

# Microcontrollers

## Course Outcome Summary

### Course Information

Organization	Madison Area Technical College
Developers	Alberto Rodriguez
Development Date	5/24/2006
Course Number	10-605-176
Instructional Level	Associate Degree
Potential Hours of Instruction	85
Total Credits	3

### Description

Topics include microprocessor architecture, operations, programming, interfacing, analog to digital conversion, pulse width modulation, parallel and serial I/O. Lab work includes design and fabrication of a digital systems project.

### Types of Instruction

Instruction Type	Contact Hours	Credits
Classroom	34	1
Laboratory	51	2

### Textbooks

Richard Barnett, Larry O'Cull and Sarah Cox. *Embedded C Programming and the Microchip PIC*. Thomson Delmar Learning. **ISBN:** 1401837484.

Carl Bergquist. *Guide to PICMICRO Microcontrollers*. Prompt Publications. **ISBN:** 0-7906-1217-8.

John C. Skroder. *Using the M68HC11 Microcontroller A Guide to Interfacing and Programming the M68HC11 Microcontroller*. Prentice Hall. **ISBN:** 0-13-120676-1.

### Learner Supplies

Microcontrollers Parts Kit. **Quantity:** 1. **Source:** Bookstore / Parts Store.

Circuit Trainer. **Source:** Parts Store.

### Prerequisites

10-605-114 AC-DC Electronics 2

10-605-119 Digital Electronics 2

10-605-173 Embedded Programming

### Exit Learning Outcomes

#### Core Abilities

- A. Critical thinking
- B. Science and Technology

- C. Social interaction

## **Competencies**

### **A. Interpret microcontroller's architectural details**

#### **You will demonstrate your competence:**

- A. by submitting a Microcontroller Architectural Homework set independently by the due date
- B. by answering an examination on Microcontroller Architectural independently by the due date
- C. by actively participating in class on the topic of Microcontroller architecture

#### **Your performance will be successful when:**

- o Microcontroller Architectural Homework contains a presentation page
- o Microcontroller Architectural Homework set contains the correct solutions
- o Microcontroller Architectural Homework set is clearly written
- o Microcontroller Architectural Homework set neatly presented

### **B. Verify microcontroller designs using computer simulators**

#### **You will demonstrate your competence:**

- A. by submitting a Microcontroller Simulator Homework set independently by the due date
- B. by completing a Microcontroller Simulator Laboratory Test Circuit in a team of two by the due date
- C. by completing a Microcontroller Simulator Laboratory Report in a team of two by the due date
- D. by answering an examination on Microcontroller Simulators independently by the due date
- E. by actively participating in class on the topic of Microcontroller Simulator

#### **Your performance will be successful when:**

- o Microcontroller Simulator Homework set contains a presentation page
- o Microcontroller Simulator Homework set contains the correct solutions
- o Microcontroller Simulator Homework set is clearly written
- o Microcontroller Simulator Homework set neatly presented
- o Microcontroller Simulator Laboratory Test Circuit is color coded
- o Microcontroller Simulator Laboratory Test Circuit performs as predicted
- o Microcontroller Simulator Laboratory Test Circuit is correctly troubleshooted
- o Microcontroller Simulator Laboratory Report contains a presentation page
- o Microcontroller Simulator Laboratory Report is completely done in a wordprocessor
- o Microcontroller Simulator Laboratory Report contains numbered pages
- o Microcontroller Simulator Laboratory Report includes a parts list
- o Microcontroller Simulator Laboratory Report includes circuit schematics
- o Microcontroller Simulator Laboratory Report includes the final C code used in the circuit
- o Microcontroller Simulator Laboratory Report includes a system block diagram

### **C. Manipulate microcontrollers digital I/O ports using push-buttons, momentary switches and LEDs**

#### **You will demonstrate your competence:**

- A. by submitting a Microcontroller Digital I/O Homework set independently by the due

