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

Course Outline

ECE 4240 – Microprocessor Interfacing

Fall 2021

Instructor
- Prof. Witold Kinsner, P.Eng
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Office Hours
- After lectures or by appointment

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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
- ECE 3610 Microprocessing Systems

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

Traditional Territories Acknowledgement

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

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.

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 course presents real-time wired and wireless interfacing of microcontrollers, microprocessors, and microcomputers to the external world, including interfacing of I/O devices with minimum hardware and software, data acquisition, and some aspects of data communications, transmission and logging with embedded systems.

Course Content

The following topics will be covered:

- Overview of computing, architectures, processors, and technologies
- Bus architectures
- Digital input and output (I/O) architectures and organization
- Digital-to-analog (D/A) and A/D signal conversions and converters
- Interfacing aspects in data communications related to real time
- Updates on new concepts, technologies, protocols, and software
  - Demos: Examples of bus architectures, modules, systems, and new devices.
  - Updates on new computer concepts, technologies, protocols, and software.

Textbook

Microcontroller, Microprocessor and Microcomputer Interfacing for Real-Time Systems. Witold Kinsner. Winnipeg, MB: OCO Research, September 2020, 973 pages. {ISBN: 978-0-9939347-0-4; pbk} (from the Bookstore)

ECE 4240 Real-Time Interfacing Lab Manual. Witold Kinsner, September 2020, 284 pp. (Online).

Embedded Systems: Real-Time Interfacing to ARM Cortex M Microcontrollers. Volume 2. Jonathan W. Valvano. Middletown, DE: CreateSpace Independent Publishing Platform, 2016 (5th ed.), 589 pp. {ISBN-13: 978-1-4635-9015-4, pbk; US$47.45; Kindle: $7.53}

Other Resources

Interfacing Course Lab Kit. W. Kinsner, 2017–2021.

Embedded Systems: Introduction to ARM Cortex M Microcontrollers. Volume 1. Jonathan W. Valvano. Middletown, DE: CreateSpace Independent Publishing Platform, 2016 (5th ed.), 508 pp. {ISBN: 978-1-4775-0899-2, pbk; US$41.75; Kindle: $7.54}

Embedded Systems: Real-Time Operating Systems for ARM Cortex M Microcontrollers. Volume 3. Jonathan W. Valvano. Middletown, DE: CreateSpace Independent Publishing Platform, 2017 (4th ed.), 486 pp. {ISBN-13: 978-1-4664-6886-3, pbk; US$39.95; Kindle: US$7.54}

The HCS12 Microcontroller: A Tutorial, W. Kinsner, 2013, 66 pp.

Embedded Microcomputer Systems: Real Time Interfacing, J. W. Valvano. Stamford, CT: Cengage Learning, 3rd edition, 2012, 793 pp. & CD-ROM. This book covers design methodologies with examples, using Motorola 6805, 6808, 6811 (no longer in the third edition), and focuses on the 9S12 machines. The book includes many practical examples. The CD-ROM includes a complete editor/assembler, and simulator for the MC9S12 machine. {ISBN 978-1-111-42625-2}

Microprocessor Systems Design: 68000 Hardware, Software, and Interfacing, Alan Clements, Boston, MA: PWS Computer Science, 3rd edition, 1998, 978 pp & CD-ROM. In addition to the material covered in the second edition (the 68000; memories; exception handling; serial I/O;

Important Dates

- **Term Test**
  October 18th, 2021
  (in class)
  November 22nd, 2021
  (in class)
- **Voluntary Withdrawal Deadline**
  November 23rd, 2021
- **National Day for Truth and Reconciliation**
  September 30th, 2021
  No classes or examinations
- **Thanksgiving Day**
  October 11th, 2021
  No classes or examinations
- **Remembrance Day**
  November 11th, 2021
  No classes or examinations
- **Fall Term Break**
  November 8th–12th, 2021

Accreditation Details

Accreditation Units

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

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

1 - Knowledge (Able to recall information)
2 - Comprehension (Ability to 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)

buses, designing systems), this third edition includes a chapter on the C programming and its relationship to assembly language, as well as new examples and applications, better representation of timing diagrams, and a CD-ROM with a 68000 cross-assembler and simulator for DOS and Windows, and a cross compiler for C. {QA76.8.M67C48 1997; ISBN 0-534-9482-7}

Other Supplementary Material

- Books and Data Sheets
  - The library has many other books covering different aspects of microprocessor and microcomputer interfacing. Laboratory write-ups provide detailed description of the devices used. Data sheets should also be consulted for specific parameters of the devices. As usual, information on current developments in interfacing is published in numerous technical magazines and journals, including:
- Magazines (examples)
  - Embedded Systems, Computer Design, Electronic Design, Digital Design, EDN, Circuit Cellar, Communications Systems Design, Wireless World, Elektor, Everyday Practical Electronics, Nuts & Volts.
- Journals (examples)
  - IEEE Magazines: (i) Micro, (ii) Computer, (iii) Computational Intelligence; IEEE Trans. on (i) Computers, (ii) Software Engineering.

Learning Outcomes

1. Describe the role of the essential elements of interfacing in real-time systems.
2. Analyze the best techniques for synchronization in digital systems.
3. Analyze and design the best techniques for analog-to-digital conversion (DAC).
4. Analyze and design the best techniques for digital-to-analog conversion (ADC).
5. Analyze and design modern data transmission systems in the presence of noise.
6. Analyze and design simple error detection and correction systems.
7. Solve open-ended problems of data transmitting data in the presence of noise.

Expected Competency Levels

Outcome	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
1	2											2
2	3	4		5			2					2
3	5	4	4	5	3	3	2					2
4	5	4	4	5	3	3	2					2
5	4	4	4	5	3	3	2					2
6	3	2	4	5	3	3	2					2
7	3			4								2

Evaluation

The final course grade is determined by the student's performance on assignments, in laboratories, in two midterm tests, and on the final 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	25	F, S	1, 2, 3, 4, 5, 6, 7
Laboratory Reports	15	F, S	1, 2, 3, 4, 5, 6, 7
Term Test	20	F, S	2, 3, 4, 5, 6, 7
Final Examination	40	S	1, 2, 3, 4, 5, 6, 7

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

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.

CEAB Graduate Attributes Assessed

IN.3 – Interprets results and reaches appropriate conclusions.

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

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 and 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 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

Copyright Notice

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.