

**FLORIDA DEPARTMENT OF EDUCATION
CLUSTER CURRICULUM FRAMEWORK**

Cluster Title: Air-Conditioning, Refrigeration and Heating Technology
Cluster Type: Job Preparatory
Occupational Area: Industrial Education
Components Two Programs, One Core, Five Occupational Completion Points

	<u>Secondary</u>	<u>PSAV</u>
Grade Level	9-12, 30, 31	30, 31
Facility Code	203	203
CTSO	SkillsUSA	SkillsUSA
Co-op Method	Yes	Yes
Apprenticeship	Yes	Yes

- I. **PURPOSE:** The purpose of the programs in this cluster is to prepare students for employment or advanced training in the heating, air-conditioning (A/C), and refrigeration and ventilation industry. The programs in this cluster prepare students for employment as A/C, Refrigeration and Heating Helper (Industry Title), A/C, Refrigeration and Heating Mechanic Assistant (Industry Title), A/C, Refrigeration and Heating Mechanic (Industry Title), A/C, Refrigeration and Heating Technician (OES 85902654), and Refrigeration Technician (OES 22511236)(SOC 49-9021).

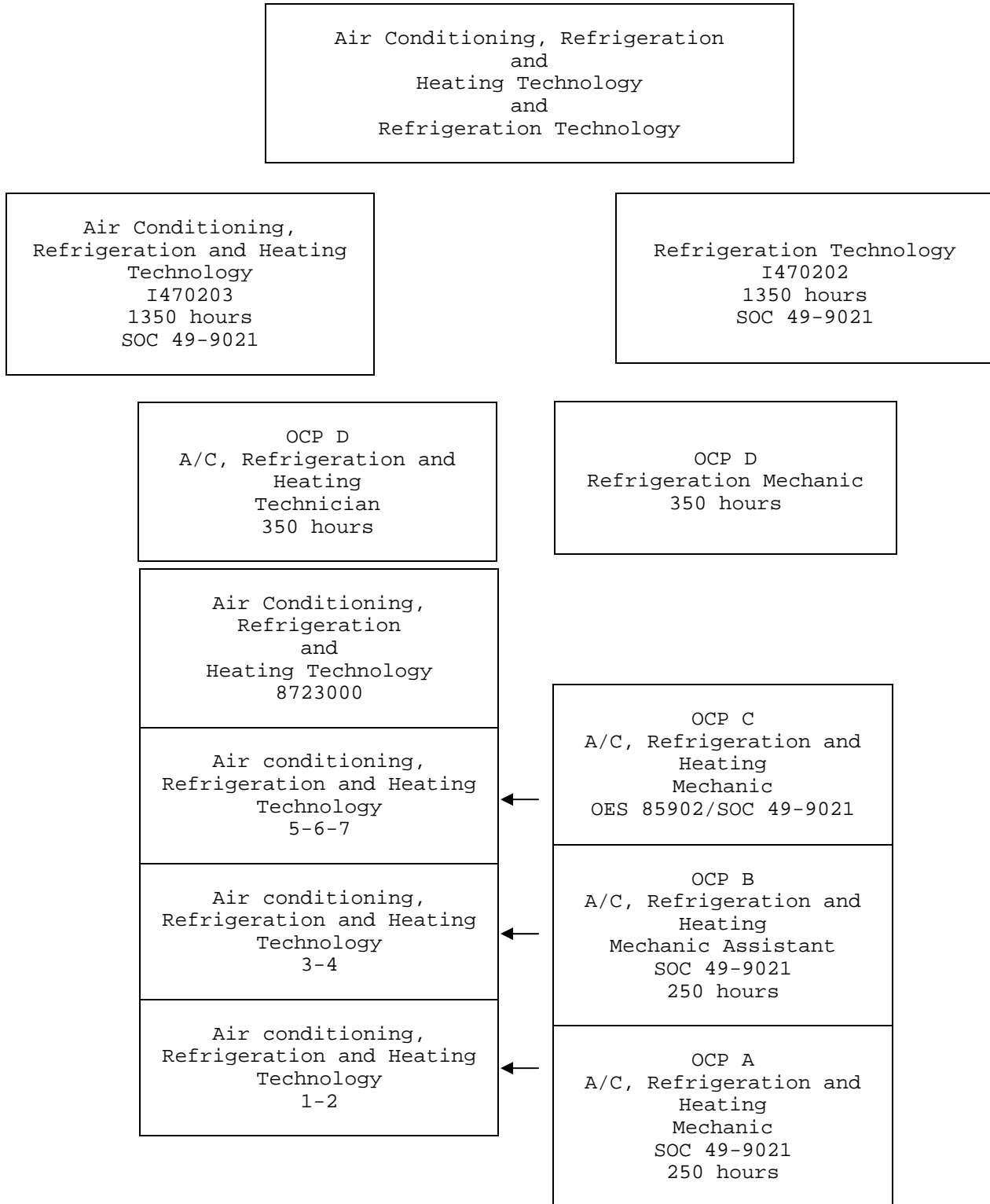
The student should obtain EPA certification prior to leaving school in order to be employed in any job that requires work with refrigerants.

This cluster of programs focuses on broad, transferable skills, stresses the understanding of the heating, air-conditioning, refrigeration and ventilation industry, and demonstrates elements of the industry such as planning, management, finance, technical and production skills, the underlying principles of technology, labor issues, community issues, and health, safety, and environmental issues.

- II. **CLUSTER STRUCTURE:** This cluster is a planned sequence of instruction consisting of two programs with one common core and five occupational completion points. The recommended sequence allows students to complete specified portions of the program for employment or to remain for advanced training. A student who completes the applicable competencies at any occupational completion point may either continue with the training program or terminate as an occupational completer.

It is recommended that students complete the core or demonstrate a mastery of the student performance standards contained in the core before advancing to the course(s) in the next level of either of the two programs: Air Conditioning, Refrigeration and Heating Technology or Refrigeration Technology.

DIAGRAM ILLUSTRATES SUGGESTED PROGRAM STRUCTURE
SOC 49-9021



At the secondary level, this cluster consists of the following courses, which include the core:

Air Conditioning, Refrigeration and Heating Technology - 7
secondary credits

CORE COURSES

(OCP A)

8713010 - Air Conditioning, Refrigeration & Heating Technology 1

8713020 - Air Conditioning, Refrigeration & Heating Technology 2

(OCP B)

8713030 - Air Conditioning, Refrigeration & Heating Technology 3

8713040 - Air Conditioning, Refrigeration & Heating Technology 4

(OCP C)

8713050 - Air Conditioning, Refrigeration & Heating Technology 5

8713060 - Air Conditioning, Refrigeration & Heating Technology 6

8713070 - Air Conditioning, Refrigeration & Heating Technology 7

III. **LABORATORY ACTIVITIES:** Classroom, shop, and laboratory activities are an integral part of this cluster. These activities include instruction in the use of safety procedures and in the care of tools, equipment, materials, and processes found in the industry. Equipment and supplies should be provided to enhance hands-on experiences for students in the chosen occupation.

IV. **SPECIAL NOTE:** SkillsUSA, Inc. is the appropriate Career and Technical Student Organization (CTSO) for providing leadership training and for reinforcing specific career and technical skills. Career and Technical Student Organizations, when provided, shall be an integral part of the career and technical instructional program, and the activities of such organizations are defined as part of the curriculum in accordance with Rule 6A-6.065, FAC.

The Refrigeration Service Engineers Society (RSES), a professional organization geared toward the education of teachers, provides opportunities for students to become members and to participate in RSES activities. The Air-Conditioning Refrigeration Institute (ARI) is another organization that provides educational opportunities, curricula, and competency exams for the industry.

To be transferable statewide between institutions, this program/course must have been reviewed, and a "transfer value" assigned the curriculum content by the appropriate Statewide Course Numbering System discipline committee. This does not preclude institutions from developing specific program or course articulation agreements with each other.

The programs in this cluster may be offered in PSAV courses. Vocational credit shall be awarded to the student on a transcript in accordance with section 1001.44 (3) (b) F.S.

The programs in this cluster may be offered in postsecondary adult vocational (PSAV) courses. Vocational credit shall be awarded to the student on a transcript in accordance with Section 230.643, F.S.

Cooperative training - OJT is appropriate for this program.

Whenever cooperative training - OJT is offered, the following are required for each student: a training plan, signed by the student, teacher, and employer, which includes instructional objectives and a list of on-the-job and in-school learning experiences; a workstation that reflects equipment, skills and tasks that are relevant to the occupation which the student has chosen as a career goal. The student must receive compensation for work performed.

In accordance with Rule 6A-10.040, FAC, the minimum basic-skills grade levels that are required for adult vocational students to complete this program are: Mathematics 10.0, Language 9.0, Reading 9.0. These grade-level numbers correspond to grade-equivalent scores obtained on one of the state-designated basic-skills examinations. If a student does not meet the basic-skills level required for completion of the program, remediation should be provided concurrently through Vocational Preparatory Instruction (VPI). Please refer to the Rule for exemptions.

Federal and state legislation requires the provision of accommodations for students with disabilities to meet individual needs and ensure equal access. Adult students with disabilities must self-identify and request such services. Students with disabilities may need accommodations in such areas as instructional methods and materials, assignments and assessments, time demands and schedules, learning environment, assistive technology and special communication systems. Documentation of the accommodations requested and provided should be maintained in a confidential file.

When a secondary student with a disability is enrolled in a vocational class with modifications to the curriculum framework, the particular outcomes and student performance standards, which the student must master to earn credit, must be specified on an individual basis. The job or jobs for which the student is being trained should be reflected in the student's desired postschool outcome statement on the Transition Individual Educational Plan (Transition IEP).

SCANS Competencies: To accomplish the Secretary's Commission on Achieving Necessary Skills (SCANS) competencies, instructional strategies for this cluster must include methods that require students to identify, organize, and use resources appropriately; to work with each other cooperatively and productively; to acquire and use information; to understand social, organizational, and technological systems; and to work with a variety of tools and equipment. Instructional strategies must also incorporate methods to improve students' personal qualities and higher-order thinking skills.

The standard length of this program is 1350 hours.

**Florida Department of Education
INTENDED OUTCOMES**

Program Title: Air Conditioning, Refrigeration and Heating Technology

	<u>Secondary</u>
Program Number:	8723000
CIP Number:	0647020303
Grade Level	9-12, 30, 31
Length	7 Credits
Certification	AC HEAT ME @7 G REFRG MECH @7 G

INTENDED OUTCOMES: After successfully completing the appropriate course(s) for each occupational completion point of this program, the student will be able to perform the following:

OCCUPATIONAL COMPLETION POINT - A (250 hours)

A/C, REFRIGERATION AND HEATING HELPER - INDUSTRY TITLE
(SOC 49-9021).

- 01.0 Identify safe working conditions and follow safety practices.
- 02.0 Describe the history and concepts of heating, air-conditioning, and refrigeration.
- 03.0 Identify, use, and maintain the hand tools and tool accessories used in the heating, air-conditioning, and refrigeration industry.
- 04.0 Demonstrate an understanding of matter and heat behavior.
- 05.0 Demonstrate a working knowledge of fluids, pressures, refrigerants, and related codes.
- 06.0 Fabricate and service the piping, tubing, and fittings used in the heating, air-conditioning, and refrigeration industry.
- 07.0 Demonstrate a working knowledge of heating, air-conditioning, and refrigeration system components and accessories.
- 08.0 Apply appropriate communication and computer skills.
- 09.0 Demonstrate an understanding of entrepreneurship.
- 10.0 Demonstrate employability skills.

OCCUPATIONAL COMPLETION POINT - B (250 hours)

A/C, REFRIGERATION AND HEATING, MECHANIC ASSISTANT - INDUSTRY
TITLE (SOC 49-9021).

