I. **OVERVIEW**

The following information will appear in the 2011 - 2012 catalog

**MFGA 226 Motors, Controls, and Controllers**

3 Units

Also offered as: ELTEC - 226: Motors, Controls and Controllers, INTEC - 226: Motors, Controls and Controllers

Formerly listed as: INTEC - 226: Motors, Controls and Controllers

Prerequisite: Satisfactory completion of ELTEC 208 or INTEC 208.

An introduction to AC and DC motors and control systems. Emphasis on system troubleshooting. Use and programming of AC and DC systems.

Field trips might be required. (A-F Only) Lecture /Lab

Transfer: (CSU)

II. **LEARNING CONTEXT**

Given the following learning context, the student who satisfactorily completes this course should be able to achieve the goals specified in Section III, Desired Learning:

A. **COURSE CONTENT**

1. **Required Content:**

   The content listed below is presented in a fashion that provides the student with both theoretical and practical skills using instrumentation and instrumentation systems. An equal amount of class time is devoted to each topic listed below.

   a. Electrical Tools, Instruments, and Safety

      i. Voltage, Current and Resistance

      ii. Sources of power generation

      iii. Power

      iv. Phase Shaft

      v. Ohm’s Law

      vi. Power Formula

      vii. Parallel and Series Circuits

   b. Electrical Tools, Instruments, and Safety

      i. Hand Tools

      ii. Organization

      iii. Tool Safety

      iv. Electrical Instruments

      v. Digital vs. Analog Displays
vi. Informational Output Devices
vii. Grounding
viii. Lockout/Tag Out
ix. Fire Safety
c. Electrical Symbols and Line Diagrams
   i. Control Language
   ii. Types of Wiring Diagrams
   iii. Control Circuits
d. Logic Applied to Line Diagrams
   i. Rule for Line Diagrams
   ii. Cross-Referencing
   iii. Signals, Decisions and Actions
   iv. Logic Functions
   v. Common Control Circuits
e. AC Manual Contactors and Motor Starters
   i. Manual Switching
   ii. Manual Contactors
   iii. Manual Starters
   iv. Interlocking
   v. Overload Protection
   vi. Start Selection
f. Magnetism and Magnetic Solenoids
   i. Magnetism
   ii. Solenoids
   iii. Solenoid Characteristics
   iv. Solenoid Selection
   v. Solenoid Applications
   vi. Solenoid Failure
g. AC/DC Contactors and Motor Starts
   i. Contractors
ii. Two-wire control
iii. Three-wire control
iv. Control Circuit Voltage
v. Magnetic Motor Starters
vi. Overloads
vii. Contactor Modifications

h. Control Devices
i. Industrial Pushbuttons
ii. Selector Switches
iii. Joysticks
iv. Limit Switches
v. Daylight Switches
vi. Pressure Switches
vii. Flow Switches
viii. Smoke and Gas Switches
ix. Level Switches
x. Troubleshooting Control Devices

i. Reversing Motor Circuits
i. 3-Phase Motors
ii. Single-Phase Motors
iii. DC Motors
iv. Reversing Motors Using Manual Starters
v. Reversing Motors Using Magnetic Starters
vi. Reversing Motors Using Drum Switches

j. Power Distribution Systems
i. Distribution Networks
ii. Phase Connections
iii. Substations
iv. Switchboards
v. Motor Control Centers
vi. Feeders and Bus-ways
vii. Grounding
viii. Troubleshooting Fuses and Circuit Boxes

k. Reduced-Voltage Starting
   i. DC Motor Reduced-Voltage Starting
   ii. Squirrel-Cage Motor Reduced-Voltage Starting
   iii. Primary Resistor Starting
   iv. Autotransformer Starting
   v. Part-winding Starting
   vi. Wye-Delta Starting
   vii. Solid-State Starting
   viii. Starting Methods Comparison

l. Accelerating and Decelerating Methods
   i. Braking
   ii. Plugging
   iii. Electric Braking
   iv. Speed Control
   v. Work
   vi. Torque
   vii. Horsepower
   viii. Speed-Torque-Horsepower Relationship
   ix. DC Motor Speed Control
   x. AC Motor Speed Control
   xi. Variable Frequency Drives
   xii. Acceleration and Deceleration

m. Preventive Maintenance and Troubleshooting
   i. Inspection
   ii. Lubricating
   iii. Voltage
   iv. Phase Sequencing
   v. AC/DC Voltage Variations
   vi. Over-cycling
vii. Belt Tensioning and Adjusting
viii. Altitude Correction
ix. Troubleshooting
x. Testing

2. **Required Lab Content:**

Laboratory applied experience utilize Lab Volt Equipment Technology to carry out installation and troubleshooting experiences where students follow handouts, log information and perform industrial related experiences linked to lecture topics.

a. Lab Volt Electric Motor Trainer Exercises
b. Lab Volt Motor Control Trainer Exercises
c. Lab Volt Industrial System Simulated Exercises
d. CBT Students Tutorial Exercises

**B. ENROLLMENT RESTRICTIONS**

1. **Prerequisites**

Satisfactory completion of ELTEC 208 or INTEC 208.

