Area of Interest: Engineering and Architecture

Bachelor of Automation and Robotics (Honours) (Co-op)

Honours Degree
4 Years
Ottawa Campus

Academic Year: 2020/2021
Program Code: 6519X03FWO

Our Program

Combine the three fields of engineering to pursue a career in the field of automation and robotics.

The four-year Bachelor of Automation and Robotics (Honours) degree program prepares you for a career in the field of automation and robotics.

Autonomous and remotely operated systems are deployed the world over with ever increasing frequency. Such systems are being implemented in many instances to reduce risk to human workers, to achieve higher efficiencies in manufacturing and to improve the quality of lives through robot-assisted rehabilitation and care. Variations of these systems are often in place for reasons of feasibility, efficiency, safety or practicality. Traditionally, in order to develop such systems, collaborative expertise and knowledge in aspects of mechanical and electrical engineering as well as computer science is necessary. Through a combination of these three fields of engineering, this program helps you acquire the theoretical and applied expertise to succeed in the field of automation and robotics.

As a student in this program, you acquire knowledge and skills specific to electrical engineering, mechanical engineering and computer science, including:

- engineering principles, professionalism and methodologies
- fundamentals of mathematics, technical writing, dynamics, electronics, computer programming, optical systems and materials science
- machine design, control systems, electromechanical actuators, sensors, vision systems and the software necessary to design and simulate autonomous and remotely operated systems and components
- project planning and management, and research and leadership

This co-operative education program provides you with learning opportunities through industrial and/or applied research placements. A comprehensive final year project tied to the needs of industry exists to challenge you, presenting the opportunity to test and further develop knowledge and skills. If you are interested in the potential of self-employment, you have an opportunity to foster entrepreneurial aspirations.

In this program may find employment opportunities in sectors such as:

- industrial automation
- mining
- agriculture
- manufacturing
- aerospace
- healthcare
- defense
Graduates may also choose to pursue further academic study in fields related to manufacturing, robotics, control systems or other areas of mechanical or electrical engineering.

Algonquin College intends to pursue accreditation of this program with the Canadian Engineering Accreditation Board of Engineers Canada.

SUCCESS FACTORS

This program is well suited for students who:

- Possess strong analytical, logical, mathematical and critical-thinking skills.
- Enjoy working with mechanical and/or electrical assemblies.
- Can work independently and collaborate in problem-solving teams.
- Are interested in working with a wide variety of people and situations.
- Have an appreciation for creative work and using cutting edge technology.

Employment

Graduates may work in the engineering fields as robotics engineers, controls engineers, automation engineers, robotics specialists and automation systems designers. As well, graduates may work in the traditional engineering field as mechanical systems designers/engineers, electronic systems engineers and controls hardware/software designer/engineers.

Learning Outcomes

The graduate has reliably demonstrated the ability to:

- Analyze, design, modify and support mechanical, software and electrical components, processes and systems by applying fundamentals of engineering.
- Build functional robotic components by researching and integrating knowledge from mechanical, electrical and software engineering practices.
- Customize existing non-autonomous systems into autonomous or semi-autonomous systems by designing and integrating solutions and developing autonomy algorithms and controls.
- Analyze and solve complex technical problems in the field of robotics and automation by applying the principles of engineering and mathematics.
- Develop, execute and interpret quantitative and qualitative analysis and tests for industrial mechatronic and automation systems.
- Lead and perform diagnostics on a variety of industrial automation controls, sensors, data acquisition devices and interfaces by developing and using troubleshooting skills and techniques.
- Ensure all work is performed in compliance of relevant laws, codes, regulations, policies, ethical principles, safety procedures and engineering practices and standards.
- Contribute to the on-going and upcoming innovation and research in the robotics and automation field.
- Develop entrepreneurship and effective business planning skills to innovate robotics technology targeting new and existing local and global markets.
- Develop personal and professional strategies and plans to adapt to change, maintain currency and foster interprofessionalism.
- Manage the project and communication with clients and other professionals to translate abstract ideas into tangible project requirements and products.
- Identify and apply discipline-specific factors that enable the contribution to the local and global community through social responsibility, economic commitment and environmental stewardship.
## Program of Study

<table>
<thead>
<tr>
<th>Level: 01</th>
<th>Courses</th>
<th>Hours</th>
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<tbody>
<tr>
<td></td>
<td>CAD8202 CAD</td>
<td>56.0</td>
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<tr>
<td></td>
<td>CST8107 Introduction to Programming and Problem Solving</td>
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<td>ENL1000 Communications and Academic Writing</td>
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<td>MAT6443 Calculus I</td>
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<td>MAT8203 Linear Algebra</td>
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<td>PHY8103 Physics I</td>
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<tr>
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<td>CHE3190 Chemistry</td>
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<td>CST8203 Advanced Programming and Data Structures</td>
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<td>MAC8102 Machine Shop and Manufacturing Techniques</td>
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<td>MAT8202 Calculus II</td>
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<td>PHI1000 Logic and Critical Thinking</td>
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<td>PHY8203 Physics II</td>
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<td>ROB8113 Introduction to Robotics</td>
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<td>ELN8304 Electrical and Electronic Circuits I</td>
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<td>ENG8332 Engineering Mechanics: Statics</td>
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<td>GEO2300 Principles of Urban Planning</td>
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<td>MAT8406 Differential Equations and Advanced Calculus</td>
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<td>PLT1105 Introductory Optics</td>
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<td>SOC2000 Introduction to Sociology</td>
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<tr>
<td></td>
<td>ELN8402 Electrical and Electronic Circuits II</td>
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<td>ELN8404 Digital Circuits, Design and Microprocessors</td>
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<td>ENG8405 Engineering Mechanics: Dynamics</td>
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<td>PHI2000 Introduction to Research</td>
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<td>ROB8403 Industrial Robotics</td>
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<td>ENG8603 Dynamics of Machinery</td>
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<td>ENG8604 Fluid Mechanics and Hydraulics</td>
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<td>ENG8605 Mechatronics</td>
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<td>ENG8607 Mechanics of Solids</td>
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<td>ENG8608 Industrial Robot Cells</td>
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<tr>
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<td>CST8703 Real Time Systems and Embedded Systems Programming</td>
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<td>ECO8904 Engineering Economics</td>
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<td>ENG8704 Mechanical Systems Design</td>
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<td>ENG8706 Heat Transfer and Thermodynamics</td>
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<td>PHI2002 Ethical Decision Making</td>
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<td>ROB8705 Computer Vision for Robotics</td>
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Bachelor of Automation and Robotics (Honours) (Co-op)

