Electrical Control Systems

The JobMaster® Electrical Control Systems teaches the specialized skills required for today’s industrial technicians. JobMaster provides a superior blended learning solution for automated manufacturing training by combining industrial-grade components with engaging e-learning content. The training system emphasizes hands-on experiments involving AC/DC, magnetism, electrical components, and the design of series and parallel circuits.

JobMaster courses are entirely skill-based, consisting of individual exercises that reproduce essential tasks performed by maintenance technicians, equipment operators, and machine repairmen.

**Course Outline**

**Electric Circuit Protection & Monitoring**

**Course Outline**

- Drawing and Reading Circuit Protection Symbols
- Sizing Fuses
- Installing Fuses
- Testing and Replacing Fuses
- Performing Preventive Maintenance and Troubleshooting Fuse Blocks
- Sizing Circuit Breakers
- Testing and Resetting a Circuit Breaker
- Installing and Setting an Overload Relay
- Installing and Setting Up a Three-Phase Monitor

**Materials Required (sold separately)**

- JobMaster Learning Station
- Power Control Panel (220V) 3-Phase
- Digital Multimeter (Fluke Model 115 or equivalent)

* International step-down transformer package (Order #10-PC09-0000) required for international applications.

**Prerequisite Courses**

- Electromagnetic Motor Starters

**Materials Included**

- Electric Circuit Protection & Monitoring, LearnMate course, Lab
- Teachers’ Guide

**Hardware Specifications**

- **Panel E019 Capacitor-Start Motor**
  - Panel type: Double
  - 1 1-phase motor, .08hp, 1725rpm
  - 2 Fault switch, 4A, 250V push-on/push-off momentary

- **Panel E022 Manual Starter**
  - Panel type: Single
  - 1 Single-phase fractional horsepower starter (FHP)
  - 1 Thermal overload unit (0.41 to 16 A) with pilot light
  - 1 Non-reversing manual starter with bimetallic thermal trip and magnetic trip
  - 2 Fault switch, 4A, 250V push-on/push-off momentary

- **Panel E030 Circuit Overload Protection & Monitoring**
  - Panel type: Double
  - 1 Relay, overload
  - 1 Circuit breaker, 2A
  - 2 Fault switch, 250V push-on/push-off momentary
  - 1 3-Phase line monitor
  - 3 Midget fuse 2A
  - 1 Midget fuse block, 30A, 3-pole

**Transformers**

**Course Outline**

- Applying Transformer Principles
- Drawing and Reading Transformer Symbols
- Installing a Control Transformer
- Troubleshooting Transformers
- Connecting a Transformer as an Auto Transformer for Buck and Boost Operation
- Connecting Transformers in Delta and Wye
- Inspecting and Servicing a Transformer
- Sizing a Transformer

**Materials Required (sold separately)**

- JobMaster Learning Station
- Power Control Panel (220V) 3-Phase
- Digital Multimeter (Fluke Model 115 or equivalent)

* International step-down transformer package (Order #10-PC09-0000) required for international applications.

**Materials Included**

- Transformers, LearnMate course, Lab
- Teachers’ Guide

**Hardware Specifications**

- **Panel E003: Three-Phase Transformer**
  - Panel type Double
  - 1 Midget fuse 2A
  - 1 Midget fuse block, 30A
  - 3 0.05kVA, 50/60 Hz, Step-down transformer
## Electrical Control Systems (continued)

### Electric Motors

Electric Motors presents a wide array of hands-on activities using industrial motors, including three-phase, split-phase and capacitor-start motors.

#### Course Outline
- Connecting and Operating a Split-Phase Motor
- Connecting and Operating a Capacitor-Start Motor
- Connecting and Operating a Shaded-Pole Motor
- Connecting and Operating a DC Motor
- Performing Visual Inspection
- Lubricating Motors
- Performing DMM and Motor Megger Tests
- Troubleshooting a Split-Phase Motor
- Troubleshooting a Capacitor-Start Motor
- Troubleshooting a Shaded-Pole Motor
- Troubleshooting a DC Motor
- Testing Motors With Adjustable Loads

#### Materials Required (sold separately)
- JobMaster Learning Station
- Power Control Panel [220V] 3-Phase
- Clamp-on ammeter (Fluke Model 115 or equivalent)
- Insulation tester (Fluke Model 108 or equivalent)
- Strobe or Photo Tachometer

* International step-down transformer package (Order #10-PC09-0000) required for international applications. DMM (Fluke Model 115 or equivalent)

### Electromagnetic Motor Starters

Electromagnetic Motor Starters guides students through hands-on activities using industrial motor controls.