- 11.0 Demonstrate a practical knowledge of basic electricity and of the electrical components of heating, air-conditioning, and refrigeration equipment.
- 12.0 Troubleshoot heating, air-conditioning, and refrigeration electrical control systems and their components.
- 13.0 Troubleshoot and wire electrical motors and their components.
- 14.0 Assist in the installation of a residential heating and air-conditioning system and determine start-up procedures.
- 15.0 Demonstrate a working knowledge of mechanical heating and air-conditioning system operations and of start-up and checkout procedures.

16.0 Identify basic principles of heating, air conditioning, refrigeration and ventilation piping and sizing.

OCCUPATIONAL COMPLETION POINT - C (500 hours)

A/C, REFRIGERATION AND HEATING, MECHANIC - OES 85902654
(SOC 49-9021)

- 17.0 Demonstrate a practical knowledge of solid-state electronics as used in heating, air-conditioning, and refrigeration systems.
- 18.0 18.0 Utilize and operate mechanical refrigeration servicing and testing equipment.
- 19.0 Use combustion-type heating servicing and testing equipment.
- 20.0 Troubleshoot combustible gas valves and regulators as used in heating, air-conditioning, refrigeration and ventilation systems.
- 21.0 Determine the properties of air.
- 22.0 Use a pressure enthalpy chart to diagram refrigerant cycles.
- 23.0 Explain the standards for and ways to measure indoor-air quality.
- 24.0 Demonstrate the installation, maintenance, and repair of heating, air-conditioning, and refrigeration systems.

**Florida Department of Education
STUDENT PERFORMANCE STANDARDS**

Course Number: 8713010
Course Title: Air Conditioning, Refrigeration and Heating
 Technology 1
Course Credit: 1

01.0 IDENTIFY SAFE WORKING CONDITIONS AND FOLLOW SAFETY PRACTICES--The student will be able to:

- 01.01 Identify and use good housekeeping practices in the laboratory.
- 01.02 Explain the reasons for regular safety meetings and for company safety policies.
- 01.03 Explain the need for employee-background checks and medical examinations.
- 01.04 Identify and use appropriate fire extinguishers and other such safety devices.
- 01.05 Identify and follow emergency and rescue procedures.
- 01.06 Identify and use safe-handling practices as they relate to hazardous and volatile fluids, compounds, and gases.
- 01.07 Apply specific safety and recovery practices for refrigerants used in the industry.
- 01.08 Apply specific safety practices as they relate to handling and storing cylinders and materials.
- 01.09 Select and wear proper protective clothing and equipment.
- 01.10 Identify and use specific safety practices when using soldering and brazing skills.
- 01.11 Identify and use Occupational Safety and Health Administration (OSHA) practices when working with heating, air-conditioning, and refrigeration systems and equipment.
- 01.12 Follow safety precautions when using hand and power tools.
- 01.13 Demonstrate an understanding of cardiopulmonary resuscitation (CPR) and first aid.

02.0 DESCRIBE THE HISTORY AND CONCEPTS OF HEATING, AIR-CONDITIONING, AND REFRIGERATION--The student will be able to:

- 02.01 Identify and explain the four major refrigeration components.
- 02.02 Identify and explain the characteristics of a compression-cycle refrigerant system.
- 02.03 Differentiate between air conditioning and refrigeration.
- 02.04 Differentiate between split systems and package systems.
- 02.05 Describe the benefits of conditioned air and environments.
- 02.06 Discuss the impact of heating, air conditioning, and refrigeration on society.
- 02.07 Discuss current issues and concerns (such as indoor-air quality, the ozone layer, and computer technology) in the heating, air-conditioning, and refrigeration industry and in the environment and explain their future ramifications.
- 02.08 Describe the purpose and requirements of local, state, and federal heating, air-conditioning, and refrigeration codes and standards and of the manufacturer's installation instructions.
- 02.09 Identify various professional organizations, associations, and societies, and explain their purposes.

- 03.0 IDENTIFY, USE, AND MAINTAIN THE TOOLS AND TOOL ACCESSORIES USED IN THE HEATING, AIR-CONDITIONING, AND REFRIGERATION INDUSTRY--The student will be able to:
- 03.01 Identify and use
 - a. Basic hand tools and tool accessories
 - b. Power tools (electric, mechanical, and pneumatic, if available).
 - c. Pipe and tube-working tools of the trade
 - d. Specialized tools of the trade
 - 03.02 Apply appropriate care and maintenance procedures for tools and tool accessories, following the directions in the tool-equipment manufacturer's manual.
- 04.0 DEMONSTRATE AN UNDERSTANDING OF MATTER AND HEAT BEHAVIOR--The student will be able to:
- 04.01 Describe and explain freezing point, critical temperature, and absolute zero.
 - 04.02 Describe matter, heat, and heat transfer.
 - 04.03 Differentiate between heat and temperature.
 - 04.04 Explain and distinguish among the characteristics of the three states of matter.
 - 04.05 Explain the relationship between temperature and humidity.
 - 04.06 Differentiate between latent heat and sensible heat.
- 05.0 DEMONSTRATE A WORKING KNOWLEDGE OF FLUIDS, PRESSURES, REFRIGERANTS, AND RELATED CODES--The student will be able to:
- 05.01 Identify the refrigeration cycle.
 - 05.02 Identify and explain general safety issues and EPA rules and regulations regarding the handling of refrigerants.
 - 05.03 Define and explain "pressure," "fluid," and "temperature."
 - 05.04 Explain the standards for and ways to measure and calculate absolute and gauge pressures.
 - 05.05 Identify and explain the classifications, properties, and uses of different refrigerants.
 - 05.06 Explain how fluids react and flow in a closed versus an open environment or vessel.
 - 05.07 Define and identify "color-coding" of refrigerant cylinders.
 - 05.08 Compare pressure and temperature (P/T) charts.
 - 05.09 Explain the proper methods of transferring, storing, and recovering refrigerants.
 - 05.10 Explain the effects of an improper refrigerant and contaminants in a system.

Florida Department of Education
STUDENT PERFORMANCE STANDARDS

Course Number: 8713020
Course Title: Air Conditioning, Refrigeration and Heating
Technology 2
Course Credit: 1

06.0 FABRICATE AND SERVICE THE PIPING, TUBING, AND FITTINGS USED IN THE HEATING, AIR-CONDITIONING, AND REFRIGERATION INDUSTRY--The student will be able to:

- 06.01 Identify and explain the purpose of the piping, tubing, and fittings used in the heating, air-conditioning, and refrigeration industry.
- 06.02 Bend tubing, using tube benders.
- 06.03 Connect tubing, using
 - a. Flared fittings
 - b. Compression fittings
- 06.04 Connect tubing, using solderless connectors.
- 06.05 Connect tubing, using a swaged-joint connection.
- 06.06 Identify and use various types of torches.
- 06.07 Identify, select, and use appropriate soldering and brazing alloys, materials, and skills.
- 06.08 Explain the purposes and procedures for protecting piping materials and fabrication, such as valves, fittings, and products, from heat.
- 06.09 Solder and/or braze tubing, including aluminum.
- 06.10 Silver-braze brass, steels, and copper.
- 06.11 Demonstrate an understanding of the procedures for installing pipe and tubing insulation.
- 06.12 Explain the procedures required for installing heating, air-conditioning, refrigerant, and ventilation accessories.
- 06.13 Fabricate and leak-test the piping, tubing, and fittings used in the heating, air-conditioning, and refrigeration industry.
- 06.14 Maintain project time and materials lists.

07.0 DEMONSTRATE A WORKING KNOWLEDGE OF HEATING, AIR-CONDITIONING, AND REFRIGERATION SYSTEM COMPONENTS AND ACCESSORIES--The student will be able to:

- 07.01 Explain the types, operation, use, and maintenance requirements of
 - a. Compressors (such as reciprocating, rotary, screw, and scroll)
 - b. Condensers and evaporators (such as evaporative condensers and evaporative coils, shell and tube, tube within a tube, and fin and tube)
 - c. Metering devices (such as adjusting automatic and thermostatic expansion valves, fixed orifices, and other devices available on the local market)
- 07.02 Evaluate metering-device performance.
- 07.03 Explain the methods of compression, lubrication, and compressor loading and unloading.
- 07.04 Analyze the operating condition of a compressor.

- 07.05 Test, troubleshoot, and correct the causes of mechanical problems in a heating, air-conditioning, and refrigeration system.
 - 07.06 Identify the location and explain the uses of refrigerant flow accessories.
 - 07.07 Identify the location and explain the uses of heating, air-conditioning, and refrigeration-system accessories (such as receivers, dryers/filters, solenoid valves, heat exchangers, accumulators, suction filter, oil separators, evaporator pressure-regulating valve, crankcase pressure-regulating valves, and check valves).
 - 07.08 Evaluate system performance.
- 08.0 APPLY APPROPRIATE COMMUNICATION AND COMPUTER SKILLS--The student will be able to:
- 08.01 Ask and answer questions coherently and concisely.
 - 08.02 Read and follow written instructions and listen to and follow oral instructions.
 - 08.03 Make oral presentations.
 - 08.04 Write reports, using word-processing software.
 - 08.05 Read and interpret industry-related materials.
 - 08.06 Find information in technical literature, such as a manufacturer's manual.
 - 08.07 Interpret graphs, charts, diagrams, and tables commonly used in the industry.
 - 08.08 Fill out the forms and invoices commonly used in the industry.
 - 08.09 Demonstrate appropriate telephone communications skills.
 - 08.10 Use industry-related computer software.
- 09.0 DEMONSTRATE AN UNDERSTANDING OF ENTREPRENEURSHIP--The student will be able to:
- 09.01 Define "entrepreneurship."
 - 09.02 Explain the importance of entrepreneurship to the United States economy.
 - 09.03 Discuss the advantages and disadvantages of business ownership.
 - 09.04 Explain the risks involved in the ownership of a business.
 - 09.05 Identify the personal characteristics of a successful entrepreneur.
 - 09.06 Identify the business skills needed to operate a small business efficiently and effectively.
 - 09.07 Describe the employer's responsibilities to support the business and industry.
 - 09.08 Demonstrate a working knowledge of state and local licensing requirements.
- 10.0 DEMONSTRATE EMPLOYABILITY SKILLS--The student will be able to:
- 10.01 Conduct a job search and identify advanced-training opportunities and their requirements.
 - 10.02 Calculate the employer's investment cost for an employee.
 - 10.03 Secure information about a job, including employee benefits.
 - 10.04 Write a resume.
 - 10.05 Evaluate a job offer, considering various factors such as career advancement, job satisfaction, employee benefits, etc.
 - 10.06 Demonstrate ethical and responsible practices.

- 10.07 Exhibit pride in the quality of work performed.
- 10.08 Describe the advantages of a good driving record and the ramifications of a poor driving record on employability opportunities.
- 10.09 Explain the law that describes the Material Safety Data Sheet (MSDS).
- 10.10 Explain the importance of confidentiality in the workplace.
- 10.11 Discuss the effects of positive human-relation skills on success in the business.
- 10.12 Demonstrate appropriate responses to performance evaluations from the employer, the supervisor, and other persons in the workplace.

