ENGG*3640 Microcomputer Interfacing
Fall 2016

UNIVERSITY of GUELPH

School of Engineering

(Revision 1: September 8, 2016)

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1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Radu Muresan, Ph.D., P.Eng.
Office: RICH 2509, ext. 56730
Email: rmuresan@uoguelph.ca
Office hours: Fridays: 4:00 pm – 6:00 pm. Or by appointment

1.2 Lab Technician

Lab Instructor: Kevin Dong
Office: RICH 2506, ext. xxxx
Email: kdong@uoguelph.ca

1.3 Teaching Assistants

GTA	Email	Office Hours
Zhaohui Gu	zgu04@uoguelph.ca	TBA on CourseLink
Tianxiang Jia	tjia@uoguelph.ca	TBA on CourseLink

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2 LEARNING RESOURCES

2.1 Course Website

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.

2.2 Required Resources

1. William Hohl and Christopher Hinds, *ARM Assembly Language, Fundamentals and Techniques*, 2nd Edition, CRC Press, 2015.
2. Radu Muresan, *ENGG3640 Microcomputer Interfacing Lecture Notes*, University of Guelph CourseLink, 2016 Version.
3. Radu Muresan, *ENGG3640 Lab Manual*, University of Guelph CourseLink, 2016 Edition.

2.3 Recommended Resources

1. J. W. Valvano, *Embedded Microcomputer Systems, Real Time Interfacing*, 3rd Edition, CENGAGE Learning, 2012.
2. Sabri Centinkunt, Mechatronics with Experiments, 2nd Edition, Wiley, 2015.
3. Freescale, 9S12DT256 Reference Manual, 2005.
4. Freescale, K60 Sub-Family Reference Manual, June 2012.
5. ARM: ARM Cortex-M4 Processor, Technical Reference Manual, 2013.
6. ARM: Cortex-M4 Devices, Generic User Guide, 2010.
7. P. Knaggs, S. Welsh, ARM: Assembly Language Programming, 2004.

2.4 Additional Resources

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

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

Exams: 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: Other information related to Microcomputer Interfacing topics will be posted on the web page.

2.5 Communication & Email

Please use lectures, tutorials and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website. **It is your responsibility to check the course website regularly.** As per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its student.

3 ASSESSMENT

3.1 Dates and Distribution

Labs: 40% (i.e, Lab 1, 2 and 3 are 5% each; Lab 4 and 5 are 8% each and Lab 6 is 9%)
See Section 5.4 below for due dates

Quizzes/Assignments: 10%: (quizzes and/or assignments delivered in the open-lab/lecture time slot)

Midterm: 20%
October 17th, 7:00 pm – 9:00 pm.

Final Exam: 30%
Thursday Dec 15th, 8:30 - 10:30, Room TBA on WebAdvisor

3.2 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. Also the students are required to have a good participation on the work evaluation form (+/- 10% variation max allowed) otherwise they will have to redo the lab individually in order to obtain the group mark. The work evaluation form can be downloaded from the Engg*3640 CourseLink system found under the LABORATORY module. 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 of 15% or higher of the total mark in the final exam portion or an average of 30% or higher of the total mark for the tests portion: [(10 top quizzes + midterm) + the final exam]/2 ≥ 30%.
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 will be applied. Applied penalties will be posted on Engg*3640 CourseLink system.

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4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 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 such as: 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)*: ENGG*4640

4.2 Course Aims

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 the general processor ARM Cortex-M4 and complex microcontroller architectures using the Cortex –M4 processor (i.e., Freescale Kinetis K family microcontroller architectures) 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.

4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability 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).

4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

Graduate Attribute	Learning Objectives	Assessment
1. Knowledge Base for Engineering	1, 3, 4, 5, 6, 7, 8, 9	Exams, Labs
2. Problem Analysis	4 - 9	Exams, Labs
3. Investigation	9	Labs
4. Design	4-9	Exams, Labs
5. Use of Engineering Tools	2, 3	Exams, Labs
6. Communication	9	Labs
7. Individual and Teamwork	9	Labs
8. Professionalism	-	-
9. Impact of Engineering on Society and the Environment	-	-
10. Ethics and Equity	-	-
11. Environment, Society, Business, & Project Management	-	-
12. Life-Long Learning	1-9	Exams, Labs

4.5 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. All lecture notes plus various exercises, examples and referenced resources will be made available to students on CourseLink system in the appropriate module. However, these are not intended to be stand-alone course notes. During lectures, the instructor will expand and explain the content of notes and provide in class solutions to problems that supplement posted notes. Scheduled classes and labs will be the principal venue to provide information and feedback for tests and labs.

