ASEN 4519/5519 Microavionics

Syllabus, Fall 2019

Lecture:	AERO N100 (COPILOT classroom)	Mon and Wed	3:30 - 4:20 PM
Lab:	AERO N100 (COPILOT classroom)	Thursday	12:30 - 2:20 PM

Instructor

Trudy Schwartz
Office: AERO 150B (Inside the Electronic Center AERO 150)
You can reach me at trudy.schwartz@colorado.edu or by phone at 303-735-2986
Office Hours: Tues 2 PM - 3 PM and Wed 9:30 AM – 10:30 AM, Location: AERO 150

Teaching Fellow

Email: Cody.Charland@colorado.edu
Office Hours: TBD, Location: AERO 150

Internet Information

Class website on Canvas (canvas.colorado.edu) will be used to post and submit assignments
Email List: The course email list provided through Canvas will be utilized for the course email list. Make sure you enable email notifications from Canvas.

Prerequisites

CSCI 1320 (or GEEN 1300) – basic programming or equivalent
ASEN 3300 – basic digital and analog electronics or equivalent
Some C programming experience is strongly recommended
Some Matlab or other programming experience is necessary

Required Texts

Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family) ***1st Edition*** by Ramesh S. Gaonkar, Thomson-DelMar, 2007. ISBN 1-4018-7914-4

References

PIC18F87K22 Data Sheet: http://ww1.microchip.com/downloads/en/DeviceDoc/39960d.pdf
PIC18F87K22 Errata Sheet: http://ww1.microchip.com/downloads/en/DeviceDoc/80507c.pdf
Embedded Design with the PIC18F452 Microcontroller, John B. Peatman, Prentice-Hall, 2003.
Designing Embedded Systems with the PIC Microcontrollers, Tim Wilshurst, Elsevier, 2007.
Microprocessors from Assembly Language to C using the PIC18Fxx2, Robert B. Reese, DaVinci, 2005.
Embedded C Programming and the Microchip PIC, Barnett, Cox & Cull, Thomson-DelMar, 2004.
The Art of Electronics, Horowitz and Hill, Cambridge University Press, 1989.

Learning Goals

Basic microcontroller architecture and memory
Assembly and C language microcontroller programming
Analog to Digital Conversion, and Digital to Analog Conversion
Basic sensors, microcontroller and sensor interfacing
Interfacing to peripherals
Interrupts and timing
Developing hardware/software systems
Embedded system debugging and troubleshooting

Course Calendar

Refer to Schedule 2019 document posted on Canvas (https://canvas.colorado.edu).

Required Hardware

This course was originally designed around the QwikFlash board that came as a kit to supplement the Gaonkar book. The QwikFlash board had been used prior by this class for about 10 years, and contained outdated hardware – the PIC18F452 in particular. In 2014, we moved to a custom in-house design with a two-part setup, a PIC Board and the Base Board, which utilized the PIC18F87K22. This microcontroller is all around very capable in the PIC18 family as measured by program memory size, RAM size, number of peripherals and low power consumption. Now, to keep up with student demand, it was more cost effective to purchase a commercial-off-the-shelf (COTS) development board, the EasyPIC PRO V7 from MikroElectronika; which is readily available on Digikey. The EasyPIC PRO V7 also consists of a main baseboard, and interchangeable PIC boards, where the default board is the PIC18F87K22 that we have already been using! For more information, refer to the hardware documents provided on Canvas.

The intent of the modular setup is to provide students a potential design to utilize for their microcontroller needs. Students can start with the EasyPIC PRO v7 as the microcontroller setup, then design a custom-sized Base Board / Daughter Board later to satisfy particular requirements to fit in a cubesat, rover, airplane, etc. or additional microcontroller capabilities. Additional PIC boards are available on Digikey for only ~$20. Not only does this give a head start on the hardware (every year there is at least one project that never gets their hardware working), it also gives a head start on the software and provides familiarity with the PIC microcontroller family. If they choose, students can also leverage the EasyPIC PRO v7 to prototype a piece of their Senior, Grad or research project as their final project for this Microavionics class.