Florida Department of Education
STUDENT PERFORMANCE STANDARDS

Course Number: 8713030
Course Title: Air Conditioning, Refrigeration and Heating
Technology 3
Course Credit: 1

- 11.0 DEMONSTRATE A PRACTICAL KNOWLEDGE OF BASIC ELECTRICITY AND OF THE ELECTRICAL COMPONENTS OF HEATING, AIR-CONDITIONING, AND REFRIGERATION EQUIPMENT--The student will be able to:
- 11.01 Explain the principles of electricity.
 - 11.02 Explain single- and three-phase power distribution.
 - 11.03 Define and explain watts, ohms, volts, and amps.
 - 11.04 Identify and explain electrical measuring tools and devices.
 - 11.05 Explain the standards for and ways to measure watts, resistance, voltage, and amperage, using appropriate instruments or devices.
 - 11.06 Identify and explain appropriate electrical wiring symbols.
 - 11.07 Draw and explain a wiring schematic diagram for a control system.
 - 11.08 Create a wiring schematic for each of the following, using all components and symbols for safe and effective operation and interpretation:
 - a. An air-conditioner
 - b. An electric furnace
 - c. A heat pump
 - d. An oil furnace
 - e. A gas furnace
 - 11.09 Explain codes and standards and safety requirements for working with the electrical components used in heating, air conditioning, and refrigeration.
 - 11.10 Troubleshoot protection devices, such as fuses and breakers.
 - 11.11 Interpret tables and charts from the National Electrical Codes (NEC).
- 12.0 TROUBLESHOOT HEATING, AIR-CONDITIONING, AND REFRIGERATION ELECTRICAL CONTROL SYSTEMS AND THEIR COMPONENTS--The student will be able to:
- 12.01 Identify and explain the operations of electrical control systems and their components (such as heat anticipators, heat and cool thermostats, outdoor thermostats/low ambient controls, defrost controls/timers, and auxiliary heating controls).
 - 12.02 Identify, install, and troubleshoot controls for heating, air-conditioning, and refrigeration systems.
 - 12.03 Explain the operation of different types of electromechanical thermostats.
 - 12.04 Wire basic heating, air-conditioning, and refrigeration systems.
 - 12.05 Troubleshoot operational problems for different types of electromechanical thermostats.
 - 12.06 Explain the electrical and mechanical operations of the basic heat pump.

13.0 TROUBLESHOOT AND WIRE ELECTRICAL MOTORS AND THEIR COMPONENTS--The student will be able to:

- 13.01 Identify and explain the functions of various types of motors and their components.
- 13.02 Troubleshoot, test, and analyze motors, using various methods.
- 13.03 Identify, troubleshoot, and wire various types of electric motors.
- 13.04 Reverse the rotation of a motor.

Florida Department of Education
STUDENT PERFORMANCE STANDARDS

Course Number: 8713040
Course Title: Air Conditioning, Refrigeration and Heating
Technology 4
Course Credit: 1

14.0 ASSIST IN THE INSTALLATION OF A RESIDENTIAL HEATING AND AIR-CONDITIONING SYSTEM AND DETERMINE START-UP PROCEDURES--The student will be able to:

- 14.01 Read and comply with dispatch orders.
- 14.02 Explain local codes and ordinances.
- 14.03 Select and use appropriate tools and safety practices to test equipment.
- 14.04 Determine the electrical requirements of equipment.
- 14.05 Assist in the installation of a heating and air-conditioning system to the manufacturer's installation and operation specifications, using a practical knowledge of duct fabrication methods.
- 14.06 Determine the proper charge in a residential air-conditioning unit and adjust superheat.
- 14.07 Determine the temperature drop across the evaporator.
- 14.08 Determine the temperature rise across the condenser.
- 14.09 Write a service report.
- 14.10 Apply good customer-relations skills.

15.0 DEMONSTRATE A WORKING KNOWLEDGE OF MECHANICAL HEATING AND AIR-CONDITIONING SYSTEM OPERATIONS AND OF START-UP AND CHECK-OUT PROCEDURES--The student will be able to:

- 15.01 Identify and explain:
 - a. Air-to-air heat-pump systems
 - b. Water-to-air heat-pump systems
 - c. Water-to-water heat-pump systems
 - d. Air-to-ground heat-pump systems (geothermal)
 - e. Open-loop heat-pump systems
 - f. Closed-loop heat-pump systems
- 15.02 Determine the start-up and check-out procedures recommended by different manufacturers.
- 15.03 Determine the electrical requirements of equipment.
- 15.04 Select and use appropriate tools, instruments, and test equipment, following safety precautions.
- 15.05 Determine the temperature drop across the outdoor coil on a heat pump.
- 15.06 Determine the temperature rise across the indoor coil on a heat pump.
- 15.07 Test for a proper refrigerant charge in a residential heat pump.
- 15.08 Apply good customer-relations skills.

16.0 IDENTIFY BASIC PRINCIPLES OF HEATING, AIR CONDITIONING, REFRIGERATION AND VENTILATION PIPING AND SIZING--The student will be able to:

- 16.01 Identify and explain various types of heating, air-conditioning, and refrigeration piping.

- 16.02 Identify basic principles of sizing various heating, air conditioning, refrigeration and ventilation piping for various tasks.
- 16.03 Explain pressure and temperature drops.

Florida Department of Education
STUDENT PERFORMANCE STANDARDS

Course Number: 8713050
Course Title: Air Conditioning, Refrigeration and Heating
Technology 5
Course Credit: 1

- 17.0 DEMONSTRATE A PRACTICAL KNOWLEDGE OF SOLID-STATE ELECTRONICS AS USED IN HEATING, AIR-CONDITIONING, AND REFRIGERATION SYSTEMS--The student will be able to:
- 17.01 Explain the basic principles and functions of direct digital control (DDC).
 - 17.02 Explain basic solid-state circuits and boards.
 - 17.03 Identify, test, and replace circuits and boards.
 - 17.04 Identify and explain the functions of a building-management system.
 - 17.05 Program a programmable thermostat.
- 18.0 UTILIZE AND OPERATE MECHANICAL REFRIGERATION SERVICING AND TESTING EQUIPMENT--The student will be able to:
- 18.01 Identify the effects of superheat and subcooling on a system.
 - 18.02 Identify and explain the functions of servicing and testing equipment (such as vacuum pumps, micron gauges, EPA-approved equipment, leak detectors, and charging systems).
 - 18.03 Operate a refrigerant recovery system.
 - 18.04 Explain the standards for and ways to measure, test, maintain, and evacuate a mechanical heating, air-conditioning, and refrigeration system.
 - 18.05 Evacuate the refrigerant system with various vacuum methods.
 - 18.06 Demonstrate compliance with Environmental Protection Agency (EPA) rules and regulations and, if possible, take the EPA test.
 - 18.07 Charge various air-conditioning and mechanical refrigeration systems by various methods.
 - 18.08 Demonstrate the effects of superheat and subcooling on a system utilizing testing equipment (such as thermometers and gages).
- 19.0 USE COMBUSTION-TYPE HEATING SERVICING AND TESTING EQUIPMENT--The student will be able to:
- 19.01 Explain combustion theory and the safety precautions for using combustion-type-heating servicing and testing equipment.
 - 19.02 Install a combustion-type-heating unit to the manufacturer's and code requirements.
 - 19.03 Identify and explain the various types of combustion-type heating servicing and testing equipment (such as draft gauge, U-tube manometer, sling psychrometer, millivolt meter, and oil-furnace testing equipment).
 - 19.04 Use the servicing and testing equipment.
 - 19.05 Test, analyze, and troubleshoot combustion-type-heating systems.

Florida Department of Education
STUDENT PERFORMANCE STANDARDS

Course Number: 8713060
Course Title: Air Conditioning, Refrigeration and Heating
 Technology 6
Course Credit: 1

20.0 TROUBLESHOOT COMBUSTIBLE GAS VALVES AND REGULATORS AS USED IN HEATING, AIR-CONDITIONING, REFRIGERATION AND VENTILATION SYSTEMS--
 The student will be able to:

- 20.01 Identify and discuss the safety and regulation issues and concerns.
- 20.02 Explain the operations of various types of gas valves and regulators (such as low-voltage, line-voltage, pneumatic, solenoid, and gas and pressure regulators).
- 20.03 Identify and size various types of gas valves and regulators.
- 20.04 Determine the application of gas valves and regulators.
- 20.05 Troubleshoot gas valves and regulators.

21.0 DETERMINE THE PROPERTIES OF AIR--The student will be able to:

- 21.01 Explain the principles of psychometrics.
- 21.02 Identify and explain the components and uses of a psychometric meter.
- 21.03 Identify indoor-air-quality concerns as related to psychometrics.
- 21.04 Determine the properties of air, using a psychometric chart.
- 21.05 Follow safety precautions.
- 21.06 Identify and explain the different types and benefits of
 - a. Air-filtration systems
 - b. Air-handling systems
 - c. Ventilation systems
- 21.07 Fabricate, operate, maintain, and troubleshoot
 - a. Air-filtration systems
 - b. Air-handling systems
 - c. Ventilation systems

22.0 USE A PRESSURE ENTHALPY CHART TO DIAGRAM REFRIGERANT CYCLES--The student will be able to:

- 22.01 Identify all components of the pressure enthalpy chart.
- 22.02 Define "enthalpy" and "entropy."
- 22.03 Diagram several refrigerant cycles, using the pressure enthalpy chart.

Florida Department of Education
STUDENT PERFORMANCE STANDARDS

Course Number: 8713070
Course Title: Air Conditioning, Refrigeration and Heating
Technology 7
Course Credit: 1

23.0 EXPLAIN THE STANDARDS FOR AND WAYS TO MEASURE INDOOR-AIR QUALITY--
The student will be able to:

- 23.01 Define indoor-air quality.
- 23.02 Identify and explain the codes and standards regarding indoor-air quality.
- 23.03 Select and use indoor-air-quality measuring devices.
- 23.04 Explain the standards for and ways to measure indoor-air quality, using various methods.

24.0 DEMONSTRATE THE INSTALLATION, MAINTENANCE, AND REPAIR OF HEATING, AIR-CONDITIONING, AND REFRIGERATION SYSTEMS--The student will be able to:

- 24.01 Follow safety precautions.
- 24.02 Describe new technologies in heating, air-conditioning, and refrigeration installation, including
 - a. Variable-speed motors
 - b. Heat-pipe systems
 - c. Desiccant systems
 - d. Gas-driven heating systems
- 24.03 Apply local and national codes.
- 24.04 Lay out, construct, and troubleshoot comfort systems.
- 24.05 Test and analyze systems.
- 24.06 Test and analyze heat-recovery systems.

**Florida Department of Education
INTENDED OUTCOMES**

Program Title: REFRIGERATION TECHNOLOGY

Program Number: PSAV
I470202
CIP Number: 0647.020202
Grade Level: 30, 31
Length: 1350 Hours
SOC: 40-2091
Certification: AC HEAT ME @7 G
REFRG MECH @7 G
Basic-Skills Grade Level
 Math 10
 Language 9
 Reading 9

INTENDED OUTCOMES: After successfully completing appropriate content for each occupational completion point of this program, the student will be able to perform the following:

OCCUPATIONAL COMPLETION POINT - DATA CODE - A (250 Hours)

A/C, REFRIGERATION AND HEATING HELPER - (SOC 49-9021).

- 01.0 Identify safe working conditions and follow safety practices.
- 02.0 Describe the history and concepts of heating, air conditioning, and refrigeration.
- 03.0 Identify, use, and maintain the hand tools and tool accessories used in the heating, air-conditioning, and refrigeration industry.
- 04.0 Demonstrate an understanding of matter and heat behavior.
- 05.0 Demonstrate a working knowledge of fluids, pressures, refrigerants, and related codes.
- 06.0 Fabricate and service the piping, tubing, and fittings used in the heating, air-conditioning, and refrigeration industry.
- 07.0 Demonstrate a working knowledge of heating, air-conditioning, and refrigeration system components and accessories.
- 08.0 Apply appropriate communication and computer skills.
- 09.0 Demonstrate an understanding of entrepreneurship.
- 10.0 Demonstrate employability skills.