4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and labs. In addition students are encouraged to consult the instructor and the TA during the scheduled office hours or to contact the instructor or TA for any help needed. 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.

4.7 Relationships with other Courses & Labs

Previous Courses:

ENGG*2410 (Digital Systems Design): Boolean algebra and truth tables. Design and synthesis of digital circuits. Synchronous and asynchronous behaviour of digital circuits. Hardware testing. UART, microcotroller CPU, ALU and data acquisition systems.

ENGG*2450 (Electric Circuits): Fundamentals of electric circuits analysis. Circuits elements. Operational amplifiers.

Follow-on Courses:

ENGG*4420 (Real-Time Systems Design): Real-time concepts from a systems and computing perspective. Real-time operating systems for embedded designs. Real-time computer control and interfacing.

ENGG*4560 (Embedded Systems Design): Systems-on-chip and embedded systems design. Embedded systems design tools.

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5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:			
M, W, F	Sec xx	8:30 am – 9:20 pm	RICH 2529
Laboratory:			
M	Sec xx	3:30 am – 5:20 am	RICH 1532
W,F	Sec xx	12:30 pm – 2:20 pm	RICH 1532
Open-Lab/Seminar:			
M,W,Th	Sec xx	7:00 pm – 7:50 pm	RICH 1532

5.2 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

5.3 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

5.4 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 4: Demo/Report
4	Lab 3: ARM Assembly – Interrupts	Week 5: Demo/Report
5-6	Lab 4: Interfacing K60 Microcontroller – GPIO, LEDs and 7–Segment Interfacing	Week 7: Demo/Report
7-8	Lab 5: Interfacing K60 Microcontroller – Timers, ADC and DAC Interfacing	Week 9: Demo/Report
9-11	Lab 6/Project: Interfacing K60 Microcontroller – Motor Control, PWM	Week 11: Demo/Report

5.5 Open-Lab Sessions

Week	Open-Lab Topics	References	Learning Objectives
1	ARM Assembly/Work on Lab 1	Lecture Notes/Lab	1, 2, 9
2	ARM Assembly/Work on Lab 1	Lecture Notes/Lab	1, 2, 9
3	ARM Assembly/Work on Lab 2	Lecture Notes/Lab	1, 2, 3
4	Interrupts/Work on Lab 3	Lecture Notes/Lab	1, 2, 4, 9
5	Microcomputer Interfacing: GPIO, LEDs, 7-Segments Displays, LCDs/Work on Lab 4	Lecture Notes/Lab	1, 2, 4, 9
6	Microcomputer Interfacing: GPIO, LEDs, 7-Segments Displays, LCDs/Work on Lab 4	Lecture Notes/Lab	1, 2, 7, 9
7	Timers, ADC, DAC/Work on Lab 5	Lecture Notes/Lab	1, 2, 7, 9
8	Timers, ADC, DAC/Work on Lab 5	Lecture Notes/Lab	1, 2, 6, 9
9	Review: Actuator Devices	Lecture Notes	1, 2, 8, 9
10	PWM/Work on Lab 6	Lecture Notes/Lab	1, 2, 8, 9
11	Course Review	Lecture Notes	1- 9
12	Course Review	Lecture Notes	1 - 9

5.6 Other Important Dates

First day of class: Thursday Sept. 8, 2016
Thanksgiving: Monday, October xx, 2016 - no classes
Fall Study day: Tuesday October xx - no classes
Last day to drop: Friday November xx, 2016
Last day of class: Friday December xx, 2016

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

6 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.

If the laboratory rules are not followed, consequences will include removing student's access to the lab. If this, results in lab work not being completed the student will receive a grade of 0.

7 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.

7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in your Engineering Program Guide.

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

8 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible.

For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.csd.uoguelph.ca/csd/

9 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, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

10 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:
http://www.uoguelph.ca/registrar/calendars/index.cfm?index