



# ENGG\*3640 Microcomputer Interfacing

01

Fall 2020

Section(s): C01

School of Engineering

Credit Weight: 0.50

Version 2.00 - September 10, 2020

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## 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-Requisites:**

ENGG\*2410, ENGG\*2450

**Restrictions:**

This is a Priority Access Course. Enrolment may be restricted to the CENG and ESC specializations in the BENG and BENG:C programs. See department for more information.

### 1.2 Timetable

**Lectures:** <https://uoguelph.webex.com/meet/rmuresan>

M, W, F

11:30 am – 12:20 pm Virtual

**Laboratory: FTF**

Tuesday      Sec 01\*, \*02 2:30 pm – 6:20 pm      RICH 1532

Thursday      Sec 03\*, \*04 2:30 pm – 6:20 pm      RICH 1532

Monday          Sec 05\*, \*06 2:30 pm – 6:20 pm    RICH 1532

### 1.3 Final Exam

Final Exam: Virtual, Regular 2 hours format

Date: Thursday, December 9, 2020;

Time: 11:30 am - 1:30 pm

Room: TBA

## 2 Instructional Support

### 2.1 Instructional Support Team

**Instructor:** Radu Muresan  
**Email:** rmuresan@uoguelph.ca  
**Telephone:** +1-519-824-4120 x56730  
**Office:** RICH 2509  
**Office Hours:** Office Hours: Friday: Time range: 1:30 pm to 4:30 pm. Or by appointment

Check engg3640 CourseLink

Virtual: <https://uoguelph.webex.com/meet/rmuresan>

Office: RICH 2509

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

### 2.2 Teaching Assistants

**Teaching Assistant:** Rahul Eswar  
**Email:** reswar@uoguelph.ca  
**Office Hours:** TBA

## 3 Learning Resources

### 3.1 Required Resources

**ENGG3640 Microcomputer Interfacing Lecture Notes, (Textbook)**

Radu Muresan, University of Guelph, CourseLink, 2010 Version.

**ENGG3640\_Lecture\_Recordings (Website)**

<https://web.microsoftstream.com/channel/19846341-a88c-41ae-8ec0-a9d14620ac71>

**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)**

**ENGG3640 Microcomputer Interfacing Laboratory Manual (Textbook)**

Radu Muresan and Kevin Dong, University of Guelph CourseLink, 2020 Edition.

### 3.2 Recommended Resources

**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, K60 Sub-Family Reference Manual, June 2012. (Readings)**

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

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

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

### 3.3 Additional Resources

**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 E-BOOKS 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 PAST EXAMS 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.

## **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	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	1, 2, 3, 4, 5, 6,

#	Outcome	Learning Outcome
	concepts	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

## 5 Teaching and Learning Activities

### COVID, Lecture Delivery:

The lectures are all delivered in the virtual mode. The students must attend the webex live lecture presentations as scheduled. The link for the lecture presentation is:  
<https://uoguelph.webex.com/meet/rmuresan>

### COVID, Laboratory Delivery:

1) Face-to-Face (FTF) Laboratory Delivery. For as long as it is permissible by the University regulations, the laboratory for the course will be delivered in FTF mode. For the FTF lab delivery, we require that groups of 4 students should be formed and at least 1 and at most 2 students per group should be participating to the in-lab activity in order to meet the social distancing requirements. Also, the students will be instructed how to follow all COVID safety requirements. The other members of the group (not present in the lab) must connect using virtual technology and contribute to the lab work through virtual activity. This must be done during the lab hours, and the students are encouraged to work in virtual mode outside the lab

hours in order to complete their laboratory work. In addition, the students should rotate their participation to the FTF in-lab activity, meaning that every other week if possible different members of the group should participate to the in-lab activity. This is to allow all students to gain their necessary hands-on engineering experience. If there are students that cannot attend the in-lab activity (due to justifiable reasons) they should try to join a group where they can contribute for the lab through virtual work and the other members agree to this virtual only participation. 2) COVID Development, Alternative to the FTF Lab Delivery. In the case that a new situation related to COVID development will take place during the progression of the fall term (F20), the requirements for the FTF laboratory meetings will be changed to virtual meetings. The laboratory marking scheme will remain unchanged. However, we will make the necessary laboratory adjustments to the laboratory requirements to accommodate the online laboratory delivery. These might include (but not limited to): providing of take home boards, omission of experimental laboratory demos and addition of virtual demos (where possible) or demo reports describing demo procedures.

