Motors and Control Circuits
Course Outcome Summary

Course Information

Organization	Madison Area Technical College
Developers	Jacob Eapen
Development Date	6/6/2005
Course Number	605-143
Alternate Title	Motors and Controls
Instructional Level	Associate Degree
Instructional Area	Electronic Technology
Division	Agriscience, Apprentice, Technical and Industrial
Department	Electronic Technology
Potential Hours of Instruction	72
Total Credits	3

Description
Course covers AC and DC motors, stepping motors, feedback systems, servo controllers, sensors, relays, SCRs Triacs, MOSFETs, programmable logic controllers, industrial controllers and applied systems and online microcomputer controls.

Types of Instruction

Instruction Type	Contact Hours	Credits
Classroom Presentation	36	2
On-Campus Lab	36	1

Textbooks

Andrew Parr (Ed.). *Industrial Control Handbook*. Industrial Press, Inc.. **Edition:** 3rd Edition.

Terry Bartlet. *Industrial Control Electronics*. Delmar Publication. **Edition:** 2nd Edition.

Gary Dunning. *Introduction to Programmable Logic Controllers*. Delmar Publication. **Edition:** 2nd Edition.

Learner Supplies

Screwdriver, Wire Stripper, Pliers, and multi-meter. **Quantity:** 1 each. **Price:** variable.

Prerequisites

10-605-115
10-605-173
10-605-176

Competencies

A. Program in LabView

You will demonstrate your competence:

A.1. By Submitting completed programming assignments

Your performance will be successful when:

A.1. The Programming assignment is complete.

A.2. The Programming assignment is printed.

A.3. The Programming assignment inculdes both the control Panel and VI for each program.

A.4. The Programming assignment is submitted in digital format.

Learning Objectives

A.1. Set up a block diagram in LabView

A.2. Learn to set up the corresponding front panel

A.3. Learn about different number types in LabView

A.4. Learn about case structures

A.5. Explore different display graph types in LabView

A.6. Learn how to simulate and troubleshoot (test) the program

A.7. Complete LabView programs incorporating the various loop structures

B. Design and Set up D/A and A/D

You will demonstrate your competence:

B.1. By building an appropriate D/A and A/D conversion set up to interface between LabView, the heater and the sensor

Your performance will be successful when:

B.1. you read an input analog signal using LabView

B.2. you write an output digital signal using LabView for Pulse Width Modulation

Learning Objectives

B.1. Review programming using LabView

B.2. Learn how to input and output data in LabView using NIDAQ

B.3. Learn to set up an outlet box unit to control the heater

B.4. Determine how to interface the outlet box using LabView

B.5. Learn about Pulse Width Modulation

C. Determine appropriate sensor for application

You will demonstrate your competence:

C.1. By selecting appropriate sensor for a chosen application

Your performance will be successful when:

C.1. you test each of the available sensor

C.2. you graph the Temperature (or voltage or resistance) vs. Time for each sensor to determing response time.

C.3. you determine step response for each sensor for assessing overshoot, steady state error etc.

C.4. you deterime cost for each sensor

C.5. you determine the temperature characteristics for each sensor

C.6. The sensor you select is water proofed appropriately

Learning Objectives

C.1. Discuss the temperature sensor selection process.

C.2. Discuss the converting output of sensor to a temperataure reading

C.3. Discuss how to obtain temperature characteristics for available sensors

C.4. Discuss how to obtain rise time for available sensors

C.5. Discuss how to obtain response time for available sensors

C.6. Discuss how to obtain sensitivity, range for available sensors

C.7. Discuss how to obtain temperature characteristics, rise time, response time, sensitivity, range for available sensors

C.8. Prepare sensor appropriately

C.9. Determine sensor output in LabView

D. Build Signal Conditioning Circuits to interface transducer

You will demonstrate your competence:

D.1. By building suitable signal conditioning circuit

Your performance will be successful when:

D.1. The Signal conditioning circuit is built on a bread board (extra credit for PCB)

D.2. The Signal conditioning circuit is built using an op-amp amplifier circuit

D.3. The Signal conditioning circuit is calibtrated for an output range of 0-5 Volts for a temperature variation of 30-100 degrees C.

Learning Objectives

D.1. Discuss the working of an op-amp.

D.2. Select the appropriate op-amp amplifiers.

D.3. Build a suitable signal conditioning circuit to transform the output of the sensor to an appropriate value for computer input

D.4. Determine how to read the sensor output in LabView.

E. Implement Basic Bang Bang (On/Off) control and Bang Bang control with limits

You will demonstrate your competence:

E.1. Submit a water temperature control system

Your performance will be successful when:

E.1. Temperature control system includes appropriate sensor

E.2. Temperature control system is done using LabView

E.3. Temperature control system - sensor has suitable signal conditioning circuit

E.4. Temperature control system has an accurate temperature display.

E.5. Temperature control system maintains temperature of water within + or - 5 degrees.

Learning Objectives

E.1. Determine Characteristics for each sensor.

E.2. Determine appropriate sensor for the application using characteristics, cost, availability etc.

E.3. Build suitable signal conditioning circuit to convert output of sensor to comply with the input of the Data acquisition card.

E.4. Program the VI to set up Bang Bang (ON/OFF) control.

E.5. Test the system to check the temperature range.

E.6. Program the VI to set up Bang Bang control with limits.

F. Implement Temperature Control using Proportional, Integral and Derivative Control

You will demonstrate your competence:

F.1. By submitting a completed project for a temperature control system using PID.

