MECH 0090 - MICROCONTROLLER EMBEDDED SYSTEMS

Catalog Description

Formerly known as CIE 90
Prerequisite: Completion of MECH 10 and MECH 14 with grades of "C" or better
Hours: 108 (54 lecture, 54 laboratory)
Description: Study of microcontroller based embedded systems using industry standard hardware and development software. Topics and laboratory exercises covering system architecture, applications of embedded systems, real world interfacing, software development, test and troubleshooting techniques. (CSU)

Course Student Learning Outcomes

- CSLO #1: Create microcontroller programs to provide deterministic control of actuators.
- CSLO #2: Design, construct and critique complete mechatronic systems.
- CSLO #3: Design and construct input and output interface hardware for microcontrollers.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

108

Outside of Class Hours

108

Total Student Learning Hours

216

Course Objectives

Lecture Objectives:
1. Evaluate the advantages and disadvantages of applying a software versus a hardware solution to circuit design problems.
2. Compare the trade offs between discrete microcontroller devices and bus based architecture systems to embedded control applications.
3. Assess the applicability of PIC microcontrollers to control applications versus competitive devices.
4. Differentiate the PICAXE microcontroller from a standard PIC device.
5. Evaluate the benefits and limitations of assembly and high level language programming of embedded system controllers.
6. Develop programming structures for the PICAXE that will perform typical embedded system tasks.
Laboratory Objectives:
1. Design and construct digital logic circuits that perform standard Boolean functions.
2. Generate the input source code for a programmable logic device that will perform a digital decoding process.
3. Create and apply instruction set assembly language to a bus based microprocessor system where the system will execute logic, math, and data manipulation processes.
4. Analyze the PICAXE serial communication technique and circuit topography.
5. Troubleshoot the PICAXE serial communication link using standard test equipment.
6. Design, build, test, and troubleshoot various output device interfaces.
7. Design, build, test, and troubleshoot various input device interfaces.
8. Develop programming structures for the PICAXE that will perform typical embedded system tasks.
9. Analyze and troubleshoot embedded systems using breakpoints, debuggers, and simulators.
10. Design, build, test, and troubleshoot a microcontroller based term project that performs a real world control function.

General Education Information

- Approved College Associate Degree GE Applicability
- CSU GE Applicability (Recommended-requires CSU approval)
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)

Articulation Information

- CSU Transferable

Methods of Evaluation

- Objective Examinations
  - Example: What radix is most commonly used in digital logic systems? _____
- Problem Solving Examinations
  - Example: For the lamp driver circuit shown below, calculate the real value of resistor R1. You must show your work to receive credit for your answer.
- Projects
  - Example: Each student is required to design, build, and present a final term project that solves a real-world problem using a microcontroller in a Mechatronics context. Grade based on industry standard.
- Skill Demonstrations
  - Example: Develop a flowchart and write the code that describes reading the value of a potentiometer into a microcontroller and then displaying the ADC value on a serial OLED display. Demonstrate the functionality of the program in operation.

Repeatable

No

Methods of Instruction

- Laboratory
- Lecture/Discussion
- Distance Learning

Lab:

1. The instructor will present a lecture outlining the methods and process necessary for a successful lab applying Breadboard Adapters. Students will be divided into lab groups to complete the assignment, and the instructor will be available to answer questions as students complete the lab.

Lecture:

1. Instructor will present and describe, using a handout and class discussion, the parameters of the course term project. The instructor will lead a discussion on potential projects, providing examples of successful and unsuccessful work in the past. The instructor will provide feedback and assessment of both the project and the notebook that accompanies it.

Distance Learning

1. Following an online video lecture on micro-controller coding software, students will write, simulate, and verify and micro-controller code using software downloaded from the internet. Instructor will review results and critique student's problem solving methodology.

Typical Out of Class Assignments Reading Assignments

1. Read the literature related to serial data communications. Read the application notes for the serial LCD display command protocol. Be prepared to apply the proper techniques of serial communications to the microcontroller LCD display interface in the laboratory assignment. 2. Research on the internet and read the chapter on unipolar stepper motor control. Be prepared to complete the laboratory assignment where a microcontroller routine controls a stepper motor to operate in a predictable motion pattern.

Writing, Problem Solving or Performance

1. Research and prepare a report proposal on the basic design requirements of a microcontroller embedded system. 2. Research and prepare term project portfolio for the embedded system including the interface and control application source code.

Other (Term projects, research papers, portfolios, etc.)

Term Project Research, design, build, program, and troubleshoot an embedded system to perform a real world control function. Include a complete portfolio for the project.

Required Materials

- Programming and Customizing the PICAXE Microcontroller
  - Author: David Lincoln
  - Publisher: McGraw-Hill / Tab
  - Publication Date: 2011
  - Text Edition: 2nd
  - Classic Textbook?:
  - OER Link:
  - OER:
- Designing Embedded Systems with PIC Microcontrollers Principles and Applications
  - Author: Tim Wilmshurst
  - Publisher: Newnes
  - Publication Date: 2009
  - Text Edition: 2nd
  - Classic Textbook?:
  - OER Link:
  - OER:
- Embedded Computing and Mechatronics with the PIC32 Microcontroller
  - Author: Kevin Lynch
  - Publisher: Newnes
  - Publication Date: 2015
  - Text Edition: 1st
  - Classic Textbook?:
  - OER Link:
  - OER:
- Microcontroller Basics with PIC
  - Author: Hanna, Tam
  - Publisher: Elektor International Media BV
  - Publication Date: 2020
  - Text Edition:
  - Classic Textbook?:
  - OER Link:
  - OER:

Other materials and-or supplies required of students that contribute to the cost of the course.

Scientific calculator, USB Flash drive