



## ITP 388 – Developing Connected Devices

**Units:** 4

**Instructor:** Kristof Aldenderfer

**Office:** RRB

**Office Hours:** Posted on edSTEM

**Contact Info:**

For all questions about assignments or pertaining to the course: edSTEM.

For all other concerns, email: [kristof@usc.edu](mailto:kristof@usc.edu)

**Teaching Assistants:** TBD

**Office:** TBD

**Office Hours:** Posted on edSTEM

## Course Description

This course teaches students the advanced concepts of connected device hardware design and firmware development through hands-on, real-life applications. The first part of the course focuses on teaching students how to create professional-quality printed circuit boards (PCBs), from schematic designs to finished boards; and the second part of the course focuses on developing firmware for production-grade microcontrollers (MCUs) with rich peripheral sets using Embedded-C language. Example assignments include interacting with temperature sensors, building USB based peripherals, creating wireless interfaces and devices.

## Learning Objectives

By the end of this course, students should be able to:

- Understand schematics capture and circuit board design process
- Write firmware logic for production-grade microcontrollers
- Develop firmware for production-based USB, Bluetooth, Wifi, Sensor Data Peripherals
- Design advanced devices that read sensor data and interface with other devices through Wi-Fi, Bluetooth, and/or USB

## Prerequisite(s):

ITP-348 or equivalent

## Course Notes

This course will make use of several tools for delivery of content and assignments, and for general communication. edSTEM (<https://estem.org>) will serve as the entry-point for everything related to this course. Lecture slides and any supplemental course content will be posted to edSTEM for use by all students. All assignments will be posted to edSTEM and will be submitted through edSTEM. General assignment help and communication will be done through EdSTEM. Please familiarize yourself with edSTEM before the course begins.

## Attendance and Etiquette

Attendance is not part of the grading breakdown, although attending scheduled meetings will help you learn the material and succeed in this class. The instructor expects you to pay attention during scheduled meetings and be an active learner. Chatting while the instructor is talking, texting on your mobile device, and participating on social media sites during class is disrespectful to the instructor and your classmates. If you are not able to attend lectures, then you should watch the recorded lectures and complete the in-class labs.

## Adding the course after the first week

Per university policy, students are allowed to add the course until the end of week three. Any students wishing to add the course should plan on attending the course from the beginning of the semester. If the student needs to add the course after week 1, they will need to apply for D-Clearance. Upon getting D Clearance, students will need to reach out to advising to add the class, and should email the instructor immediately to make sure there is a plan for completion of work and learning missed materials. Any missed work is required to be completed and submitted according to the schedule provided by the instructor.

## Technological Proficiency and Hardware/Software Required

Students will need a computer (laptop or desktop) and access to the internet. If you do not have access to a computer, please contact your instructor.

Students should have basic technical knowledge of their computer, including the ability to install software, download course material, and properly submit their assignments online. All software needed for the course is available for free.

# Required Readings and Supplementary Materials

Required materials: None

Supplementary Materials:



Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards 1st Edition  
by Simon Monk  
ISBN-13: 978-0071819251  
ISBN-10: 0071819258



Explorer 16/32 Dev Board Documentation  
<http://www.microchip.com/DevelopmentTools/ProductDetails.aspx?PartNO=DM240001-2>

Getting Started with PIC32/MPLAB User's Guide  
<http://ww1.microchip.com/downloads/en/DeviceDoc/61146B.pdf>

PIC32MX MCU Family Reference  
<http://www.microchip.com/design-centers/32-bit/architecture/pic32mx-family>

PIC32MX470F512L MCU Reference  
<http://www.microchip.com/wwwproducts/en/PIC32MX470F512L>

PIC32MX470F512L Plug-in Module Reference

<http://ww1.microchip.com/downloads/en/DeviceDoc/50002162B.pdf>

Additional reference material will be provided as needed.

## Coursework

The coursework is comprised of a mixture of Labs, Homeworks, Tests, and the Final Project, with the following grade breakdown:

Item	% of grade
Homeworks	40
Labs	10
Test (one)	10
Final Project (4 parts)	40
<b>TOTAL</b>	100

## Assignments

There are two types of assignments in this course:

- **Homework:** week-long assignments which pertain to the material from the current week as well as to previous weeks. Typically, these are due one week after being assigned.
- **Lab:** short, direct application of the week's topics for reinforcement. Typically, these are due one day after being assigned.

Generally, each week there will be one Homework and one Lab assigned, each of which relate to the topic covered that particular week. **Students are expected to complete these assignments individually.** Each assignment will include instructions, a due date, and a link for electronic submission. Assignments must be submitted using this link; they will not be accepted through any other method.

### Assignment Submission Policy

All assignments must be submitted through edSTEM; a link will be provided for each. They will not be accepted through any other method.

### Late Assignment Policy

It is the student's responsibility to submit assignments on or before the due date. Assignments may be submitted within two days with a late penalty. Homeworks turned in one day (24 hours) late will have 25% of the total points deducted from the graded score. Homeworks turned in over one day and up to two days (>24 hours and ≤ 48hours) late will have 50% of the total points deducted from the graded score. After two days, submissions will not be accepted, and the score for the assignment will be a 0. No credit is given for late Labs.

