The Master of Cybersecurity and Threat Intelligence (MCTI) is offered by the School of Computer Science.

This professionally oriented master’s is unique in its core focus on threat intelligence, Security Incident and Event Management (SIEM), intrusion prevention, malware analysis, penetration testing, and computer forensics, and in its integration of experiential lab-based learning. It covers the most challenging and technical aspects of the cybersecurity field and ensures that graduates are equipped with the professional capabilities to respond ethically and with a global social awareness of the implications of their work. Students gain hands-on experience with real and simulated security attacks such that graduates are primed to help organizations create security frameworks, protect sensitive data from threats, and analyse violations to help prevent future breaches.

Administrative Staff

**Director**

Ali Dehghantanha (3326 Reynolds, Ext. 52999)
adehghan@uoguelph.ca

**Graduate Program Coordinator**

Joe Sawada (2226 Reynolds, Ext. 53277)
graddir@socs.uoguelph.ca

**Graduate Program Assistant**

Jennifer Hughes (1116 Reynolds, Ext. 56402)
cybergrad@socs.uoguelph.ca

**Industry Liaison Officer**

An Nguyen
cyberliaison@uoguelph.ca (cybergrad@socs.uoguelph.ca)

Graduate Faculty

This list may include Regular Graduate Faculty, Associated Graduate Faculty and/or Graduate Faculty from other universities.

- **Luiza Antoine**
  B.Sc. Politehnica Bucharest (Romania), M.Sc. Alberta, PhD Alberta - Associate Professor
  Graduate Faculty

- **Neil Bruce**
  B.Sc. Guelph, M.A.Sc., Waterloo, PhD York - Associate Professor
  Graduate Faculty

- **David A. Calvert**
  BA, M.Sc. Guelph, PhD Waterloo - Associate Professor
  Graduate Faculty

- **Ritu Chaturvedi**
  PhD Windsor - Assistant Professor
  Associated Graduate Faculty

- **Rozita Dara**
  B.Sc. Shahid Teheshti, M.Sc. Guelph, PhD Waterloo - Associate Professor
  Graduate Faculty

- **Ali Dehghantanha**
  BSE Azad, M.Sc., PhD Putra Malaysia - Assistant Professor
  Graduate Faculty

- **David Flata**
  B.Sc., M.Sc., PhD Saskatchewan - Associate Professor
  Graduate Faculty

- **Dan Gillis**
  B.Sc., M.Sc., PhD Guelph - Associate Professor
  Graduate Faculty

- **Minglun Gong**
  B.Eng. Harbin Engineering, M.Sc. Tsinghua, PhD Alberta - Professor
  Graduate Faculty

- **Gary Gréwal**
  B.Sc. Brock, M.Sc., PhD Guelph - Associate Professor
  Graduate Faculty

- **Andrew Hamilton-Wright**
  B.Sc., M.Sc. Guelph, PhD Waterloo - Associate Professor
  Graduate Faculty

- **Hassan Khan Khan**
  B.Sc. NUST, M.Sc. Southern California, PhD Waterloo - Assistant Professor
  Graduate Faculty

- **Stefan C. Kremer**
  B.Sc. Guelph, PhD Alberta - Professor
  Graduate Faculty

- **Xiaodong Lin**
  BASc Nanjing, M.Sc. East China Normal, PhD Beijing, PhD Waterloo - Professor
  Graduate Faculty

- **Pascal Matsakis**
  B.Sc., M.Sc., PhD Paul Sabatier (France) - Professor
  Graduate Faculty

- **Judi R. McCuaig**
  B.Ed., B.Sc., MS, PhD Saskatchewan - Associate Professor
  Graduate Faculty

- **Denis Nikitenko**
  B.Sc. Ryerson, M.Sc., PhD Guelph - Contractually Limited Faculty, Computer Science, University of Guelph
  Associated Graduate Faculty

- **Joseph Sawada**
  B.Sc., PhD Victoria (British Columbia) - Professor
  Graduate Faculty

- **Stacey Scott**
  B.Sc. Dalhousie, PhD Calgary - Professor
  Graduate Faculty

- **Fei Song**
  B.Sc. Jilin (China), M.Sc. Academia Sinica (China), PhD Waterloo - Associate Professor
  Graduate Faculty

- **Deborah A. Stacey**
  B.Sc. Guelph, MASc, PhD Waterloo - Associate Professor
  Graduate Faculty

- **Fangju Wang**
  BE Changsha, M.Sc. Peking, PhD Waterloo - Professor
  Graduate Faculty
Mark Wineberg  
B.Sc. Toronto, M.Sc., PhD Carleton - Associate Professor  
Graduate Faculty

Michael A. Wirth  
B.Sc. New England (Aust.), M.Sc. Manitoba, PhD RMIT Melbourne - Associate Professor  
Graduate Faculty

Yang Xiang  
B.Ss., M.Sc. BUAA (Beijing), PhD British Columbia - Professor  
Graduate Faculty

MCTI Program

The Master of Cybersecurity and Threat Intelligence is a terminal masters degree focused on training individuals to become technically skilled and ethically-minded cybersecurity professionals. Students develop mastery in security analysis and design, security architecture, threat intelligence, digital forensics, and penetration testing. Hands-on training in the cybersecurity teaching lab, the Security Operations Centre, enables students to work with real and simulated security attacks independently and collaboratively. Students may choose to complete their program through an independent project wherein students partner with an industry or academic partner to produce an evidence-based solution to a complex cybersecurity problem.

