UNIVERSITY of GUELPH

ENGG*4450 Large-Scale Software Architecture Engineering

01

Fall 2020
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - September 09, 2020

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1 Course Details

1.1 Calendar Description

This course introduces the students to the analysis, synthesis and design of large-scale software systems at the architectural level. This is in contrast to the algorithmic and data structure viewpoint of most software systems. Large-scale software systems are complex, execute on many processors, under different operating systems, use a particular or many language(s) of implementation, and typically rely on system layers, network connectivity, messaging and data management and hardware interfacing. The material covered includes architectural styles, case studies, architectural design techniques, formal models, specifications and architectural design tools. The laboratory sessions will expose the students to analyzing and redesigning an existing large-scale software system.

Pre-Requisites: (CIS*2420 or CIS*2520), ENGG*2100

1.2 Course Description

This course caps a series of several software development and programming courses that started with CIS*1500 and included courses on object oriented design, algorithms and data structures. This course introduces software engineering processes and tools to deal with the complexity involved in designing, implementing and testing of large scale software systems that may involve tens or hundreds of developers. We will emphasize open-source and distributed development models.

"Software development is no longer bound by time zones or national borders. Projects of all kinds – academic, commercial, and open source may have their GUI designers in Boston, their

database team in Bangalore, and their testers in Budapest and Buenos Aires. Working effectively in such teams is challenging: it requires strong communication skills, and makes proper use of coordination tools such as version control and ticketing systems more important than ever." – Undergraduate Capstone Open Source Projects

1.3 Timetable

Lectures:
Tuesday 11:30AM - 12:50PM, AD-S
Thursday 11:30AM - 12:50PM, AD-S

Laboratory:

Section 01 Thursday 03:30PM - 05:20PM AD-S
Section 02 Monday 01:30PM - 03:20PM AD-S

1.4 Final Exam

Tuesday, Dec. 8th, 2020, 08:30AM - 10:30AM, TBA on Webadvisor
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2 Instructional Support

2.1 Instructional Support Team

Instructor:	Petros Spachos
Email:	petros@uoguelph.ca
Telephone:	+1-519-824-4120 x54012
Office:	RICH 2505
Office Hours:	Tuesday, Thursday 01:00PM - 02:00PM or by email

Lab Technician:	Kevin Dong Senior Mechatronics Engineering Laboratory Coordinator
Email:	kdong@uoguelph.ca
Office:	RICH 2506

2.2 Teaching Assistants

Teaching Assistant:	Marc Jason Baucas
Email:	baucas@uoguelph.ca

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3 Learning Resources

3.1 Required Resources

Course Website (Website)
https://courselink.uoguelph.ca
Course material, news, announcements, and grades will be regularly posted to the ENGG*4450 CourseLink site. You are responsible for checking the site regularly.

Required Resources (Textbook)
There is no required textbook for the course.

3.2 Recommended Resources

Recommended Resources (Textbook)
You will find it useful to consult a UML reference book from time to time. The following book is recommended:

- Martin Fowler, "UML Distilled: A Brief Guide to the Standard Object Modeling Language", 3rd edition, Addison-Wesley, 2003.

The following text is also a useful reference (for those who like textbooks):

- Bernd Bruegge and Allen H. Dutoit, "Object-Oriented Software Engineering", 3rd edition, Prentice Hall, 2010.

The above books are on reserve at the library. You will need to refer to other books and readings throughout the course – we will provide pointers as needed.

3.3 Additional Resources

Lecture Information (Notes)
All of the lecture notes will be posted on the web page as the term progresses.

Lab Information (Other)
The handouts for all the lab sessions will be provided within the lab section. All types of resources regarding tutorials, links to web pages, etc. can be found in this section.

Assignments (Notes)
Download the assignments according to the schedule given in this handout.

Exams (Notes)
Some final exams of previous years are posted as samples. The solutions are also posted for your convenience.

Miscellaneous Information (Other)

Other information related to Large-scale Software Architecture Engineering will be posted on the course website.

3.4 Communication & Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements and/or changes will be posted to the course website. **It is your responsibility to check the course website regularly.**

Electronic communication should be limited to the **course forum**, however topics of a personal and confidential nature (e.g. marks) should be emailed to the instructor: petros@uoguelph.ca. As per university regulations, all students are required to check their mail.uoguelph.ca e-mail account regularly: e-mail is the official route of communication between the University and its students.

