COURSE NUMBER: DP3200

COURSE TITLE: Embedded Controller Applications

COURSE DESCRIPTION:

The course will reveal why microcontrollers exist in so many products today. It explains the basics in microcontroller design through actual applications and will describe the differences between microcontrollers and microprocessors. Instruction is given in different techniques for making the best use of the microcontrollers' resources. Hands-on experience is provided in the lab environment.

PREREQUISITES: CT2300 – Applied Programming or
CP1250 – Programming Fundamentals or
CP1270 – Programming Fundamentals
DP2410 – Digital / Microprocessors or
DP2110 – Digital Systems II (Interfacing)

CO-REQUISITES: None

CREDIT VALUE: Four (4)

COURSE HOURS PER WEEK: Three (3)

LAB HOURS PER WEEK: Two (2)

SUGGESTED TEXT: None

LEARNING RESOURCES: To be determined by instructor

MAJOR TOPICS:

1.0 Introduction to the Microcontroller and its Hardware
2.0 Microcontroller Software Programming
3.0 Parallel Input/Output (I/O)
4.0 Interrupts
5.0 Timer Systems
6.0 Analog to Digital (A/D) Converter
7.0 Serial Communication Using Microcontrollers

LEARNING OBJECTIVES:

Upon completing this course the learner will be able to program and interface to a microcontroller with a combination of in-class theory and practical hands-on operation in a lab

environment. The following topics will be presented and the learner will be evaluated on each section of the course outline through written and practical methods.

1.0 Introduction to the Microcontroller and its Hardware

- 1.1 List some microcontroller applications
- 1.2 Describe the *Microcontroller Development System*
- 1.3 Explain the family of microcontrollers
  - 1.3.1 List the microcontroller features
- 1.4 Draw and explain the various parts of a microcontroller Block Diagram
  - 1.4.1 Explain the method of *Memory Mapped I/O* addressing
  - 1.4.2 Illustrate by providing examples of the addresses for each port on the microcontroller
- 1.5 Draw a diagram of a microcontroller *Memory Map*
  - 1.5.1 Explain the method of Memory Mapped I/O Addressing
  - 1.5.2 Illustrate by providing examples of the addresses for each port on the microcontroller
- 1.6 Find the address of any register inside the microcontroller

2.0 Microcontroller Software Programming

- 2.1 Addressing Modes of a Controller
  - 2.1.1 List addressing modes
  - 2.1.2 Describe addressing modes
  - 2.1.3 Illustrate by providing examples of each of the addressing modes of a controller
- 2.2 Write programs, which will be uploaded to the microcontroller using the instruction set

3.0 Parallel Input/Output (I/O)

- 3.1 List the Port Addresses for Ports, A, B, C, D, E.
- 3.2 List the Programmable I/O Ports
  - 3.2.1 Demonstrate programming Bi-directional Ports in a lab setting

4.0 Interrupts

- 4.1 Interrupts
  - 4.1.1 Explain the topic of interrupts
  - 4.1.2 Relate the technical description to the human way of dealing with interrupts

4.2 Draw the flow diagram of the microcontroller interrupt process
4.3 Explain the interrupt process and *Interrupt Service Routines* (ISR)
4.4 Describe interrupt vectors and pseudovectros
4.5 Program an ISR
4.6 Illustrate the proper function of the interrupt process in action by building a circuit
4.7 Describe how to program the IRQ Interrupt pin for edge triggered or level triggered operation
4.8 Explain Maskable and Non-Maskable Interrupts

5.0 Timer Systems

5.1 Describe the Free-Running Timer
5.2 Explain the purpose for the Prescaler
5.3 The Output Compare System
- 5.3.1 Draw the block diagram of the Output Compare System
- 5.3.2 List and describe the bits in each register associated with Output Compare
- 5.3.3 Create a squarewave of a frequency
  - 5.3.3.1 Display on an oscilloscope
  - 5.3.3.2 Measure on a frequency counter to verify proper operation
- 5.3.4 Pulsewidth Modulation Techniques
  - 5.3.4.1 Demonstrate, using the output compare system, to vary the duty cycle on a waveform
  - 5.3.4.2 Control the speed of a DC motor using the varying pulsewidth

5.4 The Input Capture System (ICS)
- 5.4.1 Draw the block diagram of the ICS
- 5.4.2 Describe how the ICS is used to measure incoming waveform pulse width and frequency
- 5.4.3 List and describe the registers associated with Input Capture
- 5.4.4 Write programs required to measure Pulsewidth / Frequency of incoming square waves
- 5.4.5 Describe the process of setting up Interrupt Service routines for Input Capture

6.0 Analog to Digital (A/D) Converter

6.1 Draw the block diagram of the A/D system
6.2 Explain the *Successive Approximation* method of A/D conversion
6.3 Describe the registers associated with the A/D System
6.4 Interface to the A/D port
6.5 Perform an analog to digital conversion using the microcontroller software
6.6 Display the A/D process

7.0 Serial Communication Using Microcontrollers

7.1 Explain the theory of serial data transmissions including framing, start and stop bits, baud rates, character pacing
- 7.1.1 Draw a diagram of a typical serial frame

7.2 List and explain the registers associated with the Serial System
7.3 Send data over the serial port of a controller
7.4 Receive data over the serial port of a controller

8.0 Current Trends in Controllers

8.1 Analyze the following emerging microcontroller technologies
- 8.1.1 Servo control
- 8.1.2 Robotic systems
- 8.1.3 Artificial Intelligence (AI)

EVALUATION:

Laboratories:	15%
Assignments:	5%
Quizzes:	30%
Final Exam:	50%

DATE DEVELOPED: **DATE REVIEWED:**

REVISION NUMBER: 3 **DATE REVISED:** April 2012

Note to instructor: *Check PIRS to ensure this outline is the most current version.*