#### Course Outline
- Connecting a Control Relay Seal-In Circuit
- Connecting, Adjusting, and Operating a Single Magnetic Starter
- Testing and Resetting Overload Protection
- Connecting, Adjusting, and Operating a Three-phase Reversing Starter
- Connecting and Operating a Magnetic Starter for Jogging
- Troubleshooting a Three-phase Motor Control Circuit
- Troubleshooting a Reversing Three-phase Motor Control Circuit
- Performing Preventive Maintenance on Magnetic Starters

#### Materials Required (sold separately)
- JobMaster® Learning Station
- Power Control Panel [220V] 3-Phase
- DMM [Fluke Model 115 or equivalent]

* International step-down transformer package (Order #10-PC09-0000) required for international applications.

### Electromagnetic Starters Included

Electromagnetic Motor Starters, LearnMate course, Lab

#### Teachers’ Guide
- [9] Flexponent™ panels:
  - Panel E002: START-STOP Control
  - Panel E004: Single Magnetic Starter
  - Panel E005: START-REVERSE-STOP Switch
  - Panel E006: Reversing Magnetic Starter
  - Panel E010: Three-Phase Motor
  - Panel E012: Transformer
  - Panel E016: Analog Relay
  - Panel E154: Lamps and Switches
  - Panel E155: HOA Switch

#### Materials Included

**Panel E002: Analog Relay**
- Panel E007: SCR Speed Controller
- Panel E012: Transformer
- Panel E027: Shaded-Pole Motor
- Panel E154: Lamps and Switches
- Panel E155: Dissectible Motor
- Panel E010: Three-Phase Motor
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E003: DC Motor**
- Panel E010: Three-Phase Motor
- Panel E012: Transformer
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E004: Single Magnetic Starter**
- Panel E007: SCR Speed Controller
- Panel E012: Transformer
- Panel E027: Shaded-Pole Motor
- Panel E154: Lamps and Switches
- Panel E155: Dissectible Motor
- Panel E010: Three-Phase Motor
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E005: START-REVERSE-STOP Switch**
- Panel E012: Transformer
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E007: SCR Speed Controller**
- Panel E012: Transformer
- Panel E027: Shaded-Pole Motor
- Panel E154: Lamps and Switches
- Panel E155: Dissectible Motor
- Panel E010: Three-Phase Motor
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E010: Three-Phase Motor**
- Panel E012: Transformer
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E012: Transformer**
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E019: Capacitor-Start Motor**
- Panel E012: Transformer
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E034: DC Motor**
- Panel E010: Three-Phase Motor
- Panel E012: Transformer
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E065: Split-Phase Motor**
- Panel E012: Transformer
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E066: Adjustable Motor Load**
- Panel E012: Transformer
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E154: Lamps and Switches**
- Panel E010: Three-Phase Motor
- Panel E012: Transformer
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E155: HOA Switch**
- Panel E010: Three-Phase Motor
- Panel E012: Transformer
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E002: START-STOP Control**
- Panel E007: SCR Speed Controller
- Panel E012: Transformer
- Panel E027: Shaded-Pole Motor
- Panel E154: Lamps and Switches
- Panel E155: Dissectible Motor
- Panel E010: Three-Phase Motor
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E004: Single Magnetic Starter**
- Panel E007: SCR Speed Controller
- Panel E012: Transformer
- Panel E027: Shaded-Pole Motor
- Panel E154: Lamps and Switches
- Panel E155: Dissectible Motor
- Panel E010: Three-Phase Motor
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E006: Reversing Magnetic Starter**
- Panel E007: SCR Speed Controller
- Panel E012: Transformer
- Panel E027: Shaded-Pole Motor
- Panel E154: Lamps and Switches
- Panel E155: Dissectible Motor
- Panel E010: Three-Phase Motor
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E010: Three-Phase Motor**
- Panel E012: Transformer
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E012: Transformer**
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E019: Capacitor-Start Motor**
- Panel E012: Transformer
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E034: DC Motor**
- Panel E010: Three-Phase Motor
- Panel E012: Transformer
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E065: Split-Phase Motor**
- Panel E010: Three-Phase Motor
- Panel E012: Transformer
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E066: Adjustable Motor Load

