1 INSTRUCTIONAL SUPPORT

1.1 Instructor
Instructor: Petros Spachos, Ph.D.
Office: RICH 2505, ext. 54012
Email: petros@uoguelph.ca
Office hours: Mondays 12:30 PM–1:30 PM or by appointment @ RICH 2505

1.2 Lab Technician
Technician: Hong Ma
Office: RICH 1506, ext. 53873
Email: hongma@uoguelph.ca

1.3 Teaching Assistants

<table>
<thead>
<tr>
<th>GTA</th>
<th>Email</th>
<th>Office Hours</th>
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<tr>
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</table>
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

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%
Discuss in class

Assignments: 10%
Assignment #1: Announced on Sept. 30th and due on Oct. 6th, 2016
Assignment #2: Announced on Oct. 14th and due on Oct. 20th, 2016
Assignment #3: Announced on Nov. 11th and due on Nov. 17th, 2016
Assignment #4: Announced on Nov. 25th and due on Dec. 1st, 2016

All assignments should be submitted electronically and till 11:59 pm on the due date

Midterm exam: 25%
Wednesday, Oct. 26, 6:00 PM – 7:20 PM, TBA on CourseLink

Final Exam: 35%
Monday Dec. 12, 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

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 embedded 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, embedded system interfaces and programming, and data acquisition/analysis.

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 and embedded system 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 integrated sensors.
6. Investigate design and deployment issues in integrated sensors and embedded systems.

4.4 Graduate Attributes

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

<table>
<thead>
<tr>
<th>Graduate Attribute</th>
<th>Learning Objectives</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knowledge Base for Engineering</td>
<td>1, 2</td>
<td>Tests and assignments</td>
</tr>
<tr>
<td>2. Problem Analysis</td>
<td>3, 4, 6</td>
<td>Lab project and experiments</td>
</tr>
<tr>
<td>3. Investigation</td>
<td>3, 5</td>
<td>Lab project and experiments</td>
</tr>
<tr>
<td>4. Design</td>
<td>3, 4, 5, 6</td>
<td>Lab project, assignments and experiments</td>
</tr>
</tbody>
</table>
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 13:30 – 14:20 MCKN 316
- Wednesday 13:30 – 14:20 MCKN 316
- Friday 13:30 – 14:20 MCKN 316

Laboratory:
- Friday 15:30 - 17:20 RICH 1532

5.2 Lecture Schedule

<table>
<thead>
<tr>
<th>Lectures</th>
<th>Lecture Topics (Tentative*)</th>
<th>References</th>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Introduction</td>
<td>Chapter 1</td>
<td>1</td>
</tr>
<tr>
<td>3-4</td>
<td>Sensor types and components report</td>
<td>Chapter 2</td>
<td>1, 2</td>
</tr>
<tr>
<td>5-6</td>
<td>Range finder sensor</td>
<td>Chapter 3</td>
<td>1, 2</td>
</tr>
<tr>
<td>7-8</td>
<td>Thermal sensors</td>
<td>Chapter 4</td>
<td>3, 4, 5</td>
</tr>
<tr>
<td>9-10</td>
<td>Embedded systems and communications (I)</td>
<td>Chapter 5</td>
<td>3, 4, 5</td>
</tr>
<tr>
<td>11-12</td>
<td>Embedded systems and communications (II)</td>
<td>Chapter 6</td>
<td>3, 4, 5</td>
</tr>
<tr>
<td>13-14</td>
<td>Embedded systems and communications (III)</td>
<td>Chapter 7</td>
<td>4, 5</td>
</tr>
<tr>
<td>15-16</td>
<td>Operating Systems (I)</td>
<td>Chapter 8</td>
<td>3, 5, 6</td>
</tr>
<tr>
<td>17-18</td>
<td>Operating Systems (II)</td>
<td>Chapter 9</td>
<td>3, 4, 6</td>
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<tr>
<td>19-20</td>
<td>Security</td>
<td>Chapter 11</td>
<td>5, 6</td>
</tr>
<tr>
<td>21-22</td>
<td>Sensor Network Programming</td>
<td>Chapter 12</td>
<td>5, 6</td>
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</tbody>
</table>

*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:

<table>
<thead>
<tr>
<th>Judgement of TA</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not attend or try</td>
<td>0</td>
</tr>
<tr>
<td>Tried, but failed to get much working</td>
<td>1</td>
</tr>
<tr>
<td>Most, but not all working</td>
<td>2</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 9</td>
<td>No lab</td>
<td></td>
</tr>
<tr>
<td>September 16</td>
<td>Laboratory 1</td>
<td>Lab manual 1 Mark</td>
</tr>
<tr>
<td>September 23</td>
<td>Laboratory 2</td>
<td>Lab manual 1 Mark</td>
</tr>
<tr>
<td>September 30</td>
<td>Laboratory 3</td>
<td>Lab manual 3 Marks</td>
</tr>
<tr>
<td>October 7</td>
<td>Laboratory 4</td>
<td>Lab manual 3 Marks</td>
</tr>
<tr>
<td>October 14</td>
<td><strong>Thanksgiving week – lecture this Friday; no lab</strong></td>
<td></td>
</tr>
<tr>
<td>October 21</td>
<td>Laboratory 5</td>
<td>Lab manual 1 Mark</td>
</tr>
<tr>
<td>October 28</td>
<td>Laboratory 6</td>
<td>Lab manual 3 Marks</td>
</tr>
<tr>
<td>November 4</td>
<td>Laboratory 7</td>
<td>Lab manual 3 Marks</td>
</tr>
<tr>
<td></td>
<td><strong>Project Proposal</strong></td>
<td></td>
</tr>
<tr>
<td>November 11</td>
<td><strong>Project Period 1</strong></td>
<td></td>
</tr>
<tr>
<td>November 18</td>
<td><strong>Project Period 2</strong></td>
<td></td>
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<tr>
<td>November 25</td>
<td><strong>Project Period 3/ Presentation</strong></td>
<td>Lab manual 8 Marks</td>
</tr>
<tr>
<td>December 2</td>
<td><strong>Final Project report/ Presentation</strong></td>
<td>Lab manual 4 Mark</td>
</tr>
</tbody>
</table>

5.4 Other Important Dates

- Thursday, September 8, 2016: First day of class
- Monday, October 10, 2016: Thanksgiving holiday
- Tuesday, October 11, 2016: Fall study day, no classes
- Friday, November 4, 2016: 40th class day, last day to drop classes
- Friday, December 2, 2016: 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.

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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](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/](http://www.academicintegrity.uoguelph.ca/)

Please also review the section on Academic Misconduct in your [Engineering Program Guide](http://www.uoguelph.ca/engineering/undergrad-counselling-ethics).

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