2019-2020 Graduate Calendar

The information published in this Graduate Calendar outlines the rules, regulations, curricula, programs and fees for the 2019-2020 academic year, including the Summer Semester 2019, Fall Semester 2019 and the Winter Semester 2020.

For your convenience the Graduate Calendar is available in PDF format.

If you wish to link to the Graduate Calendar please refer to the Linking Guidelines.

The University is a full member of:

• Universities of Canada

Contact Information:

University of Guelph
Guelph, Ontario, Canada
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519-824-4120

Revision Information:

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<tr>
<td>May 1, 2019</td>
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<tr>
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Disclaimer

The Office of Graduate and Postdoctoral Studies has attempted to ensure the accuracy of this on-line Graduate Calendar. However, the publication of information in this document does not bind the university to the provision of courses, programs, schedules of studies, fees, or facilities as listed herein.

Limitations

The University of Guelph reserves the right to change without notice any information contained in this calendar, including any rule or regulation pertaining to the standards for admission to, the requirements for the continuation of study in, and the requirements for the granting of degrees or diplomas in any or all of its programs.

The university will not be liable for any interruption in, or cancellation of, any academic activities as set forth in this calendar and related information where such interruption is caused by fire, strike, lock-out, inability to procure materials or trades, restrictive laws or governmental regulations, actions taken by the faculty, staff or students of the university or by others, civil unrest or disobedience, Public Health Emergencies, or any other cause of any kind beyond the reasonable control of the university.

The University of Guelph reaffirms section 1 of the Ontario Human Rights Code, 1981, which prohibits discrimination on the grounds of race, ancestry, place of origin, colour, ethnic origin, citizenship, creed, sex, sexual orientation, handicap, age, marital status or family status.

The university encourages applications from women, aboriginal peoples, visible minorities, persons with disabilities, and members of other under-represented groups.
Introduction

Collection, Use and Disclosure of Personal Information

Personal information is collected under the authority of the University of Guelph Act (1964), and in accordance with Ontario's Freedom of Information and Protection of Privacy Act (FIPPA) [http://www.e-laws.gov.on.ca/DBLaws/Statutes/English/90f31_e.htm]. This information is used by University officials in order to carry out their authorized academic and administrative responsibilities and also to establish a relationship for alumni and development purposes. Certain personal information is disclosed to external agencies, including the Ontario Universities Application Centre, the Ministry of Advanced Education and Skills Development, and Statistics Canada, for statistical and planning purposes, and is disclosed to other individuals or organizations in accordance with the Office of Registrarial Services Departmental Policy on the Release of Student Information. For details on the use and disclosure of this information call the Office of Registrarial Services at the University at (519) 824-4120 or see [https://www.uoguelph.ca/registrar/]

Statistics Canada - Notification of Disclosure

For further information, please see Statistics Canada's web site at [http://www.statcan.gc.ca] and Section XIV Statistics Canada.

Address for University Communication

Depending on the nature and timing of the communication, the University may use one of these addresses to communicate with students. Students are, therefore, responsible for checking all of the following on a regular basis:

Email Address

The University issued email address is considered an official means of communication with the student and will be used for correspondence from the University. Students are responsible for monitoring their University-issued email account regularly.

Home Address

Students are responsible for maintaining a current mailing address with the University. Address changes can be made, in writing, through Registrarial Services.

Name Changes

The University of Guelph is committed to the integrity of its student records, therefore, each student is required to provide either on application for admission or on personal data forms required for registration, their complete, legal name. Any requests to change a name, by means of alteration, deletion, substitution or addition, must be accompanied by appropriate supporting documentation.

Student Confidentiality and Release of Student Information Policy Excerpt

The University undertakes to protect the privacy of each student and the confidentiality of their record. To this end the University shall refuse to disclose personal information to any person other than the individual to whom the information relates where disclosure would constitute an unjustified invasion of the personal privacy of that person or of any other individual. All members of the University community must respect the confidential nature of the student information which they acquire in the course of their work.

