The information published in this Graduate Calendar outlines the rules, regulations, curricula, programs and fees for the 2020-2021 academic year, including the Summer Semester 2020, Fall Semester 2020 and the Winter Semester 2021.

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

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Revision Information:

<table>
<thead>
<tr>
<th>Date</th>
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<tr>
<td>May 25, 2020</td>
<td>Initial Publication</td>
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<tr>
<td>June 3, 2020</td>
<td>Revision 1</td>
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Disclaimer

The information published in this Graduate Calendar outlines the rules, regulations, curricula, programs and fees for the 2020-2021 academic year, including the Summer Semester 2020, the Fall Semester 2020 and the Winter Semester 2021.

The University reserves the right to change without notice any information contained in this calendar, including but not limited to that related to tuition and other fees, standards of admission, course delivery or format, continuation of study, and the offering or requirements for the granting of, degrees or diplomas in any or all of its programs. The publication of this calendar does not bind the University to the provision of courses, programs, schedules of study, or facilities as listed herein.

The University will not be liable for any failure or delay in performance arising out of any cause or causes beyond its reasonable control. Such causes may include but are not limited to fire, strike, lock-out, inability to procure materials or trades, war, mass-casualty event, flood, local, regional or global outbreak of disease or other public health emergency, social distancing or quarantine restriction, legislative or regulatory requirements, unusually severe weather, failure of public utility or common carrier, or attacks or other malicious act, including but not limited to attacks on or through the internet, or any internet service, telecommunications provider or hosting facility.

In March 2020 the World Health Organization declared a global pandemic of the virus leading to COVID-19. The Governments of Canada, the Province of Ontario, and local Governments responded to the pandemic with legislative amendments, controls, orders, by-laws, requests and requirements (collectively, the “Governmental Response”). It is uncertain how long the pandemic, and the related Governmental Response, will continue, and it is unknown whether there may be a resurgence of the virus leading to COVID-19 or any mutation thereof (collectively, the “Virus”) and resulting or supplementary renewed Governmental Response. Without limiting the foregoing paragraph, the University shall not be liable for costs associated with any failure or delay in performance arising out of:

a. the continued spread of the Virus;

b. the continuation of or renewed Governmental Response to control the spread of the Virus; and

c. a University decision, made on an organization-wide basis and in good faith, to control the spread of the Virus, even if exceeding the then current specific Governmental Response.

In particular, the COVID-19 pandemic may necessitate a revision of the format of course offerings such that courses are offered in whole or in part on an alternate delivery model to in-person classes. Tuition and mandatory fees have been set regardless of the method of instruction and will not be refunded in the event instruction occurs remotely for any part of the academic year.

Dates or times of performance including the Schedule of Dates may be extended as appropriate and the University will notify students promptly of the existence and nature of such delay and shall, so far as practicable, use reasonable efforts to minimize and mitigate any such delay or non-performance.

In the event of a discrepancy between a print version (downloaded) and the Web version, the Web version will apply.

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/DLB_Laws/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 analyse 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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Computer Science

The School of Computer Science offers an MSc degree in Computer Science. The program emphasizes both academic and applied research that can contribute to further research, academic studies, industry partnerships, and government programs. The MSc degree encompasses professors at the cutting edge of their fields, course offerings covering a wide range of computer science areas, and competitive financial incentives to eligible students.

There are four main fields that students can study in. However, interaction with other disciplines is encouraged and many of our professors work in collaboration with both industry partners and other Schools/Departments at the University of Guelph. The fields are:

- **Applied Modelling (AM):** Students working in this field will engage in research on topics such as graph theory and algorithms, formal specifications, hardware-software co-design, and interdisciplinary work in environmental modeling and disease spread modeling.
- **Artificial Intelligence (AI):** Students working in this field will engage in research on topics such as Bayesian techniques, artificial neural networks, evolutionary computation, fuzzy systems, data mining, pattern recognition, and, intelligent agents.
- **Distributed Computing (DC):** Students working in this field will engage in research on topics such as parallel computing, distributed systems, embedded systems, multi-agent systems, mobile computing, wireless networks, and ad hoc networks.
- **Human Computer Interaction (HCI):** Students working in this field will engage in research on topics such as context-aware systems, usability, interface design, and mobile and ubiquitous computing.