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<td>ROB8902</td>
<td>Mobile Robotics Navigation and Control</td>
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<td>PHY4000</td>
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**Fees for the 2020/2021 Academic Year**

Tuition and related ancillary fees for this program can be viewed by using the Tuition and Fees Estimator tool at [https://www.algonquincollege.com/fee-estimator](https://www.algonquincollege.com/fee-estimator).

Further information on fees can be found by visiting the Registrar’s Office website at [https://www.algonquincollege.com/ro](https://www.algonquincollege.com/ro).

Fees are subject to change.

Additional program related expenses include:
Books and supplies cost approximately $1,000 per academic year.

**Admission Requirements for the 2021/2022 Academic Year**

**College Eligibility**
Bachelor of Automation and Robotics (Honours) (Co-op)

- Ontario Secondary School Diploma (OSSD) or equivalent.
- Mature students are applicants who have not achieved the Ontario Secondary School Diploma (OSSD) or its equivalent and who are at least 19 years of age on or before the commencement of the program in which they intend to enroll. Mature students applying for Degree programs satisfy College Eligibility by having demonstrated academic abilities equivalent to those of Ontario high school graduates, verified by successful completion of at least one full-time term at the post-secondary level (minimum five courses taken concurrently in an academic program of study).

Program Eligibility

- Six Grade 12 university (U) or university/college (M) courses with a minimum 65% average including:
  - One Grade 12 U English course, with a minimum of 65%.
  - One Grade 12 U Physics course, with a minimum of 65%.
  - One Grade 12 U Calculus course, with a minimum of 65%.
  - One Grade 12 U Math course, with a minimum of 65%.
  - Two (2) other Grade 12 U or M courses.
- Please note that mature students must meet the following subject-specific Program Eligibility requirements, either directly or through equivalencies:

Admission Requirements for 2020/2021 Academic Year

College Eligibility

- Ontario Secondary School Diploma (OSSD) or equivalent.
- Mature students are applicants who have not achieved the Ontario Secondary School Diploma (OSSD) or its equivalent and who are at least 19 years of age on or before the commencement of the program in which they intend to enroll. Mature students have demonstrated academic abilities equivalent to those of Ontario high school graduates, verified by successful completion of courses at the post secondary level.

Program Eligibility

- A minimum of six (6) university (U) or college (M) Grade 12 courses including four (4) required university (U) level courses and two additional U or M level courses.
  - The following Grade 12 courses, or equivalent, are required:
    - One Grade 12 U English course
    - One Grade 12 U Physics course
    - One Grade 12 U Calculus course
    - One Grade 12 U Math course
    - Two (2) other Grade 12 U or M courses
  - A grade of 65% in the required courses and an overall average of 65% in the six Grade 12U, or M courses. (Ontario Academic Courses (OAC) can replace or be used in combination with U or M courses.) Requirements for Mature Students: Grade 12 U or OAC English, Grade 12 U or OAC Mathematics; and Grade 12 U or OAC Science. Minimum grade of 65% required in each course.
  - International applicants must provide proof of the subject specific requirements noted above along with proof of either: (IELTS / TOEFL) IELTS-International English Language Testing Service (Academic) Overall band of 6.5 with a minimum of 6.0 in each band; OR TOEFL-Internet-based (iBT)-overall 88, with a minimum of 22 in each component: Reading 22; Listening
• International applicants must provide proof of the subject specific requirements noted above along with proof of either: (IELTS / TOEFL) IELTS-International English Language Testing Service (Academic) Overall band of 6.5 with a minimum of 6.0 in each band; OR TOEFL-Internet-based (IBT)-overall 88, with a minimum of 22 in each component: Reading 22; Listening 22; Speaking 22; Writing 22.

• Applicants with international transcripts must provide proof of the subject specific requirements noted above and may be required to provide proof of language proficiency.

Application Information

BACHELOR OF AUTOMATION AND ROBOTICS (HONOURS) (CO-OP)
Program Code 6519X03FWO

Applications to full-time day programs must be submitted with official transcripts showing completion of the academic admission requirements through:

ontariocolleges.ca
60 Corporate Court
Guelph, Ontario N1G 5J3
1-888-892-2228

Students currently enrolled in an Ontario secondary school should notify their Guidance Office prior to their online application at http://www.ontariocolleges.ca/.

Applications for Fall Term and Winter Term admission received by February 1 will be given equal consideration. Applications received after February 1 will be processed on a first-come, first-served basis as long as places are available.

International applicants please visit this link for application process information: https://algonquincollege.force.com/myACint/.

For further information on the admissions process, contact:

Registrar`s Office
Algonquin College
1385 Woodroffe Ave
Ottawa, ON K2G 1V8
Telephone: 613-727-0002
Toll-free: 1-800-565-4723
TTY: 613-727-7766
Fax: 613-727-7632
Email: AskUs@algonquincollege.com

Additional Information

Programs at Algonquin College are Bring Your Own Device (BYOD). To see the BYOD requirements for your program, please visit: https://www7.algonquincollege.com/byod/.

Algonquin College has been granted consent by the Minister of Training, Colleges and Universities to offer this applied degree for a seven-year term starting September 21, 2017. The College shall ensure that all students admitted to the above-named program during the period of consent have the opportunity to complete the program within a reasonable timeframe.

Students may be expected to travel outside of their immediate area of residency for co-op placement. It is the student`s responsibility to arrange transportation and incur all costs associated with co-op placement.