Complete policy at [https://www.uoguelph.ca/secretariat/office-services/university-secretariat/university-policies].
Learning Outcomes

Graduate Degree Learning Outcomes

On May 27, 2013, the University of Guelph Senate approved the following five University-wide Learning Outcomes as the basis from which to guide the development of graduate degree programs, specializations and courses:

1. Critical and Creative Thinking
2. Literacy
3. Global Understanding
4. Communication
5. Professional and Ethical Behaviour

These learning outcomes are also intended to serve as a framework through which our educational expectations are clear to students and the broader public; and to inform the process of outcomes assessment through the quality assurance process (regular reviews) of programs and departments.

An on-line guide to the learning outcomes, links to the associated skills, and detailed rubrics designed to support the development and assessment of additional program and discipline-specific outcomes, are available for reference on the Learning Outcomes website.

Critical and Creative Thinking

Critical and creative thinking is a concept in which one applies logical principles, after much inquiry and analysis, to solve problems with a high degree of innovation, divergent thinking and risk taking. Those mastering this outcome show evidence of integrating knowledge and applying this knowledge across disciplinary boundaries. Depth and breadth of understanding of disciplines is essential to this outcome. At the graduate level, originality in the application of knowledge (master’s) and undertaking of research (doctoral) is expected. In addition, Critical and Creative Thinking includes, but is not limited to, the following outcomes: Independent Inquiry and Analysis; Problem Solving; Creativity; and Depth and Breadth of Understanding.

Literacy

Literacy is the ability to extract information from a variety of resources, assess the quality and validity of the material, and use it to discover new knowledge. The comfort in using quantitative literacy also exists in this definition, as does using technology effectively and developing visual literacy.

In addition, Literacy includes, but is not limited to, the following outcomes: Information Literacy, Quantitative Literacy, Technological Literacy, and Visual Literacy.

Global Understanding

Global understanding encompasses the knowledge of cultural similarities and differences, the context (historical, geographical, political and environmental) from which these arise, and how they are manifest in modern society. Global understanding is exercised as civic engagement, intercultural competence and the ability to understand an academic discipline outside of the domestic context.

In addition, Global Understanding includes, but is not limited to, the following outcomes: Global Understanding, Sense of Historical Development, Civic Knowledge and Engagement, and Intercultural Competence.

Communication

Communication is the ability to interact effectively with a variety of individuals and groups, and convey information successfully in a variety of formats including oral and written communication. Communication also comprises attentiveness and listening, as well as reading comprehension. It includes the ability to communicate and synthesize information, arguments, and analyses accurately and reliably.

In addition, Communication includes, but is not limited to, the following outcomes: Oral Communication, Written Communication, Reading Comprehension, and Integrative Communication.

Professional and Ethical Behaviour

Professional and ethical behaviour requires the ability to accomplish the tasks at hand with proficient skills in teamwork and leadership, while remembering ethical reasoning behind all decisions. The ability for organizational and time management skills is essential in bringing together all aspects of managing self and others. Academic integrity is central to mastery in this outcome. At the graduate level, intellectual independence is needed for professional and academic development and engagement.

In addition, Professional and Ethical Behaviour includes, but is not limited to, the following outcomes: Teamwork, Ethical Reasoning, Leadership, Personal Organization and Time Management, and Intellectual Independence.
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Artificial Intelligence

The Collaborative Specialization in Artificial Intelligence (AI) provides thesis-based masters students in Computer Science, Engineering, Mathematics and Statistics, and Bioinformatics with a diverse and comprehensive knowledge base in AI. Students wishing to undertake graduate studies at the masters level with emphasis on artificial intelligence will be admitted by a participating department and will register in both the participating department and in the collaborative specialization.

Students will learn from a multidisciplinary team of faculty with expertise in fundamental and applied deep learning and machine learning, while conducting AI-related research guided by a faculty advisor. By the end of this program, graduates will have comprehensive understanding of leading-edge AI techniques and will be able to apply this knowledge to solve real-world problems.

