UNIVERSITY of GUELPH

ENGG*4200   Wireless Sensor Networks

Fall 2018
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - September 05, 2018

1 Course Details

1.1 Calendar Description

This course focuses on the fundamentals behind the design of wireless sensor networks. Topics include node architecture, operating systems, prototypes and applications for wireless sensor networks. The course emphasizes basic architectural framework including physical layer, medium access control layer and network layer. It also covers network management topics such as power management, time synchronization and localization. The course has a number of experiments with sensor network software and hardware. The primary focus of the experiments is to give students hands-on programming experience with various microcontrollers and sensing platforms.

Pre-Requisite(s):   ENGG*3640
Restriction(s):   ENGG*4650

1.2 Course Description

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.

1.3 Timetable

Lectures:
Tuesday 17:30-18:50 ROZH 109
Thursday 17:30 - 18:50 ROZH 109

Laboratory
Monday 19:00 - 20:50 RICH1532

1.4 Final Exam

Tuesday, Dec. 11th, 14:30 - 16:30, Room TBA on Webadvisor

2 Instructional Support

2.1 Instructor(s)

Petros Spachos Ph.D.
Email: petros@uoguelph.ca
Office: RICH 2505
Office Hours: Tuesday 16:00 - 17:00

                                  Thursday 16:00 - 17:00

2.2 Instructional Support Team

Lab Technician: Hong Ma
Email: hongma@uoguelph.ca
Telephone: +1-519-824-4120 x53873
Office: THRN 1506

2.3 Teaching Assistant(s)

Teaching Assistant: Sebastian Sadowski
Email: ssadowsk@uoguelph.ca

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3 Learning Resources

3.1 Required Resource(s)

https://courselink.uoguelph.ca (Website)

Course material, news, announcements, and grades will be regularly posted to the ENGG*4200 Courselink site. You are responsible for checking the site regularly.

Lecture notes and slides (Notes)

3.2 Recommended Resource(s)

Recommended Resources (Textbook)

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

3.3 Additional Resources(s)

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*4200 are also posted on the web page.

3.3 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.

4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able 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.

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome Set Name	Course Learning Outcome
1	Knowledge Base	1
1.1	Recall, describe and apply fundamental mathematical principles and concepts	1
1.2	Recall, describe and apply fundamental principles and concepts in natural science	1
1.3	Recall, describe and apply fundamental engineering principles and concepts	1
1.4	Recall, describe and apply program-specific engineering principles and concepts	1
2	Problem Analysis	2, 3, 4, 6

#	Outcome Set Name	Course Learning Outcome
2.1	Formulate a problem statement in engineering and non-engineering terminology	2, 3, 4, 6
2.2	Identify, organize and justify appropriate information, including assumptions	2, 3, 4, 6
2.3	Construct a conceptual framework and select an appropriate solution approach	2, 3, 4, 6
2.4	Execute an engineering solution	2, 3, 4, 6
2.5	Critique and appraise solution approach and results	2, 3, 4, 6
3	Investigation	3, 5
3.1	Propose a working hypothesis	3, 5
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	3, 5
3.3	Analyze and interpret experimental data	3, 5
3.4	Assess validity of conclusions within limitations of data and methodologies	3, 5
4	Design	3, 4, 5, 6
4.1	Describe design process used to develop design solution	3, 4, 5, 6
4.2	Construct design-specific problem statements including the definition of criteria and constraints	3, 4, 5, 6
4.3	Create a variety of engineering design solutions	3, 4, 5, 6
4.4	Evaluate alternative design solutions based on problem definition	3, 4, 5, 6
4.5	Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping	3, 4, 5, 6
5	Use of Engineering Tools	3, 4, 5, 6
5.1	Select appropriate engineering tools from various alternatives	3, 4, 5, 6
5.2	Demonstrate proficiency in the application of selected engineering tools	3, 4, 5, 6
5.3	Recognize limitations of selected engineering tools	3, 4, 5, 6
6	Individual & Teamwork	3, 4
6.1	Describe principles of team dynamics and leadership	3, 4
6.2	Understand all members' roles and responsibilities within a team	3, 4
6.3	Execute and adapt individual role to promote team success through, for	3, 4

#	Outcome Set Name	Course Learning Outcome
	example, timeliness, respect, positive attitude	
6.4	Apply strategies to mitigate and/or resolve conflicts	3, 4
6.5	Demonstrate leadership through, for example, influencing team vision and process, promoting a positive team culture, and inspiring team members to excel	3, 4
7	Communication Skills	4, 5
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	4, 5
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	4, 5
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	4, 5
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	4, 5
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	4, 5
8	Professionalism	3, 4, 6
8.1	Demonstrate an understanding of what it means to be a professional engineer and distinguish between legislated and non-legislated professions	3, 4, 6
8.2	Effectively describe engineering law and its impact on professional engineering practice	3, 4, 6
8.3	Demonstrate professional behaviour	3, 4, 6
9	Impact of Engineering on Society and the Environment	1, 2, 4, 6
9.1	Analyze the safety, social, environmental, and legal aspects of engineering activity	1, 2, 4, 6
9.2	Evaluate the uncertainties and risks associated with engineering activities	1, 2, 4, 6
9.3	Anticipate the positive and negative impacts of introducing innovative technologies to solve engineering problems	1, 2, 4, 6
10	Ethics & Equity	1, 5
10.1	Summarize ethical theories and equity, diversity, and inclusivity principles	1, 5

