EEL 4744C: MICROPROCESSOR APPLICATIONS

https://mil.ufl.edu/4744/ eel4744.slack.com *UF's Canvas*

INSTRUCTOR Dr. Eric M. Schwartz ems@ufl.edu 352-392-2541 MALA 3110 Office Hours: Wed: 12:50pm, Fri 1:55pm

LECTURES Tues 4th (10:40-11:30am) & Thur 4th -5th (10:40am-12:35pm) in MAEA 303

LABS Time TBD; in MAEB 223

CATALOG DESCRIPTION
Elements of microprocessor-based systems; hardware interfacing and software design for their application. Laboratory.

UF SYLLABUS AND POLICIES To support consistent and accessible communication of university-wide student resources, academic policies and campus resources are available here: https://go.ufl.edu/syllabuspolicies.

COURSE OBJECTIVES (ABET Design Content 50%) [Lab fee: $40.00]
Official: Experience in the elements of microprocessor-based systems, hardware interfacing and software design for their application. Laboratory. **Pre-Requisite**: EEL3701C
Actual: Students learn the functional and technological characteristics of microprocessor structures, memory components, peripheral support devices, and interface logic. Through laboratory experiments and examples, students learn how to integrate and apply microcomputer subsystems and components to common interfacing problems. Although the Atmel ATxmega128A1U microcontroller will serve as the vehicle for exploring these topics, students gain the experience to generalize the concepts to other microprocessors.

TEXTBOOKS (NOT REQUIRED)
F. Cady, *Microcontrollers and Microcomputers Principles of Software and Hardware Engineering*, Second Edition, Oxford University Press, New York, NY, 2009. ISBN13: 9780195371611, ISBN10: 0195371615. See https://tinyurl.com/4744-uP.

REFERENCES
- H. Lam & A. Arroyo, *Fundamentals of Computer Engineering*, Univ. Copy Center, Gainesville, FL 1995.
- Gene H. Miller, *Microcomputer Engineering—2nd edition*, Prentice-Hall, New Jersey, 1999.
- J. Peatman, *Design with Microcontrollers*, McGraw Hill, New York, 1988.
- K. Doty, *Fundamental Principles of Microcomputer Architecture,* Matrix Publishers, Inc., Oregon, 1979.

PI OFFICE HOURS (PI = Peer Instructor = UPI = Undergrad PI) ;
You may go to **any PI** available (in MAEB223, if available; else MAEB 328 or TBD) for help during their office hours. (See the Faculty/PIs webpage for the office hours. Note that some office hours might be remote.) You are encouraged to use our slack's *#help* channel for questions. The slack rules for our course are available here. E-mail (not a slack DM) is preferred for individual questions to communicate with the instructors and PIs. PIs may also hold a few help sessions, which will be announced in Slack.

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LECTURE/LAB FORMAT
The course lectures and labs will be entirely synchronous and in-person. This means that your lectures and labs will occur at the times specified when you registered. Nothing will be Zoomed this semester, other than our quizzes, practicals, and exams.

QUIZ/PRACTICAL/EXAM SCHEDULE
Our quizzes and practicals are generally administered during our scheduled class periods, but might instead be in the evenings. All of our Quizzes, Practicals, and our Final Exam will utilize Honorlock with Zoom.

Quiz/Practical/Final Exam Schedule

ITEM	DATE	TIME
Lab 0 Quiz	Wed, 21 Jan	4:05pm
Lab 1 Quiz	Wed, 11 Feb	4:05pm
Lab 2 Quiz	Wed, 18 Feb	4:05pm
Lab 3 Quiz	Wed, 25 Feb	4:05pm
Lab 4 Quiz	Wed, 11 Mar	4:05pm
Practical 1	**Wed, 25 Mar**	4:05pm
Lab 5 Quiz	Wed, 1 Apr	4:05pm
Lab 6 Quiz	Wed, 8 Apr	4:05pm
Lab 7 Quiz	Wed, 15 Apr	4:05pm
Practical 2	**Wed, 22 Apr**	4:05pm
Lab 8 Quiz	Wed, 29 Apr	4:05pm
Final Exam	**Tues, 28 Apr**	**3:00pm**