OCCUPATIONAL COMPLETION POINT - DATA CODE - B (250 Hours)

A/C, REFRIGERATION AND HEATING MECHANIC ASSSISTANT - (SOC 49-9021).

- 11.0 Demonstrate a practical knowledge of basic electricity and of the electrical components of heating, air-conditioning, and refrigeration equipment.
- 12.0 Troubleshoot heating, air-conditioning, and refrigeration electrical control systems and their components.
- 13.0 Troubleshoot and wire electrical motors and their components.
- 14.0 Assist in the installation of a residential heating and air-conditioning system and determine start-up procedures.

- 15.0 Demonstrate a working knowledge of mechanical heating and air-conditioning system operations and of start-up and checkout procedures.
- 16.0 Identify basic principles of heating, air conditioning, refrigeration and ventilation piping and sizing.

OCCUPATIONAL COMPLETION POINT - DATA CODE C (500 Hours)

A/C, REFRIGERATION AND HEATING MECHANIC - OES 85902 (SOC 49-9021)

- 17.0 Demonstrate a practical knowledge of solid-state electronics as used in heating, air-conditioning, and refrigeration systems.
- 18.0 Utilize and operate mechanical refrigeration servicing and testing equipment.
- 19.0 Use combustion-type heating servicing and testing equipment.
- 20.0 Troubleshoot combustible gas valves and regulators as used in heating, air-conditioning, refrigeration and ventilation systems.
- 21.0 Determine the properties of air.
- 22.0 Use a pressure enthalpy chart to diagram refrigerant cycles.
- 23.0 Explain the standards for and ways to measure indoor-air quality.
- 24.0 Demonstrate the installation, maintenance, and repair of heating, air-conditioning, and refrigeration systems.

OCCUPATIONAL COMPLETION POINT - DATA CODE - D (350 Hours)

REFRIGERATION MECHANIC - DOT 637.261-026 (SOC 49-9021)

- 25.0 Demonstrate a working knowledge of electrical generation and distribution components for commercial heating and air conditioning systems.
- 26.0 Demonstrate a working knowledge of refrigeration-system vibration and insulation.
- 27.0 Apply commercial refrigeration-pipe sizing and troubleshooting procedures.
- 28.0 Use refrigeration-systems skills in commercial applications.
- 29.0 Demonstrate a working knowledge of refrigerated storage systems.
- 30.0 Diagnose, maintain, and repair ice-making systems.
- 31.0 Use refrigeration electrical-system skills in commercial applications.
- 32.0 Maintain and troubleshoot commercial refrigeration systems.

**Florida Department of Education
STUDENT PERFORMANCE STANDARDS**

Program Title: Commercial Refrigeration Technology

Postsecondary Number: I470202

OCCUPATIONAL COMPLETION POINT - A

A/C, REFRIGERATION AND HEATING HELPER - INDUSTRY TITLE

01.0 IDENTIFY SAFE WORKING CONDITIONS AND FOLLOW SAFETY PRACTICES--The student will be able to:

- 01.01 Identify and use good housekeeping practices in the laboratory.
- 01.02 Explain the reasons for regular safety meetings and for company safety policies.
- 01.03 Explain the need for employee-background checks and medical examinations.
- 01.04 Identify and use appropriate fire extinguishers and other such safety devices.
- 01.05 Identify and follow emergency and rescue procedures.
- 01.06 Identify and use safe-handling practices as they relate to hazardous and volatile fluids, compounds, and gases.
- 01.07 Apply specific safety and recovery practices for refrigerants used in the industry.
- 01.08 Apply specific safety practices as they relate to handling and storing cylinders and materials.
- 01.09 Select and wear proper protective clothing and equipment.
- 01.10 Identify and use specific safety practices when using soldering and brazing skills.
- 01.11 Identify and use Occupational Safety and Health Administration (OSHA) practices when working with heating, air-conditioning, and refrigeration systems and equipment.
- 01.12 Follow safety precautions when using hand and power tools.
- 01.13 Demonstrate an understanding of cardiopulmonary resuscitation (CPR) and first aid.

02.0 DESCRIBE THE HISTORY AND CONCEPTS OF HEATING, AIR-CONDITIONING, AND REFRIGERATION--The student will be able to:

- 02.01 Identify and explain the four major refrigeration components.
- 02.02 Identify and explain the characteristics of a compression-cycle refrigerant system.
- 02.03 Differentiate between air conditioning and refrigeration.
- 02.04 Differentiate between split systems and package systems.
- 02.05 Describe the benefits of conditioned air and environments.
- 02.06 Discuss the impact of heating, air conditioning, and refrigeration on society.
- 02.07 Discuss current issues and concerns (such as indoor-air quality, the ozone layer, and computer technology) in the heating, air-conditioning, and refrigeration industry and in the environment and explain their future ramifications.
- 02.08 Describe the purpose and requirements of local, state, and federal heating, air-conditioning, and refrigeration codes and standards and of the manufacturer's installation instructions.
- 02.09 Identify various professional organizations, associations, and societies, and explain their purposes.

- 03.0 IDENTIFY, USE, AND MAINTAIN THE TOOLS AND TOOL ACCESSORIES USED IN THE HEATING, AIR-CONDITIONING, AND REFRIGERATION INDUSTRY--The student will be able to:
- 03.01 Identify and use
 - a. Basic hand tools and tool accessories
 - b. Power tools (electric, mechanical, and pneumatic, if available)
 - c. Pipe and tube-working tools of the trade
 - d. Specialized tools of the trade
 - 03.02 Apply appropriate care and maintenance procedures for tools and tool accessories, following the directions in the tool-equipment manufacturer's manual.
- 04.0 DEMONSTRATE AN UNDERSTANDING OF MATTER AND HEAT BEHAVIOR--The student will be able to:
- 04.01 Describe and explain freezing point, critical temperature, and absolute zero.
 - 04.02 Describe matter, heat, and heat transfer.
 - 04.03 Differentiate between heat and temperature.
 - 04.04 Explain and distinguish among the characteristics of the three states of matter.
 - 04.05 Explain the relationship between temperature and humidity.
 - 04.06 Differentiate between latent heat and sensible heat.
- 05.0 DEMONSTRATE A WORKING KNOWLEDGE OF FLUIDS, PRESSURES, REFRIGERANTS, AND RELATED CODES--The student will be able to:
- 05.01 Identify the refrigeration cycle.
 - 05.02 Identify and explain general safety issues and EPA rules and regulations regarding the handling of refrigerants.
 - 05.03 Define and explain "pressure," "fluid," and "temperature."
 - 05.04 Explain the standards for and ways to measure and calculate absolute and gauge pressures.
 - 05.05 Identify and explain the classifications, properties, and uses of different refrigerants.
 - 05.06 Explain how fluids react and flow in a closed versus an open environment or vessel.
 - 05.07 Define and identify "color-coding" of refrigerant cylinders.
 - 05.08 Compare pressure and temperature (P/T) charts.
 - 05.09 Explain the proper methods of transferring, storing, and recovering refrigerants.
 - 05.10 Explain the effects of an improper refrigerant and contaminants in a system.
- 06.0 FABRICATE AND SERVICE THE PIPING, TUBING, AND FITTINGS USED IN THE HEATING, AIR-CONDITIONING, AND REFRIGERATION INDUSTRY--The student will be able to:
- 06.01 Identify and explain the purpose of the piping, tubing, and fittings used in the heating, air-conditioning, and refrigeration industry.
 - 06.02 Bend tubing, using tube benders.
 - 06.03 Connect tubing, using
 - a. Flared fittings
 - b. Compression fittings
 - 06.04 Connect tubing, using solderless connectors.
 - 06.05 Connect tubing, using a swaged-joint connection.

- 06.06 Identify and use various types of torches.
 - 06.07 Identify, select, and use appropriate soldering and brazing alloys, materials, and skills.
 - 06.08 Explain the purposes and procedures for protecting piping materials and fabrication, such as valves, fittings, and products, from heat.
 - 06.09 Solder and/or braze tubing, including aluminum.
 - 06.10 Silver-braze brass, steel, and copper.
 - 06.11 Demonstrate an understanding of the procedures for installing pipe and tubing insulation.
 - 06.12 Explain the procedures required for installing heating, air-conditioning, refrigerant, and ventilation accessories.
 - 06.13 Fabricate and leak-test the piping, tubing, and fittings used in the heating, air-conditioning, and refrigeration industry.
 - 06.14 Maintain project time and materials lists.
- 07.0 DEMONSTRATE A WORKING KNOWLEDGE OF HEATING, AIR-CONDITIONING, AND REFRIGERATION SYSTEM COMPONENTS AND ACCESSORIES--The student will be able to:
- 07.01 Explain the types, operation, use, and maintenance requirements of
 - a. Compressors (such as reciprocating, rotary, screw, and scroll)
 - b. Condensers and evaporators (such as evaporative condensers, evaporative coils, shell and tube, tube within a tube, and fin and tube)
 - c. Metering devices (such as adjusting automatic and thermostatic expansion valves, fixed orifices, and other devices available on the local market)
 - 07.02 Evaluate metering-device performance.
 - 07.03 Explain the methods of compression, lubrication, and compressor loading and unloading.
 - 07.04 Analyze the operating condition of a compressor.
 - 07.05 Test, troubleshoot, and correct the causes of mechanical problems in a heating, air-conditioning, and refrigeration system.
 - 07.06 Identify the location and explain the uses of refrigerant flow accessories.
 - 07.07 Identify the location and explain the uses of heating, air-conditioning, and refrigeration-system accessories (such as receivers, dryers/filters, solenoid valves, heat exchangers, accumulators, suction filter, oil separators, evaporator pressure-regulating valve, crankcase pressure-regulating valves, and check valves).
 - 07.08 Evaluate system performance.
- 08.0 APPLY APPROPRIATE COMMUNICATION AND COMPUTER SKILLS--The student will be able to:
- 08.01 Ask and answer questions coherently and concisely.
 - 08.02 Read and follow written instructions and listen to and follow oral instructions.
 - 08.03 Make oral presentations.
 - 08.04 Write reports, using word-processing software.
 - 08.05 Read and interpret industry-related materials.
 - 08.06 Find information in technical literature, such as a manufacturer's manual.

- 08.07 Interpret graphs, charts, diagrams, and tables commonly used in the industry.
 - 08.08 Fill out the forms and invoices commonly used in the industry.
 - 08.09 Demonstrate appropriate telephone communications skills.
 - 08.10 Use industry-related computer software.
- 09.0 DEMONSTRATE AN UNDERSTANDING OF ENTREPRENEURSHIP--The student will be able to:
- 09.01 Define "entrepreneurship."
 - 09.02 Explain the importance of entrepreneurship to the United States economy.
 - 09.03 Discuss the advantages and disadvantages of business ownership.
 - 09.04 Explain the risks involved in the ownership of a business.
 - 09.05 Identify the personal characteristics of a successful entrepreneur.
 - 09.06 Identify the business skills needed to operate a small business efficiently and effectively.
 - 09.07 Describe the employer's responsibilities to support the business and industry.
 - 09.08 Demonstrate a working knowledge of state and local licensing requirements.
- 10.0 DEMONSTRATE EMPLOYABILITY SKILLS--The student will be able to:
- 10.01 Conduct a job search and identify advanced-training opportunities and their requirements.
 - 10.02 Calculate the employer's investment cost for an employee.
 - 10.03 Secure information about a job, including employee benefits.
 - 10.04 Write a resume.
 - 10.05 Evaluate a job offer, considering various factors such as career advancement, job satisfaction, employee benefits, etc.
 - 10.06 Demonstrate ethical and responsible practices.
 - 10.07 Exhibit pride in the quality of work performed.
 - 10.08 Describe the advantages of a good driving record and the ramifications of a poor driving record on employability opportunities.
 - 10.09 Explain the law that describes the Material Safety Data Sheet (MSDS).
 - 10.10 Explain the importance of confidentiality in the workplace.
 - 10.11 Discuss the effects of positive human-relation skills on success in the business.
 - 10.12 Demonstrate appropriate responses to performance evaluations from the employer, the supervisor, and other persons in the workplace.