Graduates of an Ontario College Advanced Diploma in Mechanical Engineering Technology or Electrical Engineering Technology, or of an Ontario College Diploma in Electro-Mechanical Engineering Technician - Robotics are eligible for advanced standing in the Bachelor Automation and Robotics upon completion of required bridging courses.

For more information, contact the School of Advanced Technology, Mechanical and Transportation Technology at 613-727-4723 ext. 5907.

Course Descriptions
CAD8202 CAD

Techniques for designing mechanical components have evolved over time from simple hand drawings and calculations to sophisticated computer models and simulations. Computer aided design (CAD) generally refers to the use of computers for modeling components and assemblies, as well as producing manufacturing drawings. Students learn standard engineering drawing conventions such as dimensioning and tolerance specification. Fundamental principles of geometry, creative design, and conceptualization are also taught. Students use these skills to develop and realize the design of a mechanical device from conception to manufacturing drawings.

Prerequisite(s): none
Corerequisite(s): none

CHE3190 Chemistry

This course provides students with a foundation in chemistry. Through this introductory course, students learn about a variety of topics including chemical structures, the properties of liquids, solids and gases, stoichiometry, electrochemistry, chemical equilibrium and chemical kinetics. This course includes hands on experiments to support student learning.

Prerequisite(s): none
Corerequisite(s): none

CST8107 Introduction to Programming and Problem Solving

Programming skills are becoming ever more important, quickly turning into the core competency for all kinds of engineering disciplines. Students examine problem-solving methodologies in real-world applications that are aligned with principles of programming including topics such as structured analysis, design and object oriented programming. In order to evolve in this methodology of problem solving, students begin an exploration of theoretical and practical applications of a number of computer science laws and principles. Through exercises and case studies students define algorithms and model strategies to tackle problems statements using flowcharting and pseudo code approaches to develop software based solutions of real-world applications. In addition, students explore elements and tools of testing, debugging and analyzing and interpreting of results of given algorithms.

Prerequisite(s): none
Corerequisite(s): none

CST8203 Advanced Programming and Data Structures

Today's science and engineering are heavily associated with the use of computing technology in information processing that includes simulations and data processing. Students explore a number of advanced software techniques that use powerful analytical mechanisms to model robotics and automation systems. Students acquire knowledge of abstract data types, recursive algorithms, algorithm analysis, as well as sorting and searching and problem-solving strategies aligned with object oriented programming techniques and data structures. Through discussion, applied assignments, examination of examples and programming during lab time, students develop computational knowledge of robotics ranging from autonomous navigation to the development of means to support a robot framework.

Prerequisite(s): CST8107
Corerequisite(s): none

CST8703 Real Time Systems and Embedded Systems Programming

Real time systems are systems in which tasks have to be executed by timely deadline to avoid serious consequences. Embedded systems are now currently part of almost every electronic device, automotive system or new electronic technology. Students learn the principles of real time systems by developing real time systems programs and testing them on an embedded system. Students also explore operating system principles and parallel programing principles such as deadlock avoidance, locks, semaphores, message passing, memory management and multi core programming.
Prerequisite(s): CST8203 and ELN8404
Corerequisite(s): none

**ECO8904 Engineering Economics**

It is essential that engineering proposals emphasize the systematic evaluation and analysis of benefits and costs associated with suggested technical engineering projects. Students explore concepts of the time value of money, analysis of single and multiple investments, comparison of alternatives, certainty, uncertainty, risk analysis and the methods of discounted cash flow. Students examine information to make decisions between alternatives encountered in engineering system projects. Through discussions and case studies, students analyze economic and financial methodologies combined with engineering fundamentals.

Prerequisite(s): none
Corerequisite(s): none

**ELN8304 Electrical and Electronic Circuits I**

A cornerstone of the engineering field is electrical and electronic circuits. Students gain the theoretical and practical knowledge at an introductory level required in electrical and electronic circuit theory, as well as analysis and design of electrical and electronic circuits. Furthermore, knowledge of the basic principles of electrical and electronic circuits is developed. Students learn about voltage, current, power, energy, resistance, capacitance and inductance. Topics include Ohm’s Law, Kirchhoff’s laws, node analysis, mesh analysis, Thevenin’s theorem, Norton’s theorem, steady state and transient analysis, AC, DC and phasor analysis and the theory of the PN junction. Students also conduct lab experiments applying theoretical material.

Prerequisite(s): MAT8202 and PHY8203
Corerequisite(s): none

**ELN8402 Electrical and Electronic Circuits II**

Knowledge of advanced topics in electric and electronic circuits is essential in many engineering disciplines. Focus is on advanced topics electrical and electronic engineering including two port networks, star-delta transformations, Fourier series and transform and Laplace transform. Furthermore, students use the knowledge acquired to solve more complex engineering problems and to build foundation for more advanced design tasks. Students study Operational Amplifier (OP-AMP) circuits and derive the amplitude and phase response of such circuits. Other topics in electronics include different semiconductor devices: PN junction diodes, zener diodes, bipolar junction transistors, field effect transistors and transistors such as MOSFET. On the applied side, students examine the application of different diodes and transistors, design amplifiers circuits, filters, oscillators and apply proper electronic circuit analysis techniques. Students also use practical components from catalogues to create application circuits and conduct lab experiments using theoretical materials.

Prerequisite(s): ELN8304
Corerequisite(s): none

**ELN8404 Digital Circuits, Design and Microprocessors**

Digital circuits and microprocessor technologies are considered the backbone of modern electronic and computer systems. Student develop theoretical and practical knowledge required to use and perform Boolean algebra, analysis, design, optimization and implementation of combinational and sequential circuits as well as modern digital circuit technologies. Students apply these techniques to build specific circuits and gain insight into logic circuit design and understanding of microprocessor operation. Students explore the functionality of digital circuit building components such as gates, multiplexers, decoders, encoders, flip-flops, registers, latches, adders and multipliers. Students also design a digital circuit using these components. Students write and debug basic assembly code for a microprocessor and conduct experiments in a lab setting as applying the theoretical material. Other topics include an introduction to the basis of very-high-speed integrated circuits, Hardware Description Language (VHDL) and Field-Programmable Gate Array (FPGA) design.

