ENGG*3640 Microcomputer Interfacing

Fall 2018
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - September 05, 2018

1 Course Details

1.1 Calendar Description

This course focuses on the subject of interfacing microcomputers to external equipment. Topics include peripheral devices, hardware interfaces, device driver software and real time programming. Advanced programming: debugging of embedded systems, data structures and subroutine calls, high-level system programming. Interrupts and resets, real time events, signal generation and timing measurements. Synchronous and asynchronous serial communication. Parallel I/O ports and synchronization techniques. I/O interfacing, microcomputer busses, memory interfacing and direct memory access (DMA). Data acquisition topics include signal conditioning analog to digital conversion and digital signal processing.

Pre-Requisite(s): ENGG*2410, ENGG*2450
Restriction(s): ENGG*4640

1.2 Timetable

Lectures:

M, W, F 11:30 am – 12:20 pm MCKN 115

Laboratory:

Tu	Sec 01*	8:30 am – 11:20 am	RICH 1532
W	Sec 02*	8:30 am – 11:20 am	RICH 1532

1.3 Final Exam

Exam: December 12, 2018

8:30 am - 10:30 am

Room: TBA

2 Instructional Support

2.1 Instructor(s)

Radu Muresan
Email: rmuresan@uoguelph.ca
Telephone: +1-519-824-4120 x56730
Office: RICH 2509
Office Hours: Fridays: 1:00 pm – 3:00 pm. Or by appointment

2.2 Instructional Support Team

Lab Co-ordinator: Kevin Dong
Email: kdong@uoguelph.ca
Telephone: +1-519-824-4120 x56455
Office: RICH 2506

2.3 Teaching Assistant(s)

Teaching Assistant: Viktor Lidkea
Email: vlidkea@uoguelph.ca
Office Hours: TBA

Teaching Assistant: Honshil Gajjar
Email: hgajjar@uoguelph.ca
Office Hours: TBA

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3 Learning Resources

3.1 Required Resource(s)

Course Website (Website)
http://courselink.uoguelph.ca
Course material, news, announcements, and grades will be regularly posted to the ENGG*3640 CourseLink site and on my personal course webpage. You are responsible for checking the sites regularly.

William Hohl and Christopher Hinds, ARM Assembly Language, Fundamentals and Techniques, 2nd Edition, CRC Press, 2015. (Textbook)

Radu Muresan, ENGG3640 Microcomputer Interfacing Lecture Notes, University of Guelph CourseLink, 2018 Version. (Textbook)

Radu Muresan, ENGG3640 Lab Manual, University of Guelph CourseLink, 2018 Edition. (Textbook)

3.2 Recommended Resource(s)

J. W. Valvano, Embedded Microcomputer Systems, Real Time Interfacing, 3rd Edition, CENGAGE Learning, 2012. (Textbook)

Sabri Centinkunt, Mechatronics with Experiments, 2nd Edition, Wiley, 2015. (Textbook)

Freescale, 9S12DT256 Reference Manual, 2005. (Lab Manual)

Freescale, K60 Sub-Family Reference Manual, June 2012. (Lab Manual)

ARM: ARM Cortex-M4 Processor, Technical Reference Manual, 2013. (Lab Manual)

ARM: Cortex-M4 Devices, Generic User Guide, 2010. (Textbook)

P. Knaggs, S. Welsh, ARM: Assembly Language Programming, 2004. (Textbook)

3.3 Additional Resource(s)

Lecture Information (Notes)
All the lecture notes are posted on the ENGG*3640 CourseLink system (week #1 to week #12) under the LECTURES module. Additional material is found under the COURSE MATERIAL module.

Lab Information (Notes)
The ENGG3640 Lab Manual is posted on the ENGG*3640 CourseLink system under the LABORATORY module.

Assignments (Notes)
The assignments and the solutions for the assignments are posted on the ENGG*3640 Courselink system under the ASSIGNMENTS module.

Exams (Notes)
Some solutions of previous midterm exams will be posted on the ENGG*3640 CourseLink system under the EXAM SOLUTIONS section. Also, after the midterm exam a complete solution of the exam with the marking scheme applied will be posted for your reference.