HARDWARE PURCHASES

- The *Digilent Analog Discovery 3* (**DAD**) *board* is required for this course (and many other ECE courses). If you don't already have a DAD (a DAD 2 is fine), a DAD 3 is available for checkout.
- You **MUST** have and use your own laptop computer for this course. If your computer does not have **two** USB (type A) ports (one for your uPAD and one for a 3701 PLD) and a USB-C port for your DAD-3 (or another USB-A for a DAD-2), then you will need to buy a USB Port Expander (generally, $7 to $15).
  - The DAD-3 requires a female USB C type port on the PC (with a female USB C type port on the DAD-3).
  - The DAD-2 requires a female USB A type port on the PC (with a female USB B type port on the DAD-2).
  - The DE10-lite requires a female USB A type port on the PC (with a female USB B type port on the DE10). The previously used 3701 PLD PCB also requires the same.
- For one of the labs and one of the Practical Exams, you will need either your PLD from 3701 (which may be one of several types, depending on when you took the course) or your PLD for 4712. If you took 3701 prior to fall 2023, you already have everything that you need. If you took 3701 after that, you will borrow a DE10-Lite and cable; these will need to be returned after the first practical is completed and your Lab 4 has be demonstrated.
  - If you took 3701 in spring 2024. summer 2024, or spring 2025, you have everything that you need.
  - If you took 3701 in another semester, you need to acquire several items for Lab 4 and Practical 1. You can get **ALL** of the below from *Out of the Box: Electronics and Robotics*, at 4744 Complete kit or 4744 Parts only (which does not have the large breadboard and wire kit that is needed). You can also separately purchase a 40-pin breakout and cable, which will be helpful in connecting the DE10-Lite to the breadboard.
    - Breadboard (with at least two panels).; you may have this if you took EEL 3111C.
    - Wire kit. I suggest; you may have this if you took EEL 3111C.
    - The following items are available from OOTB at 4744 Parts only (without the two above items). But you can purchase these parts from any place that has them.)
      - One switch DIP (with at least 8 SPST switches) and a 2.2kΩ SIP resistor pack for the switches
      - One LED DIP (with at least 8 LEDs) and a 1kΩ DIP resistor pack for the LEDs (or a 1kΩ SIP)
      - At least 10 jumpers (to connect DE10-lite headers pins to breadboard)
  - A breadboard (about 30% smaller than the one from OOTB) and a wire kit are alternatively available from Jameco Part #: 20774 and Jameco Part #: 19290, respectively.
- A multimeter would be useful, but not absolutely required (since it is no longer provided in 3701). It will generally **not** be needed. Very inexpensive multimeters can be purchased online or at *Harbor Freight* for about $7 and *Amazon* for about $10. Good ones generally cost between $40 and $1000. *Fluke* is generally a brand that you can trust.
- Because our quizzes, practicals, and final exam will all use Honorlock and Zoom, you must have a speaker or set of speakers for your computer for these assignments. **Neither** headphones **nor** earbuds are allowed.
  - **NOTE**: During Honorlock assignments, Chrome must open pdf files **within Chrome**, i.e., it should **not** open the pdf file with another applications (like Adobe Acrobat.
- A 4744 *μPAD* lab kit will be given to you at your first lab meeting (Lab 0). You will return this kit at your last demo or after your Practical 2 (whichever is last). This kit contains the additional hardware that you will utilize over the course of the semester. The UF 4744 *μPAD* lab kit was designed to my specifications by OOTB to meet my specifications. The 4744 *μPAD* lab kit (https://www.ootbelec.com/store/p/upadlabkit) is included in your lab fees. Your kit comes with multiple printed circuit boards (PCBs) – the *μPAD Development Board*, *μPAD* Memory Base (with EBI), *μPAD* Switch and LED Backpack, *μPAD* Robotics Backpack, and the *μPAD* Analog Backpack. **You probably can now buy the lab kits separately, but please be careful as you design and construct your circuits this semester. You will return your entire 4744 lab kit (in its original packaging) at the end of the semester.**

SOFTWARE REQUIREMENTS

Microchip Atmel Studio, an integrated development environment (IDE) for developing and debugging Atmel ARM® Cortex™-M processor-based and Atmel AVR® microcontroller applications (including our XMEGA), will be utilized in our course.

Quartus (from *Altera*, now owned by *Intel*) has been required for *EEL 3701C* and *EEL 4712C* for many years, so many of you already have copies. *Quartus* is available to download, free of charge, from an *Intel* website and our website. Whatever version you have from 3701 should be sufficient. An *EEL 4744C* laboratory assignment and the first practical exam will require the use of Quartus for simple circuit design and programming a PLD.

REFERENCE MANUALS (available on our class website)

- XMEGA AU Manual (Atmel doc8331)
- XMEGA128A1U Manual (Atmel doc8385)
- Instruction Set (Atmel doc0856)
- and others

Do **NOT** printout these entire documents. Other documents are available on the class website and on the Atmel website (http://www.microchip.com/wwwproducts/en/ATXMEGA128A1U). During our live testing assignments, the relevant documents will be made available to you.

CLASS AND EXAM BEHAVIOR

Turn off all cell phones, laptop sound effects, and other noise making devices (including your microphone) before entering our classroom. If a noise-making device goes off during class, I reserve the right to lower your course grade. Do not visit websites, play games, or use other programs or apps during class that might distract nearby students.

GRADING POLICY

Grades are periodically posted on the class web site. **It is your responsibility to check your grades regularly** (on both Canvas and our course website) since mistakes often happen when dealing with a large number of students and PIs. **All grades are final one week after posting** (on either Canvas or our course website)**.** After curving quizzes and our final exam as needed, course grades are assigned using the 60 (D), 70 (C), 80 (B), and 90 (A) cuts. [$90 \rightarrow 100$ (A), $86.\overline{6} \rightarrow 89.\overline{9}$ (A-), $83.\overline{3} \rightarrow 86.\overline{6}$ (B+), $80 \rightarrow 83.\overline{3}$ (B), $76.\overline{6} \rightarrow 79.\overline{9}$ (B-), $73.\overline{3} \rightarrow 76.\overline{6}$ (C+), $70 \rightarrow 73.\overline{3}$ (C), $66.\overline{6} \rightarrow 69.\overline{9}$ (C-), $63.\overline{3} \rightarrow 66.\overline{6}$ (D+), $60 \rightarrow 63.\overline{3}$ (D), $56.\overline{6} \rightarrow 59.\overline{9}$ (D-), and $0 < 56.\overline{6}$ (E)].

Part of your grade on labs, quizzes, exams, etc. is based not only on solving a problem, but the manner in which you solve it. For example, there is a difference between two programs that meet the given specifications, but one is an elegant, extensible 20-line solution, while the other is an obfuscated 100-line program that also meets the specifications but would be difficult to extend later. Just as your future employer would value the latter program less than the first, so will I in grading your assignments.

The official UF grading policies for assigning grade points can be found on the following undergraduate catalog web page: https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx.

COURSE GRADE DETERMINATION

Laboratory*+	35%	(Note: All labs are **not** worth the same amount. Some labs may have **extra credit**.)
Laboratory Quizzes*#	35%	(Note: All quizzes are **not** worth the same amount. Quiz 0 is probably worth 1%; Quiz 1 is 4%, other Quizzes, probably 6.67%.)
Practical (Quiz) 1	3%	
Practical (Quiz) 2	7%	
Lecture Quizzes@	3%	
Homework†	3%	
Final Exam	14%	
Total$	100%	(90+ on **weighted average** of Final Exam and Practical 2 results in 5% grade bonus, e.g., 86% ⇒ 91%)

*A grade of **65%** or better for your combined weighted lab average and weighted lab quiz average is ***required*** in order to be eligible to obtain a passing grade in the course (i.e., to earn a grade better than E).