**Panel E066: Adjustable Motor Load**
- Panel E010: Three-Phase Motor
- Panel E012: Transformer
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E012: Transformer**
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E019: Capacitor-Start Motor**
- Panel E012: Transformer
- Panel E016: Analog Relay
- Panel E154: Lamps and Switches
- Panel E155: HOA Switch

**Panel E034: DC Motor**
- Panel E010: Three-Phase Motor
- Panel E012: Transformer
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load

**Panel E065: Split-Phase Motor**
- Panel E010: Three-Phase Motor
- Panel E012: Transformer
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E066: Adjustable Motor Load

**Panel E066: Adjustable Motor Load**
- Panel E010: Three-Phase Motor
- Panel E012: Transformer
- Panel E019: Capacitor-Start Motor
- Panel E034: DC Motor
- Panel E065: Split-Phase Motor
- Panel E066: Adjustable Motor Load
### Relays, Timers & Time-delay Relays

Relays, Timers & Time-delay Relays features hands-on skills in installing, programming and maintaining control devices used in industrial electric circuits.

**Course Outline**
- Connecting, Programming, and Operating Analog On-Delays and Off-Delay Relays
- Using Analog Relays and Motors
- Connecting, Programming, and Operating Digital Interval, Repeat Cycle, and One Shot Relays
- Using Digital Relays and Motors
- Connecting and Operating Electric Timers
- Using Electric Timers and Motors
- Troubleshooting Relays
- Performing Preventive Maintenance on Relays

**Materials Required**
- (2) Flexponent™ panels:
  - Panel E017: Digital Relay
  - Panel E041: Electric Timer

**Hardware Specifications**
- Panel E017: Digital Relay
  - Panel type: Single
  - 4 Fault switch, 4A, 250V, push-on/push-off momentary
  - 1 Relay, 120V 2PDT 15A LED Test PB
  - 1 Socket relay
  - 1 Time-delay relay, DPDT, multi-function
  - 1 Sockel relay, 11 pin octal
- Panel E041: Electric Timer
  - Panel type: Single
  - 1 Timer mechanism, electronic

### Solid-State Starters

Solid-State Starters guides trainees through installing, operating and troubleshooting solid-state starters used in electric motor circuits.

**Course Outline**
- Applying Solid-State Principles
- Connecting and Operating a Solid-State Starter
- Adjusting a Solid-State Starter
- Testing Solid-State Starters
- Troubleshooting Solid-State Starters

**Materials Required**
- JobMaster Learning Station
- Power Control Panel (220V) 3-Phase
- Digital multimeter (Fluke Model 115 or equivalent)

**Prerequisite Courses**
- Electric Motors

**Hardware Specifications**
- Panel E024: Solid-State Starter
  - Panel type: Single
  - 1 Solid-state soft starter, 1/2HP, 100-240V control voltage, 200-208V 3PH, 3A output
  - 2 Fault switch, 4A, 250V push-on/push-off momentary

### Variable Frequency Drives (VFD)

Variable Frequency Drives delivers comprehensive coverage of installing, operating and troubleshooting variable frequency drives in motor control circuits.

**Course Outline**
- Applying VFD Principles
- Connecting & Operating a Variable Frequency Drive
- Adjusting VFD Operating Parameters
- VFD Protection Parameters & Inputs/Outputs
- Troubleshooting the VFD
- Understanding Additional VFD Features

**Materials Required**
- JobMaster Learning Station
- Power Control Panel (220V) 3-Phase
- Digital multimeter (Fluke Model 115 or equivalent)
- Learning Management System (LMS)

**Prerequisite Courses**
- Electric Motors

**Hardware Specifications**
- Panel E027: Variable Frequency Drive (Mitsubishi)
  - Panel type: Single
  - 1 AC adjustable drive, 115V, 0.5hp, 1 phase in 3 phase out
  - 1 AC adjustable drive, 115V, 0.5hp, 1 phase in 3 phase out
  - 1 AC adjustable drive, 115V, 0.5hp, 1 phase in 3 phase out
  - 2 Fault switch, 4A, 250V push-on/push-off momentary

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### Prerequisite Courses

- Electromagnetic Motor Starters
- Digital Interval, Repeat Cycle, and One Shot Relays
- Solid-State Starters, LearnMate course, Lab
- Electric Timers & Time-delay Relays, LearnMate course, Lab
- Panel E001: START-STOP Control
- Panel E011: Limit Switch
- Panel E018: Liquid Level and Pressure Switch
- Panel E126: Proximity & Photoelectric Switch
- Panel E153: AC/DC Circuit
DC Motor Control

DC Motor Control delivers hands-on skills in installing, operating and troubleshooting DC drives used in electric motor circuits.