Admission Requirements

Admission to the Master of Cybersecurity and Threat Intelligence program may be granted on the School of Computer Science's recommendation to:

i. Applicants who have successfully completed an undergraduate degree/baccalaureate in an honors program or the equivalent (having achieved a grade average of at least 75%, B, in the last four semesters of study) in computer science, computer engineering, or a related subject area (or hold a minor in one of these areas) from a recognized university; and

ii. Applicants who have relevant experience or background knowledge of Data Communication and Networking (such as a course equivalent to CIS*3210 Computer Networks) and Computer Programming (such as a course equivalent to CIS*2500 Intermediate Programming).

Successful applicants must also meet the University of Guelph’s English Proficiency requirements for admission. If an applicant’s first language is not English, an English Language Proficiency test will be required during the application phase.

All applications will be reviewed by the cybersecurity admissions committee. Students are admitted for a September start date. The School of Computer Science office should be consulted for admission deadlines.

Program Requirements

Students in the Master of Cybersecurity and Threat Intelligence program are required to complete a minimum of 4.00 graduate credits, including CIS*6590 Professional Seminar in Cybersecurity. The remaining 3.50 credits must be completed from the following list of courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIS*6510</td>
<td>Cybersecurity and Defense in Depth</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*6520</td>
<td>Advanced Digital Forensics and Incident Response</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*6530</td>
<td>Cyber Threat Intelligence and Adversarial Risk Analysis</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*6540</td>
<td>Advanced Penetration Testing and Exploit Development</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*6550</td>
<td>Privacy, Compliance, and Human Aspects of Cybersecurity</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*6560</td>
<td>Cybersecurity and Threat Intelligence Project</td>
<td>1.00</td>
</tr>
<tr>
<td>CIS*6570</td>
<td>Advanced Cryptography and Cryptanalysis</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*6580</td>
<td>Security Monitoring and Cyber Threat Hunting</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*6670</td>
<td>Special Topics in Cybersecurity</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Students may complete up to 0.50 credits of their program requirements through a graduate level course in the related areas of Artificial Intelligence or Data Science to fulfill their elective requirement.

Courses

CIS*6000 Distributed Systems Unspecified [0.50]

Department(s): School of Computer Science  
Location(s): Guelph

CIS*6020 Artificial Intelligence Unspecified [0.50]
An examination of Artificial Intelligence principles and techniques such as: logic and rule based systems; forward and backward chaining; frames, scripts, semantic nets and the object-oriented approach; the evaluation of intelligent systems and knowledge acquisition. A sizeable project is required and applications in other areas are encouraged.

Department(s): School of Computer Science  
Location(s): Guelph

CIS*6030 Information Systems Unspecified [0.50]
Relational and other database systems, web information concurrency protocols, data integrity, transaction management, distributed databases, remote access, data warehousing, data mining.

Department(s): School of Computer Science  
Location(s): Guelph

CIS*6050 Neural Networks Unspecified [0.50]

Department(s): School of Computer Science  
Location(s): Guelph

CIS*6060 Bioinformatics Unspecified [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  
Location(s): Guelph

CIS*6070 Discrete Optimization Unspecified [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  
Location(s): Guelph
CIS*6080 Genetic Algorithms Unspecified [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
Location(s): Guelph

CIS*6090 Hardware/Software Co-Design of Embedded Systems Unspecified [0.50]
Specification and design of embedded systems, system-on-a-chip paradigm, specification languages, hardware/software co-design, performance estimation, co-simulation and validation, processes architectures and software synthesis, retargetable code generation and optimization.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6100 Parallel Processing Architectures Unspecified [0.50]
Parallelism in uniprocessor systems, parallel architectures, memory structures, pipelined architectures, performance issues, multiprocessor architectures.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6120 Uncertainty Reasoning in Knowledge Representation Unspecified [0.50]
Representation of uncertainty, Dempster-Shafer theory, fuzzy logic, Bayesian belief networks, decision networks, dynamic networks, probabilistic models, utility theory.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6130 Object-Oriented Modeling, Design and Programming Unspecified [0.50]
Objects, modeling, program design, object-oriented methodology, UML, CORBA, database
Department(s): School of Computer Science
Location(s): Guelph