+ Your lowest lab grade will be dropped. But use this drop wisely, i.e., do **not** just skip a lab since all labs are important and your next missed lab may be unavoidable. If you need to miss a single lab, it's ok; but you **cannot** make up the missed lab. (You should do this lab on your own. If necessary, you may visit a PI during an office hour for help.) **If you have a valid reason for missing this lab, get documentation for your first missed lab and hold on to it.** If you miss a **second** lab, you must show **Dr. Schwartz** (not a PI) **written documentation for BOTH your first and your second missed labs**. This documentation should be official, i.e., from a doctor, judge, etc., so that a make-up can be arranged. You must notify Dr. Schwartz at least eight days **prior** to your scheduled second missed lab or **as soon as possible after** your second missed lab. **There is no excuse that will allow you to reschedule your first missed lab other than an exam in another course or an officially sanctioned academic event.** You must notify **Dr. Schwartz** at least **8 days** prior to your exam (or other event) so that an alternate lab time might be arranged.

Your lowest lab quiz grade will be dropped. Generally, this will occur when you miss the corresponding lab, but this is not necessary.

@ During the second half of the semester, we will have a lecture quiz once a week. The intention of this quiz is to verify that you watched the required videos.

† 4 to 10 Homework. Although HW does not count much toward your grade, **not** doing it will likely influence your quiz and exam scores.

$ Attendance is required but is **NOT** worth positive points. See § Course Requirements and below for more details.

Note: All grading percentages are subject to change at Dr. Schwartz's discretion. Students will be notified of any changes.

I have found that attendance directly correlates to grades. Therefore, attendance is required but is **NOT** worth positive points. Each missed class (or a poor attendance quiz result) results in a deduction of one point (out of 100) from your overall course total. There are no excuses for missed classes, but four classes can be missed without penalty. (Since there are 27 classes this semester, missing four classes is 15%! We will have attendance quizzes through Canvas, each with a simple general question (worth 30%), at least for those that have attended and paid attention to our lectures and submitted previously due assignments. There will also be an "are you there" question worth 70%. You can miss **13** ($= 13 \times 0.3 = 3.9 < 4$) of the simple general attendance quiz questions with absolutely no penalty if you attend each class **and** answer the "are you there" question positively. There are no excuses for missed classes. Late arrival or early departure (when missing the quiz) will count as an absence. To take the attendance quizzes, you will either need your laptop or a smart phone, running Canvas. Attendance quizzes can happen at any time from the beginning to the end of a lecture, so come to class on time. Leaving class after an attendance quiz but before the end of class is considered cheating unless advanced is provided (with a reason given) to Dr. Schwartz and permission is granted.

EXTRA CREDIT

Extra credit is sometimes offered during class (or on the web, by slack, or by email). The amount of extra credit given is at the discretion of Dr. Schwartz unless specifically stated with the extra credit opportunity.

PRACTICE EXAMS, HW SOLUTIONS, LAB SHELLS, AND GRADES

We will post homework, lab, lab program shells and other class material on our class web site at https://mil.ufl.edu/4744/, along with periodic postings of your grades and the class grade statistics. Previous exams on the course material are also posted on our web site.

SCANNING SOFTWARE

Some parts of homework, labs, quizzes, exams may require you to scan some of your handwritten work. *Adobe Scan* (https://www.adobe.com/acrobat/mobile/scanner-app.html) is available for both Android phones and iPhones. Install this (or another one) and email a scan to yourself to verify that it works. Unclear scans **will not** be accepted. Unless other specified, when scans are requested for a particular assignment, a **single pdf** document should be created and submitted. You also are expected to have access to a cell phone camera for taking pictures of various hardware designs that you may construct during the semester for homework, labs, and exams.

HOMEWORK GRADING

You must submit homework through Canvas by the assigned deadline. Unless other specified (sometimes additional files are requested), a **single pdf** document should be submitted for each homework. You must use the homework template provided on our website. Scans of various parts of the homework are acceptable, but the scans must be incorporated into the single submission document. Homework is generally graded in a cursory fashion, i.e., Zen grading is used. The grades will be entered into the grade book as 0 (no significant effort or not submitted), 1 (half-hearted attempt) or 2 (significant attempt). Some homework assignments are graded more strictly. The final course grades will be assigned with strict cuts between grades, but HW **could** push you above a cut. **Late homework will not be accepted**.

All grades are **non**-negotiable **one week** after the grade is posted on either Canvas or our website. Please don't come to me after the final grades have been posted with a hard-luck story.