OCCUPATIONAL COMPLETION POINT - B

A/C, REFRIGERATION AND HEATING MECHANIC ASSISTANT -

- 11.0 DEMONSTRATE A PRACTICAL KNOWLEDGE OF BASIC ELECTRICITY AND OF THE ELECTRICAL COMPONENTS OF HEATING, AIR-CONDITIONING, AND REFRIGERATION EQUIPMENT--The student will be able to:
- 11.01 Explain the principles of electricity.
 - 11.02 Explain single- and three-phase power distribution.
 - 11.03 Define and explain watts, ohms, volts, and amps.
 - 11.04 Identify and explain electrical measuring tools and devices.
 - 11.05 Explain the standards for and ways to measure watts, resistance, voltage, and amperage, using appropriate instruments or devices.
 - 11.06 Identify and explain appropriate electrical wiring symbols.
 - 11.07 Draw and explain a wiring schematic diagram for a control system.
 - 11.08 Create a wiring schematic for each of the following, using all components and symbols for safe and effective operation and interpretation:
 - a. An air-conditioner
 - b. An electric furnace
 - c. A heat pump
 - d. An oil furnace
 - e. A gas furnace
 - 11.09 Explain codes and standards and safety requirements for working with the electrical components used in heating, air conditioning, and refrigeration.
 - 11.10 Troubleshoot protection devices, such as fuses and breakers.
 - 11.11 Interpret tables and charts from the National Electrical Codes (NEC).
- 12.0 TROUBLESHOOT HEATING, AIR-CONDITIONING, AND REFRIGERATION ELECTRICAL CONTROL SYSTEMS AND THEIR COMPONENTS--The student will be able to:
- 12.01 Identify and explain the operations of electrical control systems and their components (such as heat anticipators, heat and cool thermostats, outdoor thermostats/low ambient controls, defrost controls/timers, and auxiliary heating controls).
 - 12.02 Identify, install, and troubleshoot controls for heating, air-conditioning, and refrigeration systems.
 - 12.03 Explain the operation of different types of electromechanical thermostats.
 - 12.04 Wire basic heating, air-conditioning, and refrigeration systems.
 - 12.05 Troubleshoot operational problems for different types of electromechanical thermostats.
 - 12.06 Explain the electrical and mechanical operations of the basic heat pump.

- 13.0 TROUBLESHOOT AND WIRE ELECTRICAL MOTORS AND THEIR COMPONENTS--The student will be able to:
- 13.01 Identify and explain the functions of various types of motors and their components.
 - 13.02 Troubleshoot, test, and analyze motors, using various methods.
 - 13.03 Identify, troubleshoot, and wire various types of electric motors.
 - 13.04 Reverse the rotation of a motor.
- 14.0 ASSIST IN THE INSTALLATION OF A RESIDENTIAL HEATING AND AIR-CONDITIONING SYSTEM AND DETERMINE START-UP PROCEDURES--The student will be able to:
- 14.01 Read and comply with dispatch orders.
 - 14.02 Explain local codes and ordinances.
 - 14.03 Select and use appropriate tools and safety practices to test equipment.
 - 14.04 Determine the electrical requirements of equipment.
 - 14.05 Assist in the installation of a heating and air-conditioning system to the manufacturer's installation and operation specifications, using a practical knowledge of duct fabrication methods.
 - 14.06 Determine the proper charge in a residential air-conditioning unit and adjust superheat.
 - 14.07 Determine the temperature drop across the evaporator.
 - 14.08 Determine the temperature rise across the condenser.
 - 14.09 Write a service report.
 - 14.10 Apply good customer-relations skills.
- 15.0 DEMONSTRATE A WORKING KNOWLEDGE OF MECHANICAL HEATING AND AIR-CONDITIONING SYSTEM OPERATIONS AND OF START-UP AND CHECK-OUT PROCEDURES--The student will be able to:
- 15.01 Identify and explain:
 - a. Air-to-air heat-pump systems
 - b. Water-to-air heat-pump systems
 - c. Water-to-water heat-pump systems
 - d. Air-to-ground heat-pump systems (geothermal)
 - e. Open-loop heat-pump systems
 - f. Closed-loop heat-pump systems
 - 15.02 Determine the start-up and checkout procedures recommended by different manufacturers.
 - 15.03 Determine the electrical requirements of equipment.
 - 15.04 Select and use appropriate tools, instruments, and test equipment, following safety precautions.
 - 15.05 Determine the temperature drop across the outdoor coil on a heat pump.
 - 15.06 Determine the temperature rise across the indoor coil on a heat pump.
 - 15.07 Test for a proper refrigerant charge in a residential heat pump.
 - 15.08 Apply good customer-relations skills.

16.0 IDENTIFY BASIC PRINCIPLES OF HEATING, AIR CONDITIONING, REFRIGERATION AND VENTILATION PIPING AND SIZING--The student will be able to:

- 16.01 Identify and explain various types of heating, air-conditioning, and refrigeration piping.
- 16.02 Identify basic principles of sizing various heating, air conditioning, refrigeration, and ventilation piping for various tasks.
- 16.03 Explain pressure and temperature drops.

OCCUPATIONAL COMPLETION POINT - C

A/C, REFRIGERATION AND HEATING MECHANIC

17.0 DEMONSTRATE A PRACTICAL KNOWLEDGE OF SOLID-STATE ELECTRONICS AS USED IN HEATING, AIR-CONDITIONING, AND REFRIGERATION SYSTEMS--The student will be able to:

- 17.01 Explain the basic principles and functions of direct digital control (DDC).
- 17.02 Explain basic solid-state circuits and boards.
- 17.03 Identify, test, and replace circuits and boards.
- 17.04 Identify and explain the functions of a building-management system.
- 17.05 Program a programmable thermostat.

18.0 UTILIZE AND OPERATE MECHANICAL REFRIGERATION SERVICING AND TESTING EQUIPMENT--The student will be able to:

- 18.01 Identify the effects of superheat and subcooling on a system.
- 18.02 Identify and explain the functions of servicing and testing equipment (such as vacuum pumps, micron gauges, EPA-approved equipment, leak detectors, and charging systems).
- 18.03 Operate a refrigerant recovery system.
- 18.04 Explain the standards for and ways to measure, test, maintain, and evacuate a mechanical heating, air-conditioning, and refrigeration system.
- 18.05 Evacuate the refrigerant system with various vacuum methods.
- 18.06 Demonstrate compliance with Environmental Protection Agency (EPA) rules and regulations and, if possible, take the EPA test.
- 18.07 Charge various air-conditioning and mechanical refrigeration systems by various methods.
- 18.08 Demonstrate the effects of superheat and subcooling on a system utilizing testing equipment (such as thermometers and gages).

19.0 USE COMBUSTION-TYPE HEATING SERVICING AND TESTING EQUIPMENT--The student will be able to:

- 19.01 Explain combustion theory and the safety precautions for using combustion-type-heating servicing and testing equipment.
- 19.02 Install a combustion-type-heating unit to the manufacturer's and code requirements.
- 19.03 Identify and explain the various types of combustion-type heating servicing and testing equipment (such as draft

- gauge, U-tube manometer, sling psychrometer, millivolt meter, and oil-furnace testing equipment).
- 19.04 Use the servicing and testing equipment.
- 19.05 Test, analyze, and troubleshoot combustion-type-heating systems.
- 20.0 TROUBLESHOOT COMBUSTION GAS VALVES AND REGULATORS AS USED IN HEATING, AIR-CONDITIONING, REFRIGERATION AND VENTILATION SYSTEMS--
The student will be able to:
- 20.01 Identify and discuss the safety and regulation issues and concerns.
- 20.02 Explain the operations of various types of gas valves and regulators (such as low-voltage, line-voltage, pneumatic, solenoid, and gas and pressure regulators).
- 20.03 Identify and size various types of gas valves and regulators.
- 20.04 Determine the application of gas valves and regulators.
- 20.05 Troubleshoot gas valves and regulators.
- 21.0 DETERMINE THE PROPERTIES OF AIR--The student will be able to:
- 21.01 Explain the principles of psychometrics.
- 21.02 Identify and explain the components and uses of a psychrometric meter.
- 21.03 Identify indoor-air-quality concerns as related to psychrometrics.
- 21.04 Determine the properties of air, using a psychrometric chart.
- 21.05 Follow safety precautions.
- 21.06 Identify and explain the different types and benefits of
- a. Air-filtration systems
 - b. Air-handling systems
 - c. Ventilation systems
- 21.07 Fabricate, operate, maintain, and troubleshoot
- a. Air-filtration systems
 - b. Air-handling systems
 - c. Ventilation systems
- 21.08 Determine air properties by the use of a psychrometric chart.
- 22.0 USE A PRESSURE ENTHALPY CHART TO DIAGRAM REFRIGERANT CYCLES--The student will be able to:
- 22.01 Identify all components of the pressure enthalpy chart.
- 22.02 Define "enthalpy" and "entropy."
- 22.03 Diagram several refrigerant cycles, using the pressure enthalpy chart.
- 23.0 EXPLAIN THE STANDARDS FOR AND WAYS TO MEASURE INDOOR-AIR QUALITY--
The student will be able to:
- 23.01 Define indoor-air quality.
- 23.02 Identify and explain the codes and standards regarding indoor-air quality.
- 23.03 Select and use indoor-air-quality measuring devices.
- 23.04 Explain the standards for and ways to measure indoor-air quality, using various methods.

- 24.0 DEMONSTRATE THE INSTALLATION, MAINTENANCE, AND REPAIR OF HEATING, AIR-CONDITIONING, AND REFRIGERATION SYSTEMS--The student will be able to:
- 24.01 Follow safety precautions.
 - 24.02 Describe new technologies in heating, air-conditioning, and refrigeration installation, including
 - a. Variable-speed motors
 - b. Heat-pipe systems
 - c. Desiccant systems
 - d. Gas-driven heating systems
 - 24.03 Apply local and national codes.
 - 24.04 Lay out, construct, and troubleshoot comfort systems.
 - 24.05 Test and analyze systems.
 - 24.06 Test and analyze heat-recovery systems.