### Regrade requests

Students have one week to contest a grade once it has been posted on Blackboard. After this one week, the grade will not be changed. To contest a grade, create a private post on EdSTEM and select the grades tag. In the post, include your name, the assignment name, and your reasons. Tag your instructor and your grader. This will allow the grader and instructor to view your submission and make a decision.

# Tests

No make-up tests (except for documented medical or family emergencies) will be offered. If you will not be able to attend a test due to an athletic game or other valid reason, then you must coordinate with the instructor before the test is given. You may arrange to take the test before you leave with an approved university personnel during the time you are gone, or within the week the test is given. If you do not take a test, then you will receive a 0 for the test. If you need accommodations authorized by OSAS, notify the instructor at least two weeks before the test. This will allow time for arrangements to be made.

# Device Project

## Description

The crux of this course is a semester-long device project which will solve a problem in the real world. **Students will work in groups** to conceive, design, build, test, verify, and iterate on a solution for the given problem. Groups will be formed in the first several weeks of the semester.

The resulting project will ultimately be a functional connected device that successfully executes the features defined in the Project Proposal. Successful projects will have the completed PCB schematics and design, code/firmware deployed on MCU, allow for user interaction, demonstrate concepts learned during the course, and include appropriate documentation. Failure to note and provide links to any reference material will be considered cheating.

## Schedule

Week	Event
04	Project Proposal presentation
08	Project Update presentation #1
12	Project Update presentation #2
16 (Final exam period)	Final Project presentations

## Grading Breakdown

Item	Points
Schematic	10
PCB Layout	10
Firmware	10
Enclosure	10
Working prototype	20
Presentations (4)	40
<b>TOTAL</b>	100

# Course Schedule: A Weekly Breakdown

Week	Topics	Supplementary Reading	Assigned work	Due
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1	Welcome to engineering: electrical, mechanical, and firmware	See edSTEM	See edSTEM	See edSTEM
2	Sensors			
3	Actuators			
4	Circuit Design			Presentations
5	Wired Protocols			
6	Schematic Capture Part 1			
7	Schematic Capture Part 2			
8	Exam 01			Presentations
9	PCB Layout			
10	PCB Manufacturing			
11	Enclosure Design			
12	Enclosure Manufacturing			Presentations
13	Wireless Protocols			
14	Design for Manufacturing			
15	Advanced Topics			
<b>FINALS</b>	<b>FINAL PROJECT PRESENTATIONS</b>	<b>Date: TBD</b>		

## Academic Integrity

Assignments in computer programming courses are different from those in some other types of courses. Students may NOT collaborate, work together, share code, or in any way exchange solutions for assignments. Assignments may be analyzed by software that looks for similarity. Any sharing of ideas or code will be considered a violation of academic integrity (cheating); an SJACS report will be filed with the recommended penalty of an F in the course. Do not share your code with anyone else in this or a future section of the course, as allowing someone else to copy your code carries the same penalty as copying the code yourself.

If the instructor, a grader, or a teaching assistant suspects you of academic dishonesty, it has to be reported to SJACS. Do not share assignments with another person. Do not submit another person's work as your own. Do not look at other students' papers during tests. Do not leave the room during a test without permission. Do not cheat! As Trojans, we are faithful, scholarly, skillful, courageous, and ambitious.

## Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" [policy.usc.edu/scampus-part-b](http://policy.usc.edu/scampus-part-b). Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, [policy.usc.edu/scientific-misconduct](http://policy.usc.edu/scientific-misconduct).

## Sharing of course materials outside of the learning environment

As per SCampus Section 11.12(B):

*Distribution or use of notes or recordings based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study is a violation of the USC Student Conduct Code. This includes, but is not limited to, providing materials for distribution by services publishing class notes. This restriction on unauthorized use also applies to all information, which had been distributed to*

students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the Internet or via any other media. (See Section C.1 Class Notes Policy)

## Support Systems

*Counseling and Mental Health - (213) 740-9355 – 24/7 on call*

[studenthealth.usc.edu/counseling](http://studenthealth.usc.edu/counseling)

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

*National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call*

[suicidepreventionlifeline.org](http://suicidepreventionlifeline.org)

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

*Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call*

[studenthealth.usc.edu/sexual-assault](http://studenthealth.usc.edu/sexual-assault)

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

*Office of Equity and Diversity (OED) - (213) 740-5086 | Title IX – (213) 821-8298*

[equity.usc.edu](http://equity.usc.edu), [titleix.usc.edu](http://titleix.usc.edu)

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

*Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298*

[usc-advocate.symplicity.com/care\\_report](http://usc-advocate.symplicity.com/care_report)

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, and response.

*The Office of Student Accessibility Services - (213) 740-0776*

<https://osas.usc.edu/>

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

*USC Campus Support and Intervention - (213) 821-4710*

[campussupport.usc.edu](http://campussupport.usc.edu)

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

*Diversity at USC - (213) 740-2101*

[diversity.usc.edu](http://diversity.usc.edu)

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

*USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call*

[dps.usc.edu](http://dps.usc.edu), [emergency.usc.edu](http://emergency.usc.edu)

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

*USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call*

[dps.usc.edu](http://dps.usc.edu)

Non-emergency assistance or information.

*Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)*

[ombuds.usc.edu](http://ombuds.usc.edu)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.