The School of Computer Science also offers an Interdisciplinary PhD degree in Computational Sciences. More information on can be found at: Computational Sciences website

### Administrative Staff

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**Graduate Program Assistant**
Jennifer Hughes (1116 Reynolds, Ext. 56402)
cagradassist@uoguelph.ca

### Graduate Faculty

**Luiza Antonie**
BSc Bucharest, MSc, PhD Alberta - Associate Professor

**David A. Calvert**
BA, MSc Guelph, PhD Waterloo - Associate Professor

**Rozita Dara**
BSc Shahid Tesheshi, MSc Guelph, PhD Waterloo - Associate Professor

**Ali Dehghantanha**
BSE Azad, MSc, PhD Putra Malaysia - Assistant Professor

**David Flatla**
BSc, MSc, PhD Saskatchewan - Associate Professor

**Dan Gillis**
BSc, MSc, PhD Guelph - Assistant Professor

**Minglung Gong**
BEng Harbin Engineering, MSc Tsinghua, PhD Alberta - Professor and Director

**Gary Gréwal**
BSc Brock, MSc, PhD Guelph - Associate Professor

**Hassan Khan**
BSc NUST, MSc Southern California, PhD Waterloo - Assistant Professor

**Stefan C. Kremer**
BSc Guelph, PhD Alberta - Professor

**Xiaodong Lin**
BASC Nanjing, MSc East China Normal, PhD Beijing, PhD Waterloo - Associate Professor

**Pascal Matsakis**
BSc, MSc, PhD Paul Sabatier (France) - Professor

**Judi R. McCuaig**
BED, BSc, MS, PhD Saskatchewan - Associate Professor

**Charlie F. Obinmo**
MSc Kiev, PhD New Brunswick - Associate Professor

**Joseph Sawada**
BSc, PhD Victoria (British Columbia) - Professor and Associate Graduate Director

**Stacey Scott**
BSc Dalhousie, PhD Calgary - Associate Professor

**Fei Song**
BSc Jilin (China), MSc Academia Sinica (China), PhD Waterloo - Associate Professor

**Deborah A. Stacey**
BSc Guelph, MASc, PhD Waterloo - Associate Professor

**Fanglin Wang**
BE Changsha, MSc Peking, PhD Waterloo - Professor

**Mark Wineberg**
BSc Toronto, MSc, PhD Carleton - Associate Professor

**Michael A. Wirth**
BSc New England (Aust.), MSc Manitoba, PhD RMIT Melbourne - Associate Professor and Assistant Director

**Yang Xiang**
BSs, MSc BUAA (Beijing), PhD UBC - Professor

### Associated Graduate Faculty

**Ritu Chaturvedi**
PhD Windsor - Contractually Limited Faculty, School of Computer Science

**Denis Nikitenko**
BSc Ryerson, MSc, PhD Guelph - Contractually Limited Faculty, School of Computer Science

### MSc Program

The MSc is offered in the fields of: 1) applied modelling; 2) artificial intelligence; 3) distributed computing; and 4) human computer interaction.

### Admission Requirements

Most spaces are filled in March for entry the following September, and in October for entry the following January. Prospective students should check the School of Computer Science website [http://www.socs.uoguelph.ca](http://www.socs.uoguelph.ca) for admission procedures and deadlines.

### General Requirements

To be considered for admission, applicants must have a four-year honours degree in computer science, or a four-year honours degree in another discipline with a minor in computer science. Applicants must meet the minimum admission requirements of both the university and the School of Computer Science, including at least a 75% average during the previous two years of full-time university study for a degree.