OCCUPATIONAL COMPLETION POINT - D
REFRIGERATION MECHANIC

- 25.0 DEMONSTRATE A WORKING KNOWLEDGE OF ELECTRICAL GENERATION AND DISTRIBUTION COMPONENTS FOR COMMERCIAL HEATING AND AIR CONDITIONING SYSTEMS--The student will be able to:
- 25.01 Calculate loads, and design and lay out a commercial refrigeration system.
 - 25.02 Identify and explain commercial refrigeration-pressure-regulation devices, controls, and components.
 - 25.03 Install, service, and repair ice machines and specialty refrigeration systems.
 - 25.04 Test and troubleshoot refrigerant-pressure-regulating devices, controls, and components.
 - 25.05 Apply local and national codes and mechanical safety practices.
- 26.0 DEMONSTRATE A WORKING KNOWLEDGE OF REFRIGERATION-SYSTEM VIBRATION AND INSULATION--The student will be able to:
- 26.01 Describe the applications of vibration eliminators.
 - 26.02 Identify and select the correct insulation for commercial application.
- 27.0 APPLY COMMERCIAL REFRIGERATION-PIPE SIZING AND TROUBLESHOOTING PROCEDURES--The student will be able to:
- 27.01 Determine the capacities of refrigerant lines, including the amounts they will hold, equivalent lengths of fittings, and the total effective length for various pipelines.
 - 27.02 Identify and apply industry-approved installation procedures.
 - 27.03 Troubleshoot refrigeration-pipe-sizing problems.
 - a. Explain the use of traps in suction-line risers.
 - b. Explain pressure drop.
 - c. Calculate pressure drop in liquid-line risers.
 - d. Size double risers, hot-gas lines, and liquid lines from condenser to receiver.
- 28.0 USE REFRIGERATION-SYSTEMS SKILLS IN COMMERCIAL APPLICATIONS--The student will be able to:

- 28.01 Identify and apply the safety practices used with commercial refrigeration systems.
 - 28.02 Apply refrigeration-systems skills to commercial refrigeration systems.
 - a. Perform dehydration, evacuation, and recovery procedures.
 - b. Interpret blueprints and mechanical drawings.
 - c. Service and charge a refrigeration system.
 - d. Test, analyze, and replace compressors.
 - e. Retrofit alternative refrigerants and oils.
- 29.0 DEMONSTRATE A WORKING KNOWLEDGE OF REFRIGERATED STORAGE SYSTEMS--
The student will be able to:
- 29.01 Identify and differentiate among various types of cases, such as service cases and self-service cases.
 - 29.02 Explain the operation of
 - a. Air-screen freezers
 - b. Glass-door freezers
 - c. Coffin cases
 - d. Walk-in coolers
 - 29.03 Differentiate among medium-temperature, low-temperature, and ultralow-temperature systems.
 - 29.04 Explain various defrost methods.
 - 29.05 Maintain, test, and troubleshoot defrost components.
 - 29.06 Identify and explain the components of various refrigerated storage systems.
 - 29.07 Maintain, test, and troubleshoot various refrigerated storage system components.
- 30.0 DIAGNOSE, MAINTAIN, AND REPAIR ICE-MAKING SYSTEMS--The student will be able to:
- 30.01 Identify and explain various types and operations of ice-making systems.
 - 30.02 Maintain, test, troubleshoot, and repair various types of ice-making systems, following the manufacturers' recommendations.
 - 30.03 Identify and explain the different types of water-treatment methods and systems.
 - 30.04 Analyze water to identify water problems and the proper treatments.
- 31.0 USE REFRIGERATION ELECTRICAL-SYSTEM SKILLS IN COMMERCIAL APPLICATIONS--The student will be able to:
- 31.01 Apply electrical safety practices for commercial refrigeration systems.
 - 31.02 Apply refrigeration electrical-system skills to commercial refrigeration systems:
 - a. Interpret symbols of electrical components and diagrams.
 - b. Interpret schematics and diagrams.
 - c. Apply electrical theory and calculations.
 - d. Explain the principles of designing electrical systems.
 - e. Test and troubleshoot single- and three-phase motors.
 - 31.03 Test the solid-state components used in commercial refrigeration systems.
 - 31.04 Troubleshoot and diagnose the electrical circuits used in commercial refrigeration systems.
 - 31.05 Test and troubleshoot the thermostatic controls used in commercial refrigeration systems.

32.0 MAINTAIN AND TROUBLESHOOT COMMERCIAL REFRIGERATION SYSTEMS--The student will be able to:

- 32.01 Follow appropriate safety precautions for commercial refrigeration systems.
- 32.02 Identify and explain the operations of various types of commercial refrigeration systems and applications, such as single, multiplex, and cascade systems.
- 32.03 Maintain and troubleshoot various types of commercial refrigeration systems.

Florida Department of Education
INTENDED OUTCOMES

Program Title: Air Conditioning, Refrigeration and Heating Technology
(PS)

	<u>PSAV</u>
Program Number:	I470203
CIP Number:	0647.020302
Grade Level:	30, 31
Length:	1350 Hours
SOC	49-9021
Certification:	AC HEAT ME @7 G REFRG MECH @7 G
Basic-Skills Grade Level	
Math	10
Language	9
Reading	9

INTENDED OUTCOMES: After successfully completing the appropriate course(s) for each occupational completion point of this program, the student will be able to perform the following:

OCCUPATIONAL COMPLETION POINT - A (250 Hours)

A/C, REFRIGERATION AND HEATING HELPER (SOC 49-9021).

- 01.0 Identify safe working conditions and follow safety practices.
- 02.0 Describe the history and concepts of heating, air-conditioning, and refrigeration.
- 03.0 Identify, use, and maintain the hand tools and tool accessories used in the heating, air-conditioning, and refrigeration industry.
- 04.0 Demonstrate an understanding of matter and heat behavior.
- 05.0 Demonstrate a working knowledge of fluids, pressures, refrigerants, and related codes.
- 06.0 Fabricate and service the piping, tubing, and fittings used in the heating, air-conditioning, and refrigeration industry.
- 07.0 Demonstrate a working knowledge of heating, air-conditioning, and refrigeration system components and accessories.
- 08.0 Apply appropriate communication and computer skills.
- 09.0 Demonstrate an understanding of entrepreneurship.
- 10.0 Demonstrate employability skills.

OCCUPATIONAL COMPLETION POINT - B (250 Hours)

A/C, REFRIGERATION AND HEATING MECHANIC ASSISTANT(SOC 49-9021).

- 11.0 Demonstrate a practical knowledge of basic electricity and of the electrical components of heating, air-conditioning, and refrigeration equipment.
- 12.0 Troubleshoot heating, air-conditioning, and refrigeration electrical control systems and their components.
- 13.0 Troubleshoot and wire electrical motors and their components.
- 14.0 Assist in the installation of a residential heating and air-conditioning system and determine start-up procedures.

- 15.0 Demonstrate a working knowledge of mechanical heating and air-conditioning system operations and of start-up and checkout procedures.
- 16.0 Identify basic principles for heating, air conditioning, refrigeration and ventilation piping and sizing.

OCCUPATIONAL COMPLETION POINT - C (500 Hours)

A/C, REFRIGERATION AND HEATING MECHANIC SOC 49-9021).

- 17.0 Demonstrate a practical knowledge of solid-state electronics as used in heating, air-conditioning, and refrigeration systems.
- 18.0 Utilize and operate mechanical refrigeration servicing and testing equipment.
- 19.0 Use combustion-type heating servicing and testing equipment.
- 20.0 Troubleshoot combustion gas valves and regulators as used in heating, air-conditioning, refrigeration and ventilation systems.
- 21.0 Determine the properties of air.
- 22.0 Use a pressure enthalpy chart to diagram refrigerant cycles.
- 23.0 Explain the standards for and ways to measure indoor-air quality.
- 24.0 Demonstrate the installation, maintenance, and repair of heating, air-conditioning, and refrigeration systems.

OCCUPATIONAL COMPLETION POINT - D (350 Hours)

A/C, REFRIGERATION AND HEATING TECHNICIAN - SOC 49-9021

- 25.0 Demonstrate a working knowledge of electrical generation and distribution components for commercial heating and air conditioning systems.
- 26.0 Maintain, test, and troubleshoot electrical motors and their components for commercial heating and air-conditioning systems.
- 27.0 Demonstrate a working knowledge of environmental control systems as used in commercial heating and air-conditioning systems.
- 28.0 Maintain and troubleshoot pneumatic control systems for commercial heating and air-conditioning applications.
- 29.0 Troubleshoot electrical circuits as used in commercial heating and air-conditioning systems.
- 30.0 Select appropriate commercial compressors.
- 31.0 Test and adjust commercial evaporative condensers.
- 32.0 Maintain, test, and troubleshoot commercial evaporators.
- 33.0 Maintain, test, and adjust commercial heating and air-conditioning accessories.
- 34.0 Maintain, troubleshoot, and repair commercial heating systems.
- 35.0 Maintain and repair thermal storage systems.
- 36.0 Maintain, troubleshoot, and repair commercial heating and air-conditioning systems.
- 37.0 Calculate commercial heating and air-conditioning loads.

**Florida Department of Education
STUDENT PERFORMANCE STANDARDS**

Program Title: Air Conditioning, Refrigeration and Heating Technology

Postsecondary Number: I470203

OCCUPATIONAL COMPLETION POINT - A

A/C, REFRIGERATION AND HEATING HELPER

01.0 IDENTIFY SAFE WORKING CONDITIONS AND FOLLOW SAFETY PRACTICES--The student will be able to:

- 01.01 Identify and use good housekeeping practices in the laboratory.
- 01.02 Explain the reasons for regular safety meetings and for company safety policies.
- 01.03 Explain the need for employee-background checks and medical examinations.
- 01.04 Identify and use appropriate fire extinguishers and other such safety devices.
- 01.05 Identify and follow emergency and rescue procedures.
- 01.06 Identify and use safe-handling practices as they relate to hazardous and volatile fluids, compounds, and gases.
- 01.07 Apply specific safety and recovery practices for refrigerants used in the industry.
- 01.08 Apply specific safety practices as they relate to handling and storing cylinders and materials.
- 01.09 Select and wear proper protective clothing and equipment.
- 01.10 Identify and use specific safety practices when using soldering and brazing skills.
- 01.11 Identify and use Occupational Safety and Health Administration (OSHA) practices when working with heating, air-conditioning, and refrigeration systems and equipment.
- 01.12 Follow safety precautions when using hand and power tools.
- 01.13 Demonstrate an understanding of cardiopulmonary resuscitation (CPR) and first aid.

02.0 DESCRIBE THE HISTORY AND CONCEPTS OF HEATING, AIR-CONDITIONING, AND REFRIGERATION--The student will be able to:

- 02.01 Identify and explain the four major refrigeration components.
- 02.02 Identify and explain the characteristics of a compression-cycle refrigerant system.
- 02.03 Differentiate between air-conditioning and refrigeration.
- 02.04 Differentiate between split systems and package systems.
- 02.05 Describe the benefits of conditioned air and environments.
- 02.06 Discuss the impact of heating, air-conditioning, and refrigeration on society.
- 02.07 Discuss current issues and concerns (such as indoor-air quality, the ozone layer, and computer technology) in the heating, air-conditioning, and refrigeration industry and in the environment and explain their future ramifications.
- 02.08 Describe the purpose and requirements of local, state, and federal heating, air-conditioning, and refrigeration codes and standards and of the manufacturer's installation instructions.

