University of Victoria Engineering

Faculty of Engineering

COURSE OUTLINE

SENG 468: Software System Scalability

Term – Spring 2018 (23564,23565)

Instructor

Dr. Stephen W. Neville

E-mail: sneville@ece.uvic.ca

Office Hours

Days: Wed.
Time: 2:30 pm to 3:20 pm (or by appointment)
Location: EOW 441 or ELW A228

Note: All course emails ***MUST*** have "SEng468:" in the subject line and ***MUST*** be sent from UVic email accounts.

Emails without proper subject lines or sent from off-campus email accounts will likely be dropped by UVic's email spam filters or be automatically redirected to junk email folders.

Course Objectives

The course objectives are to introduce software systems scalability problems and concerns that arise within larger-scale, complex distributed software systems and, particularly, within modern Internet-scale systems. Students will gain understandings of middleware, how it is used to build such systems, how to assess where and why system bottlenecks occur, and identify the best paths to their resolution. Students will gain knowledge of the methods used to model user interactions and how to map these onto the system resource requirements. Students will be introduced to the mathematical models and approaches used to analyze system performance and scalability concerns, including those that commonly arises within modern high-volume system workloads, such as heavy-tailed, long-range dependent, self-similar, non-stationary, and emergent behaviours.

Through the team-based course project students will gain hands-on experience in software system scalability and testing issues, as well as software instrumentation and analysis approaches.

Learning Outcomes

Students successfully completing this course will gain an understanding of:

- The problems that arise when software systems are scaled up to significant numbers of users and/or system events, i.e. into the millions to billions of transactions or serviceable events.
- How to perform the system testing required to identify where and why system bottlenecks are occurring and assess the relative merits of potential solution approaches.
- Why middleware exists, its various forms, and how it is used to construct distributed software systems.
- Engineering design approaches and methods to mitigate consistency, reliability, and scalability issues.
- The applications of queueing networks to the modeling of distributed system performance and capacity and their limitations

- The engineering principles that underlie the construction of larger-scale software systems and the software engineering challenges inherent in this domain.
- The mathematical approaches used to model modern system workloads and guide performance analyses, including how these can be estimated from collected data sets and the limitations of such models.

From the course project, students will gain practical experience in how to build and debug a larger-scale distributed software systems and why this is fundamentally different than building small-scale software systems intended to service only low numbers of users.

Syllabus

The exact pacing and coverage of the syllabus materials will vary with course offerings, as such the listed syllabus denotes a provisional pacing and coverage which may (or may not) change.

Course introduction
Discussion of course project details
Introduction to larger-scale software systems:
  What and Why
  Core underlying issues
  Transparency
  Basic Distributed Architectures
  Cloud deployed back-ends
    VMs and Containers
Building Blocks of Large-scale Software Systems:
  Distributed Software Design
    Design Principals
    Design Mechanisms
    Design Methodology
  Middleware
    Basic Requirements
    RESTful and Soap
  Persistence
  Transactions
    Principals and ACID
    Concurrency Control
    Distributed Transactions
Basics of Distribution and Performance Analysis:
  Workload Matrix
  Performance Matrix
  Rules for addressing bottlenecks
  Customer behaviour model graph (CBMG)

- Client/Server interaction diagram (CSID)
- Example System

Formal Modeling Approaches and Complexities:

- Queuing network models
  - Markov models
- On/Off traffic/workload models
- Real-world Complications
  - Heavy-tails
  - Long-range dependencies
  - Self-similarity
  - Stationarity and ergodicity

Mapping onto operational systems and measurements:

- Timestamps
- Fitting distributions
  - Anderson-Darling test
  - Kolmogorov-Smirnov test
  - Chi-squared test
- Testing for stationarity and ergodicity
- Testing for self-similar/bursty workloads
- How much testing is enough?
- Edge networks and their complications

Lectures:

A-Section(s): A01, A02 / CRN 23564,24565
Days: Tues., Wed., Fri.
Time: 1:30 pm - 2:20 pm
Location: David Strong Building C118

Tutorial:

T01	Thurs	12:00 pm - 12:50 pm	ELW B203
T02	Mon	12:00 pm – 12:50 pm	ELW B203

Required Text:

Title: Workload Modeling for Computer Systems Performance Evaluation
Author: Dror G. Feitelson
Publisher: Cambridge University Press
Year: 2014

Optional Text:

Title: Performance Evaluation of Computer and Communication Systems
Author: Jean-Yves Le Boudec
Publisher: EPFK
Year: 2009

Course Web Site: http://www.ece.uvic.ca/~sneville/ then select the "Teaching" tab then select the "SEng 486" tab.

Assessment:

Course Project:	40%	Due Dates: Project milestone due dates are provided on the project course web site http://www.ece.uvic.ca/~seng462. All final project submissions will be due on April 9th @ 5pm
Mid-term	20%	Date: ***Wed., Feb. 21st***
Final Exam	40%	

Note:

- Failure to complete and pass all laboratory requirements will result in a grade of N being awarded for the course.
- Failure to pass the final exam will result in a failing grade for the course.

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate Calendar.

https://web.uvic.ca/calendar2018-01/undergrad/info/regulations/grading.html

There will be no supplemental examination for this course.

Note to Students:

Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Chair's Secretary to set up an appointment.

Accommodation of Religious Observance:
https://web.uvic.ca/calendar2018-01/undergrad/info/regulations/religious-observanc.html

Policy on Inclusivity and Diversity:
https://web.uvic.ca/calendar2018-01/general/policies.html

Standards of Professional Behaviour: You are advised to read the Faculty of Engineering document Standards for Professional Behaviour, which contains important information regarding conduct in courses, labs, and in the general use of facilities. https://www.uvic.ca/engineering/assets/docs/professional-behaviour.pdf

Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult the entry in the current Undergraduate Calendar for the UVic policy on academic integrity.
https://web.uvic.ca/calendar2018-01/undergrad/info/regulations/academic-integrity.html

Seeking to gain or gaining an unfair competitive (or other) advantage in the course project and/or its grading or seeking to subvert the project submission, tracking, and/or testing framework will be taken seriously and directly result in a loss of a minimum of 50% of the total overall project grade. Appropriate disciplinary processes will also apply.

Equality: This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed

to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact the Resource Centre for Students with a Disability located in the Campus Services Building.

The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.

Course Lecture Notes and Course Project Materials

Unless otherwise noted, all course materials, including all project materials, supplied to students in this course have been prepared by the instructor and are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may constitute a breach of academic integrity as defined in the UVic Calendar as well as the Standards of Professional Behaviour required of all Faculty of Engineering students.