Prerequisite(s): CST8107 and ELN8304
ELN8606 Control Systems

Feedback control systems are a fundamental aspect of engineering, especially within robotics and automation. Typical control systems rely upon sensor measurements in order to determine appropriate inputs so that the system output is regulated as desired. Students explore the theory and mathematical principles of classical and modern control theory in both time and frequency domains. Classical control theory topics include root locus and Bode diagram analysis, as well as stability analysis based upon Routh-Hurwitz and Nyquist criteria. Students also learn modern control theory using state-space analysis and digital control systems, then apply these methods within real control systems using various hardware, software and programming techniques.

Prerequisite(s): none
Corerequisite(s): none

ENG3190 Professional Ethics

This course provides a foundation in professionalism and ethics within civilization, a minimum requirement for professionals to practice in the field of Engineering. The topics include basic concepts of professional practice, hazards, liability, standards and safety, intellectual property, fairness and equity in the professional workplace, principles of ethics, case studies, environmental ethics, environmental sustainability and law. The course seeks to prepare students for the Professional Practice Exam (PPE), required to become a professional engineer in the province of Ontario.

Prerequisite(s): none
Corerequisite(s): none

ENG8332 Engineering Mechanics: Statics

Structural analysis is an essential consideration for any engineer tasked with design. In order to develop the ability to apply the principles of mechanics to practical design problems, students examine and apply theories to the static equilibrium of rigid bodies. Lectures, in-class problem solving and assignments focus on the analysis of forces and moments acting on particles and rigid bodies. Special attention is devoted to drawing free body diagrams and using concepts of work and energy methods to solve for internal and reaction forces and moments acting on trusses, frames and beams.

Prerequisite(s): MAT8405 and PHY8103
Corerequisite(s): none

ENG8405 Engineering Mechanics: Dynamics

Knowledge of the action of external forces resulting in motion is essential in the design of mechanical systems. In order to develop the ability to consider motion in mechanics, students examine and apply theories to the dynamics of rigid bodies. Lectures, in-class problem solving and assignments focus on the kinematics and kinetics of particles and bodies. Students apply Newton’s laws to determine position, velocity, acceleration and relative motion of bodies.

Prerequisite(s): ENG8332
Corerequisite(s): none

ENG8603 Dynamics of Machinery

Knowledge of the motion, forces, and general dynamic behaviours of mechanical systems is required for designers to select a machine’s required elements, dimensions, materials, or predict performance. Students acquire the fundamental skills required to model, analyze, and simulate common mechanisms used in robots or other automated machines formed by multiple joints and links. Analyzing the kinematics and dynamics of mechanisms plays a key role in the analysis of a robotic system to facilitate the design process. Students can calculate displacements, velocities, and accelerations for general linkages with an emphasis on graphical methods. Students also learn about force analysis of these linkages and the force balancing of rotating machinery. Other topics
include free and forced vibrations of first and second order mechanical systems. Finally, theoretical
skills are complemented by learning from activities such as computer simulation programs, case
studies, and laboratory activities.

Prerequisite(s): ENG8405
Corerequisite(s): none

**ENG8604 Fluid Mechanics and Hydraulics**

Fluid mechanics and hydraulics is an important branch of engineering mechanics, since these
principles relate to all engineering applications involving a fluid. Students develop knowledge of
fluid statics and dynamics in engineering by examining the fundamentals of fluid mechanics and
hydraulics. Through discussions and in-class activities, students explore topics of fluid properties,
viscosity, buoyancy and stability, continuity equations, Bernoulli’s principle, pressure and flow
measuring techniques, and series pipeline systems. Students apply dimensional analysis to design
physical/numerical experiments, and determine losses in flow systems by combining model
equations with experimental data.

Prerequisite(s): none
Corerequisite(s): none

**ENG8605 Mechatronics**

Obtaining harmonious integration of mechanism, electronics, and computer control to achieve a
functional automation system, requires mechatronics system design. Students perform and
examine, design process, project planning, data presentation, measurements and error, control
logic, sensors, actuators including AC/DC and Stepper motors, and intellectual property. Students
integrate and build upon knowledge and skills gained to design, assemble, and analyze mechatronic
systems using modern methods and tools. Students apply control theory, dynamic system
behaviour, communication protocols, pneumatics, and embedded programming in the laboratory
and in analyzing an existing mechatronic system and designing a new one.

Prerequisite(s): ELN8402 and ELN8404
Corerequisite(s): none

**ENG8607 Mechanics of Solids**

The internal reactions in solid materials resulting from the action of external forces must be known
for safe design of load supporting structures. In order to develop the ability to understand the
elastic behavior of solids, students examine and apply theories of solid mechanics. Lectures, in-
class problem solving, assignments and laboratories focus on determining mechanical response
in materials and stress-strain relationships. Special attention is paid to the behavior of prismatic
members in tension, compression, shear, bending, torsion and combined loading.

Prerequisite(s): ENG8405 and MAT8406
Corerequisite(s): none

**ENG8608 Industrial Robot Cells**

Industrial robot integration is an interdisciplinary subject spanning the areas of mechanics,
electronics, information theory, control and automation. Students examine the functionalities of
programmable logic controllers, pneumatic circuits as well as position and perception sensors.
Students integrate electro-mechanical components used in industry such as motors, automation
belts, pneumatic cylinders and lines, sensors (optical, hall effect, inductive) with robots and
programmable logic devices (PLCs). Through lab experiments students integrate the components
electrically and mechanically with industrial robots and program the PLCs generate a modular
production line. Students also design an industrial robot cell using the integration of electro-
mechanical components with and industrial robot.