#	Outcome Set Name	Course Learning Outcome
10.2	Determine an ethical course of action by applying ethical theories and the PEO Code of Ethics	1, 5
10.3	Demonstrate values consistent with good ethical practice, including equity, diversity, and inclusivity	1, 5
11	Economics and Project Management	3, 4
11.1	Apply project management techniques and manage resources within identified constraints	3, 4
11.2	Identify risk and change management techniques, in the context of effective project management	3, 4
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	3, 4
12	Life Long Learning	4, 6
12.1	Identify personal career goals and opportunities for professional development	4, 6
12.2	Self-assess skills relative to career goals and SOE defined learning outcomes	4, 6
12.3	Demonstrate capability for continuous knowledge and skill development in a changing world	4, 6

5 Teaching and Learning Activities

5.1 Lecture

Topic(s):	Lectures	Lecture Topics (Tentative*)	References	Learning Objectives
	1	Introduction and WSN Applications	Chapter 1, 2	1, 2
	2	Node Architecture	Chapter 3	1, 2

3	Operating Systems	Chapter 4	3, 4, 5
4	Physical Layer	Chapter 5	3, 4, 5
5	Medium Access Control (I)	Chapter 6	3, 4, 5
6	Medium Access Control (II)	Chapter 6	3, 4, 5
7	Network Layer (I)	Chapter 7	4, 5
8	Network Layer (II)	Chapter 7	4,5
9	Time Synchronisation	Chapter 9	3, 4, 6
10	Localization	Chapter 10	4, 5, 6
11	Security	Chapter 11	5, 6
12	Course review and final exam preparation		

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

5.2 Lab

Topic(s): The real learning in this course goes on in the laboratory where you design, build and test and fix real systems. There are **seven 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 2:

Judgement of TA	Grade
Did not attend or try	0
Tried, but failed to get much working	1
Most, but not all working	1.5
Everything worked	2

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	Refe
September 10	Laboratory 1 - Introduction to network simulators	Lab 2 N
September 17	Laboratory 2 - Generate, transmit and receive messages	Lab 2 N
September 24	Laboratory 3 - The grid topology	Lab 2 N
October 1	Laboratory 4 - Setting XBee modules	Lab 2 N
October 8	**No lab – Fall Study Break**	

October 15	Laboratory 5 - Push the button	Lab 2 N
October 22	Laboratory 6 - Sunset sensor	Lab 2 N
October 29	Laboratory 7 – Where am I? RSSI localization	Lab 3 N
	Project Proposal	Lab 1 N
November 5	*Project Period 1*	
November 12	*Project Period 2 – Interim Report*	1 I
November 19	*Project Period 3*	
November 26	*Project Presentation*	9 I
November 30	*Project final report*	4 I

5.3 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.

5.4 Other Important Dates

- Thursday, September 6th, 2018: First day of classes
- Monday, October 8th, 2018: Thanksgiving holiday
- Tuesday, October 9th, 2018: Fall study day, no classes
- Friday, November 2nd, 2018: 40th class day, last day to drop classes
- Wednesday, November 28th, 2018: Last day of classes

- Thursday, November 29th, 2018: Make up for study day (Tuesday schedule)
- Friday, November 30th, 2018: Make up for Thanksgiving day (Monday schedule)

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6 Assessments

6.1 Assessment Details

Assignments (10%)

Assignment #1 (2.5%): Announced on Sept. 27th and due on Oct. 3rd, 2018
Assignment #2 (2.5%): Announced on Oct. 11th and due on Oct. 17th, 2018
Assignment #3 (2.5%): Announced on Nov. 8th and due on Nov. 14th, 2018
Assignment #4 (2.5%): Announced on Nov. 22nd and due on Nov. 28th, 2018

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

Labs (15%)
See lab section

Project (15%)
See Project section

Midterm Exam (25%)

Tuesday, Oct. 23rd, 17:30 PM – 18:50 PM, in class

Final Exam (35%)
Tuesday, Dec. 11th, 14:30 PM - 16:30 PM, Room TBA on Webadvisor

6.2 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.

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7 University Statements

7.1 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.

7.2 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 regulations and procedures for Academic Consideration are detailed in the Undergraduate Calendar.

7.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for Dropping Courses are available in the Undergraduate Calendar.

7.4 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.

7.5 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.

More information: www.uoguelph.ca/sas

7.6 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 or faculty advisor.

The [Academic Misconduct Policy](#) is detailed in the Undergraduate Calendar.

7.7 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, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

7.8 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.