We have decided to invest *significantly* in this set of EasyPIC PRO v7 development boards in the hopes that they will last for many years to come and therefore they are the property of the department that will be on ***loan*** to you. We will also provide a protective padded static bag, static strap, laptop case and all the accessories. This also means ***you are responsible*** for treating all the hardware appropriately and will be held responsible for fixing or replacing the hardware. ALWAYS place the hardware in the provided padded anti-static bag and laptop case when not in use, and do not expose to excessive heat (i.e. do not leave in your car!). We will also provide the PicKit-3 In-Circuit Debugger for use as a programmer and debugger for the microcontroller.

Overview

The world of aerospace engineering is growing quickly and becomes more interdisciplinary every year. The major aerospace products such as aircraft and satellites are becoming more complex and intelligent in part due to the explosion of information technology. This increase in capabilities requires more detailed information about the system state, provided by sensors and processed in real-time to make a decision based about a future action. The collection and processing of these data is often made by a distributed network of inexpensive processors called microcontrollers.

This course has been developed to provide engineers with a basic understanding about the fundamental architecture of a microcontroller and how it operates and interfaces with both sensors and actuators. While the course does tend towards sensors that are useful in aerospace engineering the concepts are applicable to all disciplines of engineering. The goal of this course is to learn how to interface sensors to a microcontroller, collect input, make decisions and take an action in real-time.

To gain a full appreciation about how microcontrollers work you will develop your own software code using MPLAB X to program the development board hardware. This board uses the Microchip PIC18F87K22 microcontroller and will be the foundation of the course. In this course you will "**learn by doing**" conducting lab assignments and a semester final project using the PIC18F87K22. This will include programming in assembly language and then C to collect data from external sources such as a serial terminal, temperature or rotary sensors, etc. and outputting results to a liquid crystal display (LCD), or an actuator such as a servo.

Class Format

This class is a senior/grad level Aerospace Engineering Sciences elective designed to provide students with some background and experience working with microcontrollers. The course meets three times each week for a total of 3.5 hours. This includes two 50-minute lecture periods and one 1-hour 50-minute lab period. Lectures are generally much more productive for students when we have time for to go through exercises and examples as opposed to just dumping a summary of reading material at the students. **This lecture format expects students to come to class prepared!** Being prepared means doing the required reading ***before*** lecture and attempting all of the labs prior to the assigned lab period. All of the labs will take more that the allotted lab period, as a result you should attempt the labs on your own ***before*** the lab session. (Lab assignments are released 1 week ahead.) The lab periods should be used to receive assistance from the instructor and to help debug programs. In addition to the lab assignments, your grade for this course will also include two exams, and a final project at the end of the semester. The relative weighting for each is provided below. The idea is to have a dynamic and interactive lecture where we can focus on the material that is giving students the most problem and not spend a lot of time on concepts that can be self-taught.

This class is cross-listed as both a 4000 and 5000 level course. If you are taking this course for graduate credit (5000 level) then you will be expected to answer additional questions and complete more in-depth tasks on your lab assignments and develop a graduate caliber project. The 4000 and 5000 level students will be graded separately to insure fairness in the evaluation of performance.

Logistics

1. ***Students are expected to work independently on all lab assignments!!*** (The only exception in the final project for undergraduates in ASEN 4519 level.) All work submitted ***must be your own***, you may only discuss higher-level concepts with your classmates. **You may not sit over another person's shoulder instructing them on the proper way to complete the assignment.** We will check your assignments for similarities and penalize you accordingly. The ***only*** way to learn is to do the programming yourself.

2. **INDIVIDUAL** Lab reports are due by 11:00 PM on the specified due date. These labs must be submitted electronically through Canvas. **Late labs will be assessed a 15% penalty for each day late and will not be accepted after 4 days.**

3. These are **INDIVIDUAL** lab assignments that make up a significant portion of your final grade. While having code that meets the assigned requirements is important, this is not the only criterion by which the labs are graded. As part of this course you are expected to learn good coding practices, such as reasonable variable names, good documentation practice, good modular coding implementation and coding style. The labs will be graded on whether your solution meets the assigned requirements, code is well documented/commented and has good programming techniques i.e. using loops and functions where appropriate.