Prerequisite(s): ENG8405 and ROB8112
Corerequisite(s): none
ENG8704 Mechanical Systems Design

A successful design must satisfy prescribed performance criteria, operate safely and reliably under nominal conditions and be a manufacturable and cost effective solution. In order to develop good mechanical design practices, students examine and apply design methodologies, machine component design practices, manufacturing techniques and material failure theory. Lectures focus on two core areas: learning the design process and reinforcing solid mechanics fundamentals as it applies to mechanical components and systems. Individual and group assignments and laboratories emphasize practical experience in using technical knowledge and skills to assess requirements, select or invent components and combine and size them to satisfy performance criteria. Special attention is paid to the design of machine elements which fulfill a function in robotic and mechatronic systems such as bolts, welds, shafts, gears, drivetrains and bearings. Advanced topics such as the finite element method and design optimization are also briefly introduced.

Prerequisite(s): none
Corequisite(s): none

ENG8706 Heat Transfer and Thermodynamics

Advances in science and technology have made our day to day lives completely dependent on thermodynamics and heat transfer principles. Students identify and examine principles of thermodynamics and heat transfer, study real-world engineering examples to learn how thermal sciences are applied in engineering practices. Through a combination of discussions, assignments, case studies and experiments, students develop an understanding of thermal sciences by emphasizing the physics and physical arguments behind real-world engineering applications.

Prerequisite(s): ENG8604
Corequisite(s): none

ENG8905 Sensors and Instrumentation

Robotics and automation systems are highly dependent upon meaningful and reliable measurements of environmental conditions. Examples of these measurements include properties such as pressure, temperature, luminosity, and mechanical loads, as well as the use of laser scanners, radar, or sonar for detecting and mapping nearby objects. Robotics and automation engineering typically focus on the use of these measurements for application in control systems. Students develop the skills and knowledge to use techniques and algorithms to translate raw sensor data into meaningful information. The effects of noise, interference and resolution are covered, as well as the principles of filtering and signal conditioning.

Prerequisite(s): ELN8402 and ELN8404 and ENG8332 and PLT1005
Corequisite(s): none

ENG9103 System Level Reliability

Mechanical and electrical reliability of automated systems is critical, especially as these systems perform tasks traditionally completed by humans. Students learn the mathematical models and techniques needed to analyze automation systems to determine overall system reliability ensuring product acceptance, commercial viability, and end-user safety. Through a combination of assignments and a project, students apply reliability concepts to real-world automation and robotics systems in order to design and modify systems to meet reliability requirements, and plan for failure.

Prerequisite(s): MAT8400
Corequisite(s): none

ENL1100 Communications and Academic Writing

Effective communication is an integral component of success in the workplace and in lifelong learning. Students review communication theory and its connection to expository writing. Frequent writing exercises encourage the development of content that is coherent, well organized and correct. Students consider and use strategies to generate ideas, to collect and organize information, to acknowledge sources, to identify and develop a thesis and to adapt format, style and tone for
different purposes and audiences.

Prerequisite(s): none
Corerequisite(s): none

ENL4100 Creative Writing

Whether for personal or public consumption, many people enjoy writing short fiction to express their creative energy while improving upon their overall writing abilities. Working with professional short stories as models, students examine the stylistic components that contribute to the excitement, atmosphere, and overall readability of short fiction. Students share their work and provide formal feedback on the work of others.

Prerequisite(s): ENL1100
Corerequisite(s): none

ENL4100 Creative Writing

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Prerequisite(s): ENL1100
Corerequisite(s): none

ENL4200 New Worlds and Alternative Realities: Speculative Fiction

Speculative fiction gathers together all those works of fiction in which new worlds or alternative realities are envisioned. Within this category of prose, students have the opportunity to explore the various sub-genres that present readers with new ways of thinking about some of the issues that face society. Students also develop skills in critical analysis using a variety of approaches and methodologies from literary studies.

Prerequisite(s): none
Corerequisite(s): none

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Prerequisite(s): none
Corerequisite(s): none

GEO2300 Principles of Urban Planning

Increasingly cities and communities are feeling the pressure of expansion, and people from all walks of life feel disconnected from the processes, procedures, and decisions that are affecting everyday life. Students consider urban transformation with a focus on practicing sustainability by exploring innovations in land use, transportation, resource planning and economic development, resulting in employment opportunities, as well as healthy and vibrant cities. Students use local and regional activities as a starting point for developing a knowledge base for future social and community involvement. Research projects and assignments encourage students to identify the gaps between theoretical approaches to urban planning and the practical applications as evidenced in their local surroundings.

Prerequisite(s): none
Corerequisite(s): none
**GEP1001 Cooperative Education Readiness**

Students are guided through a series of activities which prepares them for their co-op job search term. Through a detailed orientation students learn the cooperative education program policies and procedures related to searching and securing a work term opportunity. Students identify their strengths and transferable skills and participate in workshop style sessions that focus on cover letter and resume development, interview techniques and job search strategies. Students learn how to navigate HireAC where employers post cooperative education job opportunities. Students reflect on workplace success, ethics and responsibilities.

Prerequisite(s): none
Corerequisite(s): none

**MAC8102 Machine Shop and Manufacturing Techniques**

Many different manufacturing techniques exist for fabricating engineering components from various materials. The main focus is conventional machine shop practice using machines such as the drill press, lathe, band-saw and mill. Students develop safe and competent practices through hands-on learning by selecting and using appropriate tools and machines, as well as determining proper speeds and settings. In addition to conventional machine shop operations, students also learn to use computer numerical control (CNC) mills and the required software. Further topics include manufacturing techniques such as molding, welding, riveting and the fabrication of composite materials.

Prerequisite(s): CAD8202
Corerequisite(s): none

**MAT6443 Calculus I**

Differential calculus is the study of the definition, properties and applications of the derivative of a function. Students study limits of functions. They learn the definition and interpretation of the derivative as a rate of change. Students use differentiation rules to find derivatives of algebraic and transcendental functions. They also apply implicit and logarithmic differentiation to find derivatives. Students study a variety of applications of derivatives such as finding a tangent to a curve and curve sketching. They also solve rates of change and related rates problems.

Prerequisite(s): none
Corerequisite(s): none

**MAT8202 Calculus II**

Integral calculus is the study of the definitions, properties and applications of two related concepts, the indefinite integral and the definite integral. Students calculate both indefinite and definite integrals using a variety of integration techniques, such as integration by substitution, by parts, by partial fractions and by trigonometric substitution. Students study a variety of applications of integration, such as area and volume problems. Students also study power series and their convergence, in addition to finding and computing with Maclaurin series.