COURSE REQUIREMENTS

1. Perform all laboratory experiments. A grade of 65% or better for your weighted lab average is ***required*** in order to be eligible to obtain a passing grade in the course (i.e., to earn a grade better than E). Your lowest lab grade will be dropped; these can be from different labs. But **use this drop wisely**, i.e., do **not** just skip a lab since all labs are important and your next missed lab may be unavoidable. Since there is a quiz on every lab, skipping it will likely cause you to do poorly on the associated quiz. If you need to miss a single lab, it's ok; you **cannot** make up the missed lab. (You should do this lab on your own. If necessary, you may visit a PI during office hours for help.) **If you have a valid reason for missing this lab, get documentation for your first missed lab and hold on to it.** If you miss a **second** lab, you must show **Dr. Schwartz** (not a PI) **written documentation for BOTH your first and your second missed labs**. This documentation should be official and from a doctor, judge, etc., so that a make-up can be arranged. You must notify the professor **prior** to your scheduled second missed lab or **as soon as possible after** your second missed lab. **There is rarely an excuse that will allow you to reschedule your first missed lab other than an exam in another course or an officially sanctioned academic event.** You must notify **Dr. Schwartz** at least **8 days** prior to your other event so that an alternate lab time might be arranged.
   - If you believe that you have valid university-related reason for missing a particular lab (e.g., Lab X), send an email to Dr. Schwartz with the following information (with subject: ***4744: Conflict with Lab X***, where X is the lab number).
     - State the cause for missing your Lab X and provide associated documentation for this event.
     - Info about your normally scheduled Lab X: PI's name, Lab X date (day and date) and time, and lab class number (5 digits)
   - Labs **must** be done at scheduled times (except as described above).
   - Students **must** be prepared to demo their lab when they enter. Students will be randomly selected for their demonstration times during their lab period.
   - A combined weighted lab average and weighted lab quiz average of **65% or higher** is required to be **eligible** to **pass** the course!
2. Class attendance is mandatory. The roll will be taken by means of a short Canvas quiz. (The quiz is normally very simple material from the prior class or presented previously in the class in which the quiz is administered.) Each missed class when roll is taken (or a poor attendance quiz result) will cost one point (out of 100) from your overall course total. The roll may be taken more than once in class; if you leave and a second roll is taken, this will be interpreted as an honor code violation.
   - ***No excuses accepted, but three free drops.***
   - ***Missed classes and quizzes cannot be made up.***
   - If you miss the first two classes and do not notify me prior to your second missed class, **you will be dropped from the course**.
   - Turn off all cell phones, beepers, laptop sound effects, and other noise making devices **before entering** our classroom. If a noise-making device goes off during class, I reserve the right to **lower your course grade**
3. Do all homework assignments and turn them in **through Canvas before** the time that they are due.
   - ***Late homework will not be accepted.***
4. Take all quizzes, exams, and practicals as scheduled.

- ***No makeup quizzes, exams, or practicals will be given except in cases of a medically documented incapacity, family emergency, or course conflict.***
- If you believe that you have a valid quiz, exam, or practical conflict, please send me the info specified above for a lab conflict (again, at least **8 days** in advance), but with the subject: ***4744: Conflict with TYPE X***, where TYPE is the type of assignment (Quiz X, Exam, Practical X) and *X* is the assignment number. Specify the times of your conflict, the cause of your conflict, and then times immediately before or after the scheduled exam time when you **are available**.
  - If the conflict is an exam in another course, verify that there are no alternate exam times available. If none, then provide Dr. Schwartz with the course number and name, and your teacher's name, email, and phone number. Also provide a link or screen shot of the cause of the conflict.

STUDENTS REQUIRING ACCOMMODATIONS

The University of Florida is committed to providing academic accommodation for students with disabilities. Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://disability.ufl.edu/) by providing appropriate documentation. See https://disability.ufl.edu/students/get-started/ to start the process to request academic accommodations. Once registered, a student should present his/her accommodation letter to me supporting a request for accommodation. The University encourages students with disabilities to follow these procedures as early as possible within the semester. For your optimal benefit, you must see the professor **during the first week of classes**.

COMMITMENT TO A SAFE AND INCLUSIVE LEARNING ENVIRONMENT

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Undergraduate Program Coordinator
- Donna L Stilwell, Director of Human Resources, 352-294-7977, dstil@eng.ufl.edu
- Malisa Sarntinoranont, Associate Dean of Academic Affairs, 352-392-8404, msarnt@ufl.edu
- Pamela Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu

HEALTH AND WELLNESS (UF COUNSELING SERVICES)

Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- University Counseling & Wellness Center, http://www.counseling.ufl.edu, 3190 Radio Road, (352) 392-1575.
- SHCC mental Health, Student Health Care Center, http://shcc.ufl.edu/, Infirmary Building, 1 Fletcher Drive, 392-1161.
- U Matter, We Care, http://www.umatter.ufl.edu/, umbrella organization for UF's caring culture and provides students in distress with support.

U Matter, We Care

- Your well-being is important to the University of Florida. The *U Matter, We Care* initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need.
- If you or a friend is in distress, please contact umatter@ufl.edu so that the *U Matter, We Care* Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The *U Matter, We Care* Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center.
- Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.
- **Counseling and Wellness Center**: http://www.counseling.ufl.edu/cwc and 392-1575
- **Sexual Discrimination, Harassment, Assault, or Violence**: If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the Office of Title IX Compliance, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu
- **Sexual Assault Recover Services (SARS)**: Student Health Care Center, 392-1161
  - Resources for Sexual Violence, https://umatter.ufl.edu/helping-students/sexual-violence-response/, Immediate Response/Advocacy 392-5648 or 392-1111; Medical Care from Student Health Care Center, 392-1161
- **University Police Department**: 392-1111 or http://www.police.ufl.edu 9-1-1 for emergencies.

ACADEMIC RESOURCES

- E-learning technical support, https://lss.at.ufl.edu/help.shtml, 392-4357, Learning-support@ufl.edu..
- Career Connections Center, https://career.ufl.edu/, 392-1601. Reitz Union. Career development assistance and counseling.
- Library Support, https://uflib.ufl.edu/find/ask/.
- Teaching Center, https://teachingcenter.ufl.edu/, 392-2010 or 392-6420. Broward Hall. General study skills and tutoring.

- Writing Studio, https://writing.ufl.edu/writing-studio/, 846-1138, 302 Tigert Hall. Help brainstorming, formatting, and writing papers.
- Ombuds office, https://ombuds.ufl.edu/. Ombuds office exists to assist students, staff, and faculty in resolving problems and conflicts.
- Student Complaints, Campus: https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/, https://care.dso.ufl.edu.
- On-Line Students Complaints, http://www.distance.ufl.edu/student-complaint-process.