2. **Requisite Skills**

*Before entering the course, the student will be able to:*

a. Recognize and use common electrical and electronic instruments; digital multi-meters, voltage sources, oscilloscope
b. Describe and measure the characteristics of direct current circuits
c. Describe and measure the characteristics of the alternative current parameters such as peak-to-peak, RMS, and average values of sinusoidal signals
d. Identify and troubleshoot faulty control devices in both theory and actual situations
e. Identify and describe the general purposes of transformers and electrical and electronic circuitry

**C. HOURS AND UNITS**

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<th>INST METHOD</th>
<th>TERM HOURS</th>
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<tr>
<td>Lab</td>
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D. METHODS OF INSTRUCTION (TYPICAL)
Instructors of the course might conduct the course using the following method:

1. Technical Manuals
2. Class lecture
3. Lab demonstrations
4. Laboratory experiments
5. Group discussion
6. Guest Speakers
7. Multi media: video, online material and CBTs
8. Lab Volt Trainer Technology Equipment

E. ASSIGNMENTS (TYPICAL)

1. EVIDENCE OF APPROPRIATE WORKLOAD FOR COURSE UNITS
Time spent on coursework in addition to hours of instruction (lecture hours)
   a. Weekly Chapter Reading Assignments
   b. Weekly Homework Assignments
   c. Per Term Reading Assignments on Technical Manuals
   d. Per Term Preparation for various Laboratory Assignments
   e. Per Term Preparation for Mid Term Exam
   f. Per Term Preparation for Final Exam

2. EVIDENCE OF CRITICAL THINKING
Assignments require the appropriate level of critical thinking
   a. Explain and contrast how an AC and a DC motor drive change motor speed.
   b. What are the four most common gates in digital electronics?
   c. How many circuits can single-throw contacts control? Explain.
   d. What are the benefits of using a solid-state reduced-voltage starter?
   e. How can an additional reduction in current be accomplished in a primary resistor starting?

F. TEXTS AND OTHER READINGS (TYPICAL)

2. Other: INTEC/ELTEC 226 Lab Manual – Compiled by Instructor, available in Bookstore
III. DESIRED LEARNING

A. COURSE GOAL
As a result of satisfactory completion of this course, the student should be prepared to:

(1) design, draw and test a functioning ladder diagram for a given type of motor control system using appropriate control language, labeling, numbering, and symbology and (2) analyze and interpret control language, identify control devices, and connect a properly functioning motor control circuit.

B. STUDENT LEARNING GOALS
Mastery of the following learning goals will enable the student to achieve the overall course goal.

1. Required Learning Goals
Upon satisfactory completion of this course, the student will be able to:

   a. Detect the phenomena of magnetism and its application to motors
   b. Identify and explain the concept of electromotive force
   c. Identify and explain the advantages and disadvantages of single-phase and three-phase power for application to motors
   d. Identify and apply schematic symbols used in motor control circuits
   e. Draw, label and troubleshoot a hard-wired relay control circuit
   f. Recognize the operating principles and be able to specify the advantages and disadvantages of various types of AC and DC motors
   g. Recognize and apply preventative maintenance procedures for common AC and DC motors

2. Lab Learning Goals
Upon satisfactory completion of the lab portion of this course, the student will be able to:

   a. Program a variable-frequency drive controller given a set of operating conditions.
   b. Program a DC Drive controller given a set of operating conditions.
   c. Correctly identify motor specifications that will satisfy a given industrial application.
   d. Successfully troubleshoot the following faulty industrial motor control devices and systems: motor starters, relays and contactors, two-wire control systems, three-wire control systems, separate voltage control systems, hands-off-automatic control systems, multiple pushbutton starting systems, mechanical interlocking for reversing control systems, pushbutton interlocking for reversing control systems, primary resistor starter systems

IV. METHODS OF ASSESSMENT (TYPICAL)

A. FORMATIVE ASSESSMENT

1. Quizzes
2. Laboratory Exercises
3. Homework Assignments
4. Class discussion participation

B. SUMMATIVE ASSESSMENT
1. Mid Term
2. Final Exam