Your performance will be successful when:

F.1. Temperature control system uses appropriate sensor

F.2. Temperature control system is done using LabView (or appropriate software)

F.3. Temperature control system - sensor has suitable signal conditioning circuit

F.4. Temperature control system has an accurate temperature display.

F.5. Temperature control system maintains temperature of field within + or - 1 degrees.

Learning Objectives

F.1. Learn about Proportional Control

F.2. Learn advantages of PID control

F.3. Learn to implement PID control

F.4. Learn to tune PID coefficients to achieve objective

F.5. Measure output parameters

F.6. Evaluate output parameters to meet specifications

G. Investigate various motors for applications

You will demonstrate your competence:

G.1. By submitting the lab data sheet
G.2. By demonstrating the assigned operations in presence of instructor

Your performance will be successful when:

G.1. The Lab data sheet is complete.
G.2. The Lab data sheet has instructors initials for all stages.

Learning Objectives

G.1. Learn to read motor specifications
G.2. Learn the basic principles of motors
G.3. Learn about different types of motors
G.4. Evaluate motors based on torque speed characteristics
G.5. Learn about applications for various motors
G.6. Learn about starting issues in motors
G.7. Learn about speed control issues in (AC/DC) motors
G.8. Measure speed of a motor using a tachometer
G.9. Run various DC/AC motors for applications

H. Implement AC motor control using Frequency Drives

You will demonstrate your competence:

H.1. By submitting the lab data sheet
H.2. By demonstrating the assigned operations and connection in presence of instructor

Your performance will be successful when:

H.1. The Lab data sheet is complete.
H.2. The Lab data sheet has instructors initials for all stages including demonstrations.

Learning Objectives

H.1. Set up a frequency drive connections
H.2. Program a variable frequency (VF) drive
H.3. Connect an AC motor appropriately to a VF drive
H.4. Control an AC motor using a VF drive

I. Implement stepper motor control using an H-Bridge

You will demonstrate your competence:

I.1. By submitting the lab data sheet
I.2. By demonstrating the assigned operations in presence of instructor

Your performance will be successful when:

I.1. The Lab data sheet is complete.
I.2. The Lab data sheet has instructors initials for all stages including demonstrations.

Learning Objectives

I.1. Learn about H-bridge circuits
I.2. Learn about stepper motors
I.3. Control stepper motor using H-bridge
I.4. Measure current and Voltage to the motor

J. Program microcontrollers in C

You will demonstrate your competence:

J.1. By Submitting completed programming assignments
J.2. By demonstrating the assigned task on the Microcontroller board
J.3. By submitting a lab data sheet

Your performance will be successful when:

J.1. The Programming assignment is complete.
J.2. The Programming assignment is printed.
J.3. The Programming assignment inculdes both the C code and the output

J.4. The Programming assignment is submitted in digital format.
J.5. you download the program onto the microcontroller
J.6. you demonstrate the assigned task on the microcontroller board
J.7. The lab data sheet should be complete
J.8. The lab data sheet should have the instructors signature at every stage

Learning Objectives

J.1. Program in C language
J.2. Learn about microcontroller architecture
J.3. Program a microcontroller
J.4. Test the output of a microcontroller

K. Implement controls applications using microcontrollers

You will demonstrate your competence:

K.1. By submitting a completed project for a motor control system using microcontrollers.
K.2. By submitting a brief report for the project

Your performance will be successful when:

K.1. The report should include the C code
K.2. The report should include the specifications of the motor (system) being controlled
K.3. The report should include a brief description of the control process
K.4. your project meets the requirements described in the project handout
K.5. you should demonstrate the functioning project to the instructor

Learning Objectives

K.1. Learn about microcontroller architecture
K.2. Program a microcontroller
K.3. Test the output of a microcontroller
K.4. Learn to interface systems to the I/O port of a microcontroller
K.5. learn to communicate using a microcontroller (serial)

L. Program Programmable Control Logic (PLC) using Ladder Logic

You will demonstrate your competence:

L.1. By Submitting completed programming assignments
L.2. By demonstrating the assigned task on the Allen Bradley PLC system
L.3. By submitting a lab data sheet

Your performance will be successful when:

L.1. The Programming assignment is complete.
L.2. The Programming assignment is printed.
L.3. The Programming assignment inculdes the ladder logic diagram
L.4. The Programming assignment is submitted in digital format.
L.5. you suitably interface the input/output devices to the PLC
L.6. you demonstrate the assigned task using the PLC system
L.7. The lab data sheet should be complete
L.8. The lab data sheet should have the instructors signature at every stage

Learning Objectives

L.1. Learn Ladder Logic programming
L.2. Interface systems to the I/O ports of a PLC
L.3. Program a PICO
L.4. Connect I/O to a PICO

M. Implement a control system using PLC's

You will demonstrate your competence:

M.1. By submitting a completed controls project using PLC

M.2. By submitting a brief report for the project

Your performance will be successful when:

M.1. The report should include the Ladder Logic

M.2. The report should include the specifications of the system being controlled

M.3. The report should include a brief description of the control process

M.4. your project meets the requirements described in the project handout

M.5. you should demonstrate the functioning project to the instructor

Learning Objectives

M.1. Evaluate current and voltage limits to PLC I/O

M.2. Interface systems to the I/O ports of a PLC

M.3. Learn to do real time control using PLC's

M.4. Learn to troubleshoot PLC's

M.5. Update ladder logic during process execution