UNIVERSITY of GUELPH

ENGG*4200 Wireless Sensor Networks

Fall 2019
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - September 04, 2019

___

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-Requisites: ENGG*3640
Restrictions: 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 19:00-21:50 MCKN 224

Laboratory
Thursday 10:30 - 12:20 RICH 1532

1.4 Final Exam

Friday, Dec. 13th, 11:30 am - 1:30 pm, Room TBA on Webadvisor

___

2 Instructional Support

2.1 Instructional Support Team

Instructor:	Petros Spachos Ph.D.
Email:	petros@uoguelph.ca
Office:	RICH 2505
Office Hours:	Tuesday 17:50 - 18:50
	Thursday 17:50 - 18:50

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

2.2 Teaching Assistants

Teaching Assistant:	Marc Jason Baucas
Email:	baucas@uoguelph.ca

_____

3 Learning Resources

3.1 Required Resources

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 Resources

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 discussed in class as samples of exams. The solutions are also discussed.
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. Understand the fundamental concepts of sensor network design.
2. Understand 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	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	1

#	Outcome	Learning Outcome
	science	
2	Problem Analysis	2, 3, 4, 6
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

#	Outcome	Learning Outcome
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 example, timeliness, respect, positive attitude	3, 4
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

#	Outcome	Learning Outcome
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
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

Topics:	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.

Learning Outcome: 1, 2, 3, 4, 5, 6

5.2 Lab

Topics: 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	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	F
September 12	Laboratory 1 - Introduction to network simulators	L
September 19	Laboratory 2 - Generate, transmit and receive messages	L
September 26	Laboratory 3 - The grid topology	L
October 3	Laboratory 4 - Setting XBee modules	L
October 10	Laboratory 5 - Push the button	L

October 17	**No lab – Fall Study Break**	
October 24	Tutorial	
October 31	Project Proposal	L
November 7	Project Period 1	
November 14	Project Period 2 – Interim Report	
November 21	Project Period 3	
November 28	Project Presentation	
November 29	Project final report	

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 5th, 2019: First day of classes
- Monday, October 14th, 2019: Thanksgiving holiday
- Tuesday, October 15th, 2019: Fall study day, no classes
- Wednesday, November 27th, 2019: Last day for regularly scheduled classes
- Thursday, November 28th, 2019: Make up for study day (Tuesday schedule)
- Friday, November 29th, 2019: Make up for Thanksgiving day (Monday schedule)

_____

6 Assessments

6.1 Assessment Details

Labs (15%)
Learning Outcome: 4
See lab section

Project (20%)
Learning Outcome: 3
See Project section

Midterm Exam (25%)

Tuesday, Oct. 29rd, 19:00 PM – 20:20 PM, in class

Final Exam (35%)
Friday, Dec. 13th, 11:30 am - 1:30 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.

---

7 School of Engineering Statements

7.1 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 but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. 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 labs.

7.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during

lectures and lab sessions. 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.

7.3 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.

8 University Statements

8.1 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.

8.2 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 grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions
https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml

8.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml

8.4 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.

8.5 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.

For Guelph students, information can be found on the SAS website
https://www.uoguelph.ca/sas

For Ridgetown students, information can be found on the Ridgetown SAS website
https://www.ridgetownc.com/services/accessibilityservices.cfm

8.6 Academic Integrity

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 encourages academic integrity. 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.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

8.7 Recording of Materials

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

8.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars

_____