COURSE EVALUATION

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://my-ufl.bluera.com. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

LECTURES, QUIZES, PRACTICALS, AND EXAMS (CANVAS, ZOOM, AND HONORLOCK)

During this semester, the course will be entirely synchronous. This means that your lectures and labs will occur at the times specified when you registered and in person. Quizzes/exams will generally be administered during our regularly scheduled class times, but may be in the evening.

Lectures and labs are face-to-face. Your course assignments will be specified on Canvas, but more information will be available on our website (mil.ufl.edu/4744/). All homework and lab submissions will be through Canvas. Quizzes, Practicals, and Exams will be administered through Honorlock (and Canvas Quizzes) with Zoom. Honorlock is an online proctoring service. Sometime during most classes, there will be a Canvas Quiz; therefore, all students will need computers (or at least a smart phone).

Open Canvas at the beginning of every class; keep it open during class for the inevitable attendance quiz.

For our lab quizzes, practicals, and exams, you will need to log into Zoom (at https://ufl.zoom.us/) before being admitted to the Zoom. You must connect to Zoom **prior** to connecting to the Honorlock quiz. Use your full name for our Zoom meetings, i.e., no nicknames or other alternatives.

Students to take quizzes, practicals, and exams in the course from almost any location, as long as you have a computer, and the following required components: webcam, microphone, speaker, and a stable Internet connection. Minimum upload and download bandwidths of 2 Mbps are required for this course. If you don't have the bandwidth or any of this hardware, you must secure these in order to participate in the course. (Note that **neither** headphones **nor** earbuds are allowed during Honorlock administered assignments.)

For Honorlock, you do not need to create an account, but will need Google Chrome (available from www.google.com/chrome/). You will also need to download the Honorlock Chrome Extension (from www.honorlock.com/extension/install).

Prior to any Honorlock quiz, the following has been shown to prevent problems that have happened to a few students in the past. I recommend that you do this prior to **EVERY** Honorlock quiz.

- Close **all programs/applications** other than Chrome.
- Close **all Chrome tabs** other than Canvas.
- Turn off any potential pop-ups that could occur during this assignment.

Below has been shown to prevent problems that have happened to a few students in the past. It wouldn't hurt and could save some aggravation.

- Lab quizzes, practicals, and the final exam will use Zoom. Verify that you have the Zoom link.
- Verify that you have your UF ID, passport, or driver's license (for the Honorlock ID scan).
- Clear your cache in Chrome.
  - > Reinstall the Chrome Honorlock Extension.
  - > Close then reopen Chrome.
- Verify that you have the files that you need (and are allowed, if any) available from your desktop.
- Reboot your computer.
- Be sure that there is enough light for your face to be clear during the exam (for Honorlock). If not, find a lamp or a different area.

When you are ready to start an Honorlock-monitored assignment (quiz, practical, or exam), connect to the relevant Zoom assignment and then select "Stop Video" in Zoom (to stop Zoom from using your webcam). Now log into Canvas, go to our course, and click on the appropriate assignment. Click "Launch Proctoring" to begin the Honorlock authentication process, where you will take a picture of yourself, show your ID, and show both sides your blank scratch paper (if allowed). If requested by Honorlock staff or course staff, perform a complete scan of your room; an adequate room scan should take approximately one minute. Honorlock will record your exam

session by webcam and also record your screen. Honorlock also has an integrity algorithm that can detect search-engine use, so please do not attempt to search for answers, even if it's on a secondary device. There are many more Honorlock rules; these should be investigated **BEFORE** your relevant Honorlock-monitored assignments.

As part of your Honorlock-monitored assignment, at the end of the timed session, you may be asked to scan some of your exam work. See § SCANNING SOFTWARE for more information.

For emergency situations, learn how to turn your cell phone into a hotspot to use if your internet goes out. If you ever have WiFi or other internet connection problems just before or when your practical, quiz, or exam, use your phone to send **BOTH** a slack message **and** an email to the relevant PI **and** Dr. Schwartz. Describe the issue and continue to **try to get back in**! Use your cell phone as an emergency hotspot.

Honorlock support is available 24/7/365. If you encounter any issues during a quiz, exam or other assignment, **contact Honorlock by live chat**, which should be available inside Honorlock. If you are kicked out of Honorlock, you can go to https://honorlock.com/support/ and select ***begin live chat***. At other times, i.e., not during a monitored assignment, you can send Honorlock an email (support@honorlock.com). Zoom chat Dr. Schwartz or other course staff if this problem occurs during a Honorlock-monitored assignment. **If your internet goes out, connect to Zoom with your cell phone.**

PRACTICALS
Practicals are exams where you design, simulate, build, and demonstrate in a fixed amount of time. You will have access to your own previous lab assignments and solutions, as well as the necessary documentation. You must a have a single solution, i.e., you cannot modify your solution during the demonstration to show parts of the solution and then modify or use another program to demonstrate a second part of the solution. You only earn points for parts that are demonstrated to function properly. No points are awarded for designs/code that is not demonstrated to work. If you cannot solve the entire problem, it is up to you to determine a procedure that can demonstrate what does work (but still are allowed only a single solution).

IN CLASS RECORDING
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without the permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

SOFTWARE USE
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

TECHNOLOGY
The use of cell phones and **every other** technology device not directly specified as allowed is strictly prohibited during live assignments (labs, quizzes, practicals, or exams). All use of disallowed electronic devices (or inappropriate use of allowed devices) during a live assignment will be considered a violation of the student honor code (i.e., cheating). See the *Honesty Policy* section below for the minimum penalties that are incurred for all cases of cheating in our course. Laptop computers and tablets are welcome in class as long as they are used for class-related work. Surfing the web, checking email, making posts, etc., is strictly prohibited (**if distracting to others**) and will result in course grade deductions.

