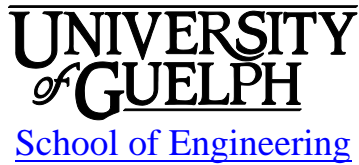


# ENGG\*4650 Integrated Sensors and Photonic Devices

## Fall 2013



(Revision 0: September 5, 2013)

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## 1 INSTRUCTIONAL SUPPORT

### 1.1 Instructor

Instructor: Fadi Al-Turjman, Ph.D.  
Office: Richards 3513, ext. 54367  
Email: [fadi@uoguelph.ca](mailto:fadi@uoguelph.ca)  
Office hours: By appointment @ Richards 3513

### 1.2 Lab Technician

Technician: Nathaniel Groendyk  
Office: THRN 2308, ext. 53873  
Email: [groendyk@uoguelph.ca](mailto:groendyk@uoguelph.ca)

### 1.3 Teaching Assistants

<u>GTA</u>	<u>Email</u>	<u>Office Hours</u>
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## 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<sup>1</sup>.

## 2.3 Recommended Resources

[2] J. Vetelino, A. Reghu, *Introduction to Sensors*, CRC Press 2010.

[3] Jacob Fraden, *Handbook of Modern Sensors*, Springer 2010.

[4] G. Meijer, *Smart Sensors Systems*, 2nd Ed., Wiley, 2008.

[5] Holger Karl, Andreas Willig, *Protocols and Architectures for Wireless Sensor Networks*, Wiley, 2005.

## 2.4 Additional Resources

**Lecture Information:** All the lecture notes will be posted on the web page as we progress (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:** All assignments will be announced/posted on the courselink. Any new assignment will be announced on the due date of the previous one. Download the assignments and submit them according to the schedule given in this handout.

**Exams:** Selected questions/answers from midterms and finals of previous years will be posted prior to exams.

**Miscellaneous Information:** Other information is 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 <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its student.

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# 3 ASSESSMENT

## 3.1 Dates and Distribution

**Labs:** 30%

See section 5.4 below for due dates.

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<sup>1</sup> There is no single textbook in general for the sensors' course simply because it is multidisciplinary.

**Assignments: 20%**

Assignment # 1: Announced on Sept 26 and due on Thu Oct 10, 2013

Assignment # 2: Announced on Oct 10 and Due on Thu Oct 31, 2013

Assignment # 3: Announced on Oct 31 and Due on Thu Nov 14, 2013

Assignment # 4: Announced on Nov 14 and Due on Thu Nov 28, 2013

**Note:** both paper and electronic copies are to be submitted.

**Midterm Exam: 20%**

Thu Oct. 31, 2013 @ 8:30-10:00, Room MACK 119.

**Final Exam: 30%**

Thu Dec 12, 2013 @ 11:30-13:30, 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. 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 at 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.

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## 4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

### 4.1 Calendar Description

This course presents an overview and the principles of integrated sensors and sensing systems. It studies the microstructures for sensor nodes (design and operation) and their measurements. Topics include design parameters, fabrication technologies, and applications. The course will also explore theoretical and practical aspects of sensor nodes utilized in wireless communications and networking to achieve critical objectives in different applications including forest fire detection, pollution monitoring, greenhouses and irrigation management.

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

### 4.2 Course Aims

The objective is to gain familiarity with sensors and their applications, which are fundamental elements in computer, communication, and control systems. The course will start with the basic sensor operation and the integration of sensors in engineering and communication systems. Then the course will present the principles of sensors architectures and a broad overview of sensing devices (including optical, chemical, thermal, magnetic, etc.) and of photonic devices (including light-emitting diodes, and optical fibres). Other topics to be covered are sensor characteristics and components, interfaces, and data acquisition/analysis.