Administrative Staff

Graduate Program Coordinator
Dr. Graham Taylor (3515 Thombrough, Ext. 53644)
gwtaylor@uoguelph.ca

TBD
Graduate Program Assistant (, Ext. )

Graduate Faculty

Sarah J. Adamowicz
Associate Professor, Integrative Biology

R. Ayesha Ali
Associate Professor, Mathematics and Statistics

Luiza Antonie
Assistant Professor, Computer Science

Shawki Areibi
Professor, Engineering

Dan Ashlock
Professor, Mathematics and Statistics

Christine Baes
Assistant Professor, Animal Biosciences

Mohammad Biglarbegian
Associate Professor, Engineering

Scott Brandon
Assistant Professor, Engineering

David Calvert
Associate Professor, Computer Science

Monica Cojocaru
Professor, Mathematics

Christopher Collier
Assistant Professor, Engineering

Rozita Dara
Assistant Professor, Computer Science

Fantahun Defersha
Associate Professor, Engineering

Ali Dehghantanz
Assistant Professor, Computer Science

Ibrahim Deiab
Associate Professor, School of Engineering

Robert Dony
Associate Professor, Engineering

Hermann Josef Eberl
Professor, Mathematics and Statistics

Zeny Feng
Associate Professor, Mathematics and Statistics

David Flatla
Associate Professor, Computer Science

Andrew Gadsden
Assistant Professor, Engineering

Bahram Gharabaghi
Professor, Engineering

Karen Gordon
Associate Professor, Engineering

Gary Grewal
Associate Professor, School of Computer Science

Andrew Hamilton-Wright
Associate Professor, Computer Science

Julie Horrocks
Professor, Mathematics and Statistics

Hadis Karimipour

Assistant Professor, Engineering

Stefan Kremers
Professor, Computer Science

Anna Lawnickzak
Professor, Mathematics and Statistics

William Lubitz
Associate Professor, Engineering

Lewis Lukens
Associate Professor, Plant Agriculture

Pascal Matsakis
Professor, Computer Science

Edward McBean
Professor, Engineering

Medhat Moussa
Professor, Engineering

Khurram Nadeem
Assistant Professor, Mathematics and Statistics

Charlie Obimbo
Associate Professor, Computer Science

Michele Oliver
Professor, Engineering

Stacey Scott
Professor, Engineering

Fei Song
Associate Professor, Computer Science

Petros Spachos
Associate Professor, Computer Science

Deborah Stacey
Associate Professor, Computer Science

Graham Taylor
Associate Professor, Computer Science

Dan Tulpan
Assistant Professor, Animal Biosciences

Fangjin Wang
Professor, Computer Science

Mark Wineberg
Associate Professor, Computer Science

Simon Yang
Professor, Engineering

Yang Xiang
Professor, Computer Science

Associated Graduate Faculty

Dirk Steinke
Associate Director Centre for Biodiversity and Adjunct Professor Integrative Biology

MSc/MASc Collaborative Specialization

Admission Requirements

Masters students in the Collaborative Specialization in Artificial Intelligence must meet the admission requirements of the participating department in which they are enrolled. The application process has two stages. First, prospective students will apply to their primary program of interest, identifying interest in the collaborative specialization as a focus. If the student is admitted to the primary program as a thesis student, the second stage is then admission to the collaborative specialization. All applications to participate in the Collaborative Specialization in Artificial Intelligence will be vetted by the specialization’s Graduate Program Coordinator.

Program Requirements

Masters students in the collaborative specialization in artificial intelligence must complete:

- UNIV*6080 [0.25] Computational Thinking for Artificial Intelligence
- UNIV*6090 [0.50] Artificial Intelligence Applications and Society
- One of the following Elective Core courses:
  - CIS*6020 [0.50] Artificial Intelligence
  - ENGG*6500 [0.50] Introduction to Machine Learning
  - STAT*6801 [0.50] Statistical Learning
- Two of the following Complementary AI-related courses:
  - BINF*6970 [0.50] Statistical Bioinformatics
  - CIS*6050 [0.50] Neural Networks
  - CIS*6060 [0.50] Bioinformatics
  - CIS*6070 [0.50] Discrete Optimization
  - CIS*6080 [0.50] Genetic Algorithms
  - CIS*6100 [0.50] Parallel Processing Architectures
  - CIS*6120 [0.50] Uncertainty Reasoning in Knowledge Representation