In addition to the university and School of Computer Science requirements, applicants must also submit (i) a current CV and (ii) a statement of research that would normally include the following sections:

- Specific research interest with justification.
- Academic and/or practical research experience.

### Course Requirement

Entrants who have a four-year honours degree in another discipline and a minor (or equivalent) in computer science must have taken at least 12 courses as described below. University of Guelph equivalents are given for comparison as appropriate.

(A) Seven prescribed courses:

- An introductory programming course (CIS*1500).
- An intermediate programming course (CIS*2500).
- An object-oriented programming course (CIS*2430).
- A software systems development course (CIS*2750).
- A course on data structures (CIS*2520).
- A course on discrete structures (CIS*1910 or CIS*2910).
- An introductory course in calculus (MATH*1200).

(B) Three core courses at the second-year or higher level selected from the following:

- A course on hardware and/or assembly language (CIS*2030).
- A course on digital systems (CIS*3120).
- A course on simulation and/or modelling (CIS*2460).
- A database course (CIS*3530).
- An operating systems course (CIS*3110).
- A computer algorithms course (CIS*3490).
- A course on automata theory (CIS*3150).
- A statistics course (STAT*2040).

(C) Two elective courses at the third-year or higher level:

These courses should be related to the applicant’s proposed research area. They can be from a discipline other than computer science if deemed relevant by the proposed supervisor.

Applicants who meet requirements (A) and (C) but who do not meet requirement (B) may be granted provisional admission, i.e., they may be granted admission with the provision that they take specified courses within a specified time and achieve grades above a specified threshold.

### English Proficiency

A test of English proficiency is required of all applicants whose first language is not English. Please refer to the University of Guelph Admission Requirements.
Program Requirements
Once a student has been admitted to the MSc program, the following components are required for the successful completion of the MSc degree:
- Completion of the Technical Communication and Research Methodology course (CIS*6090) and at least four other graduate courses.
- Completion of the seminar requirement.
- An accepted thesis.

Duration of the Program
The MSc degree is a two-year program during which students complete five courses, give a public seminar and complete and successfully defend a thesis. Heavy emphasis is placed on the thesis, which usually requires at least two semesters. Students should plan on spending at least four full-time semesters (16 months) in the program assuming adequate preparation for graduate work.

Course Requirement
An MSc student is required to take the Technical Communication and Research Methodology course CIS*6090 and at least four other CIS graduate courses. Of these four courses, at least two should be outside of the student's thesis topic area. This area and the courses which fall outside of this area are identified by the student's advisor. With approval from the Graduate Program Committee, a CIS graduate course requirement may also be met by a non-CIS graduate course or by a 4000-level course. At most one reading course (CIS*6660) and at most one 4000-level course can count towards the course requirement.

Seminar Requirement
An MSc student must give one publicly announced research seminar on their MSc thesis research. The student will be allocated times and dates for the seminar. It must be attended by the student's advisor and at least one other member of the student's Advisory Committee. The quality of the presentation is graded on a pass/fail basis. The MSc seminar requirement is intended for students to practice presentation and communication skills and to participate in the process of knowledge dissemination as part of the academic life.

Thesis Defence
Arrangements for the MSc thesis defence should be made at least four weeks prior to the anticipated date of the defence, and the student must submit their MSc thesis to the Examination Committee at least two weeks prior to the defence. The examination consists of an oral presentation by the student followed by questions from the Examination Committee.

Collaborative Specializations

Artificial Intelligence
The School of Computer Science participates in the collaborative specialization in Artificial Intelligence. MSc students wishing to undertake thesis research with an emphasis on artificial intelligence are eligible to apply to register concurrently in Computer Science and the collaborative specialization. Students should consult the Artificial Intelligence listing for more information.

One Health
The School of Computer Science participates in the collaborative specialization in One Health. Master's and Doctoral students wishing to undertake thesis research or their major research paper/project with an emphasis on one health are eligible to apply to register concurrently in Computer Science and the collaborative specialization. Students should consult the One Health listing for more information.