Miscellaneous Information (Notes)
Other information related to Microcomputer Interfacing topics will be posted on the web page.

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4 Learning Outcomes

This course is an introductory course in microcomputer interfacing and applications for students in computer engineering, electrical engineering, system and computing engineering and mechatronics engineering programs. The main goals of the course are: (1) to provide a broad and systematic introduction to microprocessors and microcontrollers, (2) to introduce complex commercial microcontroller architectures based on ARM cores and interfacing modules of typical microcontroller organizations, (3) present typical microcontroller interfaces, applications of these interfaces, and develop the theory around these applications and interfacing techniques.

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Master microcontroller interfacing concepts and internal architecture
2. Understand electrical, electronics, digital and software concepts related to interface development and device functionality and control
3. Program interfaces in assembly language and C
4. Design with interfaces using interrupts, DMA, polling techniques
5. Design with human-machine interfaces and devices

6. Design with serial communication interfaces and devices.
7. Design with data acquisition interfaces and sensor devices.
8. Design with actuator control interfaces and devices.
9. Implement and demonstrate microcomputer interfacing applications (hardware and software).

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome Set Name	Course Learning Outcome
1	Knowledge Base	1, 2, 3, 4, 5, 6, 7, 8, 9
1.4	Recall, describe and apply program-specific engineering principles and concepts	1, 2, 3, 4, 5, 6, 7, 8, 9
2	Problem Analysis	1, 2, 3, 4, 5, 6, 7, 8, 9
2.4	Execute an engineering solution	1, 2, 3, 4, 5, 6, 7, 8, 9
4	Design	1, 2, 3, 4, 5, 6, 7, 8, 9
4.2	Construct design-specific problem statements including the definition of criteria and constraints	9
4.3	Create a variety of engineering design solutions	1, 2, 3, 4, 5, 6, 7, 8, 9
4.4	Evaluate alternative design solutions based on problem definition	9
4.5	Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping	9
5	Use of Engineering Tools	9
5.2	Demonstrate proficiency in the application of selected engineering tools	9

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5 Teaching and Learning Activities

5.1 Lecture Schedule

Week	Lecture Topics	References	Learning Objectives

1	Introduction to Interfacing and Microcontrollers	Lecture Notes	1, 2, 9
1-3	ARM Assembly, The Programmer's Model, Instruction Set Description	Chapters 2- 8	2, 3, 9
3	Subroutines and Stacks	Chapters 13	2, 3, 9
4	Exception Handling	Chapters 14-17	1, 2, 4
5	Memory Mapped Peripherals	Chapter 16	1, 2, 9
6	Microcomputer Interfacing: Synchronization, Clocks, Timer Modules	Lecture Notes	1 – 4, 9
7	Microcomputer Interfacing: GPIO, LEDs, 7-Segments Displays, LCD	Lecture Notes	1 – 5, 9
8	Microcomputer Interfacing: Sensors, Data Acquisition, ADC and DAC Systems	Lecture Notes	1, 2, 3, 7, 9
9	Microcomputer Interfacing: Communication Interfaces, UART, SPI, I2C, USB	Lecture Notes	1, 2, 3, 6, 9
10	Microcomputer Interfacing: Actuators, FlexTimer Module	Lecture Notes	1, 2, 3, 8, 9
11	Microcomputer Interfacing: Human-Machine Interface, Touch-Sensing Interface, GPIO	Lecture Notes	1 – 5, 9

12	Microcomputer Interfacing: Memories and Memory Interfacing, DMA	Lecture Notes	1- 4, 9

5.2 Design Lab Schedule

Week	Activity	References	Learning Objectives
1	Lab 0 introduction/implementation	Lab Manual	1
2	Lab 1 introduction/implementation	Lab Manual	1, 2, 3, 9
3	Lab 1 demo		9
3	Lab 2 introduction/implementation	Lab Manual	1, 2, 3, 9
4	Lab 2 demo		9
4	Lab 3 introduction/implementation	Lab Manual	1, 2, 3, 4, 9
5	Lab 3 demo		9
5-6	Lab 4 introduction/implementation	Lab Manual	1-5, 9
7	Lab 4 demo		9
7-8	Lab 5 introduction/implementation	Lab Manual	1-4, 7, 9
9	Lab 5 demo		9
9-11	Lab 6/Project introduction/implementation	Lab Manual	1-4, 5 - 9
12	Lab 6/Project demo		9

