Instructor Information and Office hours

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Office hours: Wednesday, 4:00 - 5:30 pm
Otherwise email me for an appointment.

Course Number and Calendar Description

SYSC 4102 [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.

Prerequisite(s): 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.

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

The main objective/outcome of this course is to teach the students how to use performance modeling techniques and performance engineering tools for design, experimentation, simulation, visualization, and analysis. Concrete learning outcomes are as follows:

1.8 Software engineering:
- compute performance bounds for Queuing Network Models;
- apply fundamental operational laws for computing performance measures;
- apply QN and LQN models for analyzing and improving software performance;
- understand the meaning of system bottleneck and techniques to alleviate it;
- apply performance principles, performance patterns and antipatterns to improve software performance.

5.3 Performance engineering tools
- use performance tools: Java Modelling Tool (JMT), Layered Queueing Networks (LQN).

Textbooks

The following textbook will be the primary reference:
(free download from http://www.cs.washington.edu/homes/lazowska/qsp/).

Other references (optional):

Evaluation and Grading Scheme

20% Assignments
10% Labs
20% Mid-Term Exam (TBD, in-class)
50% Final Exam (Centrally scheduled, 3 hours).
Breakdown of course requirements (labs, assignments, exams)

1. **To pass this course**, a student must obtain an appropriate overall mark (D- or higher), a passing mark (D- or higher) for the final exam and get credit for at least five out of six labs.

2. **The final exam** will be held during the formal examination period set out in the University Calendar and will be scheduled by Exam Services. The instructor will not accommodate any special requests or alternate arrangements. The final exam is for evaluation purposes only and will not be returned to the student. 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. Students who miss the final exam may be granted permission to write a deferred examination (see the Undergraduate Calendar for regulations on deferred exams).

3. **Students who miss the midterm** due to illness must provide a valid medical certificate to the instructor no later than 3 working days after returning to campus. The certificate must clearly state the name of the doctor with contact information. Once the certificate has been verified, a make-up midterm examination (that will take place outside of the scheduled lecture hours) will be arranged.

4. **Lab Periods.** Attendance at the scheduled laboratory periods is mandatory, and attendance will be taken. During the labs, you will work on short exercises that are intended to provide practical experience with tools and techniques related to the concepts presented in the lectures. You will normally be required to demonstrate and submit your lab work by the end of the lab period (or other specified deadline), as indicated in that week's lab handout.

Your work in each lab period will be graded *satisfactory, marginal, or unsatisfactory.*

- **Satisfactory** (75-100%) means that you were present at the lab and made reasonable progress towards completing the lab exercises. Note that you do not have to finish all the exercises to receive a satisfactory grade.

- **Marginal** (50-75%) means that you made some progress towards completing the exercises, but your solutions were not sufficiently complete to warrant a satisfactory grade. This grade indicates that you may be falling behind and should take steps to remedy this situation.

- **Unsatisfactory** (0-50%) means that you were absent from the lab period, or you attended but made little or no progress towards completing the lab exercises. This indicates that you are likely having difficulty understanding important concepts and should seek help from your instructor as soon as possible. You will also receive unsatisfactory if you do not demonstrate or submit your work before the deadline or if it is apparent to the TA that you did not do enough of the lab work on your own; that is, you relied on your colleagues to explain the exercises and provide solutions. If you are absent from a lab period for any reason, it is up to you to do the missed lab work on your own time. Serious long-term illness will be dealt with on an individual basis. In these circumstances, please contact your instructor to discuss appropriate arrangements.

5. **Assignments.** Students are encouraged to discuss issues when working on assignments; however, you are expected to submit your own work for grading (assignments are individual work). There is a fine line between cooperating with your colleagues (discussing problems and
ideas) and copying solutions (plagiarism). Not only plagiarism is an instructional offence (see the Undergraduate Calendar), but doing the assigned work by yourself is by far the best way to prepare for the exams.

**Submission:** Assignments are due at midnight of the due date and must be submitted online on cuLearn. When submitting assignments, double check that your material has indeed been submitted.

**Late assignments** will be graded according to the following policy: a cumulative 10% penalty per day (i.e., 24 hours) with a maximum of three days.

**Week-by-Week breakdown**

The following is a tentative outline of the course; it might change, based on time constraints:

- **Week 1:** Performance concepts and requirements.
- **Week 2:** Performance measurement. Workloads.
- **Week 3:** Performance models. Cures for performance problems.
- **Week 4:** Memory hierarchy effects.
- **Week 5:** Queueing Analysis.
- **Week 6:** Software resources.
- **Winter Break. Classes are suspended.**
- **Week 7:** Layered resource effects.
- **Week 8:** Measurement and tools.
- **Week 9:** Software Performance Engineering.
- **Week 10:** Software execution models and system execution models.
- **Week 11:** Performance Oriented Design: performance principles, patterns and anti-patterns.
- **Week 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 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 (3.0) 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 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/](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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