Prerequisite(s): MAT6443
Corerequisite(s): none

**MAT8203 Linear Algebra**

Students are provided an introduction to the basic concepts and techniques of linear algebra including systems of linear equations, matrix operations, determinants, vectors in n-space, linear transformations, eigenvalues and eigenvectors, together with selected applications, such as linear programming, least squares and population growth.

Prerequisite(s): none
Corerequisite(s): none
MAT8400 Mathematics for Engineers

Real-world engineering and robotics problems often do not have a single, easily solved for, solution. Students find approximate solutions to complex mathematical problems using numerical methods, and quantify uncertainty using probability and statistics. Topics covered include solving linear and nonlinear equations, polynomial interpolation, integrating ordinary differential equations, optimization, random variables, probability distributions, confidence intervals, and least-squares regression. Students solve mathematical problems, drawn from real robotics applications, either directly or by writing computer programs in an integrated programming environment.

Prerequisite(s): MAT8406
Corerequisite(s): none

MAT8406 Differential Equations and Advanced Calculus

Forming the basis of careers in many disciplines is the ability to apply mathematical techniques and expertise needed for investigating and solving real-life problems. Students manipulate differential equations to solve problems and develop the foundations of advanced calculus and analytic geometry. Students solve first order differential equations by separating variables, integrating combinations and integrating factors for linear equations and Laplace Transforms. Students solve both homogeneous and non-homogenous second and higher order differential equations with constant coefficients using the method of undetermined coefficients and Laplace Transforms. Students calculate double integrals in both rectangular and polar coordinates and triple integrals in rectangular, cylindrical and spherical coordinates. Students define vector fields, calculate line integrals and apply Green's theorem. Students define parametric surfaces, calculate surface integrals and apply the Divergence and Stokes theorems.

Prerequisite(s): MAT8202
Corerequisite(s): none

MGT6120 Entrepreneurship

Entrepreneurship and small business management are introduced from a Canadian perspective. Students develop the skills required to identify and evaluate a business opportunity; they investigate organizational structures of businesses and develop a business plan. A business simulation model provides the opportunity to practice and develop emerging entrepreneurial skills.

Prerequisite(s): ACC6104 and MKT6108 and MKT6111
Corerequisite(s): none

PHI1000 Logic and Critical Thinking

Logic and critical-thinking skills play an important role in both daily life and ongoing academic studies. As foundational skills, they support both the development and assessment of ideas, concepts and courses of action that are presented on a daily basis. Approaching the subject from both a practical and theoretical perspective, students hone their skills in analysis, argumentation, reasoning and persuasion. A range of topics and thinkers provide material with which students can exercise and apply their skills.

Prerequisite(s): none
Corerequisite(s): none

PHI2000 Introduction to Research

Academic research requires students to possess a fundamental knowledge of accepted methodologies and practices. An overview of the research process and tools prepares students to engage in scholarly work. Emphasis is on evaluation, selection and documentation of primary and secondary sources, as well as the development of a research project.

Prerequisite(s): ENL1100 and PHI1000
Corerequisite(s): none

PHI2002 Ethical Decision Making
To avoid potential prosecution, companies and their employees are well-advised to engage in ethical decision-making practices in all business situations. Students examine ethical concepts and principles, compare a variety of ethical decision-making models and utilize these principles and models to make ethically sound decisions in a variety of contexts. Students also design a code of ethics, practice making ethically-based decisions and develop the analytical skills required to recognize, evaluate and resolve ethical dilemmas in the workplace.

Prerequisite(s): PHI1000
Corerequisite(s): none

**PHI4000 Philosophy and Popular Culture**

Many facets of today’s popular culture engage, directly or indirectly, with the concerns of a variety of philosophical traditions. Drawing on a number of examples, students explore both the way popular culture permeates and spreads through society and the way it interprets and presents philosophical questions. Students develop skills and techniques for assessing the soundness and validity of thought experiments.

Prerequisite(s): PHI1000
Corerequisite(s): none

**PHI4002 The Philosophy of Drugs**

Drugs are everywhere: professionals prescribe them to us to make us “better”; we take them recreationally; we give them to our children, pets and other loved ones; we buy them on the streets and in grocery stores. What are “drugs”? Why are some drugs legal and others not? How do drugs get to market? What ethical issues are relevant in a global drug industry? Are current intellectual property regimes appropriate if the goal of drug research is to promote benefits to society? Students critically examine these, and other, questions through the lens of historical and contemporary ethical, philosophical and legal theories and arguments. Students engage in various peer-oriented learning activities throughout the course.

Prerequisite(s): none
Corerequisite(s): none

**PHI4003 The Philosophy of Love and Sex**

Love and sex are central to the human condition, and have been topics of academic inquiry and
controversy throughout history. Various practices surrounding love and sex are celebrated in Western culture, such as monogamy and marriage, while other practices, such as polygamy and pedophilia, are condemned. Why is this? Students critically explore these and other issues surrounding love and sex using examples from popular music, movies and literature, framing those issues with the help of historical and contemporary philosophical theories and arguments. Students engage in various peer-oriented learning activities throughout the course.

Prerequisite(s): none
Corerequisite(s): none

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Prerequisite(s): none
Corerequisite(s): none

PHI4004 Technology, Society and the Environment

Environmental issues have come to occupy a central place in the marketplace, politics, policy, and society at large. Owing largely to the many environmental consequences that have accompanied industrialization, we humans have been forced to rethink the complex relationship between technology, society and the environment. Students investigate philosophical concepts and theories surrounding technology, society and the environment including: the "naturalness" of technology, sustainability and animal rights. Students critically examine course material by focusing on questions such as: What is nature, and what role do/should humans occupy in it? What do we owe non-human organisms? What do we owe future generations? Students engage in various peer-oriented learning activities throughout the course.