date

B. by completing a Microcontroller Digital I/O Laboratory Test Circuit in a team of two by the due date

C. by completing a Microcontroller Digital I/O Laboratory Report in a team of two by the due date

D. by answering an examination on Microcontroller Digital I/O independently by the due date

E. by actively participating in class on the topic of Microcontroller Digital I/O

**Your performance will be successful when:**

- o Microcontroller Digital I/O Homework set contains a presentation page
- o Microcontroller Digital I/O Homework set contains the correct solutions
- o Microcontroller Digital I/O Homework set is clearly written
- o Microcontroller Digital I/O Homework set neatly presented
- o Microcontroller Digital I/O Laboratory Test Circuit is color coded
- o Microcontroller Digital I/O Laboratory Test Circuit performs as predicted
- o Microcontroller Digital I/O Laboratory Test Circuit is correctly troubleshooted
- o Microcontroller Digital I/O Laboratory Report contains a presentation page
- o Microcontroller Digital I/O Laboratory Report is completely done in a wordprocessor
- o Microcontroller Digital I/O Laboratory Report contains numbered pages
- o Microcontroller Digital I/O Laboratory Report includes a parts list
- o Microcontroller Digital I/O Laboratory Report includes circuit schematics
- o Microcontroller Digital I/O Laboratory Report included the final C code used in the circuit
- o Microcontroller Digital I/O Laboratory Report includes a system block diagram

**D. Prioritize tasks via external hardware interrupts**

**You will demonstrate your competence:**

A. by submitting a Microcontroller External Hardware Interrupts Homework set independently by the due date

B. by completing a Microcontroller External Hardware Interrupts Laboratory Test Circuit in a team of two by the due date

C. by completing a Microcontroller External Hardware Interrupts Laboratory Report in a team of two by the due date

D. by answering an examination on Microcontroller External Hardware Interrupts independently by the due date

E. by actively participating in class on the topic of Microcontroller External Hardware Interrupts

**Your performance will be successful when:**

- o Microcontroller External Hardware Interrupts Homework set contains a presentation page
- o Microcontroller External Hardware Interrupts Homework set contains the correct solutions
- o Microcontroller External Hardware Interrupts Homework set is clearly written
- o Microcontroller External Hardware Interrupts Homework set neatly presented
- o Microcontroller External Hardware Interrupts Laboratory Test Circuit is color coded
- o Microcontroller External Hardware Interrupts Laboratory Test Circuit performs as predicted
- o Microcontroller External Hardware Interrupts Laboratory Test Circuit is correctly

troubleshooted

- o Microcontroller External Hardware Interrupts Laboratory Report contains a presentation page
- o Microcontroller External Hardware Interrupts Laboratory Report is completely done in a wordprocessor
- o Microcontroller External Hardware Interrupts Laboratory Report contains numbered pages
- o Microcontroller External Hardware Interrupts Laboratory Report includes a parts list
- o Microcontroller External Hardware Interrupts Laboratory Report includes circuit schematics
- o Microcontroller External Hardware Interrupts Laboratory Report includes the final C code used in the circuit
- o Microcontroller External Hardware Interrupts Laboratory Report includes a system block diagram

**E. Generate digital signals of arbitrary duty cycle and period using free running timer interrupts**

**You will demonstrate your competence:**

- A. by submitting a Microcontroller Timer Interrupts Homework set independently by the due date
- B. by completing a Microcontroller Timer Interrupts Laboratory Test Circuit in a team of two by the due date
- C. by completing a Microcontroller Timer Interrupts Laboratory Report in a team of two by the due date
- D. by answering an examination on Microcontroller Timer Interrupts independently by the due date
- E. by actively participating in class on the topic of Microcontroller Timer Interrupts

**Your performance will be successful when:**

- o Microcontroller Timer Interrupts Homework set contains a presentation page
- o Microcontroller Timer Interrupts Homework set contains the correct solutions
- o Microcontroller Timer Interrupts Homework set is clearly written
- o Microcontroller Timer Interrupts Homework set neatly presented
- o Microcontroller Timer Interrupts Laboratory Test Circuit is color coded
- o Microcontroller Timer Interrupts Laboratory Test Circuit performs as predicted
- o Microcontroller Timer Interrupts Laboratory Test Circuit is correctly troubleshooted
- o Microcontroller Timer Interrupts Laboratory Report contains a presentation page
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- o Microcontroller Timer Interrupts Laboratory Report includes a parts list
- o Microcontroller Timer Interrupts Laboratory Report includes circuit schematics
- o Microcontroller Timer Interrupts Laboratory Report includes the final C code used in the circuit
- o Microcontroller Timer Interrupts Laboratory Report includes a system block diagram

**F. Interface LCD panel displays using parallel peripherals**

**You will demonstrate your competence:**

- A. by submitting a Microcontroller LCD Panel Display Homework set independently by the due date