2019-2020 Graduate Calendar

January 28, 2020
**X. Collaborative Specializations, Artificial Intelligence**

**Required Courses**

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<td>BINF*6970</td>
<td>Statistical Bioinformatics W [0.50]</td>
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<tr>
<td>CIS*6050</td>
<td>Neural Networks U [0.50]</td>
</tr>
<tr>
<td>CIS*6060</td>
<td>Bioinformatics U [0.50]</td>
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<tr>
<td>CIS*6070</td>
<td>Discrete Optimization U [0.50]</td>
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<tr>
<td>CIS*6080</td>
<td>Genetic Algorithms U [0.50]</td>
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<tr>
<td>CIS*6100</td>
<td>Artificial Intelligence U [0.50]</td>
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<tr>
<td>CIS*6140</td>
<td>Software Engineering</td>
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<td>CIS*6160</td>
<td>Multiagent Systems</td>
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<td>CIS*6320</td>
<td>Image Processing Algorithms and Applications</td>
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<tr>
<td>ENGG*6100</td>
<td>Machine Vision</td>
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<td>ENGG*6140</td>
<td>Optimization Techniques for Engineering</td>
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<td>ENGG*6570</td>
<td>Advanced Soft Computing</td>
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<tr>
<td>MATH*6020</td>
<td>Scientific Computing</td>
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<td>MATH*6021</td>
<td>Optimization I</td>
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<td>MATH*6051</td>
<td>Mathematical Modelling</td>
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<td>PHIL*6760</td>
<td>Science and Ethics</td>
</tr>
<tr>
<td>STAT*6821</td>
<td>Multivariate Analysis</td>
</tr>
<tr>
<td>STAT*6841</td>
<td>Computational Statistical Inference</td>
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<tr>
<td>ENGG*4460</td>
<td>Robotic Systems</td>
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<tr>
<td>STAT*4000</td>
<td>Statistical Computing</td>
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And an acceptable AI-related thesis. Requirements of this collaborative specialization may also serve as core and/or elective requirements in the student’s home program.

**Elective Core**

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<tr>
<th>Course Code</th>
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<tr>
<td>CIS*6020</td>
<td>Artificial Intelligence U [0.50]</td>
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<tr>
<td>ENGG*6500</td>
<td>Introduction to Machine Learning U [0.50]</td>
</tr>
<tr>
<td>STAT*6801</td>
<td>Statistical Learning U [0.50]</td>
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**Complementary AI-related**

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<tr>
<th>Course Code</th>
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<tr>
<td>BINF*6970</td>
<td>Statistical Bioinformatics W [0.50]</td>
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This course presents a selection of advanced approaches for the statistical analysis of data that arise in bioinformatics, especially genomic data. A central theme to this course is the modelling of complex, often high-dimensional, data structures.

**Prerequisite(s):** Introductory courses in statistics, mathematics and programming

**Restriction(s):** Restricted to students in Bioinformatics programs. Students in other programs may consult with course instructor.

**Course Details**

- **CIS*6050 Neural Networks U [0.50]**
  - **Department(s):** School of Computer Science

- **CIS*6060 Bioinformatics U [0.50]**
  - Data mining and bioinformatics, molecular biology databases, taxonomic groupings, sequences, feature extraction, Bayesian inference, cluster analysis, information theory, machine learning, feature selection.
  - **Department(s):** School of Computer Science

- **CIS*6070 Discrete Optimization U [0.50]**
  - This course will discuss problems where optimization is required and describes the most common techniques for discrete optimization such as the use of linear programming, constraint satisfaction methods, and genetic algorithms.
  - **Department(s):** School of Computer Science

- **CIS*6080 Genetic Algorithms U [0.50]**
  - This course introduces the student to basic genetic algorithms, which are based on the process of natural evolution. It is explored in terms of its mathematical foundation and applications to optimization in various domains.
  - **Department(s):** School of Computer Science

- **CIS*6100 Artificial Intelligence U [0.50]**
  - This course provides a comprehensive overview of the field of artificial intelligence, covering a wide range of topics and applications. It introduces the fundamental concepts and techniques that are essential for understanding and working in the field of artificial intelligence.
  - **Department(s):** School of Computer Science

