Instructional/Task Analysis

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do

Unit 1: Fundamentals of Electricity

1. Terms and definitions
2. Electricity
3. Sources of electricity and their characteristics
4. The electron theory
5. The importance of electrical charges
6. How current is caused to flow in a circuit
7. Insulators, semiconductors, and conductors
8. Direct current
9. Alternating current
10. Electrical loads
11. Basic electrical circuits
12. Basic electrical symbols
13. The three types of circuits
14. Circuit grounding
15. Electrical measurements
16. Expressing large numbers
17. Terms and abbreviations used in rules governing electricity
18. The three equations for using Ohm's Law
19. Using Ohm's Law to find unknown values
20. Using Ohm's Law to determine values in a series circuit
21. Using Ohm's Law to determine values in a parallel circuit
22. Using Ohm's Law to determine values in series-parallel circuits
23. Applications of electronics in HVACR control systems
24. Investigate the differences between electrical and electronic
25. Convert electrical measurements to basic units
26. Use Ohm's Law to determine unknown values in resistive circuits

Instructional/Task Analysis

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do

Unit 2: Tools, Materials, and Test Instruments

1. Terms and definitions
2. Tools
3. Electrical wiring
4. Connecting electrical wires
5. Guidelines for splicing wires
6. Connecting wires to terminals
7. Test instrument characteristics
8. Reading test instruments
9. Using voltmeters and voltage testers
10. Using ohmmeters
11. Using an ohmmeter to check motors
12. Checking a hermetic compressor motor with an ohmmeter
13. Using ammeters
14. Using test accessories
15. Effects of current on the human body
16. How to avoid electrical accidents
17. Rescue procedure for electrical accidents
18. Locate information about test instruments used in HVACR work
19. Read a voltmeter
20. Read an ohmmeter
21. Read an ammeter
22. Identify start, run and common terminals and draw the windings of a split-phase motor
23. Solder terminals onto wires
24. Splice wires using wire nuts
25. Use digital and analog voltmeters to check power sources
26. Use digital and analog ohmmeters to check continuity of fuses
27. Use digital and analog ohmmeters to determine resistance of resistors
28. Use digital and analog ohmmeters to identify terminals and electrical condition of a hermetic compressor
29. Use digital and analog ammeters to read start and run amperage of a motor

Unit 3: Electrical Power

1. Terms and definitions
2. Characteristics of electrical power
3. Transformers
4. Power distribution
5. Types of power supplies
6. Delivery systems
7. Problems with power delivery
8. Power consumption
9. Watt's Law
10. Measuring power consumption
11. Reading a watt-hour meter
12. Locate information about the power supply to your residence
13. Use Watt's Law to determine power
14. Read an electric watt-hour meter
15. Use wattmeters and ammeters to determine watts

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do

Unit 4: Circuits, Symbols, and Diagrams

1. Terms and definitions
2. Electrical and electronic circuits
3. Integrated circuits
4. The language of electricity
5. Sources and applications of wiring diagrams
6. Pictorial wiring diagrams
7. Schematic wiring diagrams
8. Electronic wiring diagrams
9. Draw a pictorial diagram
10. Building a ladder schematic diagram
11. Using symbols
12. Locate wiring diagrams on equipment at your residence
13. Draw pictorials, fabricate working models, and draw ladder schematics for basic series and parallel circuits
14. Draw pictorials, fabricate working models, and draw ladder schematics for series-parallel circuits
15. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with varied loads and switching

Unit 5: Controls and Protection Devices

1. Terms and definitions
2. Controls and their applications
3. Types of controls
4. Control systems
5. Switch configurations and symbols
6. Identifying switch symbols
7. Three and four way switches and their applications
8. Applications of shunt circuits
9. Electronic switching
10. Protection devices
11. Overcurrent protection devices
12. Pressure-actuated protection devices
13. Motor protection devices
14. Bimetal protection devices
15. Protecting electronic circuits
16. Draw pictorials, fabricate working models, and draw ladder schematics for shunt circuits with one SPST switch
17. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with 3-way switches
18. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with 3-way and 4-way switches
19. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with safety switches
20. Draw a pictorial, fabricate a working model, and draw a ladder schematic of a basic small refrigeration circuit

