ENGG*3640 Microcomputer Interfacing

01

Fall 2022
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - September 05, 2022

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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	Sections	F2F	Room
Tuesday	Sec 01*,02*	10:00 am - 11:20 pm	MCKN, 223
Thursday	Sec 01*,02*	10:00 am - 11:20 pm	MCKN, 223

Laboratory:	Sections	F2F	Room
Wednesday	Sec 01*	2:30 pm − 5:20 pm	RICH, 1532
Monday	Sec 02*	8:30 am − 11:20 am	RICH, 1532

1.3 Final Exam

Final Exam: Regular 2 hours format exam, delivered in-class. Please follow announcements on CourseLink

Date: Wednesday, December 14, 2022;

Time: 8:30 am - 10:30 pm

Room: TBD

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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: Thursday: Time range: 3:00 pm to 5:00 pm. Or by appointment

Check engg3640 CourseLink

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 (GTA):	William Peters
Email:	wpeters@uoguelph.ca
Office Hours:	TBA

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3 Learning Resources

3.1 Required Resources

ENGG3640 Microcomputer Interfacing Lecture Notes, (Notes)
Radu Muresan, University of Guelph, CourseLink, 2022 Version.

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

ENGG3640 Microcomputer Interfacing Laboratory Manual (Lab Manual)
Radu Muresan and Kevin Dong, University of Guelph CourseLink, 2022 Edition.

3.2 Recommended Resources

ARM: ARM Cortex-M4 Processor, Technical Reference Manual, 2020. (Readings)

ARM: Cortex-M4 Devices, Generic User Guide, 2011. (Readings)

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

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

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

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

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

Texas Instruments, Various Application Notes, Datasheets and Technical Documentations. (Readings)

Analog Devices, Various Application Notes, Datasheets and Technical Documentations. (Readings)

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 and final exams will be posted on the ENGG*3640 CourseLink system under the PAST EXAMS section.

Miscellaneous Information (Notes)
Other information related to Microcomputer Interfacing topics will be posted on the ENGG*3640 CourseLink site..

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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 microcontrollers and microprocessors.
2. To introduce the basics of ARM assembly language for ARM-based microcontrollers.
3. To introduce complex commercial microcontroller architectures based on ARM cores and interfacing modules of typical microcontroller organizations.
4. To introduce basic electronic circuits, the latest integrated circuit devices, and hardware architectures used in microcontroller interfacing.
5. To present standard 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. Understand microcontroller hardware architectures, programmer's model, microcontroller interfacing concepts and and basic on-chip interface modules.
2. Understand basic assembly and C language programming for microcontroller interfacing.
3. Understand electrical logic levels, basics of integrated circuits interfacing and circuitry, and hardware interfacing with diverse devices such as microcontrollers, and input and output devices.

4. Design of microcontroller interfaces using interrupts, DMA, and polling techniques.

5. Design of microcontroller interfaces with human-machine interface specialized devices.

6. Design of microcontroller interfaces with serial communication and specialized devices.

7. Design of microcontroller interfacing with data acquisition interfaces and specialized sensor devices.

8. Design of microcontroller interfaces with actuators, sensors and specialized devices.

9. Implement and demonstrate microcontroller 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 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
4.5	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
6	Individual & Teamwork	9
6.2	Understand all members' roles and responsibilities within a team	9

#	Outcome	Learning Outcome
7	Communication Skills	9
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	9
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	9

5 Teaching and Learning Activities

Lecture Delivery:

The ENGG*3640 lectures are all delivered in-class, Face-to-Face (F2F) delivery. The students are encouraged to attend all classes as scheduled. Please follow all the recommendations the University of Guelph outlined when attending classes.

Laboratory Delivery:

The ENGG*3640 laboratory is delivered in-class, Face-to-Face (F2F) delivery. For the FTF lab delivery, we require that groups of students be formed, and all students must attend the laboratory sessions in the lab. Therefore, your participation and attendance are essential so all students will gain much-needed engineering experience. Please follow all the recommendations the University of Guelph outlined when attending classes.

Note:

The lecture and laboratory schedules are given in weeks, considering a 12 weeks term (vacation is excluded in the numbering of weeks).

5.1 Lecture Schedule

Week	Lecture Topics	References	Learning Objectives
1	Introduction to Interfacing and Microcontrollers; ARM assembler brief summary; ARM Cortex-M4 - programmer's model.	Lecture Notes: Slides 1 to	1

			82.
2	Basic ARM assembly programming concepts with examples.	Lecture Notes:	2
		Slides 83 to 132.	
3	ARM Cortex-M4 exception model, NVIC module; K60 microcontroller general architecture; IC interfacing, logic families; electrical level conversion consideration and devices.	Lecture Notes:	1 - 4
		Slides 133 to 181.	
4	Microcontroller interfacing, interfacing simple devices with examples: mechanical switches; keypads; single LEDs; K60 GPIO module; 7-segments displays.	Lecture Notes:	1 - 5
		Slides 182 to 244.	
5	Microcomputer Interfacing, interfacing simple devices with examples: RGB LEDs; LCD basics; 7-segment LCDs.	Lecture Notes:	1 - 5
		Slides 245 to 277.	
6	Basics of interfacing with transistors and operational amplifiers, with examples: BJT; MOSFET; operational amplifiers.	Lecture Notes:	3
		Slides 278 to 329.	
7-8	Digital and analog interfacing with examples: Digital to analog converters (DAC); analog to digital converters (ADC); data acquisition.	Lecture Notes:	1 – 5, 7, 9
		Slides 330 to	

462.

