ELECTRICITY FOR HVAC/R
Course Syllabus

Course Number: ARCO-0690  OHLAP Credit: No
OCAS Code: None  
Course Length: 60 Hours  
Career Cluster: Architecture & Construction  
Career Pathway: Maintenance/Operations  
Career Major(s): HVAC Technician

Pre-requisite(s): Introduction to HVAC/R, Safety, Tools and Equipment

Course Description: This course teaches students fundamental and advanced concepts in electricity, including electrical generation and distribution, electrical components, electrical motors, electrical circuits and controls, and prepares them to effectively troubleshoot and replace or repair devices in electrical circuits.

Textbooks:
- Refrigeration & Air Conditioning Technology, 7th Ed, (2013), Whitman /Johnson/ Tomczyk Silberstein / Publisher Delmar Cengage

Course Objectives:

A. Understand Basic Electricity.
   1. Define watts, ohms, volts, and amps.
   2. Describe how voltage, current, resistance, and power are related.
   3. Define and compare single- and three-phase voltage and current.
   4. Identify types of electrical loads (i.e., capacitive, inductive and resistive).
   5. Analyze applications of magnetism in electricity.
   6. Apply magnetic principles to electrical theory.
   7. Compare conducting and insulating materials.
   8. Identify principles of solid-state switching devices.
   9. Demonstrate proper use of ammeter, ohmmeter, voltmeter and wattmeter.
   10. Use Ohm’s law to calculate the current, voltage, and resistance in a circuit.
   11. Use appropriate meters to check basic electrical components.
   12. Determine the electrical characteristics of both series and parallel circuits.
   13. Demonstrate algebra/math skills.
   14. Use the power formula to calculate how much power is consumed by a circuit.
   15. Describe the differences between series and parallel circuits.
   16. Determine the equivalent resistance in a parallel and series circuit.
   17. Determine the equivalent capacitance in a parallel and series circuit.
   18. Construct and analyze:
      a. Series circuit
      b. Parallel circuit
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c. Series-parallel circuit

d. Shunt circuits

19. State and demonstrate the safety precautions that must be followed when working on electrical equipment.

B. Explain Alternating Current.
1. Describe the operation of various types of transformers.
2. Explain how alternating current is developed and draw a sine wave.
3. Identify single-phase and three-phase wiring arrangements.
4. Explain how phase shift occurs in inductors and capacitors.
5. Describe the types of capacitors and their applications.
6. Explain the operation of single-phase and three-phase induction motors.
7. Identify the various types of single-phase motors and their applications.
8. Use a wattmeter, megger, capacitor analyzer, and chart recorder.
9. Test inductors and capacitors using an ohmmeter.
10. State and demonstrate the safety precautions that must be followed when working with electrical equipment.

C. State How Electrical Power Is Generated and Distributed.
1. Explain basic generator principle.
2. Explain how electricity is produced and distributed.
3. Define Wye (Y) and Delta (Δ) distribution systems.
4. Draw and identify power transformer types.
5. Use electrical meters appropriately to test and identify voltages in both single- and three-phase systems.
6. Size/test fuses/breakers and safely replace them.
7. Use National Electrical Code (NEC) tables (i.e., NEC 310-16) to check wire size and conduit size for connected equipment.
8. Determine correct wire size and voltage drops for electrical circuits.
9. Determine whether existing load centers are adequate to supply desired load addition.

D. Identify Electrical Components.
1. Recognize and describe the purpose and operation of the various electrical components used in HVAC equipment.
2. Define magnetic theory.
3. Define and explain the use or function of:
   a. Aquastats
   b. Capacitors
   c. Contactor/Starters
   d. Crankcase Heaters
   e. Current relays
   f. Damper Actuators
   g. Defrost Timers
   h. Fan/Limit Controls
   i. Oil pressure safety
   j. Overloads
   k. Positive Temperature Co-efficient (PTC)
   l. Potentiometers
   m. Pressure Controls
   n. Relays
   o. Rheostats
   p. Sail Switches
   q. Sequencers
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r. Solenoids
s. Solid state time delays
t. Thermostats
u. Water Valves
v. Zone Valves

4. Demonstrate proper use of test equipment for testing the above items.
5. Make voltage, current, and resistance measurements using electrical test equipment.

E. Understand Electric Motors.
1. Explain electric motor theory (i.e., magnetism, electromotive force, etc.).
2. Explain the operation and application of:
   a. Capacitor start induction run motor (CSIR)
   b. Capacitor start capacitor run motor (CSCR)
   c. Electronically controlled motor (ECM)
   d. Modulating motor (economizers)
   e. Multi-speed motor
   f. Permanent split capacitor (PSC)
   g. Shaded pole
   h. Split-phase motor (RSIR)
   i. Three-phase motor
   j. Variable-speed motor
3. Describe starting components associated with single-phase and three-phase motors.
4. Explain the significance of power factor.
5. Demonstrate proper use of testing equipment for motors.
6. Determine physical conditions of motor bearings and rotors.
7. Build a basic motor using a piece of wood, copper wire, and a coat hanger.
8. Draw and explain the starting and run circuit for a single-phase CSIR compressor using a current type starting relay.
9. Draw and explain the starting and run circuit for a single-phase CSCR compressor using a potential type starting relay.
10. Draw and explain the circuit for a PSC compressor.
11. List types of units that use hermetically sealed motors.