Instructional/Task Analysis

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do

Unit 6:Transformers and Relays

1. Terms and definitions
2. How a transformer works
3. Control transformer specifications
4. Providing DC power
5. Relay components and uses
6. Using relay symbols in electrical drawings
7. Control relays and contactors
8. Control relay and contactor switching arrangements
9. Types of motor starting relays and their uses
10. Motor starting current relay operations
11. Motor starting current relay specifications
12. Motor starting voltage relay operations
13. Potential relay specifications
14. Time delay relays
15. Electronic controls for timed functions
16. Identify selected relays
17. Check current relays with an ohmmeter
18. Check potential relays with an ohmmeter
19. Check current relays with an ammeter and a voltmeter
20. Check a potential relay with an ammeter and a voltmeter
21. Install a solid-state, time-delay relay
22. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with basic relays
23. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with dual relays
24. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with special applications
25. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with multiple relays

Unit 7: Thermostats

1. Terms and definitions
2. Thermostat types and their applications
3. Temperature sensors
4. Electrical contacts
5. Major components of a heating/cooling thermostat
6. Heating thermostat anticipation
7. Cooling thermostat anticipation
8. Installing heating/cooling thermostats
9. Multistage thermostats
10. Subbase applications

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do

Unit 7: Thermostats (continued)

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do
11. Basic internal thermostat switching	16. Install a wall thermostat and determine heat anticipation
12. Programmable thermostat applications	17. Replace a standard thermostat with an electronic programmable thermostat
13. Electronic thermostat characteristics	18. Program a programmable thermostat
14. Additional benefits of solid-state thermostats	
15. Special applications of line voltage thermostats	

Unit 8: Introduction to Electric Motors

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do
1. Terms and definitions	15. Use manufacturers' catalogues to locate motors and their applications
2. Electric motor applications	16. Use a pulley selection chart and pulley selection formula
3. Types of electric motors and their applications	17. Solve electric motor problems
4. Basic DC motor operation	18. Replace a missing V-belt, adjust tension, and check motor operation.
5. Basic AC motor operation	
6. Single-phase AC motor starting	
7. Basic AC electric motor parts and their functions	
8. Types of motor construction	
9. Types of motor mounts and typical applications	
10. Motor data plates	
11. Pulleys and belts	
12. Pulley selection	
13. Sizing and selecting V-belts	
14. Troubleshooting electric motors	

Instructional/Task Analysis

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do

Unit 9: Shaded-Pole Motors

1. Terms and definitions
2. Characteristics and applications of shaded-pole motors
3. Shaded-pole motor construction
4. Controlling shaded-pole motor speed
5. Shaded-pole motor rotation
6. Troubleshooting shaded-pole motors
7. Using power factor for watt/amp amp/watt conversions
8. Wire shaded-pole motors to AC voltage
9. Disassemble, inspect, clean, reassemble and check operation of a shaded-pole motor

Unit 10: Split-Phase Motors

1. Terms and definitions
2. Characteristics and applications of split-phase motors
3. Split-phase motor construction
4. Split-phase motor starting mechanisms
5. Wiring connections for split-phase motors
6. Troubleshooting split-phase motors
7. Wire a single-voltage, split-phase motor to an AC power source
8. Wire a dual-voltage, split-phase motor for 120 VAC
9. Wire a dual-voltage, split-phase motor for 208/240 VAC
10. Disassemble, inspect, clean, reassemble, and check operation of a split-phase motor

Unit 11: Capacitors

1. Terms and definitions
2. Capacitors in HVACR circuit applications
3. Effects of inductive loads on current/voltage relationships
4. Capacitor construction and operation
5. Types of capacitors
6. Guidelines for capacitor replacement
7. Grouping capacitors
8. Calculate ratings of grouped capacitors
9. Check capacitors with an analog ohmmeter
10. Check capacitors with a capacitor analyzer