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4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able to:
1. Analyze client requirements and formulate use cases.
2. Reverse engineer a design through code inspection and reverse engineering tools.
3. Produce design specifications according to standards (e.g. UML).
4. Describe and compare different software development methodologies.
5. Master version control and concepts such as branching and merging.
6. Apply verification and validation strategies to software development.
7. Concisely and articulately communicate through written documentation for software projects.
8. Analyze risk in software projects.
9. Work effectively as part of a medium to large development team.

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	5
1.1	Recall, describe and apply fundamental mathematical principles and concepts	5
1.2	Recall, describe and apply fundamental principles and concepts in natural	5

#	Outcome	Learning Outcome
	science	
1.3	Recall, describe and apply fundamental engineering principles and concepts	5
1.4	Recall, describe and apply program-specific engineering principles and concepts	5
2	Problem Analysis	1, 3
2.1	Formulate a problem statement in engineering and non-engineering terminology	1, 3
2.2	Identify, organize and justify appropriate information, including assumptions	1, 3
2.3	Construct a conceptual framework and select an appropriate solution approach	1, 3
3	Investigation	1, 2, 4
3.1	Propose a working hypothesis	1, 2
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	1, 2
3.3	Analyze and interpret experimental data	2, 4
3.4	Assess validity of conclusions within limitations of data and methodologies	4
4	Design	2, 3, 6, 7
4.1	Describe design process used to develop design solution	2, 3, 6, 7
4.2	Construct design-specific problem statements including the definition of criteria and constraints	2, 3, 7
4.3	Create a variety of engineering design solutions	3, 7
4.4	Evaluate alternative design solutions based on problem definition	7
4.5	Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping	7
5	Use of Engineering Tools	2, 3, 5, 6
5.1	Select appropriate engineering tools from various alternatives	2, 3, 5
5.2	Demonstrate proficiency in the application of selected engineering tools	2, 6

#	Outcome	Learning Outcome
6	Individual & Teamwork	9
6.1	Describe principles of team dynamics and leadership	9
6.2	Understand all members' roles and responsibilities within a team	9
6.3	Execute and adapt individual role to promote team success through, for example, timeliness, respect, positive attitude	9
7	Communication Skills	1, 3, 7, 9
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	1, 3, 7, 9
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	1, 3, 7, 9
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	1, 3, 7, 9
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	1, 3, 7
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	1, 3, 7
9	Impact of Engineering on Society and the Environment	1, 6, 8
9.1	Analyze the safety, social, environmental, and legal aspects of engineering activity	1, 6, 8
9.2	Evaluate the uncertainties and risks associated with engineering activities	1, 6
9.3	Anticipate the positive and negative impacts of introducing innovative technologies to solve engineering problems	1, 6
11	Economics and Project Management	6
11.1	Apply project management techniques and manage resources within identified constraints	6
11.2	Identify risk and change management techniques, in the context of effective project management	6

#	Outcome	Learning Outcome
11.3	Estimate economic impact and feasibility of an engineering project or design using techniques such as cost benefit analysis over the life of the project or design	6

5 Teaching and Learning Activities

5.1 Schedule and Informations

Lecture schedule

Lecture	Lecture topics	Learning objectives
1	Orientation (classes start Thu)	—
2-3	Modeling & UML	4
4	Modeling Software Behaviour	4
5	Showing the Architecture	4
6	Software Re-Engineering	1, 3, 5
7	Software Processes	1, 3
8-9	Requirements Elicitation & Use-Case Driven Design	2, 3, 4, 6, 8
10	Risk Management	4, 5
11	Project Management	8, 9, 11
12	Requirements Analysis Case Study Slot 1	2, 3
13	From Requirements to Design Case Study Slot 2	3, 4
14	Robustness Analysis Case Study Slot 3	4
15	Verification & Validation Case Study Slot 4	8
16	Testing Case Study Slot 5	5
17	Testing Case Study Slot 6	5
18	Software Quality	
19	Course review	

Topics schedule will be adjusted throughout the course as needed.

Tutorial/laboratory schedule

There are several labs in the course meant to familiarize students with software engineering tools. The labs will be followed by a lab exam that will test proficiency in software use as well as the practical application of concepts covered in lectures.

Week	Topics
2	Introduction to lab
3	Object-oriented analysis and design
4	Assignment 1 help session
5	Version control with Git
6	No lab
7	Assignment 2 help session
8	Code review
9	Assignment 3 help session
10	Lab Test
10	Laboratory 3 with report
11	Review help session
12	Automated testing
13	Assignment 4 help session

Topics schedule will be adjusted throughout the course as needed.