- 02.09 Identify various professional organizations, associations, and societies, and explain their purposes.
- 03.0 IDENTIFY, USE, AND MAINTAIN THE TOOLS AND TOOL ACCESSORIES USED IN THE HEATING, AIR-CONDITIONING, AND REFRIGERATION INDUSTRY--The student will be able to:
 - 03.01 Identify and use
 - a. Basic hand tools and tool accessories
 - b. Power tools (electric, mechanical, and pneumatic, if available)
 - c. Pipe and tube-working tools of the trade
 - d. Specialized tools of the trade
 - 03.02 Apply appropriate care and maintenance procedures for tools and tool accessories, following the directions in the tool-equipment manufacturer's manual.
- 04.0 DEMONSTRATE AN UNDERSTANDING OF MATTER AND HEAT BEHAVIOR--The student will be able to:
 - 04.01 Describe and explain freezing point, critical temperature, and absolute zero.
 - 04.02 Describe matter, heat, and heat transfer.
 - 04.03 Differentiate between heat and temperature.
 - 04.04 Explain and distinguish among the characteristics of the three states of matter.
 - 04.05 Explain the relationship between temperature and humidity.
 - 04.06 Differentiate between latent heat and sensible heat.
- 05.0 DEMONSTRATE A WORKING KNOWLEDGE OF FLUIDS, PRESSURES, REFRIGERANTS, AND RELATED CODES--The student will be able to:
 - 05.01 Identify the refrigeration cycle.
 - 05.02 Identify and explain general safety issues and EPA rules and regulations regarding the handling of refrigerants.
 - 05.03 Define and explain "pressure," "fluid," and "temperature."
 - 05.04 Explain the standards for and ways to measure and calculate absolute and gauge pressures.
 - 05.05 Identify and explain the classifications, properties, and uses of different refrigerants.
 - 05.06 Explain how fluids react and flow in a closed versus an open environment or vessel.
 - 05.07 Define and identify "color-coding" of refrigerant cylinders.
 - 05.08 Compare pressure and temperature (P/T) charts.
 - 05.09 Explain the proper methods of transferring, storing, and recovering refrigerants.
 - 05.10 Explain the effects of an improper refrigerant and contaminants in a system.
- 06.0 FABRICATE AND SERVICE THE PIPING, TUBING, AND FITTINGS USED IN THE HEATING, AIR-CONDITIONING, AND REFRIGERATION INDUSTRY--The student will be able to:
 - 06.01 Identify and explain the purpose of the piping, tubing, and fittings used in the heating, air-conditioning, and refrigeration industry.
 - 06.02 Bend tubing, using tube benders.
 - 06.03 Connect tubing, using
 - a. Flared fittings
 - b. Compression fittings

- 06.04 Connect tubing, using solderless connectors.
 - 06.05 Connect tubing, using a swaged-joint connection.
 - 06.06 Identify and use various types of torches.
 - 06.07 Identify, select, and use appropriate soldering and brazing alloys, materials, and skills.
 - 06.08 Explain the purposes and procedures for protecting piping materials and fabrication, such as valves, fittings, and products, from heat.
 - 06.09 Solder and/or braze tubing, including aluminum.
 - 06.10 Silver-braze brass, steels, and copper.
 - 06.11 Demonstrate an understanding of the procedures for installing pipe and tubing insulation.
 - 06.12 Explain the procedures required for installing heating, air-conditioning, refrigerant, and ventilation accessories.
 - 06.13 Fabricate and leak-test the piping, tubing, and fittings used in the heating, air-conditioning, and refrigeration industry.
 - 06.14 Maintain project time and materials lists.
- 07.0 DEMONSTRATE A WORKING KNOWLEDGE OF HEATING, AIR-CONDITIONING, AND REFRIGERATION SYSTEM COMPONENTS AND ACCESSORIES--The student will be able to:
- 07.01 Explain the types, operation, use, and maintenance requirements of
 - a. Compressors (such as reciprocating, rotary, screw, and scroll)
 - b. Condensers and evaporators (such as evaporative condensers, evaporative coils, shell and tube, tube within a tube, and fin and tube)
 - c. Metering devices (such as adjusting automatic and thermostatic expansion valves, fixed orifices, and other devices available on the local market)
 - 07.02 Evaluate metering-device performance.
 - 07.03 Explain the methods of compression, lubrication, and compressor loading and unloading.
 - 07.04 Analyze the operating condition of a compressor.
 - 07.05 Test, troubleshoot, and correct the causes of mechanical problems in a heating, air-conditioning, and refrigeration system.
 - 07.06 Identify the location and explain the uses of refrigerant flow accessories.
 - 07.07 Identify the location and explain the uses of heating, air-conditioning, and refrigeration-system accessories (such as receivers, dryers/filters, solenoid valves, heat exchangers, accumulators, suction filter, oil separators, evaporator pressure-regulating valve, crankcase pressure-regulating valves, and check valves).
 - 07.08 Evaluate system performance.
- 08.0 APPLY APPROPRIATE COMMUNICATION AND COMPUTER SKILLS--The student will be able to:
- 08.01 Ask and answer questions coherently and concisely.
 - 08.02 Read and follow written instructions and listen to and follow oral instructions.
 - 08.03 Make oral presentations.
 - 08.04 Write reports, using word-processing software.
 - 08.05 Read and interpret industry-related materials.

- 08.06 Find information in technical literature, such as a manufacturer's manual.
 - 08.07 Interpret graphs, charts, diagrams, and tables commonly used in the industry.
 - 08.08 Fill out the forms and invoices commonly used in the industry.
 - 08.09 Demonstrate appropriate telephone communications skills.
 - 08.10 Use industry-related computer software.
- 09.0 DEMONSTRATE AN UNDERSTANDING OF ENTREPRENEURSHIP--The student will be able to:
- 09.01 Define "entrepreneurship."
 - 09.02 Explain the importance of entrepreneurship to the United States economy.
 - 09.03 Discuss the advantages and disadvantages of business ownership.
 - 09.04 Explain the risks involved in the ownership of a business.
 - 09.05 Identify the personal characteristics of a successful entrepreneur.
 - 09.06 Identify the business skills needed to operate a small business efficiently and effectively.
 - 09.07 Describe the employer's responsibilities to support the business and industry.
 - 09.08 Demonstrate a working knowledge of state and local licensing requirements.
- 10.0 DEMONSTRATE EMPLOYABILITY SKILLS--The student will be able to:
- 10.01 Conduct a job search and identify advanced-training opportunities and their requirements.
 - 10.02 Calculate the employer's investment cost for an employee.
 - 10.03 Secure information about a job, including employee benefits.
 - 10.04 Write a resume.
 - 10.05 Evaluate a job offer, considering various factors such as career advancement, job satisfaction, employee benefits, etc.
 - 10.06 Demonstrate ethical and responsible practices.
 - 10.07 Exhibit pride in the quality of work performed.
 - 10.08 Describe the advantages of a good driving record and the ramifications of a poor driving record on employability opportunities.
 - 10.09 Explain the law that describes the Material Safety Data Sheet (MSDS).
 - 10.10 Explain the importance of confidentiality in the workplace.
 - 10.11 Discuss the effects of positive human-relation skills on success in the business.
 - 10.12 Demonstrate appropriate responses to performance evaluations from the employer, the supervisor, and other persons in the workplace.

OCCUPATIONAL COMPLETION POINT - B

A/C, REFRIGERATION AND HEATING MECHANIC ASSISTANT -

- 11.0 DEMONSTRATE A PRACTICAL KNOWLEDGE OF BASIC ELECTRICITY AND OF THE ELECTRICAL COMPONENTS OF HEATING, AIR-CONDITIONING, AND REFRIGERATION EQUIPMENT--The student will be able to:
- 11.01 Explain the principles of electricity.
 - 11.02 Explain single- and three-phase power distribution.
 - 11.03 Define and explain watts, ohms, volts, and amps.
 - 11.04 Identify and explain electrical measuring tools and devices.
 - 11.05 Explain the standards for and ways to measure watts, resistance, voltage, and amperage, using appropriate instruments or devices.
 - 11.06 Identify and explain appropriate electrical wiring symbols.
 - 11.07 Draw and explain a wiring schematic diagram for a control system.
 - 11.08 Create a wiring schematic for each of the following, using all components and symbols for safe and effective operation and interpretation:
 - a. An air-conditioner
 - b. An electric furnace
 - c. A heat pump
 - d. An oil furnace
 - e. A gas furnace
 - 11.09 Explain codes and standards and safety requirements for working with the electrical components used in heating, air conditioning, and refrigeration.
 - 11.10 Troubleshoot protection devices, such as fuses and breakers.
 - 11.11 Interpret tables and charts from the National Electrical Codes (NEC).
- 12.0 TROUBLESHOOT HEATING, AIR-CONDITIONING, AND REFRIGERATION ELECTRICAL CONTROL SYSTEMS AND THEIR COMPONENTS--The student will be able to:
- 12.01 Identify and explain the operations of electrical control systems and their components (such as heat anticipators, heat and cool thermostats, outdoor thermostats/low ambient controls, defrost controls/timers, and auxiliary heating controls).
 - 12.02 Identify, install, and troubleshoot controls for heating, air-conditioning, and refrigeration systems.
 - 12.03 Explain the operation of different types of electromechanical thermostats.
 - 12.04 Wire basic heating, air-conditioning, and refrigeration systems.
 - 12.05 Troubleshoot operational problems for different types of electromechanical thermostats.
 - 12.06 Explain the electrical and mechanical operations of the basic heat pump.

- 13.0 TROUBLESHOOT AND WIRE ELECTRICAL MOTORS AND THEIR COMPONENTS--The student will be able to:
- 13.01 Identify and explain the functions of various types of motors and their components.
 - 13.02 Troubleshoot, test, and analyze motors, using various methods.
 - 13.03 Identify, troubleshoot, and wire various types of electric motors.
 - 13.04 Reverse the rotation of a motor.
- 14.0 ASSIST IN THE INSTALLATION OF A RESIDENTIAL HEATING AND AIR-CONDITIONING SYSTEM AND DETERMINE START-UP PROCEDURES--The student will be able to:
- 14.01 Read and comply with dispatch orders.
 - 14.02 Explain local codes and ordinances.
 - 14.03 Select and use appropriate tools and safety practices to test equipment.
 - 14.04 Determine the electrical requirements of equipment.
 - 14.05 Assist in the installation of a heating and air-conditioning system to the manufacturer's installation and operation specifications, using a practical knowledge of duct fabrication methods.
 - 14.06 Determine the proper charge in a residential air-conditioning unit and adjust superheat.
 - 14.07 Determine the temperature drop across the evaporator.
 - 14.08 Determine the temperature rise across the condenser.
 - 14.09 Write a service report.
 - 14.10 Apply good customer-relations skills.
- 15.0 DEMONSTRATE A WORKING KNOWLEDGE OF MECHANICAL HEATING AND AIR-CONDITIONING SYSTEM OPERATIONS AND OF START-UP AND CHECK-OUT PROCEDURES--The student will be able to:
- 15.01 Identify and explain:
 - a. Air-to-air heat-pump systems
 - b. Water-to-air heat-pump systems
 - c. Water-to-water heat-pump systems
 - d. Air-to-ground heat-pump systems (geothermal)
 - e. Open-loop heat-pump systems
 - f. Closed-loop heat-pump systems
 - 15.02 Determine the start-up and checkout procedures recommended by different manufacturers.
 - 15.03 Determine the electrical requirements of equipment.
 - 15.04 Select and use appropriate tools, instruments, and test equipment, following safety precautions.
 - 15.05 Determine the temperature drop across the outdoor coil on a heat pump.
 - 15.06 Determine the temperature rise across the indoor coil on a heat pump.
 - 15.07 Test for a proper refrigerant charge in a residential heat pump.
 - 15.08 Apply good customer-relations skills.
- 16.0 IDENTIFY BASIC PRINCIPLES OF HEATING, AIR CONDITIONING, REFRIGERATION AND VENTILATION PIPING SIZING--The student will be able to:

- 16.01 Identify and explain various types of heating, air-conditioning, and refrigeration piping.
- 16.02 Identify basic principles of sizing various heating, air conditioning, refrigeration and ventilation for various tasks.
- 16.03 Explain pressure and temperature drops.