## 5.1 Lecture Schedule

		<b>Learning</b>	
<b>Week</b>	<b>Lecture Topics</b>	<b>References</b>	<b>Objectives</b>
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	ARM Assembly Examples. Subroutines and Stacks. Exception Handling	Chapters 13	2, 3, 9
4	Memory Mapped Peripherals. Interfacing, Electrical Characteristics Considerations	Chapters 14-17	1, 2, 4
5	Microcomputer Interfacing: GPIO, LEDs, 7- <b>Segments</b> Displays, LCD. Examples	Chapter 16	1, 2, 9
6	Interfacing with Transistors and Operational Amplifiers. Examples		1, 2, 9
7-8	Interfacing with the Analog World: DAC Basics and ADC Basics. Examples	Lecture Notes	1 – 5, 9
9-10	Interfacing Actuators: Relays, Solenoids, Motors, PWM, Stepper Motors		
11	Microcomputer Interfacing: SPI Interface	Lecture Notes	1, 2, 3, 6, 9
	Microcomputer Interfacing: I2C Interface.		

12 External Memory Interfacing.

Lecture Notes 1, 2, 3, 6, 9

## 5.2 Design Lab Schedule

Week	Activity	References	Learning Objectives
1	Lab 1: Introduction to Lab Equipment and Safety Training  plus COVID Face-to-Face Lab Safety	Lab Manual	1
2	Lab 2 (part 1): MDK Tools, ARM Assembly – Timer using Loop Delays	Lab Manual	1, 2, 3, 9
3	Lab 2 (part 1): demo; report		1, 2, 3, 9
3	Lab 2 (part 2): MDK Tools, ARM Assembly – Simple RPN Calculator;  Introduction	Lab Manual	1, 2, 3, 9
4	Lab 2: Implementation		1, 2, 3, 9
5	Fall break		
6	Lab 2 (part 2): demo; report  Lab 3: Timer and Interrupts; Lab Introduction		1-4, 9
7	Lab 3: Lab Implementation	Lab Manual	1-4, 9
8	Lab 3: Demo; Report  Lab 4: GPIO, 7-seg LED; Lab Introduction	Lab Manual	1-5, 9
9	Lab 4: Lab Implementation		1-5, 9

10	Lab 4: Demo; Report	Lab Manual	1-9
	Lab 5: ADC, DAC and voltage meter; Lab Introduction		
11	Lab 5: Lab Implementation		1-9
12	Lab 5: Demo; Report		1-9

### 5.3 Lab Schedule

<b><u>Week</u></b>	<b><u>Topic</u></b>	<b><u>Due</u></b>
1	Lab 1: Lab Safety, Group Setup, Equipment Introduction and Distribution	Week 1:
2	Lab 2 (part 1): MDK Tools, ARM Assembly – Timer Using Loop Delays	Week 3: Demo/Report
3-4	Lab 2 (part 2): ARM Assembly – Simple Calculator	Week 6: Demo/Report
5	Fall break	
6-7	Lab 3: ARM Assembly – Interrupts	Week 8: Demo/Report
8-9	Lab 4: Interfacing K60 Microcontroller – GPIO, LEDs and 7-Segment Interfacing	Week 10: Demo/Report
10-11	Lab 5: Interfacing K60 Microcontroller – Timers, ADC and DAC Interfacing	Week 12: Demo/Report

### 5.4 Other Important Dates

First day of class: Wednesday, September 9, 2020



Friday October 9, 2020: Fall Break begins at the end of classes this day

Monday, October 12, 2020 - no classes scheduled this day; classes rescheduled for Friday December 4

Tuesday, October 13, 2020 - no classes scheduled this day; classes rescheduled for Thursday December 3

Friday, December 7, 2020: Final Examination commence

You can also refer to the undergraduate calendar for the semester's scheduled dates.

## 6 Assessments

The assessment schedule will be as presented in this section.

Please note that the laboratory requires face-to-face (FTF) delivery which means that at least one student and up to two students per group will be required to be participating to the in-lab activity including the lab presentations, lab demos and lab implementations. The students are encouraged to rotate their presence in the lab so all gain their much needed hand-on engineering experience.