F. Identify Various Motor Components.
1. Identify motor drive mechanisms.
2. List considerations for selecting motor starters.
3. Differentiate between relays, contacts and starters.
5. State the purpose of a capacitor.
6. Differentiate between a run and a start capacitor and their applications.

G. Troubleshoot Motor Problems and Build a Simple Electric Motor.
1. List common electrical problems in motors.
2. Explain the difference in troubleshooting a hermetic motor problem and an open motor problem.

H. Demonstrate Knowledge of Electrical Circuits and Controls.
1. Interpret detailed instructions for wiring circuits.
2. Draw electrical circuits that conform to standard industry logic and symbols using appropriate loads and controls.
3. Wire actual electrical circuits from wiring diagrams.
4. Demonstrate use and understanding of basic electrical meters in actual wiring.
1. Identify and draw all electrical symbols used by the HVACR industry in diagrams.

2. Size an electric motor circuit, single and multiple, including overcurrent protection in accordance with National Electrical Code (NEC).

I. Understand Electrical Symbols Used in Schematics and Diagrams.

1. Draw and identify electrical symbols used in air conditioning applications.

2. Match schematic symbols to component names.

3. Differentiate between a pictorial and a ladder type wiring schematic.

4. Compare pictorial type diagrams and ladder type schematics.

5. List the advantages of having both types of diagrams to troubleshoot a unit.

J. Draw and Interpret Electrical Schematics and Diagrams.

1. Draw and interpret schematics and diagrams for various kinds of air conditioning and heating equipment.

2. Use schematics to interpret sequence of operation.

3. Draw pictorial diagram and ladder schematic showing wiring of an air conditioning unit.

K. Wire Basic Electrical Trainer Boards.

1. Complete electrical circuit assignments.

2. Wire circuits on training board.

3. Check voltage of components on training boards.

4. Distinguish between high and low voltage circuits on training boards.

5. Use Ohmmeter to identify terminals on switches and relays.

6. Troubleshoot electrical trainers.

a. Describe and identify power and non-power consuming devices.

b. Use voltmeter to troubleshoot electrical circuits.

c. List typical problems in an electrical circuit.

d. Use an ammeter to troubleshoot an electrical circuit.

e. Troubleshoot electrical circuit in proper sequence.

f. Compare characteristics of a pictorial and line-type electrical wiring diagram.

g. Troubleshoot and identify electrical problems on training boards.

L. Wire Air Conditioner Trainer Boards.

1. Define bimetal and describe how a thermostat works.

2. Differentiate between types of thermostats and their applications.

3. Distinguish between the bellows, diaphragm and Bourdon tube.

4. Explain operation of pressure controls and their applications.

5. Compare low and high voltage controls.

6. Discuss types of motor protection.

7. Describe the functions of mechanical and electromechanical controls.

8. Complete electrical diagram of a residential air conditioning system.

9. Wire components of a residential air conditioning system on training board and explain sequence of operation.

10. Test/troubleshoot component parts.

a. Verify power at unit.

b. Test thermostat controls.

c. Adjust/calibrate thermostat controls.

d. Test capacitors.

e. Test potential relay.

f. Test and install window unit switches and thermostats.
M. Wire Refrigerator Trainer Units.
   1. Draw electrical pictorial and schematic type diagrams for refrigerator unit.
   2. Wire components in refrigerator unit according to diagram.
   3. Turn refrigerator unit on and check operation of electrical components.

1 ODCTE objective
2 NCCER objective
All unmarked objectives are TTC instructor developed.

Teaching Methods: The class will primarily be taught by the lecture and demonstration method and supported by various media materials to address various learning styles. There will be question and answer sessions over material covered in lecture and media presentations. Supervised lab time is provided for students to complete required projects.

Grading Procedures: 1. Students are graded on theory and shop practice and performance.
                     2. Each course must be passed with seventy (70%) percent or better.
                     3. Grading scale: A=90-100%, B=80-89%, C=70-79%, D=60-69%, F=50-59%.

Description of Classroom, Laboratories, and Equipment: Tulsa Technology Center campuses are owned and operated by Tulsa Technology Center School District No. 18. All programs provide students the opportunity to work with professionally certified instructors in modern, well-equipped facilities.

Available Certifications/College Credit: The student may be eligible to take state, national or industry exam after completion of the program. College credit may be issued from Oklahoma State University-Okmulgee or Tulsa Community College. See program counselor for additional information.

College Credit Eligibility: The student must maintain a grade point average of 2.0 or better.