- **CIS*6140 Software Engineering U [0.50]**
  - This course covers the fundamentals of software engineering, including software development methodologies, software design, and software testing.
  - **Department(s):** School of Computer Science

- **CIS*6160 Multiagent Systems U [0.50]**
  - This course covers the theory and practice of multiagent systems, including coordination, communication, and cooperation among autonomous agents.
  - **Department(s):** School of Computer Science

- **CIS*6230 Image Processing Algorithms and Applications U [0.50]**
  - This course provides an introduction to the field of image processing, covering topics such as image segmentation, feature extraction, and image analysis.
  - **Department(s):** School of Computer Science

- **CIS*6420 Soft Computing U [0.50]**
  - Neural networks, artificial intelligence, connectionist model, back propagation, resonance theory, sequence processing, software engineering concepts.
  - **Department(s):** School of Computer Science

- **ENGG*6100 Machine Vision U [0.50]**
  - Computer vision studies how computers can analyze and perceive the world using input from imaging devices. Topics covered include image pre-processing, segmentation, shape analysis, object recognition, image understanding, 3D vision, motion and stereo analysis, as well as case studies.
  - **Department(s):** School of Engineering

- **ENGG*6140 Optimization Techniques for Engineering U [0.50]**
  - This course serves as a graduate introduction into combinatorics and optimization. Optimization is the main pillar of Engineering and the performance of most systems can be improved through intelligent use of optimization algorithms. Topics to be covered: Complexity theory, Linear/Integer Programming techniques, Constrained/Unconstrained optimization and Nonlinear programming, Heuristic Search Techniques such as Tabu Search, Genetic Algorithms, Simulated Annealing and GRASP.
  - **Department(s):** School of Engineering
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<th>Department(s)</th>
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<tr>
<td>ENGG*6570</td>
<td>Advanced Soft Computing U [0.50]</td>
<td>Neural dynamics and computation from a single neuron to a neural network architecture. Advanced neural networks and applications. Soft computing approaches to uncertainty representation, multi-agents and optimization.</td>
<td>ENGG*4430 or equivalent</td>
<td>School of Engineering</td>
</tr>
<tr>
<td>MATH*6020</td>
<td>Scientific Computing U [0.50]</td>
<td>This course covers the fundamentals of algorithms and computer programming. This may include computer arithmetic, complexity, error analysis, linear and nonlinear equations, least squares, interpolation, numerical differentiation and integration, optimization, random number generators, Monte Carlo simulation; case studies will be undertaken using modern software.</td>
<td></td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>MATH*6021</td>
<td>Optimization I U [0.50]</td>
<td>A study of the basic concepts in: linear programming, convex programming, non-convex programming, geometric programming and related numerical methods.</td>
<td></td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>MATH*6051</td>
<td>Mathematical Modelling U [0.50]</td>
<td>The process of phenomena and systems model development, techniques of model analysis, model verification, and interpretation of results are presented. The examples of continuous or discrete, deterministic or probabilistic models may include differential equations, difference equations, cellular automata, agent based models, network models, stochastic processes.</td>
<td></td>
<td>Department of Mathematics and Statistics</td>
</tr>
<tr>
<td>PHIL*6760</td>
<td>Science and Ethics U [0.50]</td>
<td>A consideration of the problems which arise in the conjunction of science and ethics.</td>
<td></td>
<td>Department of Philosophy</td>
</tr>
<tr>
<td>STAT*6841</td>
<td>Computational Statistical Inference U [0.50]</td>
<td>This course covers Bayesian and likelihood methods, large sample theory, nuisance parameters, profile, conditional and marginal likelihoods, EM algorithms and other optimization methods, estimating functions, Monte Carlo methods for exploring posterior distributions and likelihoods, data augmentation, importance sampling and MCMC methods.</td>
<td></td>
<td>Department of Mathematics and Statistics</td>
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**Undergraduate Complementary AI-related Courses**

- **ENGG*4460 [0.50]** Robotic Systems
- **STAT*4000 [0.50]** Statistical Computing