Chapter 1 - Electrical Safety

Objectives:

- Identify the types of accidents caused by electric shock.
- Describe the effects on the human body of electric shock at different current levels.
- Explain proper precautions against electric shock.
- Identify electrical hazards related to: fuses and circuit breakers, overhead wires, exposed wiring, overloaded circuits, improper grounding, and wet conditions.
- Describe what a GFCI is and how it operates.
- Explain the proper use of PPE when working on or near electrical equipment.
- Explain how to choose the appropriate electrical meter.
- Describe proper lockout/tagout methods.

Chapter 2 - Fundamentals of Electricity

Objectives:

- Define *resistance* and explain how resistors work.
- Define *capacitance* and explain how capacitors work.
- Define *inductance* and explain how inductors work.
- Describe how the basic "building blocks" of matter—elements, compounds, molecules, atoms, and so on—are related to each other, and how atomic structure is related to the study of electricity.
- Define the *coulomb*, *volt*, *ampere*, *ohm*, and *watt*, and use these units of measurement properly.
- State Ohm's Law.
- Use the equations commonly derived from Ohm's Law to calculate voltage, current, resistance, and power in electric circuits.
- Explain the difference between series circuits and parallel circuits.

Chapter 3 - Understanding Electrical Schematics

Objectives:

- List the five basic components of any electrical schematic.
- Identify different types of wiring diagrams used in the HVACR industry.
- Identify the electrical symbols used in schematic diagrams, and the components that they represent.
- Identify the "line" side and the "load" side of a schematic diagram, and explain the difference.
- Explain how to use the line-numbering system included in many schematic diagrams.

Chapter 4 - Magnetism and Transformers

Objectives:

- State the basic laws of magnetism.
- Understand magnetic circuits.
- Describe an electromagnet.
- Understand the difference between "natural" and "artificial" magnets.
- Explain magnetic fields.
- State the two basic theories of magnetism.
- Explain how the earth's magnetic field works.
- Define the following terms: *magnetic shielding*, *lines of force*, *magnetic flux*, *self inductance*, *mutual induction*, and *counter electromotive force*.
- State Lenz's Law.

- Describe the conditions that cause transformers to fail.
- Describe the physical indications that identify defective transformers.
- Explain the differences between residential and commercial transformers.
- Determine the current-carrying capacity of a control transformer.
- Explain how to test different types of transformers.
- Define *open circuit voltage* (OCV).
- Test continuity between the primary and secondary windings of a transformers.

Chapter 5 - Relays, Contactors, and Starters
Objectives:

- List common causes of relay failure.
- Describe the physical indications that identify defective relays and contactors.
- Explain how to test pilot-duty relays and line-duty relays.
- Explain how to test contactors and starters.
- Explain how to test potential relays and current relays.
- Explain how to test time-delay relays.

Chapter 6 - Fundamentals of Alternating Current
Objectives:

- Explain alternating current.
- Define *peak-to-peak*, *RMS*, and *average* voltage values.
- Explain sine waves.
- Describe the phase relationships between currents and voltages in capacitive and inductive reactive circuits.
- Determine the capacitive reactance of a circuit, given the value of the capacitor, frequency, and voltage.
- Determine the inductive reactance of a circuit, given the value of the inductor, frequency, and voltage.
- Determine the impedance of a circuit, given the values of the inductive and capacitive reactance, and the resistance.
- Calculate the “apparent” power and the “true” or “actual” power of a circuit.
- Determine the power factor of a circuit, given the true power, the voltage, and the amount of current draw.

Chapter 7 - Series and Parallel Circuits
Objectives:

- Describe what causes resistance in a wire.
- Define an *ohm*.
- State the three basic equations derived from Ohm’s Law.
- Explain how Ohm’s Law can be applied for a series circuit.
- Explain how Ohm’s Law can be applied for a parallel circuit.
- Define electric *power*.
- State the three basic equations for calculating power.
- Define a *kilowatt-hour*.

Chapter 8 – Thermostats
Objectives:

- Describe the basic construction and operation of a bimetal mechanical thermostat.

- Explain the concept of *anticipation*.
- Describe some of the physical indications that identify defective thermostats.
- Test a mechanical thermostat with a voltmeter and/or ohmmeter.
- Set an adjustable anticipator.
- Calibrate a mechanical thermostat.
- Explain the differences between residential and commercial thermostats.
- Identify common problems that affect electronic thermostats, and explain basic troubleshooting techniques.

Chapter 9 - Motors and Capacitors
Objectives:

- List the basic types of motors used in the HVACR industry.
- Describe some of the visual indications that identify defective motors.
- Explain the difference between fractional-horsepower motors and integral-horsepower motors.
- Determine the speed and rotation of a motor.
- Use appropriate test instruments to troubleshoot various types of motors and their associated starting circuits.
- Describe some of the causes of overheating in electric motors.
- Explain what causes *single phasing* in a three-phase motor.
- Calculate voltage and current imbalances in three-phase motors.
- Explain how variable-speed motors differ from ac induction motors.
- Describe basic motor replacement procedures.
- Read a motor nameplate.
- Use NEMA data to determine motor frame sizes and dimensions.
- Observe the proper safety precautions when taking capacitance readings.
- Explain the differences between start and run capacitors.
- Discharge a capacitor safely.
- Describe the four main problems or conditions that identify a faulty capacitor.
- Describe the operation of the various types of instruments used for testing capacitors.

Chapter 10 - 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.

Chapter 11 – Compressors
Objectives:

- Explain the differences among open, semi-hermetic, and hermetic compressors.
- Describe the various starting methods used for single-phase hermetic compressors.
- Explain the function and operation of overload protection devices use in hermetic compressors.

- Check a single-phase hermetic compressor for proper resistance, voltage, and current readings.
- Identify the terminals of a single-phase hermetic compressor, even if they are unmarked.
- Check a three-phase hermetic compressor for proper resistance, voltage, and current readings.
- Calculate voltage and current imbalances in three-phase hermetic compressors.

Chapter 12 - Troubleshooting Gas Furnaces
Objectives:

- Explain some of the problems encountered with several types of ignition systems and safety controls that are used with gas furnaces.
- Describe appropriate electrical troubleshooting procedures for these types of heating systems.
- Read and interpret the schematic diagrams and troubleshooting flow charts provided by the manufacturers of such equipment.
- Locate the probable cause of a service problem (e.g., the thermostat, the printed circuit board, the wiring, etc.).

Chapter 13 - Troubleshooting Split Systems
Objectives:

- Describe appropriate electrical troubleshooting procedures for residential split systems.
- Develop a logical approach to isolating the cause of a service problem.
- Read and follow a troubleshooting flow chart.

Chapter 14 - Reading Schematics
Objectives:

- Read and interpret electrical schematic diagrams correctly as an aid in troubleshooting equipment.
- Recognize and explain some of the differences between the schematics of one manufacturer and another, including wiring and terminal designations, symbol usage, component placement, and so on.
- Describe the sequence of operation for the equipment of several different manufacturers by tracing their respective wiring diagrams.
- Explain how high-voltage and low-voltage power supply information is provided on the schematics of residential and light commercial equipment.