ECE 576B: Embedded System Design and Optimization – Spring 2021

Time: LIVE ONLINE: Monday, Wednesday, Friday, 11am – 11.50am; Credits: 3
Location: Zoom: https://arizona.zoom.us/j/87503474670 Password: on D2L welcome message. The link is also accessible via D2L -> Zoom (Note that all class sessions will be recorded. However, the video posted on D2L will not include students’ faces.)

Instructor
Tosiron Adegbija (www.ece.arizona.edu/~tosiron), tosiron@email.arizona.edu

Course Websites
This class is scheduled to be taught in the LIVE ONLINE modality (even though the official course schedule says ‘Flex In-Person’). We will use Zoom to facilitate weekly synchronous class meetings and office hours. Lectures, live discussion sessions, and office hours will take place during the allotted class period via Zoom (see Zoom Etiquette below). I will not be taking roll, but I strongly encourage you to attend the live sessions if you can. Students who miss the live sessions can access the recordings on D2L via the Panopto link.

We will use Piazza (accessible via D2L -> Piazza) for class resources, lecture notes, assignments, and discussion. The system is highly catered to getting you help fast and efficiently from classmates and myself. Unless you have questions specifically related to your grade, personal matters, or similar, you should post your questions to Piazza. Sign up link and access code are on D2L. All enrolled students must sign up on Piazza (the sign up link is on the D2L welcome page).

If possible, I encourage you to post questions on Piazza before Zoom meetings so that we can discuss the questions during class if necessary.

We will use D2L (https://d2l.arizona.edu) for Grades (via D2L -> Grades), assignment submission (via D2L -> Assignments), and class videos (posted after every class via D2L -> Panopto).

Course Overview
An embedded system is any computing system other than traditional computer systems. Embedded systems, which is one of the fastest growing and high-impact areas in computing, comprises a vast variety of applications, including digital cameras, cell phones, automotive systems, wearable devices, pace makers, etc. As applications grow increasingly complex, so do the complexity of embedded systems devices, many of which are typically resource-constrained.

This course will focus on introducing embedded system design, synthesis, and optimizations. The course will highlight methods and challenges in designing embedded systems, which typically require the tight integration of hardware and software components. The course will provide a broad look into how embedded systems work, covering a broad range of topics, including application analysis, hardware/software partitioning, design space exploration, modeling and specification, real-time operation systems, high-level synthesis for accelerator design, performance evaluation, and application-specific optimizations targeting area, power, performance, energy, temperature, security, etc.

Topics include, but are not limited to:
- Embedded systems architecture
- Embedded programming paradigms
- Power and energy consumption and optimization techniques
- Modeling and specification
- Design space exploration
- Real-time scheduling and operating systems
- Hardware-software co-design
- Adaptability

The learning objectives include, but are not limited to:

- Develop an understanding of the requirements, constraints, and problems that occur in embedded systems design
- Develop an understanding of real-time computing, real-time operating systems, and practical application design and task management
- Develop an understanding of how to analyze an embedded application to identify its bottlenecks and explore opportunities for optimization using hardware-software co-design
- Develop a broad view of active research areas in embedded systems optimization and design

Textbooks
There is no required textbook. The course will cover materials from various sources, including conference proceedings and journal articles.

Prerequisites
Basic knowledge in computer architectures and C/C++ programming; familiarity with Linux

Reading Assignments and Class Participation
Reading assignments and class participation will be an important component of the class. Reading assignments (typically of research papers) must be completed by the due date in order to facilitate a discussion environment. We will regularly use Zoom breakout rooms for small-group discussions that will focus on the topics of the reading assignments. Class participation will be evaluated through participation in discussions and in-class quizzes.

Zoom Etiquette and suggestions
To support a smooth online class environment, please follow the following etiquette and suggestions for the online classroom:

- Log into the class on time in a quiet, distraction-free environment. Treat each Zoom session like you would an in-person class. That is, be attentive and participative, avoid picking up phone calls, browsing Facebook or Twitter, don’t have your meals during class, make sure you’re wearing clothes (pajamas are totally fine), etc.
- Make sure that your video is on, if possible, so that I and your peers can see you. (Remember that videos that are posted online will NOT include your face, so the video is solely for a more personal interaction during the Zoom sessions).
- If possible, use a headset with an external mic for best audio quality.
To maximize your system’s performance, close unnecessary applications.

