ENGINEERING
McMaster-Mohawk
Bachelor of Technology
Partnership

McMaster University

Course Outline

1. COURSE INFORMATION

Session Offered	Spring/Summer 2025	
Course Name	Cyber-Physical Systems	
Course Code	SEP 769	
Date(s) and Time(s) of lectures	C01 - Wednesdays 6:30PM – 9:30PM EDT, ETB 535/ ETB 537(Lab) C02 – Wednesdays 12:30PM – 3:30PM EDT, ETB 535/ ETB 537(Lab)	
Program Name	W Booth School of Engineering Practice and Technology	
Calendar Description	Cyber-Physical Systems (CPS) involve several elements, including Embedded Systems, the Internet of Things (IoT), and Big data Analytics. This course introduces the principles of CPS and offers Embedded Systems and IoT lab experiments. The students will work in groups to implement a small-scale CPS using embedded systems. The system will gather sensory data and be controlled via the Internet. In the second part of the course, your main task is to leverage a Machine Learning technique to a large CPS data set. Students will be divided into multiple groups of three, and then groups will be bucketed into supergroups. There are several challenges that all groups in a supergroup will compete on one of the challenges. Challenges are related to different aspects of CPS, ranging from applications in Autonomous vehicles (e.g., object tracking, semantic segmentation) to applications in manufacturing (e.g. predictive maintenance).	
Instructor(s)	Dr. Marjan Alavi Dr. Anwar M. Mirza	E-Mail: alavis2@mcmaster.ca E-Mail: mirzaa24@mcmaster.ca

2. COURSE SPECIFICS

Course Description

Instruction Type

Code	Type	Hours per term
C	Classroom instruction	21
L	Laboratory, workshop, or fieldwork	21
T	Tutorial	
DE	Distance education	
	Total Hours	42

Resources

ISBN	Textbook Title & Edition	Author & Publisher

	ISBN:	Deep Learning, MIT Press, 2016	Ian Goodfellow, Yoshua Bengio and Aaron Courville
	PRINT ISBN 9780262029117 EBOOK ISBN 9780262328456	Principles of Cyber-Physical Systems	
	doi:10.1017/9781107588981	Principles of Cyber-Physical Systems: An Interdisciplinary Approach.	
Prerequisite(s)			
Corequisite(s)			
Antirequisite(s)			
Course Specific Policies	Your attendance in the lab is required. In case of illness, please stay home and communicate with your instructor to offer you an alternative way to complete your lab. Projects must be completed **in groups**. A write-up, along with the source code, must be submitted by each group. Particular emphasis will be made on the ability of the students to show why each of the approaches behaved in the way they did relative to the others used.		
Departmental Policies	Where group work is indicated in the course outline, such collaborative work is mandatory. The use of cell phones, iPods, laptops and other personal electronic devices is prohibited from the classroom during class time unless the instructor makes an explicit exception. Announcements made in class or placed on Avenue are considered to have been communicated to all students, including those individuals that are not in class. The instructors have the right to submit work to software to identify plagiarism.		

3. SUB TOPIC(S)			
Week 1	May 7, We	Introduction to Cyber-Physical Systems	
Week 2	May 14, We	Getting Started with RPi (Lab only)	Lab 6 (In-person)
Week 3	May 21, We	Communication Protocols / MQTT/ SPI / I2C / UART	Lab 2 (In-person)

Week 4	May 28, We	Introduction to Node Red (Online Lecture)	Lab 3 (Online)
Week 5	June 4, We	Internet Protocol / Types of IP Addresses	
Week 6	June 11, We	Digital Signal Processing / ADC / DAC / Sampling / Digital Filters / Denoising	
Week 7	June 18, We	IoT Project Presentations	IoT Project (In-person)
Week 8	June 25, We	Introduction to Deep Learning	
Week 9	July 2, We	Deep Feedforward Networks	
Week 10	July 9, We	Regularization and Optimization for Deep Neural Networks	
Week 11	July 16, We	Convolutional Neural Networks	
Week 12	July 23, We	Adversarial Neural Networks	
Week 13	July 30, We	Sequential Data and Recurrent Neural Networks	
Week 14	Aug 6, We	Project Presentation	Deep Learning Project

