Instructor Information and Office hours:
Dr. Gregory Franks, Room CB 5204, greg@sce.carleton.ca.
Office Hours: 10:00-12:00 noon, Mondays.

TA Information and Office hours
See CU Learn.

Course Number and Calendar Description
SYSC 3303 [0.5 credit]
Real-Time Concurrent Systems
Principles and practice of a systems engineering approach to the development of software for real-time, concurrent, distributed systems. Designing to achieve concurrency, performance, and robustness, using visual notations. Converting designs into programs. Introduction to hard real-time systems. Team project.

Prerequisite(s): for students in the Faculty of Engineering and Design: (SYSC 2003 or SYSC 3310) and SYSC 2004. For students in Computer Science: COMP 2401 and COMP 2402.
Lectures three hours a week, laboratory two hours a week.

Course Objectives
To introduce students to the principles and practice of software development for systems characterized by one or more of the following terms: real-time, concurrent, event-driven, and embedded. Although a specific implementation technology will be used to provide hands-on programming experience, the goal is to present techniques that are applicable to a diverse range of applications, hardware/software components, programming languages and operating systems.

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

1. Understand the ISO Protocol Stack with emphasis on UDP inter-process communication.
2. Model the structure and behaviour of a concurrent system using UML.
3. Write multi-threaded communicating programs in Java.
4. Understand and apply the theory of cyclic executives, rate-monotonic analysis, and priority-based scheduling of a real-time concurrent system.
5. Design, implement, test, and document a reasonably complex and large concurrent system using a development process based on incremental milestones.
6. Work in a team using industrial engineering tools, including version control, development, testing and debugging environments.
Graduate Attributes (GA's)

The Canadian Engineering Accreditation Board requires graduates of engineering programs to possess 12 attributes. Activities related to the learning outcomes listed here are intended to develop students' competence in GA:

- GA1.4S Programming and algorithms
- GA2.2 Problem Analysis - Approach to the problem.
- GA4.4 Design solution.
- GA4.5 Design implementation / task(s) definition.
- GA6.1 Personal and group time management.
- GA6.2 Group culture, group dynamics.

Data will be collected over the course of the project for all six of the attributes listed above.

Textbooks (or other resources)


Lecture slides will be posted as PDF files on the course Web site. Note that additional material that is not on the posted slides will be presented in class.

Additional supplementary references will be listed on the course web site.

Evaluation and Grading Scheme

- **Five assignments: 10%**. Late assignments will not normally be accepted; however, students who cannot submit an assignment by the due date for valid medical or compassionate reasons should contact the instructor immediately to arrange appropriate accommodations (e.g. an extension of the due date).

- **Project: 25%**. A major component of the course is a team project, done in groups of 4 or 5, which will lead you through the process of building a reasonably complex concurrent system. Each team member must participate in all aspects of the project: design, coding, testing and debugging, etc. You will get your team's mark for the project, multiplied by a factor of between 0% and 150%, based on the instructor's and the TAs' judgement of your contribution to your team. Students who do not pull their weight on their project team and projects submitted by students who refuse to join a team will receive a mark of 0; these students will receive a final grade of F regardless of how well they do in the other course components.

- **Closed book Midterm, 15%**: Scheduled for Wednesday, February 6th. Students who are unable to write the midterm exam because of illness or other circumstances beyond their control must provide, in cases of illness, a medical certificate dated no later than one working day after the exam, or appropriate documents in other cases. If this information is provided to the instructor no later than three working days after the missed midterm exam, the student is eligible to write a deferred midterm exam; otherwise, the mark for the missed midterm exam will be 0.
• **Closed-book final exam, 50%**. Held during the University's Winter examination period. With the exception of those students who receive an F based on their participation in the team project (see the "Projects" section), and those who did not write the midterm exam, all students are eligible to write the final examination. Students must pass the final exam to pass the course. Students who do not write/attend a final examination because of illness or other circumstances beyond their control may apply to write a deferred examination. The application for a deferral must be made in writing to the Registrar's Office no later than three working days after the original final examination and be fully supported by appropriate documentation and in cases of illness by a medical certificate dated no later than one working day after the examination or by appropriate documents in other cases.

The final examination is for evaluation purposes only and will not be returned to students. You will be able to make arrangements with the instructor or with the department office to see your marked final examination after the final grades have been made available.

• **Bonus: 3%** for participating in in-class polls.

**Approximate Week-by-Week breakdown**

1. Nature of Real-Time Systems
2. Concurrency
3. Java Threads
4. Synchronization of Java Threads
5. Internet Protocols
6. UML
7. Real-Time Software Design Method
8. Analysis of Real-Time Software Designs
9. Verification and Validation
10. Recent Developments in Real-Time Concurrent Systems

**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 1.2, Course Selection and Registration and Section 1.5, 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](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) 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 2.6, 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 2.7, Informal Appeal of Grade and Section 2.8, 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/](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/](http://www.carleton.ca/equity/). For an accommodation request, the processes are as follows:

- **Pregnancy obligation:** write to me 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](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

- **Religious obligation:** write to me 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](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](mailto: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). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult [https://carleton.ca/pmc/students/dates-and-deadlines/](https://carleton.ca/pmc/students/dates-and-deadlines/) 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

**Copyright on Course Materials:** The materials created for this course (including the course outline and any slides, posted notes, labs, project, assignments, quizzes, exams and solutions) are intended for personal use and may not be reproduced or redistributed or posted on any web site without prior written permission from the author(s).