Courses

Core Courses
The core graduate courses are designed to be accessible to any student with an appropriate background in Computer Science and will provide enough introduction for those unfamiliar with the specific area to allow them to keep up with the advanced material.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Department(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIS*6000</td>
<td>Distributed Systems U [0.50]</td>
<td></td>
<td>School of Computer Science</td>
</tr>
<tr>
<td>CIS*6020</td>
<td>Artificial Intelligence U [0.50]</td>
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<td>School of Computer Science</td>
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<tr>
<td>CIS*6030</td>
<td>Information Systems U [0.50]</td>
<td></td>
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</tbody>
</table>

Advanced Courses
The advanced graduate courses are taught with the assumption that the student has sufficient background in the research area to understand the advanced concepts and research ideas. Students who intend to take a course for which they have insufficient background should consult with the instructor prior to enrollment in the course.

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Department(s)</th>
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</thead>
<tbody>
<tr>
<td>CIS*6050</td>
<td>Neural Networks U [0.50]</td>
<td></td>
<td>School of Computer Science</td>
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<tr>
<td>CIS*6060</td>
<td>Bioinformatics U [0.50]</td>
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<td>School of Computer Science</td>
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<tr>
<td>CIS*6080</td>
<td>Genetic Algorithms U [0.50]</td>
<td></td>
<td>School of Computer Science</td>
</tr>
<tr>
<td>CIS*6090</td>
<td>Technical Communication and Research Methodology U</td>
<td></td>
<td>School of Computer Science</td>
</tr>
<tr>
<td>CIS*6100</td>
<td>Parallel Processing Architectures U [0.50]</td>
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<td>School of Computer Science</td>
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<tr>
<td>CIS*6120</td>
<td>Uncertainty Reasoning in Knowledge Representation U</td>
<td></td>
<td>School of Computer Science</td>
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<tr>
<td>CIS*6130</td>
<td>Object-Oriented Modeling, Design and Programming U</td>
<td></td>
<td>School of Computer Science</td>
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<tr>
<td>CIS*6140</td>
<td>Software Engineering U [0.50]</td>
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<td>School of Computer Science</td>
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<tr>
<td>Course Code</td>
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<td>Credits</td>
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<tr>
<td>CIS*6160</td>
<td>Multiagent Systems U [0.50]</td>
<td></td>
<td>Intelligent systems consisting of multiple autonomous and interacting subsystems with emphasis on distributed reasoning and decision making. Deductive reasoning agents, practical reasoning agents, probabilistic reasoning agents, reactive and hybrid agents, negotiation and agreement, cooperation and coordination, multiagent search, distributed MDP, game theory, and modal logics.</td>
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<tr>
<td>CIS*6200</td>
<td>Design Automation in Digital Systems U [0.50]</td>
<td></td>
<td>Techniques and software tools for design of digital systems. Material covered includes high-level synthesis, design for testability, and FPGAs in design and prototyping.</td>
</tr>
<tr>
<td>CIS*6490</td>
<td>Analysis and Design of Computer Algorithms U [0.25]</td>
<td></td>
<td>The design and analysis of efficient computer algorithms: standard methodologies, asymptotic behaviour, optimality, lower bounds, implementation considerations, graph algorithms, matrix computations (e.g. Strassen's method), NP-completeness.</td>
</tr>
<tr>
<td>CIS*6650</td>
<td>Topics in Computer Science I U [0.50]</td>
<td></td>
<td>This special topics course examines selected, advanced topics in computer science that are not covered by existing courses. The topic(s) will vary depending on the need and the instructor.</td>
</tr>
<tr>
<td>CIS*6660</td>
<td>Topics in Computer Science II U [0.50]</td>
<td></td>
<td>This is a reading course. Its aim is to provide background knowledge to students who need to get a head-start in their thesis research fields early during their program while no suitable regular graduate courses are offered. Admission is under the discretion of the instructor.</td>
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<td></td>
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<td>Restriction(s): Instructor consent required.</td>
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