Prerequisite(s): none
Corerequisite(s): none

PHI4004 Technology, Society and the Environment

Environmental issues have come to occupy a central place in the marketplace, politics, policy, and society at large. Owing largely to the many environmental consequences that have accompanied industrialization, we humans have been forced to rethink the complex relationship between technology, society and the environment. Students investigate philosophical concepts and theories surrounding technology, society and the environment including: the "naturalness" of technology, sustainability and animal rights. Students critically examine course material by focusing on questions such as: What is nature, and what role do/should humans occupy in it? What do we owe non-human organisms? What do we owe future generations? Students engage in various peer-oriented learning activities throughout the course.

Prerequisite(s): none
Corerequisite(s): none

PHI4100 Survival in the Information Age: Risk and the Media

On an almost daily basis, the media, through its various outlets - television, radio, web sites, RSS, and podcasts - reports on issues that address our wellbeing. Through discussions, readings, and assignments, students enhance their ability to interpret and question information presented by the media by better understanding the inherent risks. Issues like alternative medicine (i.e. vaccinations) and socio-legal issues (i.e. bullying, hacking, surveillance, privacy) provide grounds for students to use principles from the social science as a means to think critically about real and perceived risks in daily life.

Prerequisite(s): PHI1000
**PHI4100 Survival in the Information Age: Risk and the Media**

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Prerequisite(s): PHI1000
Corerequisite(s): none

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**PHY4000 Black Holes, Big Bangs and the Cosmos**

The dynamic and exciting field of Cosmology outlines our current understanding of the Universe from its start, at the so-called Big Bang, through the ensuing 13 plus billion years to the present and beyond. Students learn how to discuss our present understanding of the three phases of the Universe as well as its five part make up, with matter making up only 4% of the whole. Students explain our knowledge of the various phases of evolution of the Cosmos and also the latest theories and experiments that are trying to address our uncertainties. Throughout the course, students evaluate and debate many of today's ideas and concepts revolving around cosmology.

Prerequisite(s): none
Corerequisite(s): none

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**PHY8103 Physics I**

The world we live in cannot exist without the intricate interactions of fundamental forces of nature. Advancements in technology, medicine and standards of living are directly related to a deeper understanding of these fundamental forces. Physics provides us with the insight and tools to not only accurately describe physical phenomena, but also to predict their behaviour. Students explore introductory physics and analyze problems using calculus, trigonometry and algebra. Topics for discussion and analysis include Newton's Laws of Motion, Kinematics, Dynamics, Energy and Work, Power, Rotational Motion and Torque and the Conservation of Momentum. Students also examine Newton's Law of Gravitation, and the essentials of vibrations, waves and Simple Harmonic Motion. Through a combination of lectures, in class activities, assignments and labs, students learn to use Physics to describe the fundamental forces of nature.

Prerequisite(s): none
Corerequisite(s): none

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**PHY8203 Physics II**

In order to gain a deeper understanding of some of the fundamental forces in nature, students explore a selection of more advanced topics in physics. Class discussions begin with the description of Thermodynamics and Heat Transfer. Further topics of discussion include Electricity and Magnetism and basic DC circuit theory. Students also explore Maxwell's Equations of electro-
magnetism and the link they provide to obtaining a formulation for the speed of light. Students then study the basics of Optics and optical instrumentation, as well as the Wave - Particle Duality paradox, and Photon energy. Additional topics for analysis and discussion include an introduction to key Modern Physics concepts such as General Relativity, Quantum Mechanics, Standard Theory of Matter and Cosmology through lectures, assignments and lab experiments in a team based environment.

Prerequisite(s): none
Corerequisite(s): none

**PLT1105 Introductory Optics**

Students explore the physics of waves, optics and light propagation through lectures and lab experiments. Other topics include geometrical optics, refraction and reflection, interference, diffraction and polarization, thin lens equation and laser beams. Students also examine Michelson interferometer, birefringence, and the Abbe theory of imaging, electromagnetic spectrum, quantum nature of light, photons and the photoelectric effect.

Prerequisite(s): PHY8203
Corerequisite(s): none

**ROB8113 Introduction to Robotics**

Newer robots are becoming a main stream of life and emerging technologies, while industrial robots have been used in manufacturing for decades. Students are introduced to the history and the basic fundamentals of robotics without the need for extensive background in mathematics and physics. Emphasis is on the practical and integrated nature of robotics. Students use robotic laboratory kits to assemble robotics experiments. Students learn basic electrical and mechanical assembly and measurement skills. Basic sensors used in robotics such as sonar, infra-red and cameras are introduced. Students are introduced to the basics of industrial robots, safety and operation of industrial robots.

Prerequisite(s): none
Corerequisite(s): none

**ROB8403 Industrial Robotics**

Robots often perform tasks in place of humans for reasons such as safety, efficiency and cost. Students gain an overview of robotics topics including vision, motion planning, mobile mechanisms, kinematics, inverse kinematics, sensors an introduction to industrial robotics in a manufacturing setting. Through lab experiments and assignments students construct robots driven by a microcontroller and work with a variety of sensors and applications. Students collaborate on robotic projects in teams to work towards having a robot complete more advanced tasks. Through an examination of contemporary developments in robotics, students develop a comprehensive picture of the roles played by robots in today's society.

Prerequisite(s): CAD8202 and CST8203 and ELN8304 and ENG8332 and MAT8406 and ROB8112
Corerequisite(s): none

**ROB8705 Computer Vision for Robotics**

Cameras are becoming ever more prevalent in robots as well as in the devices people carry everywhere. Computer vision unlocks this wealth of data to help robots understand the world around them. Topics include the physics of image formation, image processing, image transforms, texture and edge detection, classification, optical flow, feature detection, tracking, stereo vision and structured light range imaging. By implementing concepts and imaging processing algorithms, both in homework assignments and in course projects, students use programming tools to develop computer vision solutions to real-world robotics challenges.