- B. by completing a Microcontroller LCD Panel Display Laboratory Test Circuit in a team of two by the due date
- C. by completing a Microcontroller LCD Panel Display Laboratory Report in a team of two by the due date
- D. by answering an examination on Microcontroller LCD Panel Display independently by the due date
- E. by actively participating in class on the topic of Microcontroller LCD Panel Display

**Your performance will be successful when:**

- o Microcontroller LCD Panel Display Homework set contains a presentation page
- o Microcontroller LCD Panel Display Homework set contains the correct solutions
- o Microcontroller LCD Panel Display Homework set is clearly written
- o Microcontroller LCD Panel Display Homework set neatly presented
- o Microcontroller LCD Panel Display Laboratory Test Circuit is color coded
- o Microcontroller LCD Panel Display Laboratory Test Circuit performs as predicted
- o Microcontroller LCD Panel Display Laboratory Test Circuit is correctly troubleshooted
- o Microcontroller LCD Panel Display Laboratory Report contains a presentation page
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- o Microcontroller LCD Panel Display Laboratory Report includes circuit schematics
- o Microcontroller LCD Panel Display Laboratory Report includes the final C code used in the circuit
- o Microcontroller LCD Panel Display Laboratory Report includes a system block diagram

**G. Implement microcontroller solutions to problems using the capture and compare timer modules**

**You will demonstrate your competence:**

- A. by submitting a Microcontroller Capture and Compare Timer Module Homework set independently by the due date
- B. by completing a Microcontroller Capture and Compare Timer Module Laboratory Test Circuit in a team of two by the due date
- C. by completing a Microcontroller Capture and Compare Timer Module Laboratory Report in a team of two by the due date
- D. by answering an examination on Microcontroller Capture and Compare Timer Module independently by the due date
- E. by actively participating in class on the topic of Microcontroller Capture and Compare Timer Module

**Your performance will be successful when:**

- o Microcontroller Capture and Compare Timer Module Homework set contains a presentation page
- o Microcontroller Capture and Compare Timer Module Homework set contains the correct solutions
- o Microcontroller Capture and Compare Timer Module Homework set is clearly written
- o Microcontroller Capture and Compare Timer Module Homework set neatly presented
- o Microcontroller Capture and Compare Timer Module Laboratory Test Circuit is color

coded

- o Microcontroller Capture and Compare Timer Module Laboratory Test Circuit performs as predicted
- o Microcontroller Capture and Compare Timer Module Laboratory Test Circuit is correctly troubleshooted
- o Microcontroller Capture and Compare Timer Module Laboratory Report contains a presentation page
- o Microcontroller Capture and Compare Timer Module Laboratory Report is completely done in a wordprocessor
- o Microcontroller Capture and Compare Timer Module Laboratory Report contains numbered pages
- o Microcontroller Capture and Compare Timer Module Laboratory Report includes a parts list
- o Microcontroller Capture and Compare Timer Module Laboratory Report includes circuit schematics
- o Microcontroller Capture and Compare Timer Module Laboratory Report includes the final C code used in the circuit
- o Microcontroller Capture and Compare Timer Module Laboratory Report includes a system block diagram

**H. Create an embedded point to point serial communications link using the universal synchronous/asynchronous serial port module**

**You will demonstrate your competence:**

- A. by submitting a Microcontroller Universal Asyn/Synch Serial Port Module Homework set independently by the due date
- B. by completing a Microcontroller Universal Asyn/Synch Serial Port Module Laboratory Test Circuit in a team of two by the due date
- C. by completing a Microcontroller Universal Asyn/Synch Serial Port Module Laboratory Report in a team of two by the due date
- D. by answering an examination on Microcontroller Universal Asyn/Synch Serial Port Module independently by the due date
- E. by actively participating in class on the topic of Microcontroller Universal Asyn/Synch Serial Port Module

**Your performance will be successful when:**

- o Microcontroller Universal Asyn/Synch Serial Port Module Homework set contains a presentation page
- o Microcontroller Universal Asyn/Synch Serial Port Module Homework set contains the correct solutions
- o Microcontroller Universal Asyn/Synch Serial Port Module Homework set is clearly written
- o Microcontroller Universal Asyn/Synch Serial Port Module Homework set neatly presented
- o Microcontroller Universal Asyn/Synch Serial Port Module Laboratory Test Circuit is color coded
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- o Microcontroller Universal Asyn/Synch Serial Port Module Laboratory Report includes a parts list
- o Microcontroller Universal Asyn/Synch Serial Port Module Laboratory Report includes circuit schematics
- o Microcontroller Universal Asyn/Synch Serial Port Module Laboratory Report includes the final C code used in the circuit
- o Microcontroller Universal Asyn/Synch Serial Port Module Laboratory Report includes a system block diagram

