Carleton UNIVERSITY | Department of Systems and Computer Engineering

SYSC 4805
Computer Systems Design Lab

Calendar description

Project-oriented experience in the design of embedded computer systems. Lectures will discuss practical aspects related to the design and development of embedded systems, starting from sensor data acquisition and processing to decision systems, testing and embedded-system based project management, with practical application examples.

Lectures two hours a week, laboratory four hours a week.

http://calendar.carleton.ca/undergrad/courses/SYSC/

Prerequisites

SYSC 3320 or SYSC 3601.

Prior knowledge

Students should have knowledge of:

- Programming in C and basic I/O interfacing.

Course objectives

This course builds on the existing knowledge about software and hardware interfacing, software modeling and software development process, systems development processes and testing, acquired during the program. It aims at enhancing the technical knowledge in the field of computer engineering by the use of various sensors, performing data fusion, and programming a microcontroller to acquire, process the data and make decisions based on it, with a practical application in mobile robots. It also aims at developing soft skills for the future engineers ready to embark in their careers by cultivating team work skills and entrepreneurial spirit. The goal is to develop a deeper understanding of the multifaceted process of managing and developing engineering projects.

List of topics

- Design and development of embedded systems with microcontrollers
- Team-based project management
- Data acquisition.
- Sensors
- Sensor types

- Protocols
- I/O interfacing
- Sensor data processing and decision-making
- Data sampling & filtering
- Dealing with noise
- Robot localization and mapping
- Robot path planning and navigation
- Testing and performance. Evaluation

Learning outcomes

By the end of this course, students should be able to:

- Define concepts of product design, development methodology and team-based (small) project management.
- Design an embedded microcontroller-based system for an engineering problem involving hardware and software components.
- Identify and adapt to realistic constraints.
- Analyze potential solutions for an engineering project.
- Use appropriate knowledge and skills to formulate, analyze and solve an engineering problem.
- Apply scientific methods to evaluate and predict performance.
- Define, plan and manage a moderately complex project.
- Develop team work and entrepreneurial skills.
- Develop communications skills through technical presentations and reports.

Graduate Attributes (GAs)

The Canadian Engineering Accreditation Board requires graduates of engineering programs to possess 12 attributes at the time of graduation. Activities related to the learning outcomes listed above are measured throughout the course and are part of the department's continual improvement process. Graduate attribute measurements will not be taken into consideration in determining a student's grade in the course. For more information, please visit: https://engineerscanada.ca/.

Graduate Attribute	Learning outcome(s)
1.5.S: Knowledge Base: Applied: Computer systems	1, 2, 3
1.8.S: Knowledge Base: Applied: Software engineering	1, 2, 3
2.2: Problem Analysis: Applied: Approach to the problem	3, 4, 5
4.4: Design: Applied: Design solution(s)	3, 4, 5, 6
4.5: Design: Applied: Design implementation / task(s) definition	3, 4, 5, 6
6.2: Individual and Team Work: Applied: Group culture, group dynamics	7, 8
7.3: Communication Skills: Applied: Oral and written presentations	9
7.4: Communication Skills: Applied: Technical reading	9

Accreditation Units (AUs)

For more information about Accreditation Units, please visit: https://engineerscanada.ca/.

The course has a total of 49 AUs, divided into:

- Engineering Design: 100%

Instructor and TA contact

Instructor:

Mostafa Taha Email: MostafaTaha@cunet.carleton.ca

Online Office Hours: Upon request via email: https://carleton-ca.zoom.us/j/96401093574

Lecture Time: Fridays 12:35 pm-2:25 pm: https://carleton-ca.zoom.us/j/95077285533

TA Information:

- Abhinav Yalamanchili: AbhinavYalamanchili@cmail.carleton.ca,
- Farhad Andalibi: FarhadAndalibi@cmail.carleton.ca,
- Jasleen Kaur Brar: JasleenBrar@cmail.carleton.ca

Textbook (or other resources)

No required textbook for this course.

Recommended Readings:

- Project Management:
  - A guide to the project management body of knowledge (PMBOK guide). 2017
  - Software Extension to the PMBOK® Guide Fifth Edition.
- Development of Embedded Systems
  - Developing and Managing Embedded Systems and Products
  - Better Embedded System Software
- Robotic Sensors:
  - Introduction to Autonomous Mobile Robots, Second Edition.

Robotics Simulation Software:

- CoppeliaSim v4.1.0
  - Resources of CoppeliaSim

Evaluation and grading scheme

The course work will be evaluated as follows:

Component	Percentage	Evaluation
Project proposal	10%	Team mark
Project progress report	10%	Team mark
Final project presentation	10%	Team mark
Final project demonstration	15%	Team mark
Final report	20%	Team mark
Quiz	10%	Individual mark
Peer review of individual contributions	10%	Individual mark
Individual project contributions	15%	Individual mark

Breakdown of course requirements

Lectures & quiz:

- There is a single ‘synchronous’ two-hours lecture per week. During the first part of the term, lectures will cover issues related to project management, design and development of microcontroller-based sensor systems and robotics sensors. During the last part of the term, lectures will be dedicated to project presentations. Lectures will be recorded for a later view.