Prerequisite(s): ROB8403
Corerequisite(s): none

**ROB8707 Mobile Robotics Systems and Design**
The wide variety of applications for mobile robots can necessitate novel designs to meet the requirements of a specific project. Students design and build innovative robots to accomplish challenging tasks. Lectures and discussions include topics such as introduction to mobile robot history, current applications and design paradigms, developing and meeting requirements, systems-level and electrical/mechanical design of mobile robotics, mobile robotic design principles, prototyping, wheel/track/leg configurations and gaits, design to meet power, size and performance requirements, and the challenges of designing and controlling non-holonomic systems. Using project-based learning, students build and integrate a mobile electro-mechanical platform that may be used in subsequent mobile robotics courses.

Prerequisite(s): ROB8403
Corerequisite(s): none

**ROB8902 Mobile Robotics Navigation and Control**

The evolving world of robotics includes an increasing number of mobile robotic platforms. Robot motion planning and navigation is a major focus of robotics. Topics include sensor based planning, probabilistic planning, localization, as well as mapping and motion planning for dynamic and non-holonomic systems. Students examine the concepts of trajectory planning and relate low-level implementation details to high-level algorithm concepts. Through implementation assignments and course projects, students apply motion, navigation methods and algorithms to both real platform and simulated robot environments.

Prerequisite(s): MAT8400 and ROB8707
Corerequisite(s): none

**ROB8903 Robotics and Automation Project I**

Industrial engineering work requires detailed design work on projects subject to strict requirement, qualifications, verification of project deliverables and professional communication with customers. Students integrate the knowledge accumulated in the previous three years of study in the program into a practical design and build of a year-long project of which the first half is in this course. Students create project work plans, set up progress milestones and verification tests to validate that the deliverables meet the project requirements. Students design project components and create a budget evaluation for the project. Students work in small groups and on their own in the project. Project topics are chosen from applied industrial an innovative robotics and automation applications.

Prerequisite(s): ENG8605
Corerequisite(s): none

**ROB9102 Advanced Mechatronics and Multi-Robot Systems**

Integration of electrical, mechanical and electrometrical components with computer aided control to produce functional technological system is becoming more and more necessary as technology advances. Multi robot systems are used in tasks where the task is insurmountable or too complicated for a single robot. Topics include advanced analysis on sensor choice, analogue to digital and digital to analogue data acquisition, PCB board design, circuit schematic design, mechanical/electrical interface methods, different battery technologies and power regulation design, specialized motors and actuators, integration of force, as well as vision and position into an electromechanical system. A brief introduction to medical robotics is also included. Students gain the skilled needed through design projects, lab experiments and assignments.

Prerequisite(s): ENG8605 and ENG8608 and ROB8902
Corerequisite(s): none

**ROB9104 Robotics and Automation Project II**

Industrial engineering work requires detailed design on projects subject to strict requirement, qualifications, verification of project deliverables and efficient communication with customers. Students apply skills and knowledge acquired throughout the program such as conceptual frameworks, methodologies and principles in executing engineering projects. Emphasis is on reliably and accurately performing engineering tasks during the completion of project work. Students finalize the design work, integrate components and execute verification tests to ensure
that the project meets the requirements set in the initial project plan.

Prerequisite(s): none
Corequisite(s): none

**SOC2000 Introduction to Sociology**

When working with individuals and groups it is important to understand both the background and influences present. Students develop a familiarity with sociological theories and methodological approaches used to study individual and group behaviours. Students also examine variables that include culture, social class, race, and gender and how these variables may impact work with diverse individuals and groups.

Prerequisite(s): ENL1100
Corequisite(s): none

**SOC4000 Criminology**

The interdisciplinary study of social science examining the individual and social aspects of crime is known as criminology. Students work through an introduction to the social science perspective on crime. Presentations, discussions, and assignments allow students to investigate the various theoretical positions related to crime and criminal behaviour. Working forward from the types and definitions of crime, students trace some of the links between government policy and the impacts of these policies on both society and the individual.

Prerequisite(s): SOC2000
Corequisite(s): none

**SOC4000 Criminology**

The interdisciplinary study of social science examining the individual and social aspects of crime is known as criminology. Students work through an introduction to the social science perspective on crime. Presentations, discussions, and assignments allow students to investigate the various theoretical positions related to crime and criminal behaviour. Working forward from the types and definitions of crime, students trace some of the links between government policy and the impacts of these policies on both society and the individual.

Prerequisite(s): SOC2000
Corequisite(s): none

**SOC4001 Global Perspectives**

Sociology, through its exploration of the organization of society and the connections between people and their surroundings, provides new ways of looking at the world. Using fundamental knowledge in the field of sociology, students analyze globalization and its impact on Canadian society. Students take opposing views to debate the opportunities and challenges that come with globalization.

Prerequisite(s): SOC2000
Corequisite(s): none

**SOC4001 Global Perspectives**

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Prerequisite(s): SOC2000
Corequisite(s): none
WKT0009 Co-Op I

The first co-op placement provides students with experiential opportunities within the field. Students attain entry-level positions that involve a variety of activities allowing application of principles and concepts developed during previous study. Students returning from Co-op I bring additional practical considerations to subsequent study. Although centred with public and private organizations located in Eastern Ontario, co-op employment opportunities may be sought throughout Canada and abroad.

Prerequisite(s): CAD8202 and CST8203 and ELN8304
Corequisite(s): none

WKT0010 Co-Op II

Co-op provides an experiential opportunity which is directly related to the field of study. The second work term centers on an expanded role with a higher level of responsibilities in the workplace. Students returning from co-op work term two contribute expanded knowledge and abilities to their program of study. Although centred with public and private organization located in Eastern Ontario, co-op employment opportunities are sought throughout Canada and abroad.

Prerequisite(s): WKT0009
Corequisite(s): none

WKT0017 Co-Op Work Term III

Co-op provides an experiential opportunity which is directly related to the field of study. The third work term centers on an expanded role with a higher level of responsibilities in the workplace. Students returning from co-op work term three contribute expanded knowledge and abilities to their program of study. Although centred with public and private institutions located in Eastern Ontario, co-op employment opportunities are sought throughout Canada and abroad.

Prerequisite(s): WKT0010
Corequisite(s): none