



# COMP-EMEC 462: Embedded Systems

Fall F2020

Location: Online

Instructor: Jason Isaacs

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Office Hours: Zoom (Link on Canvas)

Office Hours: Tue 4pm – 6pm

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## Course Description:

Covers the design of embedded systems. This includes the analysis of small, computer systems designed for robotic mechanisms and common appliances, such as cell phones and other hand-held devices. Topics include the design, implementation, and testing of software used in such systems with special attention paid to maximizing the use of limited, computational resources and the need for event-driven, real-time, system responses.

## Student Learning Outcomes

By the successful completion of this course, you will be able to:

- Sketch the key components of embedded system software
- Identify, reference and analyze embedded systems industry standards
- Sketch the key components of embedded systems hardware
- Select the appropriate software architecture for an embedded system design
- Produce software designs that use computer ports effectively
- Produce working software used as "drivers" for embedded systems
- Identify and sketch the key components of a real time embedded system
- Identify and sketch the key components of a robotic controller
- Produce working software that adds some elements of intelligence to a robot

## Course Outline:

1. Raspberry Pi Hardware and Software
2. Embedded Linux
3. Interface Electronics
4. Programming for Embedded Linux
5. Interfacing Inputs and Outputs

6. Cross Compilation
7. Interfacing Input / Output Buses
8. Enhanced Input / Output
9. Interacting with Physical World
10. Real-Time Interfacing
11. Internet of Things
12. Wireless Communication and Control
13. User Interface
14. Images, Video, and Audio
15. Kernel Programming

## Learning Environment:

This class will be conducted completely asynchronously online. The course is divided into 15 weekly modules. Each module begins on Monday and ends on Sunday evening at 11:59 pm.

I will hold two hours of open Zoom sessions per week to discuss any questions you may have.

## Grading:

The course grade will be determined by a weighted average of Theory Related Activities, Labs, and a Term Project.

- **Theory Related Activities – 50%**

- **Practice Problems – 10%**

- There will be practice problems with each module. You will be able to repeat these assignments as many times as you like to improve your grade. The idea behind this set of assignments is to give you an opportunity to get feedback on a lower stakes assignment before proceeding to the quiz.

- **Quizzes – 25%**

- There will be a timed quiz at the end of each module. Be sure to complete practice problems before proceeding to the quiz.

- **Discussion Forum – 15%**

- In the spirit of creating an online learning community you are expected to actively participate in the discussion forum. Points will be awarded for asking good questions, posting a good answer to someone else's questions, and posting information that you found useful from outside resources.

- **Labs – 30%**

- There will be a series of labs meant to give you hands on practice with interfacing peripherals to your micro-controller.

You will need to submit a markdown file documenting the steps you took and the results along with any source code that you used. Additionally, you will need to submit a short video containing a demonstration of the working lab.

- **Term Project – 30%**

For the project you will design and build a prototype IoT device using the Raspberry Pi as the base controller. Your project should include at least one sensor (actuator optional) and connect your device to a website where the data can be visualized.

You will be given a small budget of around \$30 to purchase any parts you need.

You will need to complete a project proposal laying out the idea, a schedule, and how you plan to spend your budget. The idea doesn't need to be novel but *can't be a smart mirror*.

At the mid-point of the semester you will need to submit a progress report with a detailed description of the status of the project and any revisions to the original schedule and budget.

For the completion of the project you will need to submit a final report with an accompanying video demonstration of the working project.

## Instructor Communication Policy:

I will make every effort to respond to your email questions within 24 hours Monday through Friday. If for some reason you have not received a reply after 24 hours, please feel free to email me again.

## Required Materials:

It is **required** that you obtain the textbook Exploring Raspberry Pi. Each module will include a reading assignment from this book, and quiz questions will be drawn from the reading assignment.

### Textbook Required

Title: [Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux 1st Edition](#)

Author: Derek Molloy

Publisher: Wiley

ISBN-13: 978-1119188681

I also **recommend** downloading the book by Lee and Seshia. This book is used to teach embedded systems at UC Berkeley and provides a dynamical systems perspective of the subject.

### Textbook Recommended (Available Free Online)

Title: [Introduction to Embedded Systems, A Cyber-Physical Systems Approach](#)

Edition: 2<sup>nd</sup> Edition

Author: Edward A. Lee and Sanjit A. Seshia

Publisher: <http://LeeSeshia.org>  
ISBN-13: 978-1-312-42740-2

### **Lab Kit**

You will be supplied a lab kit to use in this course. This kit contains the Raspberry Pi 3B+ microcontroller as well as all electronic components that you will need to complete the labs. The process for getting you this kit is a bit complicated due to privacy rules so please follow these instructions closely to allow us to mail these kits to you. It is important that you do this right away, so there will be time to mail the kits to you before the start of the class.