**I. Interface analog sensors and transducers using the microcontroller's A/D converter module**

**You will demonstrate your competence:**

- A. by submitting a Microcontroller A/D Converter Module Homework set independently by the due date
- B. by completing a Microcontroller A/D Converter Module Laboratory Test Circuit in a team of two by the due date
- C. by completing a Microcontroller A/D Converter Module Laboratory Report in a team of two by the due date
- D. by answering an examination on Microcontroller A/D Converter Module independently by the due date
- E. by actively participating in class on the topic of Microcontroller A/D Converter Module

**Your performance will be successful when:**

- o Microcontroller A/D Converter Module Homework set contains a presentation page
- o Microcontroller A/D Converter Module Homework set contains the correct solutions
- o Microcontroller A/D Converter Module Homework set is clearly written
- o Microcontroller A/D Converter Module Homework set neatly presented
- o Microcontroller A/D Converter Module Laboratory Test Circuit is color coded
- o Microcontroller A/D Converter Module Laboratory Test Circuit performs as predicted
- o Microcontroller A/D Converter Module Laboratory Test Circuit is correctly troubleshooted
- o Microcontroller A/D Converter Module Laboratory Report contains a presentation page
- o Microcontroller A/D Converter Module Laboratory Report is completely done in a wordprocessor
- o Microcontroller A/D Converter Module Laboratory Report contains numbered pages
- o Microcontroller A/D Converter Module Laboratory Report includes a parts list
- o Microcontroller A/D Converter Module Laboratory Report includes circuit schematics
- o Microcontroller A/D Converter Module Laboratory Report includes the final C code used in the circuit
- o Microcontroller A/D Converter Module Laboratory Report includes a system block diagram

**J. Control bi-directional DC motors via pulse width modulation**

**You will demonstrate your competence:**

- A. by submitting a Microcontroller Pulse Width Modulation Module Homework set

independently by the due date

B. by completing a Microcontroller Pulse Width Modulation Module Laboratory Test Circuit in a team of two by the due date

C. by completing a Microcontroller Pulse Width Modulation Module Laboratory Report in a team of two by the due date

D. by answering an examination on Microcontroller Pulse Width Modulation Module independently by the due date

E. by actively participating in class on the topic of Microcontroller A/D Converter Module

**Your performance will be successful when:**

o Microcontroller Pulse Width Modulation Module Homework set contains a presentation page

o Microcontroller Pulse Width Modulation Module Homework set contains the correct solutions

o Microcontroller Pulse Width Modulation Module Homework set is clearly written

o Microcontroller Pulse Width Modulation Module Homework set neatly presented

o Microcontroller Pulse Width Modulation Module Laboratory Test Circuit is color coded

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o Microcontroller Pulse Width Modulation Module Laboratory Report includes circuit schematics

o Microcontroller Pulse Width Modulation Module Laboratory Report includes the final C code used in the circuit

o Microcontroller Pulse Width Modulation Module Laboratory Report includes a system block diagram

**K. Interface external memory to microcontrollers**

**You will demonstrate your competence:**

A. by submitting a Microcontroller External Memory Homework set independently by the due date

B. by completing a Microcontroller External Memory Laboratory Test Circuit in a team of two by the due date

C. by completing a Microcontroller External Memory Laboratory Report in a team of two by the due date

D. by answering an examination on Microcontroller External Memory independently by the due date

E. by actively participating in class on the topic of Microcontroller A/D Converter Module

**Your performance will be successful when:**

- o Microcontroller External Memory Homework set contains a presentation page
- o Microcontroller External Memory Homework set contains the correct solutions
- o Microcontroller External Memory Homework set is clearly written
- o Microcontroller External Memory Homework set neatly presented
- o Microcontroller External Memory Laboratory Test Circuit is color coded
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- o Microcontroller External Memory Laboratory Report includes a parts list
- o Microcontroller External Memory Laboratory Report includes circuit schematics
- o Microcontroller External Memory Laboratory Report includes the final C code used in the circuit
- o Microcontroller External Memory Laboratory Report includes a system block diagram