

ENGG*3640 - Microcomputer Interfacing

Fall 2024 Course Outline

Section: 01

Credits: 0.50

Land Acknowledgement: Guelph

The University of Guelph resides on the ancestral lands of the Attawandaron people and the treaty lands and territory of the Mississaugas of the Credit. We recognize the significance of the Dish with One Spoon Covenant to this land and offer respect to our Anishinaabe, Haudenosaunee and Métis neighbours. Today, this gathering place is home to many First Nations, Inuit, and Métis peoples and acknowledging them reminds us of our important connection to this land where we work and learn.

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.

Prerequisite(s): ENGG*2410, ENGG*2450

Restriction(s): 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. Non-BENG students may take a maximum of 4.00 ENGG credits.

Department(s): School of Engineering

Lecture Schedule

MonWedFri 1:30pm-2:20pm in RICH*2520 (9/5 to 12/13)

Timetable

Laboratory

Day	Sections	Time	Room
Monday	Sec 01*	2:30 pm – 5:20 pm	RICH, 1532
Wednesday	Sec 02*	2:30 pm – 5:20 pm	RICH, 1532
Friday	Sec 03*	2:30 pm – 5:20 pm	RICH, 1532

Instructor Information

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Additional Support

Lab Co-ordinator

Kevin Dong

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Telephone: +1-519-824-4120 x56455

Office: RICH 2506

Teaching Assistants

Teaching Assistant (GTA)	Email	Office Hours
Maheshwari Pranav	pmaheshw@uoguelph.ca	TBD
Nisyif Murtadha	mnisyif@uoguelph.ca	TBD
Parmar Herikumari Jagdishbhai	herikuma@uoguelph.ca	TBD

Textbooks

Group	Title	Author	ISBN
Recommended	ARM Assembly Language, Fundamentals and Techniques, 2nd Edition, CRC Press, 2015	William Hohl and Christopher Hinds	
Recommended	ARM: Assembly Language Programming, 2004	P. Knaggs, S. Welsh	
Recommended	Mechatronics with Experiments, 2nd Edition, Wiley, 2015	Sabri Centinkunt	
Recommended	, Embedded Microcomputer Systems, Real Time Interfacing, 3rd Edition, CENGAGE Learning, 2012.	J. W. Valvano	

Learning Resources

Required Resources

ENGG3640 Microcomputer Interfacing Lecture Notes, (Notes)

Radu Muresan, University of Guelph, CourseLink, 2023 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.

Course 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)

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

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

Additional Resources

Lecture Information (Notes)

All the lecture notes are posted on the ENGG*3640 CourseLink system. Additional material is found under the eREFERENCES module.

Lab Information (Notes)

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

Miscellaneous Information (Notes)

Other information related to Microcomputer Interfacing topics will be posted on the ENGG*3640 CourseLink site..

Campus Resources

If you are concerned about any aspect of your academic program: Make an appointment with a Program Counsellor (<https://www.uoguelph.ca/uaic/programcounsellors/>) in your degree program. If you are struggling to succeed academically: There are numerous academic resources offered by the Learning Commons (<https://www.lib.uoguelph.ca/using-library/spaces/learning-commons/>) including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills.

Course Learning Outcomes

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).

Course Level 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.

Teaching and Learning Activities

Lecture Delivery:

The ENG*3640 lectures are all delivered in-class, Face-to-Face (FtF) 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 ENG*3640 laboratory is delivered in-class, Face-to-Face (FtF) 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)

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	1
2	Basic ARM assembly programming concepts with examples.	Lecture Notes	2

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
4	Microcontroller interfacing, interfacing simple devices with examples: mechanical switches; keypads; single LEDs; K60 GPIO module; 7-segments displays.	Lecture Notes	1 - 5
5	Microcomputer Interfacing, interfacing simple devices with examples: RGB LEDs; LCD basics; 7-segment LCDs.	Lecture Notes	1 - 5
6	Basics of interfacing with transistors and operational amplifiers, with examples: BJT; MOSFET; operational amplifiers.	Lecture Notes	3
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
9-10	Interfacing actuators with examples: relays, solenoids, motors, PWM, Stepper Motors; K60 FTM module with examples.	Lecture Notes	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	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	1-4, 6, 7, 9

Lab Schedule

Lab Excution	Topic	Start	Ends	Learning Objective
Week 2	Lab 1	Sept. 16-20	Sept. 23-27	1, 2, 9
Week 3	Lab 2	Sept 23-27	Oct. 7-11	1, 2, 9
Week 5	Lab 3	Oct. 7-11	Oct. 21 - 25	1, 2, 9
Week 7	Lab 4	Oct. 21 - 25	Nov. 4 - 8	1, 2, 4, 9
Week 9	Lab 5	Nov. 4 - 8	Nov. 18 - 22	1, 2, 4, 9