Course Outline
- Demonstrating DC Drive Principles
- Connecting and Operating a SCR Speed Controller
- Connecting and Operating a PWM Speed Controller
- Connecting, Setting-up, and Operating a DC Drive
- Connecting and Operating Braking Controls
- Testing a DC Drive
- Troubleshooting a DC Drive
- Performing Preventative Maintenance

Prerequisite Courses
Electrical Motors

Materials Required (sold separately)
- JobMaster® Learning Station
- Power Control Panel: (120V)*
- Digital multimeter (Fluke Model 115 or equivalent)

* International step-down transformer package (Order #10-PC09-0000) required for international applications.

Materials Included
- DC Motor Control, LearnMate course, Lab
- Teachers' Guide
- 17 Flexponent™ panels:
  ○ Panel E007: SCR Speed Controller
  ○ Panel E017: Digital Relay
  ○ Panel E025: F-O-R Switch & Potentiometer
  ○ Panel E034: DC Motor
  ○ Panel E038: PWM Motor Control
  ○ Panel E048: Inertial Load
  ○ Panel E071: Regenerative Four Quadrant DC Drive

Hardware Specifications
- Panel E007: SCR Speed Controller
  - Panel type: Single
  - 1 115V DC SCR speed control
  - 2 Fault switch, 4A, 250V push-on/push-off momentary
- Panel E017: Digital Relay
  - Panel type: Single
  - 1 Relay, 120V 2PDT 15A LED test PB
  - 1 Socket relay
  - 1 Time-delay relay, DPDT, multi-function
  - 1 Socket relay, 11 pin octal
  - 4 Fault switch, 4A, 250V push-on/push-off momentary
- Panel E025: F-O-R Switch & Potentiometer
  - Panel type: Single
  - 1 Toggle switch, SPDT, On-Off-On, contact rating 125V/15A, 250V/10A
  - 1 Potentiometer, linear, 5k ohm, 1/2 w
- Panel E034: DC Motor
  - Panel type: Double
  - 1 Motor, 90VDC, 13hp
  - 1 Fault switch, 4A, 250V push-on/push-off momentary
- Panel E038: PWM Motor Control
  - Panel type: Single
  - 1 Pulse Width Modulated (PWM) speed control, 115VAC input, 1 HP, 10A, 0-130VDC output
- Panel E048: Inertial Load
  - Panel type: Single
  - 1 Rotor, balanced, 4” diameter, 1141 steel
  - 1 Flanged bearing and bearing mount
- Panel E071: Regenerative Four Quadrant DC Drive
  - Panel type: Single
  - 1 4-Quadrant regenerative DC drive, 115V/230V input, 0.75HP/1.5HP, 90V/180VDC armature

Ordering Information

Electrical Series Bundles
- Electric Circuit Protection & Monitoring: JM-CTRL-EA02
- Three-Phase Transformers: JM-CTRL-EA03
- Electric Motors: JM-CTRL-EA04
- Electromagnetic Motor Starters: JM-CTRL-EA07
- Timers & Time - Delay Relays: JM-CTRL-EA08
- Pilot Devices: JM-CTRL-EA09
- Solid-State Reduced Voltage Starter: JM-CTRL-EA11
- Variable Frequency Drives: JM-CTRL-EA12
- DC Motor Control: JM-CTRL-EA16

Complete Electrical Control Systems Series with Two Sided Bench: JM-CTRL-SYMS

Electrical Series - Hardware
- JobMaster Learning Station: 10-LS00-0200
- Power Control Panel (120V) Single-phase: 10-PC04-0000
- Power Control Panel (240V) 3-Phase: 10-PC06-0000
- Portable Panel Storage Rack: 10-PPSU-0001
- DC Motor Control: JM-CTRL-EA16

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