Lesson 1 - Introduction to Electronic Controls
Objectives:

- Identify and describe the six major classes of environmental controls.
- Describe the advantages of electronic control systems.
- Explain the function of a signal adapter.
- Explain the function of a bridge circuit.
- Explain the function of a sensor, a controller, and a controlled device.

Lesson 2 - Solid-State Fundamentals
Objectives:

- Explain how semiconductors differ from conductors and insulators.
- Explain how a semiconductor is affected by doping.
- Define the term “diode” and give a brief description of its construction and operation.
- Explain how external voltages applied to semiconductor devices create a forward bias or a reverse bias.
- Define the term “transistor” and give a brief description of its construction and operation.
- Describe the bias polarity requirements for both NPN and PNP transistors.

Lesson 3 - Diodes and Power Supplies
Objectives:

- Define rectification.
- Explain how a diode can be used as a half-wave rectifier.
- Explain how diodes can be used as full-wave rectifiers.
- Describe the basic operation of a bridge rectifier.
- Describe the basic construction, operation, and applications of a variety of special-purpose diodes, including LEDs, Zener diodes, diacs, varactors, tunnel diodes, and phtodiodes.

Lesson 4 - Power Supply Regulation and Filtration
Objectives:

- Explain the need for regulation and filtration in power supplies.
- Describe basic resistive/capacitive regulation and filtration.
- Describe basic inductive/capacitive regulation and filtration.
- Explain how a Zener diode can be used in a power supply circuit.
- Describe the operation of a multistage filter network.
- Explain the purpose of fixed and adjustable voltage regulators.
- Discuss the need for heat sinks on regulators.

Lesson 5 - Silicon-Controlled Rectifiers
Objectives:

- Describe the basic construction and operation of a silicon-controlled rectifier (SCR).
- Explain how the SCR is ”gated” on and off.
- Explain what effect the removal of the gate signal has on an SCR.
- Describe the two basic types of gate ”turn-on” circuits.
- Explain the difference between single-phase and three-phase alternating current SCR control.
- Describe the basic construction and operation of light-activated SCRs and optocoupled SCRs.

Lesson 6 - Triacs, Diacs, and Solid-State Relays
Objectives:

- Explain how the development of the triac has made HVACR controls more versatile.
- Explain the difference between a triac and a SCR.
- Describe how a triac is Agated on and off.
- Explain how and why triacs can be used on resistive and inductive loads.
- Describe the operation of three-phase triacs.
- Describe the basic construction and power limitations of a triac.
- Explain how a solid-state relay functions.

Lesson 7 - Protective Devices
Objectives:

- Explain the need for protection in solid-state electronic equipment.
- Define a transient, and explain how it can damage electronic equipment.
- Describe the operation of a pi filter.
- Explain how a metal-oxide varistor (MOV) functions.
- Describe how and where spark arrestors and snubbers are used.
- Explain how crowbar circuits protect against excessive voltage.

Lesson 8 - Measuring Circuits
Objectives:

- Explain how the Wheatstone bridge is used as a measuring circuit.
- Describe the basic operation of the op amp.
- Identify the three basic functional applications of the op amp.
- Define and calculate gain.
- Explain how and why negative feedback is used in amplifiers.
- Explain how op amps are used in comparator circuits.

Lesson 9 - Installation and Wiring Techniques
Objectives:

- Select proper locations for the installation of electronic controls systems.
- Identify and describe the various types of wire and cable used for electronic control systems.
- Describe the proper way to install and terminate control wiring.
- List common sources of ”noise” and explain how to correct electrical noise problems.

Lesson 10 - AC Power and Grounding Practices
Objectives:

- Discuss the fundamental principles of ac power and grounding and explain how they are applied to both existing and new electronic control systems.
- Identify power and grounding problems typically found in the field.
- Explain how properly installed electric circuits protect personnel.
- Describe the objectives of equipment grounding.
- Explain to installing electricians how to run branch circuits correctly.
- Calculate the maximum length of an equipment-grounding conductor.
- Define a ground loop.

Lesson 11 - Basic Electronic Troubleshooting
Objectives:

- Select a digital multimeter (DMM) that will meet your troubleshooting needs.
- Use a DMM to check for voltage drop, voltage imbalance, and current imbalance.
- Describe general troubleshooting and fault location procedures for basic electronic control systems.
- Describe proper wiring practices for electronic control systems.
- Diagnose EM/RFI and grounding problems in electronic control systems.
- Simulate and test various types of sensors when troubleshooting electronic control systems.
- Test for excessive voltage drops across current-controlling devices.

Lesson 12 - Electronic Controllers
Objectives:

- Explain how a proportional controller differs from a two-position controller.
- Explain the difference between direct-acting and reverse-acting controllers.
- Describe how the components in a simple electronic control system are combined.
- Determine the throttling range of a controller.
- Explain the concepts of summer/winter and day/night changeover.
- Use a system reset schedule to calculate the proper reset ratio.
- Calibrate a two-input controller.

Lesson 13 - Electronic Adapters and Indicators
Objectives:

- Describe the basic operation of reversing adapters and sequencing adapters.
- Explain how and why a deadband is used in a control system.
- Describe the basic operation of minimum position selectors and signal selectors.
- Explain the function of integral action adapters.
- Explain how temperature, pressure, and humidity transmitters can be used in control systems to indicate the value of the controlled variable.

Lesson 14 - Final Control Devices
Objectives:

- Describe the differences between parallel-blade dampers and opposed-blade dampers.
- Explain the principles of operation of hydraulic damper actuators and gear train damper actuators.
- Describe the basic operation of two-way valves, and explain how three-way mixing valves differ from three-way diverting valves.
- Explain how to size steam valves correctly.
- Describe the three different methods of providing proportional control in a water system.
- Distinguish between direct-return distribution systems and reverse-return distribution systems.

Lesson 15 - Applications (Part 1)
Objectives:

- Define the concept of reset as it applies to automatic control systems.
- Explain the difference between direct reset and reverse reset.
- Describe the operation of a face-and-bypass control system.
- Troubleshoot two-stage control systems.

- Explain the relationship between proportional band and sensitivity.
- Describe the various control options available with a mixed-air control system.
- Explain the concept of controlling devices in sequence.
- Describe the operation of a basic economizer system.

Lesson 16 - Applications (Part 2)
Objectives:

- Describe the four basic types of control systems used with electric heat.
- Explain the relationship between ”master” and ”submaster” thermostats.
- Define the terms minimum current rating, maximum current rating, maximum voltage rating, forward breakover voltage rating, and reverse breakover voltage rating as they apply to SCRs.
- Explain the difference between wye-connected and delta-connected heaters.
- Explain how signal selectors are used in dehumidification and cooling applications.
- Troubleshoot signal selectors.
- Describe the control concepts utilized in make-up air systems.
- Explain the operation of hot deck/cold deck multizone control systems.
- Identify the benefits of controlling space conditions with a load-sequenced economizer system.