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

Course Outline

Instructor
- Colin Gilmore, P.Eng.
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Office Hours
- By appointment

Teaching Assistant
- Amir Bani Saeed
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- Seth Cathers
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- Enze Cui
  cuie@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 3610 Microprocessor Systems
- COMP 1012 Computer Programming for Scientists and Engineers

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 3730 – Principles of Embedded Systems Design Winter 2024

Course Objectives

This course will introduce students to the design and implementation of embedded systems. Topics include introduction to UML and data structures, A2D, D2A, serial bus architectures (SPI and I²C), embedded computing, bus-based computer systems, program design and analysis, networks, and hardware-software co-design.

Course Content

The following topics will be covered:

- Embedded systems design process and principles
- Formalisms for system design
- ARM Cortex M Processors and system implementation via STM32 Nucleo Board
- Inter-component communications
- Program design and analysis
- Data structures.

Other Resources

- Donald Norris, *Programming with STM32. Getting Started with the Nucleo Board & C/C++*. McGraw Hill Education. 2018.
- Jonathan W. Valvano, *Embedded Systems: Real-Time Interfacing to ARM Cortex M Microcontrollers*. Volume 2, 2021{ISBN-13: 978-1-4635-9015-4, pbk; US$47.45; Kindle: $7.53}
- Geoffrey Brown, *Discovering the STM32 Microcontroller*. 2012. Online.
- Johnathan Valvano and Ramesh Yerraballi. *Embedded Systems – Shape the World*. Online.

Learning Outcomes

1. Demonstrate the ability to model the design of an embedded system.
2. Demonstrate the ability to use the C language to write programs for embedded systems.
3. Demonstrate the ability to apply C linked-list, pointer, and data structures in embedded applications.
4. Demonstrate the ability to apply COTS components (A2D, D2A, configurable real-time clock, rotary encoder, LCD, RGB LED Control) in the design of various embedded systems applications (device tuner, arbitrary waveform generator, signal filter, error detection and correction, and LCD display system).
5. Apply the SPI and I2C inter-component communications protocols in embedded systems.

Important Dates

- **Term Test**
  Monday, February 26th, 2024
  6:00PM–8:00PM
- **Voluntary Withdrawal Deadline**
  March 20th, 2024
- **Louis Riel Day**
  February 19th, 2024
  No classes or examinations
- **Spring Break**
  February 20th – 23rd, 2024
  No classes or examinations
- **Good Friday**
  March 29th, 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)

Expected Competency Levels

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

CEAB Graduate Attributes Assessed

KB.4 – Recalls and defines, and/or comprehends and applies, first principles and concepts in specialized engineering science.

DE.3 – Develops/implements possible solutions to an open-ended design problem, leading to an appropriate recommendation.

Evaluation

Students must satisfy each evaluation component in the course to receive a final grade. This means that students must complete and pass all laboratories, projects, and examinations to be eligible to receive a passing grade. The final course grade is determined by the student's performance in the following:

Component	Value (%)	Method of Feedback	Learning Outcomes Evaluated
Projects: Laboratories and Assignments	40	F, S	1, 2, 3, 4, 5
Term Test	20	F, S	2, 3, 4, 5
Final Examination	40	S	1, 2, 3, 4, 5

∗ 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)

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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.

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.

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.

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, smart watches, 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