Lesson 1 - Electrical Safety

Objectives:
- Describe the different levels of electric shock, and explain their effects on the human body.
- Identify the kinds of accidents caused by electric shock.
- State the precautions against shock.
- Differentiate between hot, neutral, and ground wires
- Explain the proper grounding of electric power tools.
- Describe what a GFCI is and how it operates.
- Explain how to lock out a system.
- List the three basic forms of fires.

Lesson 2 - Ohm’s Law

Objectives:
- Define many of basic terms, including the units of measurement, commonly associated with electricity.
- Explain the relationship among voltage, current, and resistance in an electric circuit.
- Apply Ohm’s Law to basic series and parallel circuits.
- Calculate power in dc circuits.

Lesson 3 - Relays and Contactors

Objectives:
- Describe the basic construction of a relay.
- Explain how a contactor works.
- Describe the operation of a potential relay.
- Describe the operation of a current relay.
- Describe the operation of an impedance relay.
- Calculate the impedance of a relay coil.
- Explain the term “delay on make”.
- Explain the term “delay on break”.
- Identify the different types of time-delay relays.

Lesson 4 - Transformers

Objectives:
- List the main components of a transformer.
- Describe the basic operation of a transformer.
- Explain the relationship between turns and voltage.
- Calculate primary and secondary voltages.
- Describe how and when transformers are connected in series and in parallel.
- Explain the common applications of control transformers and autotransformers.

Lesson 5 - Capacitors

Objectives:
- Explain the basic structure of capacitors.
- Describe the movement of the electrons in a capacitor.
- Define dielectric.
• Calculate the value of capacitors in series.
• Calculate the value of capacitors in parallel.
• State the basic rules of capacitance.
• Test capacitors for shorts, opens, and values.
• Calculate the capacitive reactance of a capacitor.

Lesson 6 - Test Instruments
Objectives:
• Describe the basic operation of the d’Arsonval meter movement.
• Explain the difference between analog and digital measuring instruments.
• Distinguish between voltmeters, ammeters, ohmmeters, and multimeters, and describe the operational principles of each.
• Explain how the sensitivity of a voltmeter is calculated.
• Describe how various electrical meters are used to measure resistance, voltage, and current, and to check for continuity.
• Demonstrate how clamp-on ammeters are used.
• Describe the basic operation of a Wheatstone bridge, and explain how it can be configured to act as a resistance bridge or a capacitance bridge.

Lesson 7 - Electrical Symbols and Schematic Diagrams
Objectives:
• Identify the electrical symbols used in schematic diagrams, and the components that they represent.
• Read and use basic wiring diagrams, including “label”-type diagrams and schematic or “ladder”-type diagrams.
• Identify the "line" side and the "load" side of a schematic diagram, and explains the difference.
• Construct simple schematic or "ladder"-type diagrams.

Lesson 8 - Circuit Protection Devices
Objectives:
• Discuss the conditions under which circuit protection is needed.
• Describe the different types of fuses.
• List the main components and explain the basic function of a circuit breaker.
• Describe the operation of overload protectors used on compressors and motors.
• Explain the difference between "inherent" overload protection and "external" overload protection.
• Describe the various types of electronic motor protectors.

Lesson 9 - Power Supplies
Objectives:
• Describe basic power distribution systems for residential and light commercial applications.
• Explain the difference between three-phase power and single-phase power.
• Explain what a "stinger" leg is, and why it is used.
• Describe how single-phase power can be derived from a three-phase power supply.
• Explain the difference between wye and delta transformers.

**Lesson 10 - Electrical Troubleshooting**

Objectives:
• Describe the proper and safe use of voltmeters, ammeters, and ohmmeters.
• Troubleshoot electrical problems related with capacitors, relays, motors, and compressors.
• Identify the terminals on an unmarked hermetic compressor.

**Lesson 11 - Control Basics**

Objectives:
• Explain the need for automatic control systems.
• Identify the four major classifications of automatic control systems.
• Explain the difference between two-position (on/off) controls and proportional controls.
• Describe the operation of a three-wire oil failure control.
• Describe the operation of a four-wire oil failure control.
• Describe the operation of electric defrost controls.
• Describe the operation of pump-down controls.
• Describe the operation of Carrier’s Time Guard and Cycle-Loc controls.
• Describe the operation of a “winter start relay.”

**Lesson 12 - Modulating Controls (Part 1)**

Objectives:
• Explain how dampers are used in modulating control systems.
• Discuss the importance of selecting and sizing dampers correctly.
• Describe the advantages and disadvantages of different types of dampers.
• Define damper authority.
• Explain how to determine the percentage of outside air used in a modulating control system.
• Define hysteresis, and explain how it applies to actuators and dampers.
• Describe the main difference between pneumatic and electronic actuators.

**Lesson 13 - Modulating Controls (Part 2)**

Objectives:
• Define some of the most important terms associated with modulating controls.
• Explain the basic operation of a modulating control system.
• Describe the four basic types of control actions.
• Explain how bridge circuits are used in modulating control systems.
• Describe the operation of low-limit and high-limit controllers.
• Explain how central fan systems work.
• Explain how modulating controls are used in refrigeration systems.

**Lesson 14 - Applications (Part 1)**

Objectives:
• Explain the five-step procedure for troubleshooting electromechanical control circuits.
• Use an electrical schematic to troubleshoot a furnace humidifier.
• Use an electrical schematic to troubleshoot a domestic refrigerator.
• Use an electrical schematic to troubleshoot a split-system condensing unit.
• Use an electrical schematic to troubleshoot a commercial ice flaker.
• Use an electrical schematic to troubleshoot a packaged air conditioner with electric heat.

Lesson 15 - Applications (Part 2)
Objectives:
• Use an electrical schematic to troubleshoot a rooftop gas heating and electric cooling unit.
• Use an electrical schematic to troubleshoot a five-in-one packaged unit.
• Use an electrical schematic to troubleshoot a packaged heat pump with supplemental electric heat.

Lesson 16 - Appendix