OCCUPATIONAL COMPLETION POINT - C

A/C, REFRIGERATION AND HEATING MECHANIC

- 17.0 DEMONSTRATE A PRACTICAL KNOWLEDGE OF SOLID-STATE ELECTRONICS AS USED IN HEATING, AIR-CONDITIONING, AND REFRIGERATION SYSTEMS--The student will be able to:
- 17.01 Explain the basic principles and functions of direct digital control (DDC).
 - 17.02 Explain basic solid-state circuits and boards.
 - 17.03 Identify, test, and replace circuits and boards.
 - 17.04 Identify and explain the functions of a building-management system.
 - 17.05 Program a programmable thermostat.
- 18.0 UTILIZE AND OPERATE MECHANICAL REFRIGERATION SERVICING AND TESTING EQUIPMENT--The student will be able to:
- 18.01 Identify the effects of superheat and subcooling on a system.
 - 18.02 Identify and explain the functions of servicing and testing equipment (such as vacuum pumps, micron gauges, EPA-approved equipment, leak detectors, and charging systems).
 - 18.03 Operate a refrigerant recovery system.
 - 18.04 Explain the standards for and ways to measure, test, maintain, and evacuate a mechanical heating, air-conditioning, and refrigeration system.
 - 18.05 Evacuate the refrigerant system with various vacuum methods.
 - 18.06 Demonstrate compliance with Environmental Protection Agency (EPA) rules and regulations and, if possible, take the EPA test.
 - 18.07 Charge various air-conditioning and mechanical refrigeration systems by various methods.
 - 18.08 Demonstrate the effects of superheat and subcooling on a system utilizing test equipment (such as thermometers and gages)
- 19.0 USE COMBUSTION-TYPE HEATING SERVICING AND TESTING EQUIPMENT--The student will be able to:
- 19.01 Explain combustion theory and the safety precautions for using combustion-type-heating servicing and testing equipment.
 - 19.02 Install a combustion-type-heating unit to the manufacturer's and code requirements.
 - 19.03 Identify and explain the various types of combustion-type heating servicing and testing equipment (such as draft gauge, U-tube manometer, sling psychrometer, millivolt meter, and oil-furnace testing equipment).
 - 19.04 Use the servicing and testing equipment.
 - 19.05 Test, analyze, and troubleshoot combustion-type-heating systems.
- 20.0 TROUBLESHOOT COMBUSTION GAS VALVES AND REGULATORS AS USED IN HEATING, AIR-CONDITIONING, REFRIGERATION AND VENTILATION SYSTEMS--The student will be able to:
- 20.01 Identify and discuss the safety and regulation issues and concerns.

- 20.02 Explain the operations of various types of gas valves and regulators (such as low-voltage, line-voltage, pneumatic, solenoid, and gas and pressure regulators).
 - 20.03 Identify and size various types of gas valves and regulators.
 - 20.04 Determine the application of gas valves and regulators.
 - 20.05 Troubleshoot gas valves and regulators.
- 21.0 DETERMINE THE PROPERTIES OF AIR--The student will be able to:
- 21.01 Explain the principles of psychrometrics.
 - 21.02 Identify and explain the components and uses of a psychrometric meter.
 - 21.03 Identify indoor-air-quality concerns as related to psychrometrics.
 - 21.04 Determine the properties of air, using a psychrometric chart.
 - 21.05 Follow safety precautions.
 - 21.06 Identify and explain the different types and benefits of
 - a. Air-filtration systems
 - b. Air-handling systems
 - c. Ventilation systems
 - 21.07 Fabricate, operate, maintain, and troubleshoot
 - a. Air-filtration systems
 - b. Air-handling systems
 - c. Ventilation systems
- 22.0 USE A PRESSURE ENTHALPY CHART TO DIAGRAM REFRIGERANT CYCLES--The student will be able to:
- 22.01 Identify all components of the pressure enthalpy chart.
 - 22.02 Define "enthalpy" and "entropy."
 - 22.03 Diagram several refrigerant cycles, using the pressure enthalpy chart.
- 23.0 EXPLAIN THE STANDARDS FOR AND WAYS TO MEASURE INDOOR-AIR QUALITY--The student will be able to:
- 23.01 Define indoor-air quality.
 - 23.02 Identify and explain the codes and standards regarding indoor-air quality.
 - 23.03 Select and use indoor-air-quality measuring devices.
 - 23.04 Explain the standards for and ways to measure indoor-air quality, using various methods.
- 24.0 DEMONSTRATE THE INSTALLATION, MAINTENANCE, AND REPAIR OF HEATING, AIR-CONDITIONING, AND REFRIGERATION SYSTEMS--The student will be able to:
- 24.01 Follow safety precautions.
 - 24.02 Describe new technologies in heating, air-conditioning, and refrigeration installation, including
 - a. Variable-speed motors
 - b. Heat-pipe systems
 - c. Desiccant systems
 - d. Gas-driven heating systems
 - 24.03 Apply local and national codes.
 - 24.04 Lay out, construct, and troubleshoot comfort systems.
 - 24.05 Test and analyze systems.
 - 24.06 Test and analyze heat-recovery systems.

OCCUPATIONAL COMPLETION POINT - D

A/C, REFRIGERATION AND HEATING TECHNICIAN

- 25.0 DEMONSTRATE A WORKING KNOWLEDGE OF ELECTRICAL GENERATION AND DISTRIBUTION COMPONENTS FOR COMMERCIAL HEATING AND AIR CONDITIONING SYSTEMS--The student will be able to:
- 25.01 Determine wire sizes and voltage drops.
 - 25.02 Draw and identify power-transformer types.
 - 25.03 Test, size, and replace protection devices such as fuses and breakers, motor starters, and overloads.
- 26.0 MAINTAIN, TEST, AND TROUBLESHOOT ELECTRICAL MOTORS AND THEIR COMPONENTS FOR COMMERCIAL HEATING AND AIR-CONDITIONING SYSTEMS--The student will be able to:
- 26.01 Identify and explain the operations and applications of various types of electrical motors and their components as used in commercial heating and air-conditioning systems.
 - 26.02 Maintain, test, and troubleshoot various types of commercial electrical motors and their components as used in commercial heating and air-conditioning systems.
 - 26.03 Demonstrate the proper use of motor testing equipment.
- 27.0 DEMONSTRATE A WORKING KNOWLEDGE OF ENVIRONMENTAL CONTROL SYSTEMS AS USED IN COMMERCIAL HEATING AND AIR-CONDITIONING SYSTEMS--The student will be able to:
- 27.01 Identify and explain the various types of environmental control systems and their sequences of operation as used in commercial heating and air-conditioning systems.
 - 27.02 Maintain, test, and troubleshoot various types of environmental control systems as used in commercial heating and air-conditioning systems.
- 28.0 MAINTAIN AND TROUBLESHOOT PNEUMATIC CONTROL SYSTEMS FOR COMMERCIAL HEATING AND AIR-CONDITIONING APPLICATIONS--The student will be able to:
- 28.01 Identify pneumatic control systems.
 - 28.02 Demonstrate the ability to maintain and troubleshoot pneumatic control systems.
- 29.0 TROUBLESHOOT ELECTRICAL CIRCUITS AS USED IN COMMERCIAL HEATING AND AIR-CONDITIONING SYSTEMS--The student will be able to:
- 29.01 Explain how the principles of designing an electrical system for residential heating and air-conditioning systems apply to commercial heating and air-conditioning systems.
 - 29.02 Define and compare single- and multiphase voltage and current related to commercial heating and air-conditioning systems.
 - 29.03 Calculate various circuit loads in commercial heating and air-conditioning applications, using Ohm's law.
 - 29.04 Calculate the electrical circuit loads used in commercial heating and air-conditioning applications.
 - 29.05 Troubleshoot electrical circuits for commercial heating and air-conditioning systems.

- 30.0 SELECT APPROPRIATE COMMERCIAL COMPRESSORS--The student will be able to:
- 30.01 Compare commercial-compressor requirements with those for residential and light commercial heating and air-conditioning systems.
 - 30.02 Select appropriate commercial compressors for cooling requirements.
- 31.0 TEST AND ADJUST COMMERCIAL EVAPORATIVE CONDENSERS--The student will be able to:
- 31.01 Determine the proper air and fluid flow for commercial evaporative condensers.
 - 31.02 Test and adjust the airflow for proper temperature difference.
 - 31.03 Test and adjust the water flow for proper GPM and temperature difference.
- 32.0 MAINTAIN, TEST, AND TROUBLESHOOT COMMERCIAL EVAPORATORS--The student will be able to:
- 32.01 Determine the operational requirements for evaporators used in commercial heating and air-conditioning applications.
 - 32.02 Select appropriate evaporators for commercial heating and air-conditioning systems.
 - 32.03 Maintain, test, and adjust various commercial heating and air-conditioning accessories.
- 33.0 MAINTAIN, TEST, AND ADJUST COMMERCIAL HEATING AND AIR-CONDITIONING ACCESSORIES--The student will be able to:
- 33.01 Compare commercial accessories with residential and light-commercial-heating and air-conditioning accessories.
 - 33.02 Select the heating and air-conditioning accessories appropriate for various commercial applications.
 - 33.03 Maintain, test, and adjust commercial heating and air-conditioning accessories.
- 34.0 MAINTAIN, TROUBLESHOOT, AND REPAIR COMMERCIAL HEATING SYSTEMS--The student will be able to:
- 34.01 Apply local and national codes and safety practices.
 - 34.02 Keep a record of the installation, maintenance, and repair of commercial heating systems.
 - 34.03 Identify the components of various commercial heating systems.
 - 34.04 Explain the operational principles of various commercial heating systems.
 - 34.05 Test and analyze heating air-distribution systems.
 - 34.06 Maintain, troubleshoot, and repair various commercial heating systems, including
 - a. A gas furnace and boiler
 - b. An oil furnace and boiler
 - c. An electric furnace
 - d. Electric heaters
 - e. A heat pump
 - f. Solar-heating systems

- 34.07 Maintain, troubleshoot, and repair heat-recovery units.
 - a. Identify the uses, including freeze-protection and superheating, for potable water or hot water.
 - b. Identify components and their functions.
 - c. Explain the method of operation for various heat-recovery systems.
 - d. Troubleshoot and repair common problems.
- 34.08 Design a commercial heating system.
- 35.0 MAINTAIN AND REPAIR THERMAL STORAGE SYSTEMS--The student will be able to:
 - 35.01 Apply appropriate codes, standards, and safety practices.
 - 35.02 Describe the benefits and limitations of each type.
 - 35.03 Explain the operational principles of a thermal storage system.
 - 35.04 Identify and explain various types of thermal storage systems.
 - 35.05 Maintain, troubleshoot, and test various types of thermal storage systems.
- 36.0 MAINTAIN, TROUBLESHOOT, AND REPAIR COMMERCIAL HEATING AND AIR-CONDITIONING SYSTEMS--The student will be able to:
 - 36.01 Keep a record of the installation, maintenance, and repair of commercial heating and air-conditioning systems.
 - 36.02 Apply local and national codes and safety practices.
 - 36.03 Lay out a commercial heating and air-conditioning system.
 - 36.04 Lay out a typical split commercial air-conditioning system.
 - 36.05 Lay out a typical split commercial heating system.
 - 36.06 Maintain, test, analyze, and repair various types of commercial heating and air-conditioning systems.
 - 36.07 Maintain, troubleshoot, and repair
 - a. Cooling towers
 - b. Water-cooled condensers
 - c. Water-treatment systems
 - d. Chilled water systems
- 37.0 CALCULATE COMMERCIAL HEATING AND AIR-CONDITIONING LOADS--The student will be able to:
 - 37.01 Explain conduction as a heat-load source.
 - 37.02 Describe the implications of conducting and the resistance values for different types of construction materials.
 - 37.03 Define "U" value (BTU/hr/ft²F).
 - 37.04 Define "K" value (°Fft²hr/BTU).
 - 37.05 Define "C" value (°Fft²hr/BTU).
 - 37.06 Define "R" value (°Fft²hr/BTU).
 - 37.07 Interpret heat-transfer tables ("U," "K," "C," and "R").
 - 37.08 Locate the total heat-transfer value of any surface (R) - (U).
 - 37.09 Explain infiltration and exfiltration/ventilation as a heat-load source.
 - 37.10 Explain a product heat-load source.
 - 37.11 Explain miscellaneous loads (people, motors, and equipment) as heat-load sources.
 - 37.12 Explain the purpose of vapor barriers.
 - 37.13 Interpret tables of specific heat values as applied to commercial heating and air-conditioning systems.

- 37.14 Calculate and design systems.
- 37.15 Calculate cooling and heating equipment sizes.
- 37.16 Design and identify methods of installing air-movement systems.