MASTER OF SYSTEMS SCIENCE AND ENGINEERING WITH CONCENTRATION IN INTERDISCIPLINARY ARTIFICIAL INTELLIGENCE

Overview
* Please note that the former title of this program was: Master of Systems Science.

Summary
- Degree offered: Master of Systems Science and Engineering (MSysScEng)
- Registration status options: Full-time; Part-time
- Language of instruction:
  - English
- Program option (expected duration of the program):
  - within two years of full-time study
- For immigration purposes, the summer term (May to August) for this program is considered a regularly scheduled break approved by the University. Students should resume full-time studies in September.

Program Description
The Systems Science and Engineering program provides qualified students with the opportunity for master’s-level study in a broad range of areas that emphasize transdisciplinary work in the context of general systems analysis. The emphasis in Systems Science and Engineering is on the development of analytical and integration skills for use in the resolution of complex applied problems that require a broad-based perspective.

Many professors in Information Technology and Engineering, Mathematics and Statistics, Administration, Economics, and other disciplines are active in the Systems Science and Engineering program as instructors, student advisers and thesis directors. Others are interested in ongoing Systems Science and Engineering activities including the seminar series, and Systems Science and Engineering applications days.

The graduate program in System Science is an interdisciplinary program specially designed for those who are interested in the analysis and modelling (mathematical and computer) of natural and man-made systems. It provides the professional with skills and knowledge required to understand, control, predict and optimize behaviour in a variety of fields from engineering and computer science to management and applied economics. The program is supervised by a Committee composed of representatives from the Department of Economics, the School of Information Technology and Engineering, the Telfer School of Management, and the Department of Mathematics and Statistics.

To accommodate part-time students, the core courses are usually offered in the late afternoon or evening.

Main Areas of Research
Their areas of research, both theoretical and applied, span a wide variety of fields:
- Operations research
- Deterministic and probabilistic modelling
- Optimization
- Computer science
- Information systems
- Control
- Economic modelling

Other Programs Offered Within the Same Discipline or in a Related Area
- Graduate Diploma Systems Science and Engineering
- Master of Science Systems Science and Engineering (MSc)

Fees and Funding
- Program fees:
  - The estimated amount for university fees (https://www.uottawa.ca/university-fees/) associated with this program are available under the section Finance your studies (http://www.uottawa.ca/graduate-studies/programs-admission/finance-studies/).
  - International students enrolled in a French-language program of study may be eligible for a differential tuition fee exemption (https://www.uottawa.ca/university-fees/differential-tuition-fee-exemption/).

- To learn about possibilities for financing your graduate studies, consult the Awards and financial support (https://www.uottawa.ca/graduate-studies/students/awards/) section.

Notes
- Programs are governed by the academic regulations (http://www.uottawa.ca/graduate-studies/students/general-regulations/) in effect for graduate studies.
- In accordance with the University of Ottawa regulation, students have the right to complete their assignments, examinations, research papers, and theses in French or in English. Research activities can be conducted either in English, French or both, depending on the language used by the professor and the members of his or her research group.

Graduate Studies Office, Faculty of Engineering (https://engineering.uottawa.ca/graduate-studies-office/)
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Ottawa ON Canada
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Tel.: 613-562-5347
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Email: engineering.grad@uottawa.ca
Program Requirements

Master's with Coursework

To receive this Master's degree, a student enrolled in the program must successfully complete 30 course units.

Students must meet the following requirements:

**Compulsory courses**

- GNG 5301 Professional Skills and Responsibility 1
- SYS 5110 Foundation of Modelling and Simulation
- SYS 5130 Systems Optimization and Management
- SYS 5170 Essential Concepts in Data Science
- SYS 5180 Mathematics for Artificial Intelligence
- SYS 5185 Foundations and Applications of Machine Learning
- SYS 5295 Ethics for Design, AI, and Robotics

**Optional courses**

- 3 units from the list of optional artificial intelligence courses

**Project**

- 6 course units from:
  - GNG 5902 Industry Internship Project
  - SYS 5975 Project in Systems Science

Note(s)

1 GNG 5301 should be completed during the first trimester of registration in the program.

2 The project must be an AI project related to Systems Science.

List of Optional Courses in Artificial Intelligence

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>ADM 6420</td>
<td>Digital Marketing</td>
<td>1.5</td>
</tr>
<tr>
<td>ADM 6287</td>
<td>Business Intelligence Technologies and Big Data Analytics for DTI</td>
<td>1.5</td>
</tr>
<tr>
<td>DTI 6402</td>
<td>Affective and Persuasive Computing</td>
<td>3</td>
</tr>
<tr>
<td>GNG 5125</td>
<td>Data Science Applications</td>
<td>3</td>
</tr>
<tr>
<td>MEM 6287</td>
<td>Advanced Data Analytics</td>
<td>3</td>
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</tbody>
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Research

Research Fields & Facilities

Located in the heart of Canada's capital, a few steps away from Parliament Hill, the University of Ottawa is among Canada’s top 10 research universities.

uOttawa focuses research strengths and efforts in four Strategic Areas of Development in Research (SADRs):

- Canada and the World
- Health
- e-Society
- Molecular and Environmental Sciences
With cutting-edge research, our graduate students, researchers and educators strongly influence national and international priorities.

Research at the Faculty of Engineering

Areas of research:

- Chemical and Biological Engineering
- Civil Engineering
- Electrical Engineering and Computer Science
- Mechanical Engineering

For more information, refer to the list of faculty members and their research fields on Uniweb.

