Lecture Contact Hours: 32-36; Homework Hours: 64-72; Total Student Learning Hours: 96-108
Laboratory Contact Hours: 48-54; Homework Hours: 0; Total Student Learning Hours: 48-54

CUYAMACA COLLEGE
COURSE OUTLINE OF RECORD

COMPUTER SCIENCE 175 – MECHATRONICS: INTRODUCTION TO MICROCONTROLLERS AND ROBOTICS

2 hours lecture, 3 hours laboratory, 3 units

Catalog Description
Mechatronics is the combination of mechanical, electronic, and computer engineering to create automatic "intelligent" devices. Microcontrollers offer an easy and flexible way to do this. This course introduces the use of microcontrollers to operate motors, lights, and other electromechanical devices in response to inputs from sensors. Application of these ideas through the development of an autonomous robot. *Also listed as ENGR 175. Not open to students with credit in ENGR 175.*

Prerequisite
None

Course Content
1) Fundamentals of electrical circuits (e.g. voltage, current, resistance, Ohm's law, power, and ground)
2) Proper use of electronic components (e.g., light-emitting diodes (LEDs), photoresistors, switches)
3) Use of schematics to represent electronic circuits
4) High-level design of control systems using flowcharts and pseudocode
5) Use of a high-level programming language (C++) which incorporates commands specific to microcontroller input and output (I/O)
6) Computer program subroutine development and testing
7) Programming a microcontroller using a personal computer (PC)
8) Digital I/O with microcontrollers (switches, LEDs, 7-segment displays)
9) Motion control using servo motors
10) Analog-to-digital (A/D) conversion
11) Light and infrared (IR) sensors
12) Use of both volatile and non-volatile memory
13) Sound production
14) Control of medium power circuits using transistors
15) Simple DC motor control
16) Control of AC circuits
17) System integration for development of large projects
18) Robot navigation: integration of sensor outputs and motion control for path following and obstacle avoidance
19) Behavior-based robotics:
    a. Development of complex autonomous robot behavior from the combination of simple responses to stimulus
    b. Modeling animal behavior with a robot
20) State machines: theory, state transitions, utility in robotics
21) Robust strategies for robots to achieve goals while surviving in an uncertain environment
22) Additional projects

Course Objectives
Students will be able to:
1) Write programs in a high-level programming language such as C++ to control a microcontroller.
2) Use a microcontroller to:

   a. Detect inputs from sensors, and use the inputs to control the microcontroller.
   b. Control LEDs, servo motors, speakers, and other devices in response to inputs and programming.
   c. Store and retrieve data using non-volatile memory (EEPROM).
3) Integrate the elements of #1-2 above to create an electromechanical device to achieve a desired goal.
4) Design an autonomous robot that can function in an uncertain environment.

Method of Evaluation
A grading system will be established by the instructor and implemented uniformly. Grades will be based on demonstrated proficiency in subject matter determined by multiple measurements for evaluation, one of which must be essay exams, skills demonstration or, where appropriate, the symbol system.
1) Periodic quizzes that evaluate student learning and retention of underlying theory. Questions are mostly word problems, but with some short answer conceptual questions. An example would be a problem in which students compute the current in an LED circuit protected by a known resistor.
2) Lab projects of increasing complexity that measure students' ability to use subroutines in programming, draw and follow wiring diagrams, test electrical and mechanical systems, and apply robotics concepts covered in the class. An example would be the development of a robot that behaves like a cockroach, scuttling around until it finds a dark place, then remaining active in the dark while avoiding light.
3) Final lab project in which students integrate and demonstrate the various topics and techniques covered in class to solve an interesting real world robotics problem. One past example was to develop a robot that acted as an autonomous vacuum cleaner in a multi-room house, returning periodically to a home base for recharging.

Special Materials Required of Student
Microcontroller and robotics kits as specified by instructor

Minimum Instructional Facilities
1) Lab with large flat work tables, computers, storage cabinets, computer projection system, overhead projector
2) Microcontrollers and experimenter boards (e.g., Arduino)
3) Robot test-bed (e.g. Parallax Boe-bot)
4) High-level programming language appropriate for the microcontrollers (e.g., Arduino C)
5) Assorted electronic parts such as LEDs, servo motors, light sensitive components, switches and the like
6) Multimeters

Method of Instruction
1) Lecture and discussion
2) Lab demonstration and assignments
3) Design exhibitions
4) Guest speakers

Out-of-Class Assignments
1) Weekly homework including reading and writing assignments
2) Final project

Texts and References
1) Required (representative example): Monk, Simon, *Programming Arduino, Getting Started with Sketches*. McGraw-Hill, 2012.
2) Supplemental: McGehee, Duncan. *Microcontroller and Robotics Lab Lecture Notes,* 2014.

Exit Skills

Students having successfully completed this course exit with the following skills, competencies and/or knowledge

1) Understanding of what a microcontroller is.
2) Basic knowledge of programming techniques including the use of flowcharts, pseudocode, and subroutines.
3) Basic knowledge of a high-level computer language such as C++ that can be used with microcontrollers.
4) Ability to use a microcontroller to take inputs from sensors such as switches, potentiometers, and photoresistors.
5) Ability to use a microcontroller to output signals to devices such as LEDs, servo motors, and DC motors.
6) Ability to integrate a microcontroller into a larger circuit.
7) Integrate elements of #1-6 above to develop an automatic electromechanical device to achieve a desired goal, and to design a robot that can function in an uncertain environment.

Student Learning Outcomes

Upon successful completion of this course, students will be able to:

1) Write programs in a high-level programming language such as C++ to control a microcontroller.
2) Use a microcontroller to:
   a. Detect inputs from sensors, and use the inputs to control the microcontroller.
   b. Control LEDs, servo motors, speakers, and other devices in response to inputs and programming.
   c. Store and retrieve data using non-volatile memory (EEPROM).
3) Integrate the elements of #1-2 above to create an electromechanical device to achieve a desired goal.
4) Design an autonomous robot that can function in an uncertain environment.