Course Outline

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Course Details

Course Code	COMP9334
Course Title	Capacity Planning of Computer Systems and Networks
Units of Credit	6
Course Website	http://cse.unsw.edu.au/~cs9334 (http://cse.unsw.edu.au/~cs9334)
Handbook Entry	http://www.handbook.unsw.edu.au/postgraduate/courses/current/COMP9334.html (http://www.handbook.unsw.edu.au/postgraduate/courses/current/COMP9334.html)

Course Summary

We live in a world that events do not happen instantly. It takes a certain amount of time to download a video from a server to your own mobile device. It takes a certain amount of time for a computer to finish the execution of an algorithm. The time to completion (or response time in performance analysis terminology) is a performance metric that computer scientists and computer engineers should be concerned about because no one wants to wait unnecessarily. If you can understand the factors that determine the response time, then you can influence those factors so that the response time is acceptable. This course will take a mathematical modelling and analytical approach to understand response time in computer systems and networks. The primary goal is to explore how mathematical modelling and mathematical methods can be used to model, analyse and design computer systems and networks so that they have good performance. There are three major topics that will be covered by this course:

- Queuing analysis (Note: Queues are important because they give rise to waiting time.)
- Discrete event simulation
- Integer programming for network design

Course Timetable

The course timetable is available here (/COMP9334/21T1/timetable) .

Course Aims

Students will learn about mathematical modelling and analysis of response time in computer systems and networks. These topics will be covered

- Modelling computer systems and networks to understand response time
- Analytical methods to determine response time
- Discrete event simulation
- Integer programming for network design

Student Learning Outcomes

On completion of this course, the students will have developed:

- Understanding of capacity planning principles;
- Ability to develop models of practical applications and evaluate their performance by rigorous analytical means and by programming computer simulations;
- Problem-solving abilities, characterized by flexibility of approach;
- Analytical, critical and creative thinking, with an aptitude for continued self-directed learning.

This course contributes to the development of the following graduate capabilities:

Graduate Capability	**Acquired in**
scholarship: understanding of their discipline in its interdisciplinary context	lectures, assignment, project
scholarship: capable of independent and collaborative enquiry	lectures, assignment, project
scholarship: rigorous in their analysis, critique, and reflection	lectures, assignment, project
scholarship: able to apply their knowledge and skills to solving problems	lectures, assignment, project
scholarship: ethical practitioners	-
scholarship: capable of effective communication	assignment, project
scholarship: information literate	-
scholarship: digitally literate	assignment, project
leadership: enterprising, innovative and creative	project
leadership: capable of initiating as well as embracing change	-
leadership: collaborative team workers	-
professionalism: capable of independent, self-directed practice	project

professionalism: capable of lifelong learning	project
professionalism: capable of operating within an agreed Code of Practice	the whole course
global citizens: capable of applying their discipline in local, national and international contexts	-
global citizens: culturally aware and capable of respecting diversity and acting in socially just/responsible ways	-
global citizens: capable of environmental responsibility	-

Assumed Knowledge

Students are expected to have working knowledge in:

- Mathematical skills including: probability and statistics, calculus, linear algebra
- Basics overview of communications protocols; basic computer systems architecture;
- Programming

Teaching Rationale

Learning will be largely facilitated through the delivery of lectures. The sample problems and assignment will help in the development of problem-solving skills. The project will help the students to apply what they have learnt to solve problems.

Teaching Strategies

- The lectures are designed to facilitate learning and understanding of the important concepts within course syllabus focusing especially on the principles, concepts and methods behind the capacity planning of computer systems and networks. Lecture notes will be available at the course web site for download before the lecture.
- A number of sample problems will be issued each week and will be discussed in the tutorial session of the following week. These sample problems give the students a chance to test whether they have understood the concepts introduced in the lectures. Solutions to all sample problems will be published on the course web site.

Assessment

Assessments	Details	Weighting
Assignment	Due 5:00pm Fri 19 March 2021 Submissions accepted up to 2 days late.	20
Project	Due 5:00pm Fri 23 April 2021 Submissions accepted up to 2 days late.	30
Final exam		50

The assessments are organised into 2 assessment components.

- Component 1 consists of the an assignment and the project (Total weighting = 50)
- Component 2 consists of the examination (Total weighting = 50)

The final mark will be computed using the a weighted geometric mean, according to:

- Let C be the score of Component 1 rescaled to be out of 100
- Let P be the score of Component 2 rescaled to be out of 100
- Final mark for the course = C^{0.5} * P^{0.5} = sqrt(C * P)

Late submission of assignments : Assignments submitted late are subject to the following penalty: the maximum mark obtainable reduces by 10% per day late. Thus if the assignment is marked out of 10, and students A and B hand in assignments worth 9 and 7, both two days late, then the maximum mark obtainable is 8, so A gets min(9, 8) = 8 and B gets min(7,8) = 7.

