# ENGG**4650 Integrated Sensors and Photonic Devices
# Fall 2015

School of Engineering

(Revision 0: September 8, 2015)

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## 1 INSTRUCTIONAL SUPPORT

### 1.1 Instructor


Instructor: Petros Spachos, Ph.D.
Office: RICH 2505, ext. 54012
Email: petros@uoguelph.ca
Office hours: Mondays 2:30 PM– 3:30 PM or by appointment @ RICH 2505


### 1.2 Lab Technician


Technician: Nate Groendyk
Office: THRN 2308, ext. 53873
Email: groendy@uoguelph.ca


### 1.3 Teaching Assistants

| GTA | Email | Office Hours |
|---|---|---|
| Hans Tee | htee@uoguelph.ca | - |

# 2 LEARNING RESOURCES

## 2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*4650 Courselink site. You are responsible for checking the site regularly.

## 2.2 Required Resources

1. Lecture notes and slides

## 2.3 Recommended Resources

1. W. Dargie, C. Poellabauer*, Fundamentals of Wireless Sensor Networks: Theory and Practice,* John Wiley & Sons 2010.
2. I. F. Akyildiz, M. C. Vuran, *Wireless Sensor Networks*, John Wiley & Sons 2010.

## 2.4 Additional Resources

**Lecture Information**: All the lecture notes are posted on the web page (week #1-#12).

**Lab Information**: The handouts for all the lab sessions are within the lab section. All types of resources regarding tutorials, links to web pages can be found in this section.

**Assignments**: Download the assignments according to the schedule given in this handout. All the solutions will be posted as indicated.

**Exams**: Some midterms and finals of previous years are posted as samples of exams. The solutions are also posted for your convenience.

**Miscellaneous Information**: Other information related to ENGG*4650 are also posted on the web page.

## 2.5 Communication & Email Policy

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

# 3 ASSESSMENT

## 3.1 Dates and Distribution

**Labs**: 15%

See section 5.3 below for due dates.

**Project**: 15%

See section 5.4 below for due dates.

**Assignments:** 20%

Assignment #1: Announced on Oct. 2 and due on Oct. 16, 2015

Assignment #2: Announced on Oct. 16 and due on Oct. 30, 2015

Assignment #3: Announced on Nov. 6 and due on Nov. 20, 2015

Assignment #4: Announced on Nov. 20 and due on Dec. 4, 2015

**Midterm exam**: 20%

Monday, Oct. 26, 1:00 PM - 2:20 PM, CRSC, Room 101

**Final Exam**: 30%

Wednesday Dec. 16, 7:00 PM - 9:00 PM, Room TBA on Webadvisor

## 3.2 Course Grading Policies

**Missed Assessments**: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. Please see below for specific details and consult 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 within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

**Passing grade**: In order to pass the course, you must pass both the laboratory and exam course portions. Students must obtain a grade of 50% or higher on the exam portion of the course in order for the laboratory write-up portion of the course to count towards the final grade.

**Missed midterm tests**: If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of the missed test will be added to the final exam. There will be no makeup midterm tests.

**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 makeup lab.

**Late Lab Reports**: Late submissions of lab reports will not be accepted.

# 4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

## 4.1 Calendar Description

This course presents an overview and the principles of operation of integrated solid-state sensors and sensing systems. It studies the microstructures for the measurement of visible and infrared radiation, pressure, acceleration, temperature, gas purity, and ion concentrations. Topics include transduction mechanisms, design parameters, fabrication technologies, and applications. The course will also explore the theoretical and practical aspects of current photonic devices and applications based on linear and nonlinear optics.

*Prerequisite(s)*: CHEM*1040, ENGG*2450, PHYS*1010

## 4.2 Course Aims

This course provides students with an opportunity to learn the fundamentals behind the design of wireless sensor networks. A primary focus of this course is to give students hands-on programming experience with various sensors and sensing platforms.

## 4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Learn the fundamental concepts of sensor network design.
2. Learn to apply sensor network protocols, mechanisms, and algorithms to implement sensing systems.
3. Design, program, simulate, and experiment with sensor network software and hardware.
4. Solve various sensor network design problems individually and in teams.
5. Communicate effectively about specifications, design, simulation, testing, and applications of wireless sensor networks.
6. Investigate design and deployment issues in wireless sensors network systems.

## 4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

| Graduate Attribute | Learning Objectives | Assessment |
|---|---|---|
| 1. Knowledge Base for Engineering | 1, 2 | Tests and assignments |
| 2. Problem Analysis | 3, 4, 6 | Lab project and experiments |
| 3. Investigation | 3, 5 | Lab project and experiments |
| 4. Design | 3, 4, 5, 6 | Lab project, assignments and experiments |
| 5. Use of Engineering Tools | 3, 4, 5, 6 | Lab project and experiments |
| 6. Individual and Teamwork | 3, 4 | Lab project and experiments |
| 7. Communication | 4, 5 | Lab project and experiments |

| | | |
|---|---|---|
| 8. Professionalism | 3, 4, 6 | Lab project and experiments |
| 9. Impact of Engineering on Society and the Environment | 1, 2, 4, 6 | Lab project and experiments |
| 10. Ethics and Equity | 1, 5 | Lab project and experiments |
| 11. Economics & Project Management | 3, 4 | Lab project, assignments and experiments |
| 12. Life-Long Learning | 4, 6 | Lab project, assignments and experiments |

## 4.5 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/D2L but these are not intended to be stand-alone course notes. 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 project.

