ECE 2534
Microcontroller Programming and Interfacing
Spring 2018
Sunday 15th April, 2018 13:50

Instructor:	Patrick Schaumont
Office:	Durham 337
E-mail:	schaum@vt.edu
Office Hours:	M 1:00PM - 3:00PM
	W 5:00PM - 7:00PM or by appointment
Class Website:	http://canvas.vt.edu
CEL Website:	http://tinyurl.com/CEL-ECE-VT
Section:	CRN 12924
Class Time:	MWF 10:10A-11:00A
Class Location:	WLH 350
Section:	CRN 12925
Class Time:	MWF 11:15A-12:05A
Class Location:	SURGE 109
TA:	Yamini Gaur (12924)
E-mail:	yamini94@vt.edu
TA:	Brian Worek (12924)
E-mail:	briandw@vt.edu
TA:	Jinyuan Yu (12925)
E-mail:	jianyuan@vt.edu

1   Description

You may own one or two general-purpose PCs, but you probably own 100 micro-controllers as well. Easily the most pervasive digital component around, they are found in anything from car-brake control to door-bell melody sequencing. There may be a handful in your cell phone as well. In this course you will learn about this great digital component, how to program it in C, and how to interface it with embedded peripherals.

2   Formal Objectives

Having successfully completed this course, you will be able to

- develop software for micro-controller systems using a high-level programming language;

- demonstrate familiarity with common micro-controller subsystems, such as timer modules;

- demonstrate an ability to use both polling and interrupt-driven approaches for interfacing a micro-controller with peripheral devices;

- develop and analyze software to interface a micro-controller with common peripheral devices, such as switches, visual displays, digital-to-analog converters, analog-to-digital converters, and flash memory to produce a system to accomplish a specified task;

- design interfaces to external devices connected to the micro-controller using a standard bus; and

- describe the roles of micro-controllers in contemporary systems, including common consumer products.

3   Prerequisites

- ECE 2504 (for concepts related to digital logic, data representation, computer arithmetic, basic computer organization and operation). You have to have obtained a grade of C- or better in ECE 2534.

- Practical knowledge of the C/C++ programming language, as taught in ECE 1574. This course does not teach how to program C; it teaches how to program a micro-controller using C.

4   Text and References

- There are no required textbooks. Data sheets, user manuals, and other materials will be available for download at no cost.

5   Equipment and Design Software

- The ECE department will lend a lab kit to each student for this course. The kit will contain a microcontroller board, a peripheral board, and several cables. We will provide instructions on when to pick up your kit from the CEL.

- You are required to return these materials to the CEL at the end of the semester when you complete the last lab assignment.

- You will need to develop software for the microcontroller board using the Texas Instruments Code Composer Studio. This software package is available to everyone at no cost. Installation instructions will be provided as part of the first lab assignment.

- All students must own a laptop that meets College of Engineering requirements.

6   Course Work

- There will be several homework assignments. Some of these may also require you to develop software for the micro-controller board. Late homework will receive a grade of 0.

- Lab assignments will require you to investigate hardware and software details related to embedded systems, and to write C-language code for the Digilent board. Tentatively, late work will be accepted for an additional 48 hours, with a grade penalty of up to 15%. Work will not be accepted after the late cut-off. Details will be provided for each assignment.

- Several quizzes will be held, normally in class at the beginning of the lecture period. Some of the quizzes will not be announced in advance. A missed quiz receives a grade of 0, and there are no make-ups. To allow for unavoidable absences, everyones lowest quiz grade will be dropped at the end of the semester.

All assignments submitted shall be considered graded work and all aspects of your course work are covered by the Honor Code. All projects and

homework assignments are to be completed individually unless otherwise specified.

7   Grading

- Semester grades will be based on the following weights. 3-4 Quizes (5%), 7-10 Homework (15%), 4 Labs (30%), 2 Midterms (30%), 1 Final Exam (20%). Labs have non-uniform weights. The first lab will count less than later labs. Tentatively: 3% for Lab 1, and 9% for each remaining lab.

- Students are expected to take all examinations during the announced time periods. The exams will be cumulative, and closed-book in format. There will be no make-up exams. A missed exam receives a grade of 0 unless a valid reason has been approved in advance.

- Due dates will not be extended because of problems with equipment, communication networks, power outages, or computer viruses. Because of this, it is important to plan ahead and back up your files frequently.

- If you have trouble with your microcontroller board or the software development environment for it, you should meet with a 2534 GTA in the CEL. The GTA can exchange parts that do not function correctly.

- If your laptop crashes, then you should seek help from www.4help.vt.edu. If they cannot help you fix the problem, then you might ask swat.eng.vt.edu for assistance. If that avenue fails, then you may be able to borrow a laptop from www.helpdesk.ece.vt.edu. With any of these solutions, you will need your back-up files in order to continue your work.