5.3 Lab Schedule

Week	Topic	Due
1	Lab 0: Lab Safety, Group Setup, Equipment Introduction and Distribution	Week 1:
2	Lab 1: MDK Tools, ARM Assembly – Timer Using Loop Delays	Week 3: Demo/Report
3	Lab 2: ARM Assembly – Simple Calculator	Week 5: Demo/Report
4	Lab 3: ARM Assembly – Interrupts	Week 6: Demo/Report
5-6	Lab 4: Interfacing K60 Microcontroller – GPIO, LEDs and 7–Segment Interfacing	Week 8: Demo/Report
7-8	Lab 5: Interfacing K60 Microcontroller – Timers, ADC and DAC Interfacing	Week 10: Demo/Report
9-11	Lab 6/Project: Interfacing K60 Microcontroller – Motor Control, PWM	Week 12: Demo/Report

5.4 Other Important Dates

First day of class: Thursday Sept. 6, 2016

Monday, October 8, 2018: Thanksgiving Day, No Classes

Tuesday, October 9, 2018: Study Day, No Classes

Friday, November 2, 2018: 40^{th} Class Day - Last day to drop classes

Thursday, November 29, 2018: Make up for Study Day (Tuesday Schedule)

Friday, November 30, 2018: Make up for Thanksgiving Day (Monday Schedule)

You can refer the student undergraduate calendars for the semester scheduled dates.

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6 Assessments

6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Labs	45
Midterm	25
Final Exam	30
Total	100

6.2 Assessment Details

Labs (45%)
Lab 1, 2 and 3 are 6% each; Lab 4 and 5 are 9% each; and Lab 6 is 10% (The weight distribution between demo and reports will be 50% for each lab)

Midterm (25%)
Date: Sat, Oct 20, TBA
Saturday, October 20, 2018; Time: 10:00 am - 12:00 pm

Final Exam (30%)
Date: Wed, Dec 12, TBA
Wednesday December 12, 8:30am - 10:30am

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7 Course Statements

7.1 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor at the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Passing grade: In order to pass the course, you must meet the following conditions:

1. Students must finalize and submit all the labs (Demo + Report) and obtain a passing grade of 50% or higher in the lab portion of the course. If an overall grade of lower than 50% is obtained in any lab, the students need to arrange with the instructor and the teaching assistant to reschedule a new demo and report submission.
2. Obtain a passing mark in the final exam portion or an average of 40% or higher of the total

mark for the tests portion: [midterm + the final exam]/2 ≥ 40%.
3. If the course passing conditions 1 and 2 are not met then the final course grade will be 47% (the laboratory grades will not be considered).

Contesting marks: All laboratory, quizzes, and midterm exam marks must be contested within 2 day from the grade submission. Also the exams must be written in pen or ink for contest considerations.

Missed midterm tests: If you miss a test due to grounds for granting academic consideration or religious accommodation, you will need to arrange a makeup exam date with the instructor.

Lab Work: You must attend and complete all laboratories. If you miss a laboratory demo due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup lab demo.

Late Lab Reports: Late submissions of lab reports will be accepted only with the approval of the course instructor. However, penalties on late submissions (up to 10% deductions) will be applied. Applied penalties will be posted on Engg*3640 CourseLink system.

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8 School of Engineering Statements

8.1 Instructor's Role and Responsibility to Students

The instructor’s role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

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9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The regulations and procedures for Academic Consideration are detailed in the Undergraduate Calendar.

9.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for Dropping Courses are available in the Undergraduate Calendar.

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance, and not later than the 40th Class Day.

More information: www.uoguelph.ca/sas

9.6 Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar.

9.7 Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.
