Area of Interest: Advanced Technology

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

Degree

Program Code: 6519X03FWO

4 Years

Ottawa Campus

Our Program

Blend the three fields of engineering to succeed in the high-demand field of automation and robotics.

The four-year Bachelor of Engineering (Automation and Robotics Engineering) 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 high-demand 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
- mathematics, technical writing, computer programming, physics
- dynamics, electronics, optical systems, 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 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.

Students also gain real-world experience through a paid co-operative education (co-op) work term (s) (see Additional Information for more details). Please note that places in the co-op work term(s) are subject to availability and academic eligibility. **Please note admission to a co-op program does not guarantee a co-op placement.**

There is a wide variety of work opportunities for you after graduation. As a graduate of this degree, you may find employment opportunities in sectors such as:

- industrial automation
- mining
- agriculture
- manufacturing

- chemical
- pharmaceutical
- food
- aerospace
- healthcare
- defence

This program is not yet accredited by the Canadian Engineering Accreditation Board (CEAB), however, Algonquin College intends to pursue accreditation.

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 electronic 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 a mechanical systems designer/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

Level: 01	Courses	Hours
CAD8202	Computer Aided Design	56.0
CST8107	Introduction to Programming and Problem Solving	56.0
ENL1100	Communications and Academic Writing	42.0
MAT6443	Calculus I	56.0
MAT8203	Linear Algebra	42.0
PHY8103	Physics I	70.0
Level: 02	**Courses**	**Hours**
CHE3190	Chemistry	56.0
CST8203	Advanced Programming and Data Structures	56.0
MAT8202	Calculus II	56.0
PHI1000	Logic and Critical Thinking	56.0
PHY8204	Physics II	42.0
ROB8113	Introduction to Robotics	42.0
Level: 03	**Courses**	**Hours**
ELN8304	Electrical and Electronic Circuits 1	56.0
ENG8001	Principles of Design	56.0
ENG8332	Engineering Mechanics: Statics	42.0
ENL8810	Technical Communications	42.0
GEP1001	Cooperative Education and Job Readiness	21.0
MAC8102	Machine Shop and Manufacturing Techniques	42.0
MAT8406	Differential Equations and Advanced Calculus	70.0
Level: 04	**Courses**	**Hours**
ELN8402	Electrical and Electronic Circuits 2	56.0
ELN8404	Digital Circuits, Design and Microprocessors	56.0
ENG8405	Engineering Mechanics: Dynamics	56.0

ENG8604	Fluid Mechanics and Hydraulics	56.0
ENG8607	Mechanics of Solids	56.0
SCI2000	Environmental Science	42.0
Co-op: 01	**Courses**	**Hours**
WKT0009	Co-Op Work Term I	
Level: 05	**Courses**	**Hours**
ELN8606	Control Systems	56.0
ENG8603	Dynamics of Machinery	42.0
ENG8605	Mechatronics	56.0
ENG8608	Industrial Robot Cells	56.0
MAT8400	Mathematics for Engineers	42.0
ROB8403	Industrial Robotics	56.0
Co-op: 02	**Courses**	**Hours**
WKT0010	Co-Op Work Term II	
Level: 06	**Courses**	**Hours**
CST8703	Real Time and Embedded Systems Programming	56.0
ENG8704	Mechanical Systems Design	56.0
ENG8905	Sensors and Instrumentation	56.0
MGT8904	Engineering Economics and Entrepreneurship	56.0
ROB8224	Mobile Robotics: Control, Guidance, and Navigation	84.0
Co-op: 03	**Courses**	**Hours**
WKT0017	Co-Op Work Term III	
Level: 07	**Courses**	**Hours**
ENG8706	Heat Transfer and Thermodynamics	42.0
ROB8705	Computer VIsion for Robotics	42.0
ROB8904	Robotics and Automation Project 1	84.0
ROB9102	Advanced Robotics	56.0
Elective: choose 1	**Courses**	**Hours**
ENL4016	World Literature	42.0
ENL4100	Creative Writing	42.0
ENL4200	New Worlds and Alternative Realities: Speculative Fiction	42.0
PHI4000	Philosophy and Popular Culture	42.0