1. Go into myCI>CI Records and click on Mailing Address and update your address to where you are currently living.
2. Once you have confirmed that your address is correctly on file, email Stephanie Chavez ([stephanie.chavez@csuci.edu](mailto:stephanie.chavez@csuci.edu)) the Academic Program Analyst to let her know and include Ricky Medrano ([ricky.medrano@csuci.edu](mailto:ricky.medrano@csuci.edu)) the Mechatronics Technician and myself on the email.
3. Stephanie Chavez will then provide all student addresses to Ricky Medrano.
4. Ricky Medrano will then print the labels and get the kits sent out.

## **Course Policies:**

### **Online Etiquette**

All learners in this course are expected to abide by our [community ground rules](#).

### **Academic Dishonesty**

By enrolling at CSU Channel Islands, students are responsible for upholding the University's policies and the Student Conduct Code. Academic integrity and scholarship are values of the institution that ensure respect for the academic reputation of the University, students, faculty, and staff. Cheating, plagiarism, unauthorized collaboration with another student, knowingly furnishing false information to the University, buying, selling or stealing any material for an examination, or substituting for another person may be considered violations of the [Student Conduct Code](#).

**If a student is found responsible for committing an act of academic dishonesty in this course, the student may receive academic penalties including a failing grade on an assignment or in the course, and a disciplinary referral will be made and submitted to the Dean of Students office.** For additional information, please see the faculty [Academic Senate Policy on Academic Dishonesty](#), also in the CI Catalog. Please ask about my expectations regarding academic dishonesty in this course if they are unclear.

### **Accommodations for Students with Disabilities**

If you are a student with a disability requesting reasonable accommodations in this course, please visit Disability Accommodations and Support Services (DASS) located on the second floor of Arroyo Hall or call 805-437-3331. All requests for reasonable accommodations require

registration with DASS in advance of needed services. Faculty, students and DASS will work together regarding classroom accommodations. You are encouraged to discuss approved accommodations with your faculty.

- [Apply for DASS Services.](#)

### ***Title IX and Inclusion***

Title IX & Inclusion manages the University's equal opportunity compliance, including the areas of affirmative action and Title IX. Title IX & Inclusion also oversees the campus' response to the University's nondiscrimination policies. CSU Channel Islands prohibits discrimination and harassment of any kind on the basis of a protected status (i.e., age, disability, gender, genetic information, gender identity, gender expression, marital status, medical condition, nationality, race or ethnicity, religion or religious creed, sexual orientation, and Veteran or Military Status). This prohibition on harassment includes sexual harassment, as well as sexual misconduct, dating and domestic violence, and stalking. For more information regarding CSU Channel Islands' commitment to diversity and inclusion or to report a potential violation, please contact Title IX & Inclusion at 805.437.2077 or visit <https://www.csuci.edu/titleix/>.

## Weekly Modules:

**Each module will begin on Monday and end on following Sunday at 11:59pm.**

Module 1 | Raspberry Pi Hardware and Software | Dates: 8/24/20 - 8/30/20

Module 2 | Exploring Embedded Linux Systems | Dates: 8/31/20 - 9/6/20

Module 3 | Interfacing Electronics | Dates: 9/7/20 - 9/13/20

Module 4 | Programming on the Raspberry Pi | Dates: 9/14/20 - 9/20/20

Module 5 | Interfacing to the Raspberry Pi Input/Outputs | Dates: 9/21/20 - 9/27/20

Module 6 | Cross-Compilation and the Eclipse IDE | Dates: 9/28/20 - 10/4/20

Module 7 | Interfacing to the Raspberry Pi Buses | Dates: 10/5/20 - 10/11/20

Module 8 | Enhancing the Input / Output Interfaces on the RPi | Dates: 10/12/20 - 10/18/20

Module 9 | Interacting with the Physical Environment | Dates: 10/19/20 - 10/25/20

Module 10 | Real-Time Interfacing Using the Arduino | Dates: 10/26/20 - 11/1/20

Module 11 | The Internet of Things | Dates: 11/2/20 - 11/8/20

Module 12 | Wireless Communication and Control Dates: 11/9/20 - 11/15/20

Module 13 | Raspberry Pi with a Rich User Interface | Dates: 11/16/20 - 11/22/20

Module 14 | Images, Video, and Audio | Dates: 11/23/20 - 11/29/20

Module 15 | Kernel Programming | Dates 11/30/20 - 12/4/20