and methods of machine vision, machine learning and identification, decision-making, and their applications in the design of an autonomous system.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: MREN 178, MREN 223 and ELEC 371, or permission of the instructor Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 18
Offering Faculty: Smith Engineering