PHI4002	The Philosophy of Drugs	42.0
PHI4003	The Philosophy of Love and Sex	42.0
PHI4004	Technology, Society and the Environment	42.0
PHI4100	Survival in the Information Age: Risk and the Media	42.0
PHY4000	Black Holes, Big Bangs and the Cosmos	42.0
SOC4000	Criminology	42.0
SOC4001	Global Perspectives	42.0
Level: 08	**Courses**	**Hours**
ENG3191	Professional Practice and Ethics	28.0
ENG9103	System Level Reliability	42.0
ROB9106	Robotics and Automation Project 2	84.0
Elective: choose 2	**Courses**	**Hours**
ENL4016	World Literature	42.0
ENL4100	Creative Writing	42.0
ENL4200	New Worlds and Alternative Realities: Speculative Fiction	42.0
PHI4000	Philosophy and Popular Culture	42.0
PHI4002	The Philosophy of Drugs	42.0
PHI4003	The Philosophy of Love and Sex	42.0
PHI4004	Technology, Society and the Environment	42.0
PHI4100	Survival in the Information Age: Risk and the Media	42.0
PHY4000	Black Holes, Big Bangs and the Cosmos	42.0
SOC4000	Criminology	42.0
SOC4001	Global Perspectives	42.0

Fees for the 2024/2025 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 .

Further information on fees can be found by visiting the Registrar`s Office website at http://file:///C:/Users/wingraph/AppData/Local/Apps/2.0/85J89O2J.M29/57NR9QLR.4D2/test..tion-_e800ab5aa35904b3_0001.0000_d5a94ace07199376/www.algonquincollege.com/ro .

Fees are subject to change.

Additional program related expenses include:
Books and supplies cost approximately $1,200 per academic year.

Admission Requirements for the 2025/2026 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 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 2024/2025 Academic Year

College Eligibility

- Ontario Secondary School Diploma (OSSD) or equivalent.

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- 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:

Application Information

BACHELOR OF ENGINEERING (AUTOMATION AND ROBOTICS ENGINEERING) (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 https://www.ontariocolleges.ca/ .

The equal consideration date is February 1. After the equal consideration date, applications for open program spaces will be considered on a first-come, first-serve basis.

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
Contact: https://www.algonquincollege.com/ro

Additional Information

Algonquin College has been granted consent by the Minister of Colleges and Universities to offer this applied degree for a seven-year term starting December 20, 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.

CO-OP INFORMATION:
Co-operative education (Co-op) allows students to integrate their classroom learning with a real-world experience through paid work terms. Two academic terms prior to the cooperative education work term, students are required to actively participate in and successfully complete the self-directed co-op course, readiness activities and workshops.

Students must actively conduct a guided, self-directed job search and are responsible for securing approved program-related paid co-op employment. Students compete for co-op positions alongside students from Algonquin College and other Canadian and international colleges and universities. Algonquin College`s Co-op Department provides assistance in developing co-op job opportunities and guides the overall process, but does not guarantee that a student will obtain employment in a co-op work term. Co-op students may be required to relocate to take part in the co-op employment opportunities available in their industry and must cover all associated expenses; e.g., travel, work permits, visa applications, accommodation and all other incurred expenses.

Co-op work terms are typically 14 weeks in duration and are completed during a term when students are not taking courses. For more information on your program`s co-op level(s), visit the courses tab on your program`s webpage.

International students enrolled in a co-op program are required by Immigration, Refugees and Citizenship Canada (IRCC) to have a valid Co-op/Internship Work Permit prior to commencing their work term. Without this document International students are not legally eligible to engage in work in Canada that is part of an academic program. The Co-op/Internship Work Permit does not authorize international students to work outside the requirements of their academic program.