**IMPORTANT:** Candidates and students looking for professors to supervise their thesis or research project can also consult the website of the faculty or department (https://www.uottawa.ca/graduate-studies/students/academic-unit-contact-information/) of their program of choice. Uniweb does not list all professors authorized to supervise research projects at the University of Ottawa.

Courses

**SYS 5100 Systems Engineering (3 units)**

Controllability and observability. Euler-Lagrange equations, Pontryagin maximum principle, dynamic programming, linear quadratic regulator problem, matrix Ricatti differential equations and properties of their solution, design of optimal regulator based on steady state solution of the Ricatti differential equation, time optimal control, LaSalle bang-bang principle, applications to motor speed control, satellite attitude control, etc.

**Course Component:** Lecture, Laboratory, Tutorial

The following courses are recommended as prerequisites: CSI 1100, MAT 2341, (MAT 2324 or MAT 2331), MAT 2371, MAT 2375.

**SYS 5110 Foundation of Modelling and Simulation (3 units)**


**Course Component:** Lecture

The following courses are recommended as prerequisites: CSI 1100, MAT 2341, (MAT 2324 or MAT 2331), MAT 2371, MAT 2375.

**SYS 5111 Foundations and Applications of Machine Learning (3 units)**

The capabilities and limitations of machine learning; problem formulation; supervised and unsupervised learning techniques; deploying, monitoring, and evaluating machine learning models; storytelling and assessing the results of learning; current advances in application areas such as business, law, arts, social sciences and education.

**Course Component:** Lecture

The courses CSI 4145, CSI 5155, ELG 5255, IAI 5100, SYS 5111 cannot be combined for units.

**SYS 5120 Applied Probability (3 units)**

An introduction to stochastic processes, with emphasis on regenerative phenomena. Review of limit theorems and conditioning. The Poisson process. Renewal theory and limit theorems for regenerative processes; Discrete-time and continuous-time Markov processes with countable state space. Applications to queuing.

**Course Component:** Lecture

The following courses are recommended as prerequisites: CSI 1100, MAT 2341, (MAT 2324 or MAT 2331), MAT 2371, MAT 2375.

**SYS 5122 Essential Concepts in Data Science (3 units)**

An introduction to the foundations of data science using a case study approach; overview of the data science process: types of tasks and models, data manipulation, exploratory data analysis, data summarization and data visualization; predictive modeling, descriptive modeling; reporting and deployment.

**Course Component:** Lecture

The courses CSI 4142, DTI 5125, DTI 5126, MAT 4373, SYS 5122 cannot be combined for units.

**SYS 5130 Systems Optimization and Management (3 units)**

Analysis of user requirements and model design. Data mining. Use of optimization software. Systems thinking and its application to economic systems and hierarchical systems. Applications to economic systems simulation, modeling, optimization and management.

**Course Component:** Lecture

The following courses are recommended as prerequisites: CSI 1100, MAT 2341, (MAT 2324 or MAT 2331), MAT 2371, MAT 2375.

**SYS 5140 Economic System Design (3 units)**

Introduction to the epistemology of systems thinking and its application to economic systems. Basic concepts of complex systems thinking including hierarchical systems and economic systems simulation and behaviour. Soft systems thinking. Examples from other fields of application will be reviewed from an interdisciplinary perspective.

**Course Component:** Lecture

The following courses are recommended as prerequisites: CSI 1100, MAT 2341, (MAT 2324 or MAT 2331), MAT 2371, MAT 2375.

**SYS 5160 Systems Integration (3 units)**


**Course Component:** Lecture

Prerequisites: 6 course units from SYS 5100, SYS 5110, SYS 5120, SYS 5130, SYS 5140.

**SYS 5170 Essential Concepts in Data Science (3 units)**

An introduction to the foundations of data science using a case study approach; overview of the data science process: types of tasks and models, data manipulation, exploratory data analysis, data summarization and data visualization; predictive modeling, descriptive modeling; reporting and deployment.

**Course Component:** Lecture

The courses CSI 4142, DTI 5125, DTI 5126, MAT 4373, IAI 5120 and SYS 5170 cannot be combined for units.

**SYS 5180 Mathematics for Artificial Intelligence (3 units)**


**Course Component:** Lecture

SYS 5185 Foundations and Applications of Machine Learning (3 units)
The capabilities and limitations of machine learning; problem formulation; supervised and unsupervised learning techniques; deploying, monitoring, and evaluating machine learning models; storytelling and assessing the results of learning; current advances in application areas such as business, law, arts, social sciences and education.
**Course Component:** Lecture
The courses CSI 5155, ELG 5255, IAI 5100, IAI 5101, MIA 5100 and SYS 5185 cannot be combined for units.

SYS 5190 Directed Readings in Systems Science (3 units)
Directed Readings in Systems Science
**Course Component:** Research
Courses SYS 5190, SYS 5975 cannot be combined for units.

SYS 5295 Ethics for Design, AI, and Robotics (3 units)
The interplay between Artificial Intelligence, society, the law, and ethics; the course will explore how advances in Artificial Intelligence affect the law and other social institutions, and, conversely, how societal, legal, and ethical considerations affect the development and deployment of Artificial Intelligence technologies.
**Course Component:** Lecture
The courses CSI 5195, DTI 5310, ELG 5295, IAI 5130 and SYS 5295 cannot be combined for units

SYS 5975 Projet en science des systèmes / Project in Systems Science
(6 crédits / 6 units)
**Volet / Course Component:** Recherche / Research
Les cours SYS 5190, SYS 5975 ne peuvent être combinés pour l'obtention de crédits. / Courses SYS 5190, SYS 5975 cannot be combined for units.

SYS 7990 Proposition de thèse de maîtrise / Master Thesis Proposal
**Volet / Course Component:** Recherche / Research