Project: You may be asked to demonstrate the work from your project. If this is the case, it will be specified at the time when the project specification document is issued.

Interview: You may be asked to attend interviews for your assignment or project. You will be notified if this is the case.

Supplementary Assessment: CSE policy available here (https://www.engineering.unsw.edu.au/computer-science-engineering/about-us/organisational-structure/student-services/policies/essential-advice-for-cse-students) . Note that in general, supplementary exams are only offered to those students who cannot attend the final exam due to circumstances beyond their control. If a student has attended the final exam, they will not be offered a supplementary exam.

Academic Honesty and Plagiarism

Plagiarism is defined as (https://student.unsw.edu.au/what-plagiarism) *using the words or ideas of others and presenting them as your own* . UNSW and CSE treat plagiarism as academic misconduct, which means that it carries penalties as severe as being excluded from further study at UNSW. There are several on-line sources to help you understand what plagiarism is and how it is dealt with at UNSW:

- Learning Centre: Plagiarism and Academic Integrity (http://www.lc.unsw.edu.au/academic-integrity-plagiarism)
- MyUNSW: Plagiarism (https://student.unsw.edu.au/plagiarism) and Academic Misconduct (https://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf)

Make sure that you read and understand these. Ignorance is not accepted as an excuse for plagiarism.

Course Schedule

The following table lists the tentative schedule. Students will be informed of any changes during the lecture and by announcements on the notice page.

Sometimes the lecture hours may be used to discuss revision problems.

The format given in the table below is only a guide. The format may vary from what's stated below.

Week	Date	Lecture topic	Assessments
1	16 Feb + 18 Feb	Introduction to capacity planning + Queueing Models, Basic operational analysis	
2	23 Feb + 25 Feb	Advanced operational analysis. Workload characterisation + Single server queues with Poisson Arrival	

3	2 Mar + 4 Mar	Multi-server queues with Poisson Arrival. Markov model (1) + Markov chain	
4	9 Mar + 11 Mar	Non-Markovian queues. Processor sharing. + Priority queues. Generating random numbers	
5	16 Mar + 18 Mar	Discrete event simulation (1): Organising discrete event simulation + Mean value analysis	Assignment due Fri 19 March 2021
6	23 Mar + 25 Mar	Flexibility Week. No lectures	
7	30 Mar + 1 Apr	Discrete event simulation (2): Analysing simulation data + Continuation of Discrete event simulation (2) Queueing applications	
8	6 Apr + 8 Apr	Fork-join queues + Optimisation and network planning (1): LInear Programming	
9	13 Apr + 15 Apr	Optimisation and network planning (2): Integer Programming + Optimisation and network planning (3): Network flow	
10	20 Apr + 22 Apr	Optimisation and network planning (4): Placement problem + Optimisation and network planning (5). Revision	Project due Fri 23 April 2021
11		No lectures. Project demo (To be confirmed.)	

Resources for Students

Textbook: There is no single text book. Please refer to lecture notes for references.

A number of lectures are based on

- Daniel A. Menasce, Virgilio A.F. Almeida and Lawrence W. Dowdy. Performance by Design, Prentice Hall, 2004
- Mor Harchol-Balter, Performance Modeling and Design of Computer Systems: Queueing Theory in Action, Cambridge University Press, 2013. (Available eletronically via UNSW Library website.)

Reference Texts:

- Raj Jain, The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling, Wiley, 1991
- Dimitri Bertsekas and Robert Gallager, Data Networks, Prentice Hall, Second Edition, 1992.
- Averill M. Law and W. David Kelton, Simulation Modeling and Analysis, McGraw-Hill, Second Edition, 1991.

- Wayne L. Winston, Operations Research: Applications and Algorithms, Duxbury Press. Third Edition, 1994.

Other Resources: Lecture materials may also be drawn from journal papers, conference papers and magazine articles published by professional bodies such as IEEE and ACM.

Software Availability:

- You can choose any programming language to do computation and simulation. For illustration purposes, sample code will be given in mostly in Python scripts.
- For optimisation, we will be using AMPL (http://ampl.com (http://ampl.com)). The demo version for AMPL can be downloaded for free.

Course Evaluation and Development

This course is evaluated each session using the myExperience survey. Sample program scripts used to be provided in Matlab but we will now use Python 3.

Resource created 5 months ago (Friday 22 January 2021, 01:40:14 PM), last modified 4 months ago (Monday 08 February 2021, 02:39:53 PM).