List of experiments (Only Lab 2, 3, and 6 are mandatory)	
Lab 1	Lab 1-Packet capture by Wireshark
Lab 2	Lab 2-MQTT implementation with MQTTBox
Lab 3	Lab 3- Introduction to Node-RED
Lab 4	Lab 4-Smart Energy Monitoring Using Node-Red
Lab 5	Lab 5- Smart Energy Monitoring Using Node-Red And Raspberry Pi with Twitter
Lab 6	Lab 6- Controlling External Hardware Using Raspberry Pi
Lab 7	Lab 7 - Controlling External Hardware Using Raspberry Pi Remotely Using SSH
Lab 8	Lab 8: Interfacing Raspberry Pi with the Cloud

Note that this structure represents a plan and is subject to adjustment term by term.

The instructors and the University reserve the right to modify elements of the course during the term. The University may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with an explanation and the opportunity to comment on changes.

4. ASSESSMENT OF LEARNING *including dates*	**Weight**

IoT Part: The students need to submit only three labs based on due dates determined on the Avenue: Lab 6 – (3%) Lab 2 – (3%) Lab 3 – (3%) Project Prototype and Presentation – (15%) Paper submission- (11%) IoT Knowledge Test – (15%)	50%
Deep Learning Part: Assignments • Assignment 1 (7%) • Assignment 2 (7%) Deep Learning Project: • Report – Info Sheet & Initial Abstract 2% – Final Report 6% • Presentation – Slides 3% – Presentation + Q&A 9% • Quality of Code 6% • Overall Quality of the Project 10%	50%
TOTAL	**100%**
Percentage grades will be converted to letter grades and grade points per the University calendar.	

5. LEARNING OUTCOMES

1. Understand how to combine different Deep Learning models to solve a real-world problem.
2. Build artificial neural networks with Tensorflow, Keras, or PyTorch in Python
3. Clean and pre-process input data with Pandas and SciKit-Learn in Python
4. Communicate effectively engineering content, work in teams, manage projects, assess risks, and assure quality.
5. Integrate electro-mechanical components, IT hardware and software infrastructure and software applications into a functioning cyber-physical system and control its operation.
6. Approach holistically domain-specific problems and apply system engineering methods (software/hardware, data analysis, control and optimization and others) to solve them.
7. Apply system engineering tools and methods to monitor, analyze, and improve the performance of cyber-physical systems based on data and models.

6. COURSE OUTLINE – APPROVED ADVISORY STATEMENTS

ANTI-DISCRIMINATION

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.
http://www.mcmaster.ca/policy/General/HR/Discrimination_Harassment_Sexual_Harassment-Prevention&Response.pdf

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. The academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. a grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty, please refer to the Academic Integrity Policy, located at https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/

The following illustrates only three forms of academic dishonesty: The following illustrate only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which another credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student-submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., online search, other software, etc.). For more details about McMaster's use of Turnitin.com, please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use online elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses online elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

COMMUNICATIONS

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the University provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, fax, or e-mail to the student's designated primary e-mail account via their @mcmaster.ca alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- Check the McMaster/Avenue email and course websites on a regular basis during the term.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

Students may request relief for missed work in two ways using the McMaster Student Absence Form (MSAF), Type A and Type B. In both cases, an email notification is sent to the instructor (or designate), and students must follow up with the instructor promptly after the absence (by email, Avenue to Learn, or other communication pathway indicated by the instructor for the course) for the relief to be provided, and while instructors are expected to provide relief, instructors determine the relief that is appropriate for the work and the course.

Type A MSAF is used directly by students through the Mosaic reporting tool for assignments worth <25% and for absences lasting 3 days or fewer. The Type A pathway can only be used once, whether for a first request or subsequent to another Type B request. No documentation is required.

Type B MSAF requires that the student meets with an academic advisor to complete the MSAF request through the Mosaic reporting tool. Type B is used for assignments worth 25% or more and absences lasting more than three days. Type B will also be used if this is the second or subsequent reported absence. This pathway provides for students missing a significant amount of work to benefit from advising as students are required to seek advice before a Type B MSAF is submitted. No documentation is required for the fall 2022 term, and the role of the academic advisor is not to approve the request but to advise the student on the potential impact on their academic success.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests. http://www.mcmaster.ca/policy/Students-AcademicStudies/Studentcode.pdf

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, including lectures by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.