UNIVERSITY of GUELPH

ENGG*4200 Wireless Sensor Networks

01

Fall 2020
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - September 09, 2020

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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:
Wednesday, Friday 11:30AM- 12:50PM, AD-S

Tutorial/ Laboratory sessions
Monday 10:30AM - 12:20PM, AD-S

1.4 Final Exam

There is no final exam.

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2 Instructional Support

2.1 Instructional Support Team

Instructor:	Petros Spachos Ph.D.
Email:	petros@uoguelph.ca
Office:	RICH 2505
Office Hours:	Wednesday, Friday 1:00PM - 2:00PM or by email

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

2.2 Teaching Assistants

Teaching Assistant:	Lili Zhu
Email:	lzhu03@uoguelph.ca

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3 Learning Resources

3.1 Required Resources

Course Website (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)
All the lecture notes are posted on the course web page.

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 and related material are posted on the course webpage (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.
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.

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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
2	Problem Analysis	1, 2, 3, 4, 6
2.1	Formulate a problem statement in engineering and non-engineering terminology	1, 2, 3, 4, 6

#	Outcome	Learning Outcome
2.2	Identify, organize and justify appropriate information, including assumptions	1, 2, 3, 4, 6
2.3	Construct a conceptual framework and select an appropriate solution approach	1, 2, 3, 4, 6
2.4	Execute an engineering solution	1, 2, 3, 4, 6
2.5	Critique and appraise solution approach and results	1, 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 example, timeliness, respect, positive attitude	3, 4

#	Outcome	Learning Outcome
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

5 Teaching and Learning Activities

5.1 Schedule and Information

Lecture schedule

Week	Dates	Lecture topics	References	Learning objectives
1	Sep.-11	Introduction (classes start Fri)	Chapter 1, 2	1, 2
2	Sep.-16, Sep.-18	Node Architecture	Chapter 3	1, 4
3	Sep-23, Sep-25	Physical Layer	Chapter 5	3, 4, 5
4	Sep-30, Oct-2	Medium Access Control (I)	Chapter 6	3, 4, 5
5	Oct-7, Oct-9	Medium Access Control (II)	Chapter 6	3, 4, 5
6	Oct-14, Oct-16	Network Layer	Chapter 7	4, 5
7	Oct-21, Oct-23	Time Synchronisation	Chapter 9	3, 4, 6
8	Oct-28, Oct-30	Midterm		
9	Nov-4, Nov-6	Localization	Chapter 10	4, 5, 6
10	Nov-11, Nov-13	Operating Systems	Chapter 4	3, 4, 5
11	Nov-18, Nov-20	Security	Chapter 11	5, 6
12	Nov-25, Nov-27	Course review and final project preparation	—	
13	Dec-2	Project presentations	—	

Topics schedule will be adjusted throughout the course as needed.

Tutorial/laboratory schedule

Week	Dates	Topics	Weight
1	Sep-7	No tutorials/labs scheduled	
2	Sep-14	Introduction	
3	Sep-21	Lab 1 - Sensors and Actuators	5%
4	Sep-28	Tutorial - Introduction to OMNeT++	
5	Oct-5	Lab 2 - Exchange messages	5%
6	Oct-12	Holiday (No lab)	
7	Oct-19	Lab 3 - Random paths	10%
8	Oct-26	Midterm review	
9	Nov-2	Review	
10	Nov-9	Lab 4 - Localization	10%
11	Nov-16	Project preparation	—
12	Nov-23	Project preparation	
13	Nov-30	Project presentations	

Topics schedule will be adjusted throughout the course as needed.

Assignments

Assignment	Posted	Due
1	Friday, Oct. 16	Thursday, Oct. 22
2	Friday, Nov. 6	Thursday, Nov. 19

The assignments are due midnight on the due date.

Project
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 (if available) in some creative way. You may use any of the parts available in the lab. An important part of this task 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 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:

Project Proposal (5%)

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 diagram describing how the various parts of your system interact.
- Your plan of action for each of the following lab periods - "milestones"
- Present this to your TA and the instructor 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 (15%) and Report (20%)

You will demonstrate your project to the instructor and submit a final report describing your project.

5.2 Other Important Dates

- Thursday, September 10th, 2020: First day of classes
- Monday, October 12th, 2020: Holiday (no classes scheduled)
- Tuesday, October 13th, 2020: Fall Study Break day, (no classes scheduled)
- Wednesday, December 2nd, 2020: Last day for regularly scheduled classes
- Thursday, December 3rd, 2020: Classes rescheduled from Tuesday, October 13
- Friday, December 4th, 2020: Classes rescheduled from Monday, October 12

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6 Assessments

6.1 Assessment Details

Assignments (10%)
Learning Outcome: 3
Your ability to apply course concepts will be assessed by solving assigned problems. There will be two assignment sets, one covering the topics from Week 1- 5 and one covering the topics from Week 6 - 9. Both assignments are equally weighted and should be submitted individually.

Labs (30%)
Learning Outcome: 4
After each lab session, you will need to submit a report, before the beginning of the next lab/ tutorial session. Please see section 5.1 for the schedule and weight for each report.

Midterm Exam (20%)
Date: Fri, Oct 30, 11:30 AM - 12:50 PM

The midterm exam will include all the material covered in lectures and tutorials to-date.

Project (40%)
This is the course project. Please see details on the different components on Section 5.1.

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

Missed midterm exam: Any student not taking the midterm exam will receive a grade of zero. In case you have a legitimate reason for missing the midterm exam, the

instructor may consider accommodation upon presentation of a written request and suitable documentation before the time of the exam.

Laboratory work: You must 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 laboratory report, assignment, or project report: Any student/ group not handing in a report by the deadline will receive a grade of zero for that submission. In case you have a legitimate reason for missing a submission deadline, the instructor may consider accommodation upon presentation of a written request and suitable documentation before the submission deadline.

Submissions and back-up copies: When you upload a submission to the course webpage or through Crowdmark, you have to verify that the file meets the requirements, is readable, and is the one you intended to upload. Non-complying submissions, including late or incomplete submissions, will not be accepted for marking. Please keep reliable back-up copies of all your submissions, because you may be asked to resubmit your work.

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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

8.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings and academic schedules. Any such changes will be announced via CourseLink and/or class email. All University-wide decisions will be posted on the COVID-19 website (https://news.uoguelph.ca/2019-novel-coronavirus-information/) and circulated by email.

8.10 Illness

The University will not normally require verification of illness (doctor's notes) for fall 2020 or winter 2021 semester courses. However, requests for Academic Consideration may still require medical documentation as appropriate.

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