During practical exams, use of the internet (other than Zoom and Honorlock) or other external access is **not** allowed. You may only use files and software on your computer that are explicitly specified by Dr. Schwartz several days prior to the practical exam date.

TWO-STEP AUTHENTICATION BACKUP
You should get a backup for the two-step authentication. See https://it.ufl.edu/2fa/using2fa/. There have been students who had cell phone issues (like a lost phone, a broken phone, or the battery runs out) just before starting a quiz/exam and were unable to participate. To assure that you can always get in, generate some passcodes and always keep them with you (perhaps in your wallet). To do this, go to account.it.ufl.edu and select *GENERATE PASS CODES*; then login and authenticate as normal and select the *GENERATE PASS CODES* button. Five codes will appear, each of which will work once and do not expire.

All grades are **non**-negotiable **one week** after the grade is posted. Please don't come to me after the final grades have been posted with a hard-luck story.

STUDENT PRIVACY
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see https://registrar.ufl.edu/ferpa.html.

COMMUNICATION
Slack is utilized for course announcements. You are also responsible for getting the slack messages. You are also responsible for regularly checking announcements and course-related postings on the class website, Canvas, and your UF email.

MULTIMEDIA CLASS/AUDIENCE NOTES
Audience notesare normally posted on the class web site every week or so for the subsequent week or more of classes. The notes consist of pdf versions of the class PowerPoint slides. These notes are not required but are **highly** recommended. Check the class web site for information on exactly when the notes are available. **For optimal performance**, read the notes and examples for a class **before** that class and augment the material with your own notes during class. My notes are removed shortly after they are covered in class.

Historically, student that take good notes perform much better in this course then those who do not take notes (or take poor notes). Augmenting my notes with your own is strongly encouraged.

HONESTY POLICY
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor in this class.

Artificial intelligence (AI) language models, such as ChatGPT, and online assignment help tools, such as Chegg®, are examples of online learning support platforms: they can**not** be used for course assignments except as explicitly authorized by the instructor. The following actions are prohibited in this course:

- submitting all or any part of an assignment statement to an online learning support platform
- incorporating any part of an AI generated response in an assignment
- using AI to summarize or contextualize source materials
- submitting your own work for this class to an online learning support platform for iteration or improvement

Each quiz, practical, and exam should be assumed to contain that specific pledge; opening and starting the assignment commits you to honoring that pledge.

*CHEATING WILL **NOT** BE TOLERATED*. We will actively search for cheaters; we have and will use excellent software to help us in the search. If you are caught, there will be no negotiations. You will earn a course grade penalty (almost always failure for the course) and get reported to UF's honor court. There are **no excuses and no exceptions**. You may talk to other students about assignments, but the final work **must** be your own. You must also report others (anonymously, if desired) that you suspect are cheating. If you are caught cheating on **any** assignment (homework, lab, or exam, etc.), you **will** be prosecuted. A meeting with the UF honor court, along with the instructor, will determine penalties, none of which are desirable or pleasant (*i.e.,* cheating in this course always results in notification to the honor court, often results in a failing grade in the course, and can possibly result in suspension or expulsion from the university). If you know someone is cheating, **it is your responsibility to report it**. For more information about cheating, the UF Honor code, and the consequences of academic dishonesty, please refer to https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/. If you have any questions or concerns, please consult with Dr. Schwartz. The flow chart for an honor code violation is available here. A link to report an academic honesty incident is available here.

WORKING TOGETHER
You are encouraged to work with other students on assignments in a professional manner. Each person in the group should attempt to solve all problems **independently** and **only** then discuss the results with one's partner(s) to correct errors. Copying your partner's work constitutes cheating and should not be permitted. All solutions should reflect your style of problem solving. You may **not** copy and submit old or new posted solutions as if they were your own.

Although you may **consult** with other students, PIs, or instructors for your assignments, you **must** do independent work. Consulting means **"seeking opinions or advice," not** getting working solutions, programs, or designs, understanding them, and then modifying them to make them your own. The latter constitutes cheating (see above section). Working side-by-side to find solutions, construct a program, or design in a group constitutes cheating. (Solving homework are good practice for solving quizzes and exams, which are also **not** group activities.) **You should note that we have used and will continue to use software that can detect similar submissions.**

Failure to do your own work in lab will likely result in failure in these associated quizzes, practicals, and exams.

HANDOUTS
Handouts are supplied on-line and can be downloaded from the class web site: https://mil.ufl.edu/4744/.

RECIPE FOR SUCCESS
Recently, a student asked me how to be successful in our course. I thought it would be helpful to share what I told the student.

0) Take care of your health by sleeping well, eating well, and participating in some regular physical activity.
1) Attend all classes and actively participate by trying to follow the material, take notes, and ask questions (or write them down to ask later), if you have any.
2) Work a little bit on the material every day, even if it is only for an hour.
3) Review the notes within 24 hours after a class and read the relevant manual sections with 24-48 from that class.
4) Simulate/Emulate the examples demonstrated in class on your own within a few days after class to be sure that you understand the key parts, which you will likely need to do yourself in subsequent labs.
5) Complete all homework.
6) Read a lab as soon as we have gone over the relevant material. Start on it ASAP, at least trying to understand it.
7) Start each lab a week in advance of the due date, generally immediately after your prior lab is done.
8) When you don't understand something, immediately ask a question in class, slack, or go to the next PI, or faculty office hour.
9) Watch the help session videos early in the semester and the lecture videos later in the semester.
10) Before lab quizzes and exams, complete several practice exams. Do these **BEFORE** the exam help session(s), if any, and then go to the help sessions to see the PIs solve those exams.
11) About halfway between the due date of a lab and the due date of the prior lab, have all flowcharts/pseudo-code completed as well as answers to all the lab questions. (A few years ago, this was a requirement for the course.)
12) RTFM (**R**ead **T**he **F**antastic **M**anuals)!

