ELEC 4709A Integrated Sensors Fall 2022

Lecture T/R 0835-0955 ME4236

Lab A1O T 1435-1725, A2O R 1435-1725 ME4135

Instructor: Niall Tait, Niall.Tait@carleton.ca

Teaching assistant: Kenny Gregory, KennyGregory@cmail.carleton.ca

Grading:	Labs	35%	
	Quizzes (2)	30%	October 6, November 10
	Final exam	35%	

The final exam is for evaluation purposes only and will not be returned to the student.

Satisfactory performance during the term requires completion of all lab experiments and a combined average grade of >40% on lab reports and quizzes.

The final exam must be completed with a minimum grade of 40% to pass the course.

Course Web Site: Carleton Brightspace

Health and Safety: Normally this would just be a review of typical lab precautions, however this year we will be participating in activities on campus in the tail-end of a pandemic.

> *It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are a number of actions you can take to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.*
>
> ***Feeling sick?** Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's symptom reporting protocols.*
>
> ***Masks:** Carleton has paused the COVID-19 Mask Policy, but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.*
>
> ***Vaccines:** Further, while proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in cuScreen as soon as possible. Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.*
>
> *All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 response and health and safety requirements please see the University's COVID-19 website and review the Frequently Asked Questions (FAQs). Should you have additional questions after reviewing, please contact covidinfo@carleton.ca.*

Standard lab safety precautions are still important and can be found at https://carleton.ca/ehs/programs/working-lab/laboratory-health-and-safety/

Labs: Labs are intended to provide practical experience in working with integrated sensors. Labs typically require design and simulation of simple circuits, sensor measurements, and analysis. One lab will also use finite element numerical analysis (FEA) software (COMSOL) in the design of an integrated sensor.

Lab instructions will be available on the course web page during the term. Due to lab station limitations labs this year will be completed in self-organized groups of 2 students.

In most cases design work is required prior to attending the lab. Most labs require circuit simulation using **NI Multisim** with results verified by experimental measurements.

Labs will include:

1. Making accurate measurements using common lab equipment
2. Characterization of a piezoresistive pressure sensor
3. Analysis and simulation of a pressure sensor
4. Oscillometric blood pressure measurement
5. Temperature sensor data acquisition
6. Optical signal generation and sensing

Outline:

The emphasis in the course will on sensors that can be integrated in silicon technology, including principles of operation and application examples. There will also be some fundamental material on dealing with low signal levels in the presence of noise, as this problem is often encountered in working with sensors. Sensors for consumer, biomedical and industrial applications will be considered. Specific topics include:

1. Measurement principles; uncertainty, precision and accuracy
2. Signals and interfaces
3. Fabrication technologies for silicon ICs and sensors; micromachining
4. Mechanical sensors (strain and pressure)
5. Temperature sensors
6. Sensors for visible and infrared radiation, including imagers
7. Sensors for ionizing radiation (x-rays, gamma rays, etc.)
8. Magnetic sensors
9. Chemical sensors
10. Selected topics (to be determined)

Textbook: (not compulsory)

Handbook of Modern Sensors, 4th Edition, Jacob Fraden, Springer 2010, ISBN 978-1-4419-6465-6
Electronic resource:
https://ocul-crl.primo.exlibrisgroup.com/permalink/01OCUL_CRL/1gorbd6/alma991022634465205153

Sensors and Signal Conditioning, 2nd Edition, Ramon Pallas-Areny and John G. Webster, Wiley Interscience, 2001. ISBN: 0471332321

Course Learning Objectives:

On successful completion of the course, a student is expected to be able:

1. To understand integrated sensor specification and selection.

2. To appreciate the process of designing sensor elements.

3. To design signal conditioning circuitry suitable for interfacing sensor output with digital or analog readout or data logging.

4. To identify and resolve sources of noise and signal artifacts in sensor measurements.

5. To relate sensor signals to physical quantities of interest.

Academic accommodation:

Students requiring academic accommodation please refer to the Carleton Equity Services web site:
https://students.carleton.ca/services/accommodation/