The midterm is designed as a virtual take home group research design problem. All students must contribute to this assignment.

The final exam is scheduled as a regular exam but using the virtual method. Please follow the CourseLink for more information.

### 6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Labs	46
Midterm	14
Final Exam	40
Total	100

### 6.2 Assessment Details

#### Labs (46%)

**Learning Outcome:** 1, 2, 3, 4, 5, 6, 7, 8, 9

Lab 2 (part 1): 6% total (3% demo, 3% report)

Lab 2 (part 2): 8% total (4% demo, 4% report)

Lab 3: 8% total (4% demo, 4% report)

Lab 4: 12% total (6% demo, 6% report)

Lab 5: 12% total (6% demo, 6% report)

### **Group Midterm Design Assignment with Report (14%)**

**Date:** Week 7, TBA

**Learning Outcome:** 1, 2, 3, 5, 6

**Midterm:** This is a group midterm design assessment with report. A small design problem related to the topics presented in the first part of the course will be the topic of this midterm. The group will design the solution (hardware plus software) for an embedded microprocessor application problem accompanied by a 3 to 4 page report. The problem might contain research component.

Submission deadline by the end of week 7

### **Final Exam (40%)**

**Date:** Wed, Dec 9, 11:30 AM - 1:30 PM, Virtual

**Learning Outcome:** 1, 2, 3, 4, 5, 6, 7, 8

**Final Exam:** The final exam is virtual mode. You will be required to upload your exam paper by a specified time (Check CourseLink). The final exam will cover the entire material taught in the course.

## **6.3 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 each individual lab. 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 the course (50% or higher in the final exam portion).
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.

**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. Check the information for FTF laboratory requirements.

**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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## 7 Course Statements

### 7.1 F20, Course Delivery (COVID)

#### **COVID, Lecture Delivery:**

The lectures are all delivered in the virtual mode. The students must attend the webex live lecture presentations as scheduled. The link for the lecture presentation is:  
<https://uoguelph.webex.com/meet/rmuresan>

#### **COVID, Laboratory Delivery:**

1) Face-to-Face (FTF) Laboratory Delivery. For as long as it is permissible by the University regulations, the laboratory for the course will be delivered in FTF mode. For the FTF lab delivery, we require that groups of 4 students should be formed and at least 1 and at most 2 students per group should be participating to the in-lab activity in order to meet the social distancing requirements. Also, the students will be instructed how to follow all COVID safety requirements. The other members of the group (not present in the lab) must connect using virtual technology and contribute to the lab work through virtual activity. This must be done during the lab hours, and the students are encouraged to work in virtual mode outside the lab hours in order to complete their laboratory work. In addition, the students should rotate their participation to the FTF in-lab activity, meaning that every other week if possible different members of the group should participate to the in-lab activity. This is to allow all students to gain their necessary hands-on engineering experience. If there are students that cannot attend the in-lab activity (due to justifiable reasons) they should try to join a group where they can contribute for the lab through virtual work and the other members agree to this virtual only participation. 2) COVID Development, Alternative to the FTF Lab Delivery. In the case that a new situation related to COVID development will take place during the progression of the fall term (F20), the requirements for the FTF laboratory meetings will be changed to virtual meetings. The laboratory marking scheme will remain unchanged. However, we will make the

necessary laboratory adjustments to the laboratory requirements to accommodate the online laboratory delivery. These might include (but not limited to): providing of take home boards, omission of experimental laboratory demos and addition of virtual demos (where possible) or demo reports describing demo procedures.

## **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.

## **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 grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

### 9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

### 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.

For Guelph students, information can be found on the SAS website

<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website  
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

## 9.6 Academic Integrity

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 encourages academic integrity. 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.

Undergraduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

## 9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, 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 that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>

## 9.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of

course offerings and academic schedules. Any such changes will be announced via CourseLink and/or class email. All University-wide decisions will be posted on the COVID-19 website (<https://news.uoguelph.ca/2019-novel-coronavirus-information/>) and circulated by email.

## **9.10 Illness**

The University will not normally require verification of illness (doctor's notes) for fall 2020 or winter 2021 semester courses. However, requests for Academic Consideration may still require medical documentation as appropriate.

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