Assessment Breakdown

Marking Schemes & Distributions

Name	Scheme (%)
Labs	40%
In-class Activity	10%
Midterm	10%
Final Exam	40%
Total	100%

Assessment Details

Lab Assignments

Labs	40%
<ul style="list-style-type: none">• Lab 1: 4%• Lab 2: 8%• Lab 3: 8%• Lab 4: 10%• Lab 5: 10%	

Course Learning Outcomes Assessed: 1, 2, 3, 4, 5, 6, 7, 8, 9

Discussion

In-class Activity

Date: Once every week. Consider best 10	10%
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Course Learning Outcomes Assessed: 1, 2, 3, 4, 5, 6, 9

Exam

Midterm

Date: Wed, Oct 9, F2F during the class time (1:30 pm -2:20 pm)	10
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Course Learning Outcomes Assessed: 1, 3, 4, 5, 6, 7, 8, 9

Final Exam

Date: See "Final Exam" Section	40%
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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.

Course Learning Outcomes Assessed: 1, 2, 3, 4, 5, 6, 7, 8, 9

Final Exam

Date: Dec 9

Time: Mon 8:30am-10:30am

Location: TBA *Please see Web Advisor closer to the date of scheduled final for location.*

To understand rules and regulations regarding Examinations students are encouraged to read Student's Responsibilities (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/examinations/>)

If the student is unable to meet the final exam requirements due to medical, psychological or compassionate circumstances they are encouraged to review Student's Responsibilities in the Academic Consideration, Appeals and Petitions (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-consideration-appeals-petitions/>) section of the Academic Calendar.

Last Day to Drop Course

The final day to drop Fall 2024 courses without academic penalty is the last day of classes: November 29

After this date, a mark will be recorded, whether course work is completed or not (a zero is assigned for missed tests/assignments). This mark will show on the student's transcript and will be calculated into their average.

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 (<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml/>) for information on regulations and procedures for Academic Consideration

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 score 40% or better in the final exam.
3. If the course passing conditions is not met, then the final course grade will be a fail.
4. A missed midterm will be graded with 0. However, in case of sickness then the midterm assignment mark is combined with the final. No make up midterm.

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.

Course Standard Statements

F23, Course Delivery

Lecture Delivery:

The ENGG*3640 lectures are all delivered in-class, Face-to-Face (FtF) 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 (FtF) 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.

School of Engineering Statements

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.

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.

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

Standard Statements for Undergraduate Courses

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 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 (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-misconduct/>) is outlined in the Undergraduate Calendar.

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 10 days in advance, and no later than the first business day in November, March or July as appropriate for the semester. Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time. For students at the Guelph campus, information can be found on the SAS website. (<https://www.uoguelph.ca/sas/>)

Accommodation of Religious Obligations

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements.

See the Academic calendar for information on regulations and procedures for Academic Accommodations of Religious Obligations (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-accommodation-religious-obligations/>).

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.

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 undergraduate students 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 the Undergraduate Calendar - Dropping Courses (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/dropping-courses/>).

Email Communication

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

Health and Wellbeing

The University of Guelph provides a wide range of health and wellbeing services at the Vaccarino Centre for Student Wellness (<https://wellness.uoguelph.ca/>). If you are concerned about your mental health and not sure where to start, connect with a Student Wellness Navigator (<https://wellness.uoguelph.ca/navigation/>) who can help develop a plan to manage and support your mental health or check out our mental wellbeing resources (<https://wellness.uoguelph.ca/shine-this-year/>). The Student Wellness team are here to help and welcome the opportunity to connect with you.

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).

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.

Resources

The Academic Calendars (<http://www.uoguelph.ca/registrar/calendars/?index>) are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.

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. See the Undergraduate Calendar for information on regulations and procedures for Academic Consideration. (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-consideration-appeals-petitions/>)

Professional Accreditation Outcomes

Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

1. Knowledge Base

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
1.4	Recall, describe and apply program-specific engineering principles and concepts	Developed	Yes

2. Problem Analysis

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
2.4	Execute an engineering solution	Developed	No

4. Design

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
4.2	Construct design-specific problem statements including the definition of criteria and constraints	Advanced	No
4.3	Create a variety of engineering design solutions	Advanced	No
4.5	Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping	Advanced	No

5. Use of Engineering Tools

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
5.2	Demonstrate proficiency in the application of selected engineering tools	Developed	No