For more information on co-op programs, the co-op work/study schedule, as well as general and program-specific co-op eligibility criteria, please visit https://www.algonquincollege.com/coop .

Completion of the total number of co-op work terms listed under the courses section on the program page are mandatory for graduation. Co-op students must make every effort to remain on schedule and participate in co-op work terms as planned. Students who fail to complete co-op work terms as scheduled may be required to take an unscheduled break in their studies, resulting in a delay in graduation in order to complete their co-op at a later date. Taking an unscheduled break in studies can impact an international student’s immigration status, including, in most cases, the ability to work. International students are advised to consult with the International Education

Centre to understand the potential implications of unscheduled breaks at https://www.algonquincollege.com/international/student-handouts/scheduled-unscheduled-breaks/ .

ADVANCED STANDING:
Graduates of recognized Electro-Mechanical Engineering Technician Diploma, Electrical Engineering Technology Advanced Diploma, Mechanical Engineering Technology Advanced Diploma and Electrical Engineering Technician Diploma programs are eligible to apply to customized pathway programs reducing program duration.

Graduates of other related Ontario College Diploma or Ontario College Advanced Diploma programs may be eligible for advanced standing into the degree program. Please visit the degree program listing or speak to the Program Coordinator for more information and to confirm eligibility.

Contact Information

Program Coordinator(s)

- Raymond Greiss, mailto:greissr@algonquincollege.com , 613-727-4723, ext. 7713
- Chandika Samynathan, mailto:samynac@algonquincollege.com , 613-727-4723

Course Descriptions

CAD8202 Computer Aided Design

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 are introduced to CAD tools and 3D printing technologies. Students explore standard engineering drawing conventions such as dimensioning and tolerance specifications. Fundamental principles of geometry, creative design processes, conceptualization and prototyping are also taught. Through applied CAD activities, students ideate, design, and leverage 3D printing to develop a mechanical device prototype.

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

CHE3190 Chemistry

Chemistry is both directly and indirectly used in engineering. Students develop a foundation in chemistry learning about a variety of topics including chemical structures, the properties of liquids, solids and gases, stoichiometry, electrochemistry, chemical equilibrium and chemical kinetics. Hands-on experiments 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): none
Corerequisite(s):none

CST8703 Real Time and Embedded Systems Programming

With the advent of the Internet of Things (IoT) and more powerful microcontrollers (MCU), electronics are becoming more ubiquitous in applications ranging from a washer and dryers, to back-up cameras in cars. These applications typically employ MCUs that are optimized to specific tasks and employ lower-level programming languages. In the case of real-time embedded systems, a task must be completed by a certain time or it is considered a failure of the system. In this course, students apply embedded programming techniques for both real and non-real time systems to complete real world tasks. Students also explore real-time operating system principles and parallel programing principles such as deadlock avoidance, locks, semaphores, message passing, memory management and multi core programming. Through applied activities, students write real-time programs on a micro-controller.

Prerequisite(s): CST8203 and ELN8404
Corerequisite(s):none

ELN8304 Electrical and Electronic Circuits 1

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 further explore voltage, current, power, energy, resistance, capacitance and inductance concepts. 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. Through simulation activities and lab experiments, students build electronic circuits.

Prerequisite(s): MAT8202 and PHY8204
Corerequisite(s):none

ELN8402 Electrical and Electronic Circuits 2

Knowledge of advanced topics in electric and electronic circuits is essential in many engineering disciplines. Students examine advanced topics in circuit theory including circuit analysis using Fourier series and transform and Laplace transform. Furthermore, students use the knowledge acquired to solve more complex engineering problems and to build the foundation for more advanced design tasks. Students study Operational Amplifier (OP-AMP) circuits and derive the amplitude and phase response of such circuits. Topics in electronics include different semiconductor devices: PN junction diode, zener diode, bipolar junction transistor, field-effect transistor and MOSFET. On the applied side, students study the application of different diodes and transistors. In addition, student design amplifier circuits, filters, oscillators and apply proper electronic circuit analysis techniques. Students use practical components from catalogues in application circuits and conduct lab experiments applying theoretical materials. In addition, experiments in the practical lab component with experiments support the theoretical material.

