University of Manitoba | Price Faculty of Engineering
Department of Electrical and Computer Engineering

Course Outline

Instructor

- Prof. Douglas Thomson, P.Eng.
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Office Hours
- By appointment

Teaching Assistant
- Monsurul Alam
  alama@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.

Course Website:
http://umanitoba.ca/umlearn

Important Dates

- **Term Test**
  Thursday, February 25th, 2021
  6:00PM – 8:00PM
- **Voluntary Withdrawal Deadline**
  March 31st, 2021
- **Louis Riel Day**
  February 15th, 2021
  No classes or examinations
- **Spring Break**
  February 16th – 19th, 2021
  No classes or examinations
- **Good Friday**
  April 2nd, 2021
  No classes or examinations

ECE 4860 T08 – Sensors, Instrumentation, and the IoT

Winter 2021

IMPORTANT NOTICE – Mandatory Requirement to Report

This course will be conducted using remote instruction. Students who are accessing the course from outside of Canada or the USA ***must notify the instructor*** and indicate in which country they are located. Access to software may be restricted from some countries and failure to comply with these restrictions may result in criminal prosecution.

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.

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	4	4						2	2		2	
2	5	5	4	3				2	2		2	
3	4		3		5							

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.

Accreditation Details

Accreditation Units

- Mathematics: 0%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 100%
- Engineering Design: 0%

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

1 - Knowledge (Able to recall information)
2 - Comprehension (Ability rephrase information)
3 - Application (Ability to apply knowledge in a new situation)
4 - Analysis (Able to break problem into its components and establish relationships.)
5 - Synthesis (Able to combine separate elements into a whole)
6 - Evaluation (Able to judge the worth of something)

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.

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)

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.

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 Information

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.