Digitally raise your hand if you have a question and wait to speak until I call on you. Remember to unmute your mic when you’re called upon.

Make use of the chat box for reactions and questions. Remember that it is public and a record of the chat is kept and archived.

Keep a notepad or paper and a pen or pencil handy to take notes and work on in-class activities. Make sure to attempt every assigned in-class exercise to the best of your abilities within the allotted time and ask questions, if you have any, when the allotted time as elapsed or on Piazza.

Your dogs are welcome (and encouraged) to attend Zoom classes with you. If they’re in the room with you, I would like to see them on camera, especially if they’re good boys or girls, which they obviously are. Cats are also welcome, if they will not judge me for my life choices. However, please keep other exotic pets (like tigers or reptiles or mountain lions) away from the camera.

Please participate in class discussions and any breakout sessions to enable a lively, active learning environment.

If I lose Internet connection, please try to reconnect within about 5 minutes. If I’m not back in 10 minutes, we can assume it is a long-term issue and we will meet back during the next meeting time.

Communication with the Instructor

In general, questions about class contents should be posted on Piazza. That way, responses can be helpful to other students and other students (or the grader) may also be able to provide quicker responses to questions. Please be respectful in all your posts on Piazza, especially when answering other students’ questions, even if the answers are obvious to you.

For questions related to grades and personal matters, please email me. In your emails to me, please include the course number in brackets in your subject (i.e., [ECE 5768]) so that I can sort my email and give a quicker response.

Grading

Grading for the class will be performed on an individual basis. You will not be competing with other students for your grade. Your grade is only dependent on the effort you put into the class. Letter grades will be assigned using a 10% scale:

- 90 – 100%: A
- 80 – 89%: B
- 70 – 79% C
- 60 – 69% D

The grading will be based on a weighted sum as follows:

- 10% - Homework assignments
- 20% - Project
- 20% - Midterm 1 (tentatively on Wednesday, March 3)
- 20% - Midterm 2 (not cumulative; tentatively on Wednesday, April 28)
Midterms will be administered via the D2L Quiz function as open book/open notes exam. No proctor will be required. The exam will be administered on the honor system.

- **20% - Quizzes**
  - The weight of each individual component will be provided on each assignment. Most quizzes will be administered via the D2L Quiz function.

- **10% - Reading assignments and class participation**

### Required Equipment and Software

All software used for this class can be obtained for free. A few examples include:

- Webcam-enabled computer or computer, webcam, and microphone; reliable Internet connection
- Free software: Xilinx Vitis, FreeRTOS, a computer with a Linux operating system or a virtual machine with Linux installed (I recommend Ubuntu)

### Policies

- **No academic dishonesty will be tolerated. Unless otherwise instructed, all course work should be done on your own. Please consult the UA Code of Academic Integrity.**
- Students are expected to read any assigned material before lecture.
- No late work will be accepted, unless in extraordinary circumstances, e.g., medical emergency, University/College approved absences, etc.
- Quizzes and exams will be administered either as take-home written or via the online D2L Quiz function. You will have a period of time (typically at least 3 days) to complete the exams and assignments. Missed exams can only be made up in case of documented illness or personal emergency. Please submit a written documentation (including supporting documentation) to me ASAP. When possible, make-up arrangements must be made prior to the scheduled activity.
- Attendance is not mandatory and I will not be taking roll. However, I highly recommend that you attend online class sessions regularly. I have seen a direct correlation of positive learning outcomes and good grades to consistent class attendance and active engagement with the classes.

### Disability/Counseling Resources

Students requesting classroom accommodation must register with the Disability Resource Center for assistance with obtaining the necessary accommodations, and request the DRC to send me official notification of your accommodation needs ASAP. Please meet with me to discuss accommodations and how to maximize your productivity in this class.

Additionally, resources are available on campus to students having personal problems or lacking clear career and academic goals. Students who need assistance should contact Counseling and Psych Services for the necessary assistance.
Inclusive Excellence

Inclusive Excellence is a fundamental part of the University of Arizona's strategic plan and culture. As part of this initiative, the institution embraces and practices diversity and inclusiveness. These values are expected, respected, and welcomed in this course.

This syllabus is subject to change at the discretion of the instructor, with proper notice to the students.