5.2 Other Important Dates

- Thursday, September 10th, 2020: First day of classes
- Monday, October 12th, 2020: Holiday (no classes scheduled)
- Tuesday, October 13th, 2020: Fall Study Break day, (no classes scheduled)
- Wednesday, December 2nd, 2020: Last day for regularly scheduled classes
- Thursday, December 3rd, 2020: Classes rescheduled from Tuesday, October 13
- Friday, December 4th, 2020: Classes rescheduled from Monday, October 12

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6 Assessments

6.1 Assessment Details

Assignments (35%)
Learning Outcome: 1, 2, 3, 5, 6, 7, 9
A1: Reverse Engineering & Design Recovery (5%), due Oct. 5, by PDF to CourseLink Dropbox class
A2: Implementing Change Requests (10%), due Oct. 26, by PDF to CourseLink Dropbox
A3: Requirements Analysis (10%), due Nov. 16, by PDF to CourseLink Dropbox
A4: Build and Test a New Feature (10%), due Dec. 3, by PDF to CourseLink dropbox

Assignments must be submitted to CourseLink Dropbox, before midnight on the specified date (i.e. by 11:59 pm). TA and instructor will not answer any queries related to the assignments in the 24 hour period prior to the deadline

You will work in teams of approximately 6-7 students for all assignments. Teams will be announced in the first or second week of the term. Each team will submit a single report for each assignment. All members of a team will receive the same grade for the assignment, except in exceptional circumstances at the discretion of the instructor. Detailed instruction on the content of each assignment will be distributed during the term.

Lab Test (20%)
Date: Mon, Nov 9 - Thu, Nov 12
Learning Outcome: 1, 2, 3, 5, 6, 7
The lab test will be held November 9 and November 12 in the regular lab session. It will test all material covered in lectures and labs to-date.
See section 5.2 below for more details on labs.

Case study (5%)
Presented per group. Each group will select a Case Study from Volume 1 and 2 of *The Architecture of Open Source Applications* (http://aosabook.org/) to present in class.

Final Exam (40%)
Date: Tue, Dec 8, TBA
Learning Outcome: 1, 2, 3, 5, 6, 7
Tuesday, Dec. 8th, 8:30AM - 10:30AM, TBA on Webadvisor

6.2 Course Grading Policies

Passing Grade: The passing grade is 50%.

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration of

Religious Obligations:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08-accomrelig.shtml

Missed Lab Test: Any student not taking the lab test will receive a grade of zero. In case you have a legitimate reason for missing the midterm exam, the instructor may consider accommodation upon presentation of a written request and suitable documentation before the time of the exam.

Lab Work: You must attend and complete all laboratories. If you miss a laboratory due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a make-up lab.

Late Assignments: Due dates for the assignments are firm. Assignments must be submitted to CourseLink Dropbox, by midnight on the submission date (i.e. by 11:59PM). Late submissions of assignments will not be accepted.

Clarification About Grades: If you have questions about the grade your assignment received, please ask your TA. However, all requests for re-marking must be made to the instructor. Any item that is remarked will be re-marked entirely. Therefore it is strongly suggested that you thoroughly review your entire document before making a re-marking request. Re-marking requests will not be honoured more than one week after the document has been returned.

6.3 Relationships with other Courses & Labs

Previous Courses:

- CIS*2520: Data structures & algorithms.
- ENGG*2100: Design practices.

Follow-on Courses:

- ENGG*4120 or ENGG*4170: Collaborative design project.

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7 School of Engineering Statements

7.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests

and labs.

7.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

7.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

8 University Statements

8.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

8.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions
https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml

8.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml

8.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

8.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website
https://www.uoguelph.ca/sas

For Ridgetown students, information can be found on the Ridgetown SAS website
https://www.ridgetownc.com/services/accessibilityservices.cfm

8.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community-faculty, staff, and students-to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

8.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

8.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars

8.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings and academic schedules. Any such changes will be announced via CourseLink and/or class email. All University-wide decisions will be posted on the COVID-19 website (https://news.uoguelph.ca/2019-novel-coronavirus-information/) and circulated by email.

8.10 Illness

The University will not normally require verification of illness (doctor's notes) for fall 2020 or winter 2021 semester courses. However, requests for Academic Consideration may still require medical documentation as appropriate.

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