LABORATORY GUIDELINES

LABORATORY OBJECTIVES
The purpose of this laboratory is that through the design, development, and demonstration process, you develop skills in both the hardware and software design of microprocessor-based applications. The laboratory complements the lectures by providing hands-on experience with microprocessors, peripheral devices, and the required hardware and software development tools.

LABORATORY RULES & POLICIES
See *Lab Rules and Policies* for important information that you should re-read prior to each lab submission.

LABORATORY ENTRY
Your PI has the right to either not admit you or kick you out of the lab if you are not prepared, i.e., you have not uploaded the required Canvas submissions (by the specified date and time) and/or have not built the required circuits. You may also be removed from lab if you are uncooperative or disruptive. You must be able to **demonstrate your understanding** of the design that you have created, the code that you submitted, and the lab topics in general. If you are not properly prepared, you will get a zero for the lab and will be asked to leave. You may **not** make-up this lab later. Therefore, **it is imperative that you come to lab prepared!**

LABORATORY STRUCTURE
We will **NOT** have quizzes during our lab periods. Our lab quizzes will occur in the evening a few days following your lab submission and before most students perform their lab demonstrations.

Lab times will be scheduled by your PI; you will be assigned a 10 minute window for you to perform the required lab demonstrations to your PI during your regularly scheduled lab period. You will enter the lab, just before your scheduled time, having previously set up everything on the table just outside the lab door (reserved for the next student to demo). Failure to be ready at your schedule lab time will result in a grade of zero on that lab. We encourage you to start setting up outside the lab at least 10 minutes prior to your scheduled time slot.

LABORATORY PREPARATION LIST
1. **Structure your program into functional modules and comment the modules as part of the coding.**
   - Each subroutine/function should accomplish just one function. If a subroutine extends beyond 40 instructions, it is probably doing more than one function and should be split into two or more smaller subroutines/functions.
2. **Devise means for testing each subroutine/function separately so that problem isolation (debugging) is easily accomplished.**

- Simulate your program with the *simulator* or debug it on your board (i.e., *emulate*) **before** coming to Lab. Bring to your lab your **working** assembly or C code and circuit diagram file (if any) on your laptop. You will **not** be allowed in the Lab without the required submitted documentation.

3. **Arrive at the lab on time to give yourself adequate time.**

LABORATORY GRADING

You must attend your lab at the scheduled date and time; failure to do so, even if your lab deliverables were submitted on time, will result in your earning a zero for that lab.

You will not be admitted to the lab without a previously submitted *Pre-Lab Report and zip file*, as described in the *Lab Rules and Policies*. The *Pre-Lab Report* and other files also **must** be submitted before the scheduled deadline. Lab files will be accepted up to 24 hours late with a 25-point penalty (resulting in a maximum possible grade of 75). Nothing will be accepted that is more than 24 hours late. You can only submit **two** labs late, after that, late labs will earn **no** credit.

Each circuit diagram, VHDL file, assembly language program, and C program file must have your name included at the top. The entire Quartus folder/project should be included in the zip with the Microchip/Atmel Studio folder/project.

Some labs will count more than other labs. Grading emphasis will be placed upon your producing well documented, well-structured programs and hardware designs that realize the functional requirements specified by the lab handout and the lab instructor. The remaining portion of your grade will result from observations by your lab instructor on such matters as your understanding of the lab, your lab techniques, your pre-lab preparation, your lab reports, and your cooperation and compliance with the rules. Having your design perform properly does **not** guarantee a grade of 100 but makes a 100 grade **possible**. Lab designs and/or software that are similar and/or identical to other student's work constitute cheating (see above) and result in you failing the course, honor court charges, and possibly expulsion from UF. We have software that will be used to look for plagiarized software.

LABORATORY ATTENDANCE

Laboratory attendance during scheduled times is mandatory. **Documented** personal or family emergencies will be accepted as an excuse for absence for a **second** missed lab if documentation for a **first** missed lab is **also provided**. In such cases, consult Dr. Schwartz (**not** your PI) about a make-up lab **as soon as possible**. See ***Course Requirements*** for more details. Students should make serious attempts on **all** labs. **Grades less than 50% may be interpreted as not a serious attempt and may be scaled to 0. Note:** ALL students MUST have everything working BEFORE coming to the lab.

All grades are **non**-negotiable **one week** after the grade is posted on either Canvas or our website. Please don't come to me after the final grades have been posted with a hard-luck story.

Failure to attend your scheduled lab will result in a lab grade of zero, even if you previously submitted the required lab documents.

You will **not** officially make up your dropped lab. You should do this missed lab at home (or, if necessary, during a PI office hour) to be sure you understand the required material.

See the **COURSE REQUIREMENTS** section of this document for information.

EQUIPMENT REQUIRED

1. UF 3701 equipment includes DAD (Digilent Analog Discovery), breadboard, wires, switches, LEDs, and resistor packages. A multimeter might also be helpful, but is not required.
2. In your first lab (lab 0) you will also be given a "bag of goodies," i.e., parts that you will use during the semester, including the UF 4744 board kit. **All of these parts must be returned at the end of the semester.**
3. See § HARDWARE PURCHASES for more requirements.