- If you feel that an error has been made in grading an assignment, please notify the person who did the grading within one week after the material is returned. For midterm exams, please present a short written appeal to the instructor.

8   Special Needs

- Reasonable accommodations are available for students who have documentation of a disability from a qualified professional. Students should

work through Services for Students with Disabilities (SSD) in 152 Henderson Hall. Any student with accommodations through the SSD Office should contact the instructor during the first two weeks of the semester.

- If participation in some part of this class conflicts with your observation of specific religious holidays during the semester, please contact the instructor during the first two weeks of class to make alternative arrangements.

- If you miss class due to illness, especially in the case of an exam or some deadline, see a professional in Schiffert Health Center. If deemed appropriate, documentation of your illness will be sent to the Deans Office for distribution to the instruction.

- If you experience a personal or family emergency that necessitates missing class, contact the Dean of Students at 231-3787 or see them in 152 Henderson Hall.

9   Honor Code Policy

The Undergraduate Honor Code pledge that each member of the university community agrees to abide by states: *As a Hokie, I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do.*

Students enrolled in this course are responsible for abiding by the Honor Code. A student who has doubts about how the Honor Code applies to any assignment is responsible for obtaining specific guidance from the course instructor before submitting the assignment for evaluation. Ignorance of the rules does not exclude any member of the University community from the requirements and expectations of the Honor Code. For additional information about the Honor Code, please visit: www.honorsystem.vt.edu.

The bottom line is: the Honor Code is a serious matter. Don't play games you cannot win.

10   Words of Advice

- *Attend class.* Students who do not go to lectures tend to receive very low grades in this course.

- *Take advantage of office hours and CEL sessions.* The instructor and the GTAs are available many hours every week to help with the course material.

- *Keep up with coursework.* Each assignment tends to build on previous assignments. It is not easy to catch up after falling behind.

- *Plan ahead and start early.* Some of the assignments will require a substantial amount of time. Careful management of your time will allow you to avoid last-minute rushes, and will provide the opportunity to seek help when it is needed.

- *Make back-up copies of your files.* As deadlines approach, it is especially important to back up your course-related files. Put these copies on removable media or in the cloud, so that you can continue working on borrowed equipment if your laptop or Digilent board is damaged.

- *Submit the correct files.* Most assignments will require you to upload files to Canvas. Unfortunately, it can be easy to upload the wrong files. Please double-check every file that you submit for an assignment, because the files that you upload to Canvas are the ones that will be graded.

11   Tentative Schedule

Week	Date	Lecture	Topic	Lab
1	17 Jan	R	Introduction	
	19 Jan	R	Impatient LED	
2	22 Jan	R	Code Composer Studio	
	24 Jan	R	Hardware Connectivity and Documentation	
	26 Jan	R	GitHub Version Control	Lab 1 available
3	29 Jan	R	Bit Manipulation in C	
	31 Jan	R	Programming with Time	
	2 Feb	R	State Machines in Software	Lab 1 due
4	5 Feb	R	Switch Debouncing	
	7 Feb	R	Review	
	9 Feb		Midterm I	
5	12 Feb	R	UART Basics	Lab 2 available
	14 Feb	R	UART Programming	
	16 Feb	R	UART Flow Control	
6	19 Feb	R	LCD Graphics	
	21 Feb	R	LCD Graphics, C Structs	
	23 Feb	R	Software Timer, Include Files	
7	26 Feb	R	Analog to Digital Conversion	Lab 2 due
	28 Feb	R	ADC Programming	
	2 Mar	R	Joystick	
8	5 Mar		Spring Break	
	7 Mar			
	9 Mar			
9	12 Mar	R	(cancelled: weather)	
	14 Mar	R	Interrupt Basics	Lab 3 Available
	16 Mar	R	Interrupt Software Examples	
10	19 Mar	R	Timer Peripheral	
	21 Mar	R	Timer Measurement	
	23 Mar	R*	Pulse Width Modulation	
11	26 Mar	R	DSP Basics	
	28 Mar	R	Fixed Point Arithmetic	Lab 3 due
	30 Mar	R	Sound Processing	
12	2 Apr	R	Memory Constraints	
	4 Apr		Lab 4 Homework 7 Introduction	Lab 4 available
	6 Apr	R	Midterm II Review	
13	9 Apr	R	Midterm II	
	11 Apr	R	I2C Bus Programming	
	13 Apr	R	I2C Example	
14	16 Apr	R	Temperature and Light	
	18 Apr	R	SPI	
	20 Apr	R*	Software Performance Evaluation	

15	23 Apr	R	Robustness	
	25 Apr	R	Micro-controller Operating Systems	Lab 4 due
	27 Apr	R	Micro-controller Families	
16	30 Apr	R	Review Final Exam	
	2 May		(no lecture)	

R are *regular* lectures.

R* are lectures on travel days for the instructor.