CIS*6140 Software Engineering Unspecified [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 meta-heuristics.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6160 Multiagent Systems Unspecified [0.50]
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.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6200 Design Automation in Digital Systems Unspecified [0.50]
Techniques and software tools for design of digital systems. Material covered includes high-level synthesis, design for testability, and FPGAs in design and prototyping.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6320 Image Processing Algorithms and Applications Unspecified [0.50]
Brightness transformation, image smoothing, image enhancement, thresholding, segmentation, morphology, texture analysis, shape analysis, applications in medicine and biology.
Department(s): School of Computer Science
Location(s): Guelph

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

CIS*6490 Analysis and Design of Computer Algorithms Unspecified [0.25]
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.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6510 Cybersecurity and Defense in Depth Fall Only [0.50]
This course provides an overview of concepts and technical measures that are employed to enforce security policies and protect networks and systems from malicious activities. Students will learn how to engineer a secure system and how to secure networks in an ethical manner.
Restriction(s): Student registered in the MCTI program.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6520 Advanced Digital Forensics and Incident Response Fall Only [0.50]
This course provides an in-depth understanding of theoretical concepts and practical issues in the field of digital forensics and incident response. Students will develop necessary skills, methodologies, and processes to detect cyber incidents and conduct in-depth computer and network investigation.
Restriction(s): Student registered in the MCTI program.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6530 Cyber Threat Intelligence and Adversarial Risk Analysis Winter Only [0.50]
This course provides an in-depth understanding of techniques for detecting, responding to, and defeating Advanced Persistent Threats (APT) and malware using artificial intelligence and data mining techniques. Students will identify, extract, and leverage intelligence from different types of cyber threat actors.
Restriction(s): Student registered in the MCTI program.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6540 Advanced Penetration Testing and Exploit Development Winter Only [0.50]
This course provides an in-depth understanding of techniques for detecting, responding to, and defeating Advanced Persistent Threats (APT) and malware using artificial intelligence and data mining techniques. Students will identify, extract, and leverage intelligence from different types of cyber threat actors.
Restriction(s): Student registered in the MCTI program.
Department(s): School of Computer Science
Location(s): Guelph
CIS*6550  Privacy, Compliance, and Human Aspects of Cybersecurity Unspecified [0.50]
This course provides an in-depth view of the privacy, regulatory, and ethical issues surrounding cybersecurity. It covers methods of mitigating/treating privacy risks associated with emerging technologies that collect, manage, and analyse data. This course also examines data protection regulations and compliance strategies.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6560  Cybersecurity and Threat Intelligence Project Winter and Summer Reg Required [1.00]
Students plan, develop, and write an industry- or faculty-led report and produce required tools, services, and software. Projects should advance knowledge or practice, and address an emerging challenge in cybersecurity, cyber threat intelligence, digital forensics and incident response, cyber threat hunting, or a closely related field.
Restriction(s): Student registered in the MCTI program.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6570  Advanced Cryptography and Cryptanalysis Unspecified [0.50]
This course provides an in-depth understanding of modern cryptography, with emphasis on practical applications. Topics covered include classical systems, information theory, symmetrical cryptosystems, block ciphers, stream ciphers, DES, AES, asymmetric cryptosystems, ECC, provable security, key exchange and management, and authentication and digital signatures, among others.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6580  Security Monitoring and Cyber Threat Hunting Unspecified [0.50]
This course provides a comprehensive review of tools, techniques, and procedures for monitoring network events and assets to build a secure network architecture. It trains students in methods for hunting attackers that could bypass designed network defense mechanisms in an enterprise.
Restriction(s): Student registered in the MCTI program.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6590  Professional Seminar in Cybersecurity Fall and Winter Reg Required [0.50]
This two-semester course offers a multidisciplinary forum for discussion of topics related to cybersecurity. The seminar fosters professional skills development (academic and industry), promotes collaboration between industry experts and graduate students, facilitates mentoring and project development, and contributes to the transfer of knowledge between industry and academia.
Location(s): Guelph

CIS*6660  Topics in Computer Science II Unspecified [0.50]
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.
Restriction(s): Instructor consent required.
Department(s): School of Computer Science
Location(s): Guelph

CIS*6670  Special Topics in Cybersecurity Unspecified [0.50]
This course provides an in-depth view of a variety of advanced topics within cybersecurity. Subject areas discussed in any particular semester will depend upon the interests of both the students and the instructor. Students should check with the School of Computer Science to determine what topics will be offered during specific semesters.
Location(s): Guelph

CIS*6890  Technical Communication and Research Methodology Unspecified [0.50]
This course aims to develop students’ ability in technical communication and general research methodology. Each student is expected to present a short talk, give a mini lecture, review a conference paper, write a literature survey and critique fellow students’ talks and lectures.
Department(s): School of Computer Science
Location(s): Guelph