Prerequisite(s): ELN8304 and ENG8001
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 and ENG8001
Corerequisite(s):none

ELN8606 Control Systems

Feedback control systems are a fundamental aspect of engineering, especially within robotics and automation. Typical control systems rely upon sensor measurements 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 explore 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. Through the application of control theory in laboratory activities and a design project, students engage in the formal process of designing and testing a control system within a given set of constraints.

Prerequisite(s): ENG8001 and MAT8406
Corerequisite(s):none

ENG3191 Professional Practice and Ethics

Knowledge of the responsibilities of engineers towards the public and the legal obligations of practicing engineering is essential for the graduates of engineering programs. Students develop basic knowledge of professionalism and ethics within society and the engineering profession. Topics include basic concepts of professional practice, hazards, liability, standards and safety, fairness and equity in the professional workplace, principles of ethics, environmental ethics, environmental sustainability, and legal considerations relating to practice. Students are also introduced to the criteria for Professional Practice Exam (PPE). Through case studies and scenarios, students develop a broad understanding of professional practice for engineers.

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

ENG8001 Principles of Design

Design principles are essential tools and techniques that enable engineers to iteratively solve problems in a targeted way. In this applied course, students are introduced to the design process and develop solutions to complex open-ended engineering problems. Students are introduced to ways of quantifying objectives and constraints to define engineering problems. Students iterate on ideas and apply formal-decision making techniques to narrow the scope for feasible designs. Students evaluate their designs through prototyping, experiments and validation activities. Throughout the design process, students consider and incorporate professional, legal, ethical and sustainability concerns into their work. Through applied design activities, practical exercises and case studies, students develop solutions to a variety of engineering problems.

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): MAT8202 and MAT8203 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

Information about the motion, forces, and general dynamic behaviors of mechanical systems are essential for a designer to be able to select a machine's required elements, dimensions, materials, or predict their performance. Students attain the fundamental skills required to model, analyze, and simulate common mechanism used in automated machines formed by multiple joints and links. Students develop skills in analyzing the kinematics and dynamics of mechanisms to analyze a mechanical system to inform design decisions. Students calculate displacements, velocities, accelerations and forces for general linkages. The free and forced vibrations of first and second order mechanical systems are discussed. Through analysis of planar mechanisms, problem solving activities and assignments, students develop a set of techniques to calculate motion of mechanical systems.

Prerequisite(s): CAD8202 and ENG8405
Corerequisite(s):none

ENG8604 Fluid Mechanics and Hydraulics

Fluid mechanics and hydraulics is an important branch of engineering mechanics, since these principles are widespread in all engineering applications involving a fluid. Students develop knowledge of fluid statics and dynamics in engineering by examining fundamentals in 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): ENG8332 and MAT8406
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 processes, data presentation, measurements and error, control logic, sensors, actuators including AC/DC and stepper motors. 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 behavior, communication protocols, pneumatics, and embedded programming and in analyzing existing mechatronic systems and designing new systems. Through case studies and practical lab and design activities, students

develop hands on experience with industrial automation.

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): ENG8332 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 to 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): ELN8404 and ENG8604
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: Reinforcing the design process and 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 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): ENG8001 and ENG8607 and MAC8102
Corerequisite(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): MAT8406 and PHY8204
Corerequisite(s):none

ENG8905 Sensors and Instrumentation

Robotics and automation systems use sensors and instrumentation to reliably measure environmental conditions such as pressure, temperature, luminosity, and mechanical loads to perform operations safely and optimally. 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. Through case studies and in-class discussions, students are exposed to the operating principles of common sensors and metrics of sensor performance. Laboratory activities and a design project complement in-class activities through critical analysis of published sensor data and independent testing of various sensors.