9-10	Interfacing actuators with examples: relays, solenoids, motors, PWM, Stepper Motors; K60 FTM module with examples.	Lecture Notes: Slides 463 to 591	1-4, 8, 9
11	Example of FTM input capture design; serial peripheral interface (SPI) bus protocol and examples or enabled SPI ICs interfacing.	Lecture Notes: Slides 592 to 652.	1-4, 6 - 9
12	Inter-integrated circuit (I2C) bus interface protocol; examples of I2C enabled ICs interfacing; external memory interfacing (reading topic); final exam review.	Lecture Notes: Slides 653 to ...	1-4, 6, 7, 9

5.2 Lab Schedule

Lab Execution	**Topic**	**Lab Intro**	**Lab Demo Report Due**	**Learning Objectives**
Week 1: (Sept. 8 to Sept. 14)	Lab 0: Lab Safety, Group Setup, Equipment Introduction and Distribution	Week 1	Week 1:	
Week 2: (Sept. 15 to Sept. 21)	Lab 1: MDK Tools, ARM Assembly – Timer Using Loop Delays	Week 1	Week 3	1, 2, 9
Weeks 3,4: (Sept.	Lab 2: ARM Assembly – Simple Calculator	Week	Week 5	1, 2, 9

22 to Oct. 5)		2		
Oct. 7 to Oct. 11	Fall break			
Weeks 5, 6: (Oct. 12 to Oct. 25)	Lab 3: ARM Assembly – Interrupts	Week 4	Week 7	1, 2, 4, 9
Weeks 7, 8: (Oct. 26 to Nov. 8)	Lab 4: Interfacing K60 Microcontroller – GPIO, LEDs and 7−Segment Interfacing	Week 6	Week 9	1-5, 9
Weeks 9, 10: (Nov. 9 to Nov. 22)	Lab 5: Interfacing K60 Microcontroller – Timers, ADC and DAC Interfacing	Week 8	Week 11	1-5, 7, 9
Weeks 11, 12: (Nov. 23 to Dec. 2)	Lab 6/Project: Interfacing the K60 Microcontroller - Project Motor Interfacing Using the FTM Module	Week 10	Week 12	1-9

5.3 Other Important Dates

First day of class: Thursday, September 8, 2022

Friday October 7, 2022: Fall Break begins at the end of classes this day

Monday, October 10, 2022 - no classes scheduled this day; classes rescheduled for Friday, December 2

Tuesday, October 11, 2022 - no classes scheduled this day; classes rescheduled for Thursday, December 1

Monday, December 5, 2022: Final Examination commence

Wednesday, December 14, 2022: Final exam starting at 8:30 am

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

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6 Assessments

The assessment schedule will be as presented in this section.

Please note that the course requires face-to-face (FTF) delivery. Therefore, all students will be required to participate in the in-class lectures and the in-lab activities, including all lab presentations, lab demos, and implementations.

The course does not have a midterm exam, instead we have an individual take home assignment.

The course has a final exam scheduled as a regular F2F in-class exam. Please follow the CourseLink for specific information.

6.1 Marking Schemes & Distributions

Name	Scheme A (%)	Scheme B (%)
Labs	50	40
Assignment	10	10
Final Exam	40	50
Total	100	100

6.2 Assessment Details

Labs (50%)
Learning Outcome: 1, 2, 3, 4, 5, 6, 7, 8, 9
Lab 1: 4% total (2% demo, 2% report)
Lab 2: 8% total (4% demo, 4% report)
Lab 3: 8% total (4% demo, 4% report)
Lab 4: 10% total (5% demo, 5% report)
Lab 5: 10% total (5% demo, 5% report)

Lab 6: 10% total (5% demo, 5% report)

Individual design assignment (10%)
Date: Fri, Oct 28, Take home assignment
Learning Outcome: 1, 2, 3, 4, 5, 6, 9
Assignment: This assignment is an individual design assessment. A small design problem related to the topics presented in the first part of the course (Weeks 1 to 4) will be the topic of this midterm. The design will require a simple hardware interface and some programming. Also, the assignment might contain research components related to ICs usage. The solution to the assignment must be uploaded in pdf format to the ENGG*3640 CourseLink dropbox for this assignment.

The submission deadline is currently set for October 28, 2022; however, we can change this date to accommodate the unforeseeable workload of the students.

Final Exam (40%)
Date: Wed, Dec 14, 8:30 AM - 10:30 AM, Virtual
Learning Outcome: 1, 2, 3, 4, 5, 6, 7, 8, 9
Final Exam: The final exam is scheduled as a regular F2F in-class exam. Please follow the CourseLink for specific information. 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 ENGG*3640 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 lab. If an overall grade below 50% is received in any individual lab, the students must arrange with the instructor and the teaching assistant to reschedule a new demo and report submission.
2. In order to pass the course, following marking distribution scheme A, students must obtain a cumulative passing mark (>= 50%) in the combined individual assessment components of the course (assignments plus the final exam).
3. If the course passing conditions 1 is not met then the final course grade will be a fail set at 47%.
4. If the course passing condition 2 is not met, the final course mark will be calculated based on marking distribution scheme B.

Contesting marks: Issues with the laboratory, quizzes, and midterm exam marks must be contested within two days from the grade submission.

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) might be applied.

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7 Course Statements

7.1 F22, Course Delivery

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Laboratory Delivery:

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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.

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 make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

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, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email.

This includes on-campus scheduling during the semester, mid-terms and final examination schedules. 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

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

9.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

- https://news.uoguelph.ca/return-to-campuses/how-u-of-g-is-preparing-for-your-safe-return/
- https://news.uoguelph.ca/return-to-campuses/spaces/#ClassroomSpaces

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.

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