

# Engineering Design with Embedded Systems, draft version 2

## ECE155, Winter 2013

Patrick Lam

### Brief Overview

This course is a medley of three different topics: software design, project management, and the underlying theme of embedded systems. In this offering of the course, you'll learn about embedded systems by developing for Android (as in smartphones) and working with phone sensors, which provide a rich source of information about the world. Also, this course presents a collection of miscellaneous topics, relating to software development, which electrical and computer engineers ought to know about.

**Course Description.** “Introduction to embedded systems, review of engineering design and analysis principles, software development life cycle, integrated development environments, use of software requirements and specifications, unified modeling language and documentation, event handling, simulation, project management, project scheduling, testing, verification, and maintenance considerations.”

**Objectives.** More specifically, after this course you will be able to:

1. describe the major blocks comprising common embedded systems;
2. program an event-driven embedded system;
3. compare and contrast different software development lifecycles and situations in which they work well;
4. describe the engineering design process, planning and estimation, reviews, simulation, and software maintenance;
5. collect and document requirements for, and design, a simple software system;
6. use modern software development tools and concepts, including: integrated development environments; version control; UML; refactoring; and unit tests.

## General Information

**Course Web Page:** Information will be posted on Learn and mirrored at <http://patricklam.ca/ece155>.  
**Schedule:**

Regular lectures	SEC001	MF 13:30-14:20 T 15:30-16:20	Patrick Lam	RCH302
Extra lectures		[Th 01/24, 02/07, 03/07, 03/21, 04/04], 16:30-15:20		
Midterm		03/01, 13:00-15:00		EIT 1015/RCH 302
Tutorials	TUT101	T 10:30-11:20		MC 4040
	TUT102	Th 10:30-11:20		MC 4040
	TUT103	T 14:30-15:20		RCH 204
TA Office Hours		M 11:30-12:30		various
		M 16:30-17:30		various
		T 11:30-12:30		various
		W 11:30-12:30		various
		W 15:30-16:30		various
Lab Hours	LAB201	W 8:30-11:20		E2 2356
		01/09, 01/23, 02/06, 02/27, 03/13, 03/27		
	LAB202	F 8:30-11:20		
		01/11, 01/25, 02/08, 03/01, 03/15, 04/08		
	LAB203	M 8:30-11:20		
		01/07, 01/21, 02/04, 02/25, 03/11, 03/25		

Regular lectures are cancelled for midterm week, February 25–March 1. Labs continue.

### Instructors:

Prof. Patrick Lam  
Office: DC2597D  
Office Hours: Tuesday 11:30-12:30, or by appointment  
Email: [p.lam@ece.uwaterloo.ca](mailto:p.lam@ece.uwaterloo.ca)  
Phone: Use email instead!

I encourage you to see me during office hours or to communicate with me by email. I am here to help you learn, but you have to contact me first, and we'll figure out how to best proceed. If my office hours don't work for you, send an email to set a mutually convenient appointment time.

### Lab Instructor:

Sanjay Singh  
Office: E2 3343  
Phone: x36165  
Email: [ssingh@uwaterloo.ca](mailto:ssingh@uwaterloo.ca)

The lab instructor can answer your questions about the laboratory studies in the course and can arrange additional time with the laboratory equipment. You can arrange an individual appointment with the lab instructor by contacting the lab instructor via email.

## Teaching Assistants:

Devin Binnie  
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The teaching assistants can help with course material, tutorials, labs, exams, and assignments. You can arrange individual appointments with teaching assistants (outside office hours) via email.

## Grading Scheme

Your final mark  $G$  includes your marks on the labs  $l_i$ , marks on assignments  $a_i$ , the midterm  $m$ , and the final exam  $f$ .

$$\begin{aligned}L &= \frac{20}{30} \sum_{i=1}^4 l_i + \frac{10}{30} \sum_{i=1}^5 a_i \\E &= \frac{20}{70} m + \frac{50}{70} f \\W_l &= \begin{cases} 30 & \text{if } E \geq 60 \\ E - 40 + 10 & \text{if } 40 \leq E < 60 \\ 10 & \text{if } E < 40 \end{cases} \\W_e &= 100 - W_l \\G &= \frac{W_l}{100} L + \frac{W_e}{100} E\end{aligned}$$

There will be 6 (small) marked assignments on alternate weeks from labs. I will count the best 5 marks.

## Recommended Textbook

- A. Stellman and J. Greene, Applied Software Project Management, O'Reilly Media, 2006.

## Other References of Potential Interest

- S. McConnell, Code Complete, 2nd Edition, Microsoft Press, 2004.

## Lecture Topics

Here is a detailed list of topics, the objective they contribute to (in parentheses), and estimated lecture hours for each topic.

Introduction to Embedded Systems	2
Event-Driven Programming (2)	3
Integrated Development Environments (6)	1
Practical Debugging Techniques (6)	1
Intro to Concurrency: threads and timers (2, 6)	1
Software Development Life Cycle (3)	2
Engineering Design and Analysis (4)	2
Planning and Estimation (4)	2
Requirements Specifications (5)	1
Unified Modelling Language (6)	2
Version Control Systems (6)	1
Refactoring (6)	2
Reviews (4)	1
Simulation (4)	1
Testing (6)	1
Verification and Validation (4)	1
Software Maintenance (4)	1
Android Development (2, 6)	9

The number of lecture hours per topic is approximate, and may vary based on the needs of the class. The number of lecture hours provided is based on past experience in teaching the course. Some topics will be introduced early in the course and revisited later in the course.