### 4.3 Learning Objectives

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

1. Identify terms, quantities, and models used by engineers for describing integrated sensors and photonic devices.
2. Identify and describe types and components of integrated sensors and photonic devices.
3. Analyze the needs of a sensor system and choose sensors accordingly.
4. Comprehend the importance of microfabrication technologies, physical and technological parameters, and device modeling.
5. Communicate effectively about specifications, design, simulation, testing, and applications of integrated sensors and photonic devices.
6. Investigate design and deployment issues in sensors systems.

### 4.4 Graduate Attributes

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

<b>Graduate Attribute</b>	<b>Learning Objectives</b>	<b>Assessment</b>
1. Knowledge Base for Engineering	1, 2	Tests and assignments.
2. Problem Analysis	2, 3	Lab project and experiments.
3. Investigation	4	Lab project and experiments.

4. Design	2, 3, 4	Lab project and experiments and assignments.
5. Use of Engineering Tools	4	Lab experiments.
6. Communication	5	Lab project and experiments and presentations.
7. Individual and Teamwork	5	Assignments, tests, lab project and experiments, and presentations.
8. Professionalism	1, 5	Lab project and experiments, and presentations.
9. Impact of Engineering on Society and the Environment	3	Tests, assignments and lab project.
10. Ethics and Equity	1	Tests and lab project.
11. Environment, Society, Business, & Project Management	1, 2, 3	Lab project and assignments.
12. Life-Long Learning	-	Tests, presentations, and lab project 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 lab 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:

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## 5 TEACHING AND LEARNING ACTIVITIES

### 5.1 Timetable

**Lectures:**

Tue	8:30 – 9:50	MACK 119
Thu	8:30 – 9:50	MACK 119

**Tutorials:**

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**Laboratory:**

Fri	8:30 - 10:30	THRN 2307
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### 5.2 Lecture Schedule

Lectures	Lecture Topics	References	Learning Objectives
1-2	Introduction to integrated sensors and photonic devices	[1][3]	1
3-4	Sensor node components and architecture	[1][3][5]	1, 2
5-6	Design issues	[1][3][5]	1, 2
7-8	Sensors in networking and communication systems	[1][5]	3, 5
9-10	Deployment planning	[1][5]	3, 5
11-12	Measurement methods and sensor systems	[1][3]	1, 3, 5
13-14	Data acquisition/analysis	[1][3][5]	2, 3
15-16	Microfabrication technologies and sensor interfaces	[1][3]	4
17-18	Sensor types and integration	[1][3]	2
19-20	Thermal sensors	[1][3]	2, 3
21-22	Magnetic sensors	[1][3]	2, 3
23-24	Light-emitting diodes, and optical fibres	[1]	5

### 5.3 Design Lab Schedule

Week	Activity	References
1	-	-
2	Introduce new terminologies, and describe sensors' types and components.	Lab manual
3-5	Introducing sensors in communication systems and apply simulations in OMNET++ environment.	Lab manual
6-7	Design range finder sensors.	Lab manual
8-9	Design thermal sensors and viewing outputs on oscilloscope/PC using LabView.	Lab manual

10-11	Design magnetic sensors and viewing outputs on oscilloscope/PC using LabView.	Lab manual
12	Lab project discussion.	Lab manual

#### 5.4 Lab Schedule

Week	Topic	Due
1	-	-
2	Sensor types and components report.	Week 3
3-5	Sensors in communication systems report.	Week 6
6-7	Range finder sensor report.	Week 8
8-9	Thermal sensors report.	Week 10
10-11	Magnetic sensors report.	Week 12
12	Final project report.	Dec 12, 2013

#### 5.5 Other Important Dates

- Thursday, 5 September 2013: First class
- Monday, 14 October 2013: Thanks giving holiday
- Thursday, 31 October 2013: drop date – 40th class
- Thursday, 28 November 2013: last class (Monday Schedule in effect)
- Students are also encouraged to check the undergraduate calendars for the semester scheduled dates.

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## 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. Please refer to your lab manual for further safety instructions.

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## 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>

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## 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](mailto:csd@uoguelph.ca) or see the website: <http://www.csd.uoguelph.ca/csd/>