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do

Unit 12: Capacitor Motors

1. Terms and definitions
2. Applications of capacitors to motors
3. CS motor characteristics and applications
4. PSC motor characteristics and applications
5. CSR motor characteristics and applications
6. Troubleshooting capacitor motors
7. Troubleshooting capacitor motor start components
8. Draw connecting wiring for a CS motor with a start capacitor and a current relay
9. Draw connecting wiring for a PSC motor
10. Draw connecting wiring for a CSR motor
11. Wire a CS compressor with a current relay
12. Wire a PSC motor
13. Wire a CSR compressor motor
14. Disassemble, inspect, clean, reassemble, and check operation of a PSC fan motor
15. Use a hermetic analyzer to start, reverse, and check operation of a PSC compressor motor
16. Install a hard start kit
17. Troubleshoot a CSR compressor with an ammeter

Unit 13: Electronically Commutated Motors

1. Terms and definitions
2. Characteristics and applications of Electronically Commutated Motors (ECM)
3. ECM motor construction and programming
4. Controlling airflow with an ECM motor
5. Benefits and limits of ECM motors
6. Power connections for a typical ECM
7. Modes of communication
8. ECM motors and Electromagnetic Interference (EMI)
9. Installation guidelines to minimize ECM motor generated EMI
10. Service basics for all ECM motors
11. Compare the applications and uses of PSC motors with ECM motors

Instructional/Task Analysis

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do

Unit 14: Three-Phase Motors

1. Terms and definitions
2. Characteristics and applications of three-phase motors
3. Three-phase motor construction
4. Wiring connections for three-phase motors
5. Troubleshooting three-phase motors
6. Draw connecting wiring for wye wound and delta wound dual-voltage motors
7. Wire a dual-voltage, three-phase motor, reverse rotation, and check operation

Unit 15: Troubleshooting HVACR System Electrical Circuits

1. Terms and definitions
2. Guidelines for troubleshooting HVACR system electrical circuits
3. Identifying circuit components and their operations
4. Guidelines for test meter selection
5. Using a voltmeter
6. Applying the hopscotch method for troubleshooting
7. Using an ammeter
8. Using an ohmmeter
9. Check for shorts and grounds
10. Using jumpers to troubleshoot
11. Troubleshooting techniques
12. Identify components on HVACR system electrical diagrams
13. Identify component operations from HVACR system electrical diagrams
14. Select test instruments or procedures for specific HVACR system troubleshooting
15. Solve HVACR electrical troubleshooting problems
16. Troubleshoot series electrical circuits on selected HVACR equipment
17. Troubleshoot parallel electrical circuits on selected HVACR equipment
18. Troubleshoot series-parallel electrical circuits on selected HVACR equipment

Unit 16: HVACR System Wiring Diagrams

Related Information: What the Student Should Know

1. Terms and definitions
2. Guidelines for drawing system diagrams
3. HVACR components and their schematic symbols
4. HVACR system switches and their schematic symbols
5. Solid-state components and their schematic symbols
6. Procedure for drawing typical HVACR system wiring diagrams

Application: What the Student Should Be Able to Do

7. Draw wiring diagrams for a small refrigeration unit with a coil-type current relay
8. Draw wiring diagrams for a small refrigeration unit with a solid-state start relay
9. Draw wiring diagrams for a window air conditioner
10. Draw wiring diagrams for a standard upflow gas furnace
11. Draw wiring diagrams for a standard downflow gas furnace
12. Draw wiring diagrams for a multi-position gas furnace with an integrated control board
13. Draw wiring diagrams for a condensing unit
14. Draw wiring diagrams for an electric furnace
15. Draw wiring diagrams for a condensing unit and an air handler
16. Draw a ladder schematic for a small refrigeration unit
17. Observe a small refrigeration unit and draw a ladder schematic of its electrical circuits
18. Observe a window air conditioner and draw a ladder schematic of its electrical circuits
19. Observe a heating/cooling system with 24V controls and draw a ladder schematic of its electrical circuits
20. Observe a heat pump system and draw a ladder schematic of its electrical circuits