4. Under ***NO circumstances*** should you share or provide your code to another student. If you work or speak with another student about your ideas, you should provide a reference in your code or report. We will use Turnitin, code checking software and the grading meetings to help determine if your work is original.

5. If you are ill and will not be able to complete an assignment or attend an exam, you must contact the instructor via email as soon as possible to make specific arrangements and documentation may be required. Late lab policy is covered above. Make ups for exams and final presentations are extremely difficult to accommodate. There will be no unexcused exam makeups provided. If you miss an exam, the course instructor will evaluate each case on an individual basis based on the context and information available to decide if a makeup exam will be provided. Students are encouraged to provide as much documentation as possible to enable an informed decision. If necessary, the instructor may choose to use your existing grades to cover your missed grade(s).

6. There will be 2 in-class Exams and one Final Presentation/Demo for the course. **All exams are cumulative**. Copying, collaborating, or discussing material in a written or oral exam during the exam period constitutes **cheating and will result in an F for the exam** and will be reported to the University Honor Code. The following dates and times are **mandatory**.

   All students must be present, please *plan your travel plans* accordingly:

   - **Written Exam #1** **Wednesday Oct 23th (in class)**
   - **Written Exam #2** **Wednesday Nov 20th (in class)**
   - **Final Present/Demo** **Wednesday Dec 18th 7:30 – 10:00pm (Location TBD)**

7. Review quizzes will be given in class – but are not for credit but rather to test yourself on learning and retaining the necessary information.

8. The course instructor reserves the right to make changes to the weekly course schedule based on occurring events that require different dispositions. Sufficient advance notice will be given through announcements in class and posting on the web. Changes to this syllabus and schedule may be announced at any time during class periods. We will post the current syllabus and schedule on the course website.
9. University closure: If an assignment is due and the University is closed due to weather or other circumstance, then the assignment will be due on the next day that the University is open. In the event that a lab or lecture is cancelled due to a University closure please check the course web site and email for updated information.
10. Emailed questions will be responded to during normal business hours, i.e. Monday through Friday, 8:00 am – 5:00 pm. Extra questions outside of class and office hours directed to the TF or Instructor that are 24 hours or less of the lab due date or exam date may not receive a timely response. Please utilize the exam reviews given in the lecture prior to exams and office hours effectively.

Course Grading

60%	6 Lab Assignments (10% each)
20%	2 Exams (10% each)
20%	Final Project
100%	Final Grade

Grading Meetings

You will *sign up for a 15 time slot* to meet with the Teaching Fellow after each lab submission to demonstrate your code is working on the hardware and your knowledge and understanding of the code *you have* written as part of the grade for each lab assignment.

Grading Disputes

If you feel that a lab, exam, or project has been graded incorrectly you must submit your complaint in writing via email to the instructor. All complaints must be filed within 1 week after the assignment has been returned to the class. Your written request must clearly state your complaint. Be aware the *entire* assignment will be re-graded during the re-assessment process and the new grade may increase or decrease.

Accommodation Statement

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition or injury, see Temporary Medical Conditions under the Students tab on the Disability Services website.

This course requires the use of MPLAB X and Realterm software as well as the EasyPIC PRO v7 hardware which has not yet been reviewed fully for accessibility. This course requires the use of Piazza for class discussions, which is currently not fully accessible to users using assistive technology. If you use assistive technology to access the course material, please contact your faculty member immediately to discuss.
If you use assistive technology to access the course material, please contact the Instructor and Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu as soon as possible to discuss other effective

means for providing equal alternate access.

Religious Observances

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, we require a minimum of 2 weeks advanced notice of these conflicts.

See the campus policy regarding religious observances for full details.

Classroom Behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on classroom behavior and the Student Code of Conduct.

Discrimination and Harassment

The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct intimate partner abuse (including dating or domestic violence), stalking, protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, anonymous reporting, and the campus resources can be found on the OIEC website.

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students who are found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the Honor Code Office website.