## Assignments

I've found that a lot of learning happens while doing assignments. I've therefore prepared assignments to help you learn the material and prepare for the exams. What's more, assignments are a great source for exam questions. Here are projected assignment topics; only 6 of them will be marked.

- 1 Writing Simple Android Apps
- 2 Writing Event Handlers, Timers
- 3 Raw Device Access
- 4 Code Review
- 5 Software Lifecycle Models
- 6 Debugging
- 7 Unit Testing
- 8 UML
- 9 Requirements and Use Cases
- 10 Refactoring

I may continue revising assignments to better reflect our new Android-based revision of ECE155.

## Labs

This course includes labs, to be done in randomly-assigned groups of 2 or (maybe) 3. In the labs, you will write apps for an Android phone. In keeping with the embedded-systems theme of the course, these apps will process sensor data. Android phones are a rich source of sensor data.

**Phone Availability.** We will provide UW-owned Nexus One phones for you to use during the lab sessions. You can also use your own personal Android device (phone or tablet). There are also 30 Nexus One phones on reserve for 3-day loan from the Davis Centre library. Previous students have complained bitterly about the limited access to the LEGO Mindstorm robots that we used in prior offerings; I hope that you will have enough access to devices for this offering of the course.

**How The Labs Will Work.** This term, I've placed most of the lab manual online at the beginning of the course. I may need to make amendments to the labs as students work through them. I'll announce them in class and update the files on LEARN, along with their version numbers.

The 6 lab sessions last approximately 3 hours each. During the lab sessions, you can work on the labs and get help from TAs. Think of them as dedicated office hours with phones available. After Lab  $N$ , you may continue working on your solution for Lab  $N$  until the beginning of Lab  $N + 1$ , where you must be prepared to demonstrate your solution to Lab  $N$  and have committed your code to the repository. Of course, that doesn't work for Lab 4. You must be ready to demonstrate Lab 4 by Tuesday, April 2. If you're not ready to demonstrate your lab at demo time, you will receive a 0 for that lab.

Lab 0 will introduce the equipment you'll be using in this course. The remaining lab sessions will make up 4 labs. All labs will be in E2 2364. Here is a list of the labs:

Lab 0	Hello, Android!
Lab 1	Displaying Sensor Values
Lab 2	Pedometer: Processing Accelerometer Data
Lab 3	Directed Pedometer: Combining Sensor Values
Lab 4	Sensor-Enabled Navigation
(2 sessions)	

In the labs, you will write the control software in Java under the Eclipse Integrated Development Environment. Java is quite similar to C#, which you learned in ECE150; I don't anticipate problems adjusting from C# to Java. You may also simulate and test your software. We will mark each of the four graded labs (1-4) based on the quality and performance of your software designs. You must submit your source code to the course Subversion repository and demonstrate working software to a teaching assistant during the lab demo period.

**Grading of Labs.** We will assign each lab submission a grade out of 5, according to a rubric that we'll develop and distribute. We will provide feedback about the quality of your solution. All of the 4 lab submissions contribute to your mark for the course.

## Lateness, Collaboration, Extra Credit, etc.

Here are the policies on late submissions, collaboration, extra credit and attendance.

**Lateness.** In this course, a late assignment will be penalized 20% of the maximum grade for the assignment for each business day that the assignment is submitted late. That is,

- Assignments handed in 1 day late will be penalized 20% of the maximum grade.
- Assignments handed in 2 days late will be penalized 40% of the maximum grade.
- Assignments handed in 3 days late will be penalized 60% of the maximum grade.
- Assignments handed in 4 days late will be penalized 80% of the maximum grade.
- Assignments handed in 5 or more days late will be assigned a grade of 0.

I'll drop your lowest assignment mark.

**Collaboration.** I encourage collaboration, but I condemn plagiarism: copying penalizes students who do the work. I will therefore be reporting any cases of plagiarism that I detect.

You are expected to collaborate within your group. Also, you may discuss ideas, design alternatives, and help each other debug small fragments of code. Each group must submit their own, independently-developed, code for each lab. A good heuristic is “look, but don’t write:” you can look at other groups’ code, but don’t do that anywhere that you might be writing your own code.

To be precise, groups are not permitted to share code electronically or in written form, unless such sharing has been clearly documented and acknowledged in the receiving work. An acknowledged fragment will not be considered while grading the assignment (but will not trigger disciplinary penalties). The receiving group will not be further penalized. Acknowledgements must include the name of the providing group and the date of the collaboration.

**Extra Credit.** In ECE 155, there are no opportunities for extra credit work. Makeup assignments and makeup examinations will not be offered to students under any circumstances.

**Attendance.** Although I encourage you to attend class, attendance is not graded. If you feel ill, you should immediately seek medical attention. If you miss an exam for health reasons, you need a verification of illness form.

- Forms can be completed by the physicians at Health Services.
- Forms should be presented to the First-Year Engineering Office for verification.

If you anticipate missing a deliverable deadline or an examination for a non-medical reason, you should contact me as soon as you are aware of the problem. Given sufficient notice, alternate arrangements may be possible. Alternate arrangements are rare and subject to my discretion.

## Required inclusions

**Academic Integrity:** In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check [www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/) for more information.]

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, [www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm). When in doubt please be certain to contact the departments administrative assistant who will provide further assistance.

**Discipline:** A student is expected to know what constitutes academic integrity [check [www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/)] to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, [www.adm.uwaterloo.ca/infosec/Policies/policy71.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm). For typical penalties check Guidelines for the Assessment of Penalties, [www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm](http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm).

**Appeals:** A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) [www.adm.uwaterloo.ca/infosec/Policies/policy72.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm).

**Note for Students with Disabilities:** The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.