Course Outline

Instructor Information and Office hours:
Dr. Gregory Franks, Room CB 5204, greg@sce.carleton.ca.
Office Hours: See CULearn.
TA Information and Office hours: See CULearn.

Course Number and Calendar Description

**SYSC 4102A [0.5 credit]**

**Performance Engineering**
Techniques based on measurements and models, for predicting and evaluating the performance of computer systems. Instrumentation. Simple queueing models and approximations. Techniques for modifying software designs to improve performance. Includes: Experiential Learning Activity
Prerequisite(s): (ECOR 2050 or STAT 3502) and SYSC 4001.
Also offered at the graduate level, with different requirements, as SYSC 5101, for which additional credit is precluded.
Lectures three hours a week, laboratory/problem analysis three hours alternate weeks.

Prerequisites

Students who have not satisfied the prerequisites for this course must either withdraw from the course or obtain a prerequisite waiver by visiting the Engineering Undergraduate Academic Support Office.

Assumed Knowledge

This course involves the analysis of software. Students are expected to know how to program in a systems programming language such as C, and understand how operating systems work, in particular inter-process communication and synchronization.

Course Objectives

Performance in this course deals with time and capacity characteristics of computer-based systems. When systems are designed for functionality only, the time to complete a response may be so long that the system is ineffective; similarly, its capacity to serve a large number of users may be inadequate making the system uneconomic to use. Both of these problems occur often in practice. Performance engineering that aims at
solving these problems is a body of concepts and techniques for evaluating systems and system designs, using measurements and models.

Meeting performance requirements (such as response time, throughput, etc.) is a major concern for all kinds of software products with performance constraints, and especially for real-time systems. Software Performance Engineering (SPE) addresses performance issues throughout the whole software lifecycle and aims to ensure that software products under development will meet their performance requirements. SPE uses predictive performance models to assess different design alternatives at an early stage, before major obstacles to performance are frozen in design and code. This can improve the quality of the final product by helping designers to make informed choices and trade-offs early in the life cycle, when changes are not expensive and open alternatives still exist. As the product evolves, so does the performance model, capturing more system features and producing more accurate results.

The course will cover different basic approaches to performance engineering. Topics will be chosen from measurement techniques, interpreting and comparing results, models that explain capacity constraints and delays (bottleneck models, queueing models and layered queueing models), an introduction to performance-oriented design based on performance principles, patterns and antipatterns.

The goal of this course is to prepare the students to address performance problems in real-time concurrent and distributed systems, such as embedded controllers, enterprise distributed systems, web services-based systems and cloud systems. It will introduce the conceptual framework and the nature of performance problems and solutions, so that the student can apply them into the field.

**Learning Outcomes**

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

1. compute performance bounds for Queuing Network Models;
2. apply fundamental operational laws for computing performance measures;
3. apply QN and LQN models for analyzing and improving software performance;
4. understand the meaning of system bottleneck and techniques to alleviate it;
5. employ tools to measure the performance of software;
6. apply performance principles, performance patterns and antipatterns to improve software performance.

**Graduate Attributes (GA’s)**

The Canadian Engineering Accreditation Board requires graduates of engineering programs to possess twelve (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 measurement will not be taken into consideration in determining a student’s grade in the course. For more information, please visit engineerscanada.ca.

Other references (optional):


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.

Evaluation and Grading Scheme

* **Five assignments: 20%**. 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).

* **Labs: 10%**.

* **Closed book Midterm: 20%**: Scheduled for Thursday, 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. 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.

Approximate Week-by-Week breakdown

1. Performance concepts and requirements.
4. Memory hierarchy effects.
5. Queuing Analysis.
6. Software resources.
7. Layered resource effects.
10. Software execution models and system execution models.
12. Review.

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) 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/](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 offence 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 or Religious obligation**: Please 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](https://carleton.ca/pmc) (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](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf) 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 of the exam or test 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 ([carleton.ca/pmc](http://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

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