Prerequisite(s): ELN8402 and ELN8404
Corerequisite(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 explore 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 case studies, applied data analysis activities and assignments, students apply reliability concepts to real-world automation and robotics systems to meet reliability requirements.

Prerequisite(s): MAT8400
Corerequisite(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

ENL4016 World Literature

Exposure to broad sources of literature promotes an open-minded perspective on today's global society and encourages an appreciation of diversity and human differences. In World Literature, students explore key literary works from around the world and examine the socio-historical and cultural contexts in which authors wrote and set these texts. Students learn to identify common themes and apply literary and cultural theory to these works towards expanding critical thinking skills and developing an analytical vocabulary. Through seminar presentations, group discussions, debates, journaling, and creative writing, students grapple with literary representations of social, political, and cultural issues from around the world, gaining an appreciation of what it means to be responsible global citizens and possess the ability to listen to, question, and value diverse perspectives.

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

ENL4016 World Literature

Exposure to broad sources of literature promotes an open-minded perspective on today's global society and encourages an appreciation of diversity and human differences. In World Literature, students explore key literary works from around the world and examine the socio-historical and cultural contexts in which authors wrote and set these texts. Students learn to identify common themes and apply literary and cultural theory to these works towards expanding critical thinking skills and developing an analytical vocabulary. Through seminar presentations, group discussions, debates, journaling, and creative writing, students grapple with literary representations of social, political, and cultural issues from around the world, gaining an appreciation of what it means to be responsible global citizens and possess the ability to listen to, question, and value diverse

perspectives.

Prerequisite(s): ENL1100
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

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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

ENL8810 Technical Communications

Students develop an appreciation of both the applications and the implications of technical communication. Through a combination of written and oral assignments, the practical requirements of technical communication, along with some of its theoretical foundations, are investigated. As part of these investigations, students examine, discuss and prepare the components of a formal technical report.

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

GEP1001 Cooperative Education and Job Readiness

Students are guided through a series of activities that prepare them to conduct a professional job search and succeed in the workplace. 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 a web-based resource centre, which is used to post employment and 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): none
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 and continuity 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, curve sketching, and finding an approximate solution to an equation using Newton's method. 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. They use the Trapezoidal and Simpson's Rules to perform numerical integrations. Students study a variety of applications of integration, such as area, volume and work problems.

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 eigen vectors, together with selected applications, such as linear programming, economic models, 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 programing environment.

Prerequisite(s): CST8107
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 involved in control systems and mechatronics and develop the foundations of advanced calculus and analytic geometry to solve problems involving volumes and fluid mechanics. Students calculate double integrals in both rectangular and polar coordinates and triple integrals in rectangular, cylindrical and spherical coordinates. Topics include defining vector fields and calculating line integrals, defining parametric surfaces and calculating surface integrals, solving first-order differential equations by separating variables, by integrating factors for linear equations and Laplace Transforms. Students also solve both homogeneous and non-homogenous second-order differential equations with constant coefficients using variation of parameters and Laplace Transforms.

Prerequisite(s): MAT8202 and MAT8203
Corerequisite(s):none

MGT8904 Engineering Economics and Entrepreneurship

Knowledge of entrepreneurship and economics is essential for engineers to identify the right kind of business opportunities and to help them with better decision-making. Students gain insights into entrepreneurial potential, small business management and systematic evaluation of business opportunities. Using different techniques and concepts, including 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 understand the importance of systematic evaluation and analysis of technical engineering projects. Through discussions and case studies, students analyze methodologies of economics and finance combined with engineering fundamentals.

Prerequisite(s): none
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

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

PHI4000 Philosophy and Popular Culture

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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

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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

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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
Corerequisite(s):none

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

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

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

PHY8204 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 and assignments in a team-based environment.