EEL 4744 LABORATORY SCHEDULE

Lab	Tentative Lab Topics
0	Introduction to lab rules, your PI, course hardware, and kit assembly (including soldering).
1	Use *Microchip (Atmel) Studio* (an IDE) to write an assembly program, simulate the program, download the program to the *µPAD*, and emulate the program on the *µPAD*.
2	Delay loops, built-in GPIO Port utilization with LED and switch circuits, XMEGA timer/counter. Use DAD for timer testing.
3	Timers and external interrupts (w/ timers for debouncing).
4	External Bus Interface (EBI) I/O Port Expansion (for SRAM, input port, and output port w/ expansion PCB). Bus Timing using DAD as LSA. .
5	UART Asynchronous Serial Communication (SCI) in Assembly w/ interrupts.
6	C programming. Asynchronous Serial Communication in C, Synchronous Serial Communication (SPI) - connected IMU.
7	ADC to sample CdS cell and DAD waveform. Use ADC and Events to create scope-like device.
8	Utilize DMA with DAC. Output waveforms using DAC. Create music.

WEEK/DAY		DATE	Class #	Lab due	Lab quiz	Lab demo	Comments
1	M	12 Jan					**Classes Begin**
1	Tu	13-Jan	1				Syllabus, Web tour (Install Microchip/Atmel Studio Installation)
1	W	14-Jan					Intro to uP, XMEGA Architecture
1	Th	15-Jan	2-3				
1	F	16-Jan					**Drop/Add Deadline**: Fri, 11:59pm
2	M	19-Jan	No class				**Holiday: Martin Luther King Jr. Day** (no classes or labs)
2	Tu	20-Jan	4				GCPU review, Assembly examples
2	W	21-Jan		0	0		Demo: Assembly, Simulation, Emulation Lab selections and Lab 0 Quiz, ~4:05pm
2	Th	22-Jan	5-6				
2	F	23-Jan					
3	M	26-Jan				0*	Addressing Modes, Instruction Set * Lab 0 is scheduled independently from your other labs
3	Tu	27-Jan	7			0*	GPIO, Ports
3	W	28-Jan				0*	Program Structures, Data Structures, Stack
3	Th	29-Jan	8-9			0*	
3	F	30-Jan				0*	
4	M	2-Feb					Program Structures, Data Structures, Stack AI and CISE Fair, O'Connel Center, 1-6pm
4	Tu	3-Feb	10				Simplified Timer-Counter CCC Non-Tech Day: O'Connell Center, Feb 3, 9am-3pm
4	W	4-Feb					CCC Tech Day: O'Connell Center, Feb 4, 9am-3pm
4	Th	5-Feb	11-12				
4	F	6-Feb		1 (Sun)			
5	M	9-Feb				1	Resets & Interrupts; External Interrupts
5	Tu	10-Feb	13			1	Interrupts for Timer-Counter
5	W	11-Feb			1	1	
5	Th	12-Feb	14-15			1	
5	F	13-Feb		2 (Sun)		1	
6	M	16-Feb				2	Keypad, Parameter Passing
6	Tu	17-Feb	16			2	Include file (BM, BP, GC)
6	W	18-Feb				2	Hardware and Software Debugging
6	Th	19-Feb	17-18			2	Address and Data Bus Timing (EBI)
6	F	20-Feb		3(Sun)		2	
7	M	23-Feb				3	Address and Data Bus Timing (EBI) [Input Port Example]
7	Tu	24-Feb	19			3	Interfacing, Interfacing Examples, Address Decoding
7	W	25-Feb			2	3	
7	Th	26-Feb	20-21			3	
7	F	27-Feb				3	

EEL 4744 SCHEDULE (Part 2 of 2)

WEEK/ DAY	DATE	Lecture #	Lab due	Lab quiz	Lab demo	Tentative Weekly Topics / Comments
8 M	2-Mar					LED Array, LCD
8 Tu	3-Mar	22				SCI (Asynch Data Communications) [UART Example]
8 W	4-Mar			3		
8 Th	5-Mar	23-24				
8 F	6-Mar		**pre-4 (Fri)**			
9 M	9-Mar		4			SPI Subsystem [SPI Example]
9 Tu	10-Mar	25				
9 W	11-Mar			4		
9 Th	12-Mar	26-27				Intro to embedded C
9 F	13-Mar					
	14-Mar 22-Mar	No class	5 (Mon)		4	**Spring Break** (no classes or labs)
10 M	23-Mar					Intro to embedded C [Serial in C Example]
10 Tu	24-Mar	28			4	[Timer RGB in C Example]
10 W	25-Mar				4	**PRACTICAL 1**: **Wed, 25 Mar, 4:05pm**
10 Th	26-Mar	29-30			4	
10 F	27-Mar				4	
11 M	30-Mar		**pre-6 (Mon)**		5	A/D Conversion, A/D Subsystem
11 Tu	31-Mar	31			5	Event System
11 W	1-Apr			5	5	
11 Th	2-Apr	32-33			5	
11 F	3-Apr		6 (Sun)		5	
12 M	6-Apr				6	Lookup Table
12 Tu	7-Apr	34			6	System Clock
12 W	8-Apr			6	6	DAC Subsystem, Direct Memory Access (DMA)
12 Th	9-Apr	35-36			6	
12 F	10-Apr		7 (Sun)		6	
13 M	13-Apr				7	Topic: uP 2 and Real-time DSP Applications
13 Tu	14-Apr	37			7	
13 W	15-Apr			7	7	
13 Th	16-Apr	38-39			7	
13 F	17-Apr		8 (Sun)		7	**DROP DEADLINE at 11:59pm**
14 M	20-Apr				8	Topic: Other microprocessors/microcontrollers; Multitasking
14 Tu	21-Apr	40			8	
14 W	22-Apr				8	**PRACTICAL 2**: **Wed, 22 Apr, 4:05pm**
14 Th	23-Apr	Reading Day			8	
14 F	24-Apr	Reading Day			8	
T	28-Apr					**Final Exam**: **Tues, 28 Apr, 3:00-5:00pm** (as scheduled)

RELATION TO PROGRAM OUTCOMES (ABET) [although not utilized]

Outcome	**Coverage**
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	
3. An ability to communicate effectively with a range of audiences	Low
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	High
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Medium