## 4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. 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.

## 4.7 Relationships with other Courses & Labs

**Previous Courses:**

**CHEM*1040**: chemical bonding, simple reactions

**ENGG*2450**: circuit analysis, circuit theorems, operational amplifier, first and second order circuits, magnetically coupled circuits

**PHYS*1010**: electromagnetism, electric charges and fields, magnetic fields, electromagnetic waves, optics

**Follow-on Courses:**

- Not Applicable

# 5 TEACHING AND LEARNING ACTIVITIES

## 5.1 Timetable

**Lectures**:

| | | |
|---|---|---|
| Monday | 13:00 – 14:20 | CRSC 101 |
| Wednesday | 13:00 – 14:20 | CRSC 101 |

**Laboratory:**

| | | |
|---|---|---|
| Friday | 10:30 - 12:20 | THRN 2307 |

## 5.2 Lecture Schedule

| Lectures | Lecture Topics (Tentative*) | References | Learning Objectives |
|---|---|---|---|
| 1-2 | Introduction | Chapter 1 | 1 |
| 3-4 | Applications | Chapter 2 | 1, 2 |
| 5-6 | Node Architecture | Chapter 3 | 1, 2 |
| 7-8 | Operating Systems | Chapter 4 | 3, 4, 5 |
| 9-10 | Physical Layer | Chapter 5 | 3, 4, 5 |
| 11-12 | Medium Access Control | Chapter 6 | 3, 4, 5 |
| 13-14 | Network Layer | Chapter 7 | 4, 5 |
| 15-16 | Power Management | Chapter 8 | 3, 5, 6 |
| 17-18 | Time Synchronisation | Chapter 9 | 3, 4, 6 |
| 19-20 | Localization | Chapter 10 | 4, 5, 6 |
| 21-22 | Security | Chapter 11 | 5, 6 |
| 23-24 | Sensor Network Programming | Chapter 12 | 5, 6 |

*Topics schedule will be adjusted throughout the course as needed.

## 5.3 Lab Schedule and Information

The real learning in this course goes on in the laboratory where you design, build and test and fix real systems. There are **ten mandatory** labs of two hours each. You will work in groups.

In each lab you will typically have to build, in software or hardware a sensor network system. Once this is done, show it to your TA for grading, out of 3:

| Judgement of TA | Grade |
|---|---|
| Did not attend or try | 0 |
| Tried, but failed to get much working | 1 |
| Most, but not all working | 2 |
| Everything worked | 3 |

Note: Although the lab portion of the course is worth only 15%, both the midterm and the final exam will contain questions directly related to skills learned in the lab.

| **Date** | **Activity** | **References** |
|---|---|---|
| September 11 | No lab | |
| September 18 | Introduction – Tutorial 1 | Lab manual<br>1 Mark |
| September 25 | Tutorial 2 | Lab manual<br>1 Mark |
| October 2 | Laboratory 1 | Lab manual<br>3 Marks |
| October 9 | Laboratory 2 | Lab manual<br>3 Marks |
| October 16 | **Thanksgiving week – <u>lecture this Friday</u>; no lab** | |
| October 23 | Tutorial 3 | Lab manual<br>1 Mark |
| October 30 | Laboratory 3 | Lab manual<br>3 Marks |
| November 6 | Laboratory 4 | Lab manual<br>3 Marks |
| | **Project Proposal** | Lab manual<br>1 Mark |
| November 13 | **Project Period 1** | Lab manual<br>1 Mark |
| November 20 | **Project Period 2** | Lab manual<br>1 Mark |
| November 27 | **Project Period 3/ Presentation** | Lab manual<br>8 Marks |
| December 4 | **Final Project report** | Lab manual<br>4 Mark |

## 5.4 Project Schedule and Information

**The Task**

The purpose of the project is to:

1. Gain experience dealing with the design of a network system, and to deal with the issues in going from a soft simple specification ("make a wireless sensor node") to an actual complete design.
2. Express your creativity by applying what you have learned in this course to a project of your own choosing.

You will design and implement a project of your own choosing that uses network software or hardware components in some creative way. You may use any of the parts available in the lab. An important part of this lab is the creativity required to think up an interesting project, and then negotiate with the TA or instructor as to the final form of the project.

**Originality/Uniqueness Approval**

The first step in your project is to come up with an original idea. You must submit your idea, in a 1-3 line description, via email to the instructor for "originality" or "uniqueness" approval. The instructor will quickly respond to tell you if the idea has already been proposed more than once. If it has, you'll have to come up with something different. Please note that this approval is only the first step and only deals with the basic idea, and not the scope/effort required for the project; that comes next:

**Before the First Project lab**

You will submit a short project proposal of what your project is about. This should be a short description that gives:

- The basic idea of the project, and the basic function of your system.
- Describe the inputs and outputs, and give a simple block diagrams describing how the various parts of your system interact.
- Your plan of action for each of the three lab periods - "milestones"
- Present this to your TA to get their opinion on whether the project is viable. This is just a check to make sure that you do not try something overly ambitious.

**Demonstration and Report**

You will demonstrate your project to the instructor in the final lab period, and will be required to provide a short report describing your project.

## 5.5 Other Important Dates

- Thursday, September 10, 2015: First day of class
- Monday, October 12, 2015: Thanksgiving holiday
- Tuesday, October 13, 2015: Fall study day, no classes
- Friday, November 6, 2015: 40th class day, last day to drop classes
- Friday, December 4, 2015: last day of class

# 6 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.

If the laboratory rules are not followed, consequences will include removing student's access to the lab. If this results in lab work not being completed, the student will receive a grade of 0.

# 7 ACADEMIC MISCONDUCT

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 discourages misconduct. 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.

## 7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in your Engineering Program Guide.

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

# 8 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible

For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.uoguelph.ca/csd/

# 9 RECORDING OF MATERIALS

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

# 10 RESOURCES

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs: http://www.uoguelph.ca/registrar/calendars/index.cfm?index