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

ROB8113 Introduction to Robotics

Newer robots are becoming a mainstream of life and emerging technologies, while industrial robots have been used in manufacturing for decades. Students examine 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 explore 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. Through a group design project, students explore the scope and limitation of sensors commonly used in robotics. Furthermore, students build experience in engineering design

through written reports which detail their efforts to formally outline objectives, synthesis, and analysis of their project design.

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

ROB8224 Mobile Robotics: Control, Guidance, and Navigation

The wide variety of applications for mobile robots can necessitate novel design approaches to meet the requirements of today's projects. In this course, students explore the corresponding theories and apply them in the design and fabrication of mobile robots to accomplish designated tasks. The emphasis will be on wheeled mobile robots. Lectures and discussions include topics such as History of mobile robots, artificial positioning, forward kinematics, steering, Design for wheels, degree of mobility, degree of steerability, robot Control, sensor classification, sensor response, uncertainty, error propagation, noise and aliasing, error modeling, belief, SLAM problem, path planning, obstacle avoidance, navigation strategies, and filtering algorithms. In a major course project students will learn the basics of robot operating systems, and then design, program, simulate and integrate a mobile robot that can be further developed to the fourth-year project and/or used in other advanced courses. Through implementation assignments and course projects, students apply motion, navigation methods and algorithms to both real platform and simulated robot environments.

Prerequisite(s): ELN8606 and ROB8403
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): CST8203 and ENG8405 and MAT8406 and ROB8113
Corerequisite(s):none

ROB8705 Computer VIsion for Robotics

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

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

ROB8904 Robotics and Automation Project 1

Engineering projects require significant planning to clearly outline objectives, constraints and function of design solutions. Students apply their knowledge in automation and robotics engineering towards the completion of a single engineering project through a pair of project courses. The first project course emphasizes the planning and iterative concept selection phases of the engineering design cycle. Students work in small groups to create project work plans, set up progress milestones, perform a risk assessment and perform engineering analysis on solution concepts. Through the application of risk assessments, concept selection and evaluation and comprehensive design documentation, students prepare a project plan to support future prototyping and building phases.

Prerequisite(s): ENG8605 and ENG8704
Corerequisite(s):none

ROB9102 Advanced Robotics

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. Advanced mechatronics builds on earlier knowledge gained in mechatronics, circuit analysis, sensors and instruments and dynamics. Students explore advanced topics in electrical/mechanical and electrometrical hardware integration, develop computer aided software controls for mechatronic systems. Topics covered 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, vision and position into an electromechanical system. Students gain the skilled needed from this through design projects, lab experiments and assignments.

Prerequisite(s): ROB8224
Corerequisite(s):none

ROB9106 Robotics and Automation Project 2

Engineering projects require comprehensive testing and prototyping to ensure a design solution meets specific objectives and design criteria. Students prototype a design based on initial design documentation and stakeholder input. Students develop and perform verification and validation tests to ensure designs achieve intended functions. Students iterate on prototypes to optimize a final design deliverable. Through failure modes and effects analysis, test planning and integration of stakeholder feedback, students develop and deliver a working prototype. Students also reflect on their experience working on a stakeholder project to support professional development.

Prerequisite(s): ROB8904
Corerequisite(s):none

SCI2000 Environmental Science

Environmental science is an interdisciplinary study of how the earth works, human interaction with the earth and how to address the existing environmental problems. Students explore natural capital and the degradation. Students engage in case studies, critical thinking and analysis of alternatives in exploring solutions and trade-offs in trying to address degradation.

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

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of these policies on both society and the individual.

Prerequisite(s): SOC2000
Corerequisite(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
Corerequisite(s):none

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Prerequisite(s): SOC2000
Corerequisite(s):none

WKT0009 Co-Op Work Term 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
Corerequisite(s):none

WKT0010 Co-Op Work Term 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
Corerequisite(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
Corerequisite(s):none