- The course will contain a ‘synchronous’ quiz. The quiz will be conducted on cuLearn without using any e-Proctoring software. There are no make-up quizzes. The grade of the quiz can be shifted to the “Individual project contributions” based on a valid medical certificate. The medical certificate must adhere to the format required by the Registrar. The format is available through the Registrar’s website http://www.carleton.ca/registrar/forms.

Labs:

- There is one ‘synchronous’ four-hour lab per week. Each student should check-in with the TA and submit a lab report. Checking-in to labs is mandatory and will be monitored throughout the term.

- During the first lab sessions, students will work on a series of guided exercises to navigate through CoppeliaSim simulation environment. In subsequent lab sessions, students will work on their project: select their sensor system, learn how to perform data acquisition from various sensors, design their solution, work on their project specific tasks and conduct demo sessions by teams.

- Each team is expected to demonstrate the lab exercises and the project milestones.

Project:

- A major component of the course is a team-based project. Each team will consist of 3 students. The project must be related to a computer system design for a mobile robot application. The target of the application is the choice of each team. A line-following mobile robot using infrared proximity sensors will be introduced in CoppeliaSim. Each team will a set of sensors of different types at their choice to the robot kit in order to meet the project target.

- Each team is responsible for proposing a solution to a practical robot task and for planning and delivering a workable prototype. Each member of the team is expected to participate in all aspects of project planning, management and the design and development of the technical solution. The final grade will take into consideration team functioning aspects, the individual contributions, the quality of the project and of the submitted documents

Tentative week-by-week breakdown

1. Introduction.

2. Design and development of embedded systems with microcontrollers.

3. Team-based project management.

4. Data acquisition. Sensors. Sensor types. Protocols. I/O interfacing.

5. Sensor data processing and decision-making. Data sampling & filtering. Dealing with noise. Robot localization and mapping. Robot path planning and navigation.

6. Testing and performance. Evaluation.

7. Students presentations (~5 weeks)

Important Information

Session Recording

Web conferencing sessions in this course may be recorded and made available only to those within the class. Sessions may be recorded to enable access to students with internet connectivity problems, who are based in different time zone, and/or who have conflicting commitments. If students wish not to be recorded, they need to leave your camera and microphone turned off.

You will be notified at the start of the session when the recording will start, and Zoom will always notify meeting participants that a meeting is being recorded. It is not possible to disable this notification.

Please note that recordings are protected by copyright. The recordings are for your own educational use, but you are not permitted to publish to third party sites, such as social media sites and course materials sites.

You may be expected to use the video and/or audio and/or chat during web conferencing sessions for participation and collaboration. If you have concerns about being recorded, please email me directly so we can discuss these.

General regulations

Attendance: Students are expected to attend all lectures and lab periods. The University requires students to have a conflict-free timetable. For more information, see the current *Undergraduate Calendar, Academic Regulations of the University, Section 2.1.3, Course Selection and Registration and Section 2.1.7, Deregistration.*

Health and Safety: Every student should have a copy of our Health and Safety Manual. A PDF copy of this manual is available online: http://sce.carleton.ca/courses/health-and-safety.pdf

Deferred Term Work : Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases this must occur no later than three (3.0) working days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. For more information, see the current *Undergraduate Calendar, Academic Regulations of the University, Section 4.4, Deferred Term Work.*

Appeal of Grades : The processes for dealing with questions or concerns regarding grades assigned during the term and final grades is described in the *Undergraduate Calendar, Academic Regulations of the University, Section 3.3.4, Informal Appeal of Grade and Section 3.3.5 Formal Appeal of Grade.*

Academic Integrity: Students should be aware of their obligations with regards to academic integrity. Please review the information about academic integrity at: https://carleton.ca/registrar/academic-integrity/. This site also contains a link to the complete Academic Integrity Policy that was approved by the University's Senate.

Plagiarism: Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offense that will not be tolerated.

Academic Accommodation: You may need special arrangements to meet your academic obligations during the term. You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at http://www.carleton.ca/equity/ For an accommodation request, the processes are as follows:

- **Pregnancy or Religious obligation**: Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf
- **Academic Accommodations for Students with Disabilities**: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are

already registered with the PMC, contact your PMC coordinator to send me your ***Letter of Accommodation*** at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (*if applicable*). **Requests made within two weeks will be reviewed on a case-by-case basis.** After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (www.carleton.ca/pmc) for the deadline to request accommodations for the formally-scheduled exam (*if applicable*).

- **Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/sexual-violence-support/.
- **Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf