



## Course Outline

### Instructor

- Douglas Thomson, P.Eng.  
E3-455 EITC  
(204) 474-8797  
Douglas.Thomson@umanitoba.ca

### Office Hours

- By appointment

### Teaching Assistant

- Shijie Fu  
fus34@myumanitoba.ca

### Contact Hours

- 4 credit hours
- Lectures:  
3 hours x 13 weeks = 39 hours
- Laboratories:  
3 hours x 5 weeks = 15 hours

### Prerequisites:

- ECE 2160 Electronics 2E.

## Traditional Territories Acknowledgement

*The University of Manitoba campuses and the Department of Electrical and Computer Engineering are located on original lands of the Anishinaabeg, Cree, Ojibwe-Cree, Dakota, and Dene peoples, and on the homeland of the Red River Métis.*

*We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of Reconciliation and collaboration.*

## ECE 4860 T08 – Sensors, Instrumentation, and the IoT

Winter 2024

### Course Objectives

The purpose of the course is to introduce students to the fundamental concepts and application of sensors and instrumentation.

### Course Content

The following topics will be covered:

- Sensor characteristics: precision, error, uncertainty, sensitivity, calibration, accuracy, linearity, and hysteresis.
- Sensors for temperature: thermoresistive, bandgap sensors, and thermoelectric sensors.
- Sensors for acceleration, force, pressure, and strain.
- Sensors for position, displacement, and level.
- Sensors for light: sources, detectors, optical sensor circuits.
- Analog to digital conversion.
- Sensor transduction: bridge circuits and capacitance.
- Sensor electronic circuit and signal conditioning: input/output characteristics, overview of amplifiers, amplifier noise, differential amplifiers, instrumentation amplifiers, signal averaging.
- Instrumentation System architecture and performance: analog versus digital, quantization error, sampling frequency, aliasing frequency.
- Analytics – How can we extract information from data?
- Sensors, instrumentation, and the IoT: Edge computation and cloud based IoT issues.

### Textbook

None.

### Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the *General Academic Regulations on Academic Integrity*, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

### Learning Outcomes

1. Understand the fundamentals principles of sensors and instrumentation.
2. Being able to architect sensor and instrumentation system to address specific monitoring situations.
3. Hands-on measurement and development of electric and digital circuits in a range of applications spanning the discipline.

### Expected Competency Levels

Outcome	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
1	D	D						I	I		I	
2	A	A	D	D				I	I		I	
3	D		D		A							

## Important Dates

- **Term Test**  
Monday, March 11<sup>th</sup>, 2024  
6:00PM–8:00PM
- **Voluntary Withdrawal Deadline**  
March 20<sup>th</sup>, 2024
- **Louis Riel Day**  
February 19<sup>th</sup>, 2024  
No classes or examinations
- **Spring Break**  
February 20<sup>th</sup>–23<sup>rd</sup>, 2024  
No classes or examinations
- **Good Friday**  
March 29<sup>th</sup>, 2024  
No classes or examinations

## Accreditation Details

### Accreditation Units

- Mathematics: 0%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 70%
- Engineering Design: 30%

### Graduate Attributes

KB: A knowledge base for engineering  
PA: Problem analysis  
IN: Investigation  
DE: Design  
ET: Use of engineering tools  
IT: Individual and team work  
CS: Communication skills  
PR: Professionalism  
IE: Impact of engineering on society/  
environment  
EE: Ethics and equity  
EP: Economics and project  
management  
LL: Life-long learning

### Competency Levels

I - Introduced (Introductory)  
D - Developed (Intermediate)  
A - Applied (Advanced)

## CEAB Graduate Attributes Assessed

- KB.4 – Recalls and defines, and/or comprehends and applies information, first principles, and concept in specialized engineering science.
- IN.2 – Devises and/or implements an appropriate plan/methodology for gathering information required to solve a complex engineering problem.

## Evaluation

The final course grade is determined by the student's performance in laboratories, on the project and presentation, and on an examination. Students must complete all the laboratories in order to be eligible to receive a passing grade.

Component	Value (%)	Method of Feedback	Learning Outcomes Evaluated
Laboratories	30	F, S	1, 3
Term Test	20	F, S	1, 3
Final Examination	50	S	1, 2, 3

\* Method of Feedback: F - Formative (written comments and/or oral discussion), S - summative (numerical grade)

## Student Absences

Attendance in lectures, tutorials, and laboratories is mandatory. For short-term absences due to illness or other extenuating circumstances of 120 hours (5 days) or less, students are required to complete a *Self-Declaration Form for Brief or Temporary Absence* available on the University website. This form must be submitted to the course instructor within 48 hours of the absence. (No additional documentation is required.)

Note that students are responsible to complete any missed work and must consult with the instructor to make appropriate arrangements.

For absences longer than 120 hours, students must contact the instructor and ECE Undergraduate Advisor, Tammy Holowachuk (Tammy.Holowachuk@umanitoba.ca) for further instructions.

## Deferred Final Examinations

Students who miss the regular scheduled writing of a final examination, for valid medical or compassionate reasons, may be given the opportunity to write a deferred examination, subject to approval by the Associate Dean (Undergraduate). All requests for a deferred examination must be made within 48 hours of the missed examination, and must follow the procedure described on the Faculty website, without exception. Course instructors do not have the discretion to grant deferred final examinations.

(<https://umanitoba.ca/engineering/student-experience#engineering-student-policies>)

## Copyright Notice

All materials provided in this course are copyright and are provided under the fair dealing provision of the Canadian Copyright Act. This material may not be redistributed in any manner without the express written permission of the relevant copyright holder.

## Retention of Student Work

Students are advised that copies of their work submitted in completing course requirements (i.e. assignments, laboratory reports, project reports, test papers, examination papers, etc.) may be retained by the instructor and/or the department for the purpose of student assessment and grading, and to support the ongoing accreditation of each Engineering program. This material shall be handled in accordance with the University's *Intellectual Property Policy* and the protection of privacy provisions of *The Freedom of Information and Protection of Privacy Act (Manitoba)*. Students who do not wish to have their work retained must inform the Head of Department, in writing, at their earliest opportunity.

## Grading Scale

Letter	Mark
A+	95–100
A	85–94
B+	80–84
B	70–79
C+	65–69
C	55–64
D	45–54
F	< 45

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure consistency of grading from year-to-year.

## Requirements/Regulations

- Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a passing final grade.
- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with the University's General Academic Regulations, as well as Section 3 of the Faculty of Engineering Academic Regulations dealing with incomplete term work, deferred examinations, attendance and withdrawal.
- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, wireless communication or data storage devices) are allowed in examinations unless approved by the course instructor.
- Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices as well as documentation of key University policies e.g. Academic Integrity, Respectful Behaviour, Examinations and related matters.

 [Supplemental Resources](#)