ADOPTED

Career Technical Credit Transfer (CT²)
Environmental Control - Heating Ventilation and Air Conditioning/Refrigeration
Career Technical Assurance Guide (CTAG)
February 24, 2009

The following course or Career-Technical Assurance Number (CTAN) is eligible for transfer between career-technical education, adult workforce education, and post-secondary education.

HVACI001 – Heating Ventilation and Air Conditioning/Refrigeration	**Credits: 22 Semester or 33 Quarter**
Advising Notes: Those persons holding current and valid HVAC Excellence, NCCER, or ICE certification will be given what the receiving institution is offering as credit for its CT² approved HVAC/R course. The awarding of credit for the HVAC/R course of study may decrease the time to associate degree completion, when such a degree is offered. Note: All components of the ICE certifications must be complete in order for the student to receive credit. **Prerequisite:** A valid and current EPA 608 certification.	
Module I Fundamentals	
Module II Electrical Values	
Module III Single-phase, Split-phase and Three-phase Circuits	
Module IV Physical Laws of Refrigeration	
Module V Refrigeration Cycle and Components	
Module VI Piping Fundamentals	
Module VII Installation	
Module VIII System Maintenance	
Module IX Troubleshooting	
Module X Service and Repair	
Module XI Work Sequence, Assignments and Clients	
	Minimum Hours = 600 Hours
Note: Credit hours assigned to CTANs are "relative values," which are used to help determine the equivalency of submitted coursework or content. Once approved by a validation panel as a CT² course, students will be given what the receiving institution is offering as credit for its approved course.	

The CTAN illustrates the learning outcomes that are equivalent or common in introductory technical courses. In order for completers to receive the indicated credit, institutions must document that their course/program content matches the learning outcomes in the CTANs. The program outcomes identified below represent the **technical course/content** found in HVAC/R programs of study. In some cases, completers must also hold certain licenses and/or credentials or have satisfied specific external validators such as the examination to acquire an ICE, NCCER or HVAC Excellence certificate.

Pertinent to H. B. 66 legislation, industry standards and certifications provide documentation of student learning. Recognized industry standards are expectations established by business, industry, state agencies, or professional associations that defines training program curricular requirements, establishes certification or licensure criteria, and often serves as the basis for program accreditation.

Institutional Requirements and Credit Conditions:

1. The applicant must provide proof to the receiving institution that she/he holds a current and valid HVAC/R ICE, NCCER or HVAC Excellence certificate.
2. The applicant must provide proof to the receiving institution that she/he has completed an HVAC/R training course offered by public assisted career-technical institution (secondary or adult) or state supported college.
3. Candidates for graduation from collegiate or university programs may have to satisfy additional degree requirements associated with the basic related or general education studies.
4. Admission requirements of individual institutions and/or programs are unaffected by the implementation of CT² outcomes.
5. Institutional residency requirements may affect the amount of transfer credit.

HVAC/RI001 – HVAC/R
Ohio Department of Education Subject Codes Pertinent to HVAC/R

0100	**Environmental Control**	Classroom and shop experiences that enable the student to become proficient in the installation, and repair, maintenance of commercial, industrial, and domestic air-conditioning systems. Included is instruction in the theory and application of basic principles involved in conditioning of air, e.g., cooling, heating, filtering, and controlling humidity; the operating characteristics of various units and parts; blueprint reading; the use of technical reference manuals; the diagnosis of malfunctions; the overhaul, repair, and adjustment of units and parts, such as pumps, compressors, valves, springs, and connections; and the repair of electric and pneumatic control systems

CIP Codes and Description Pertinent to HVAC

47.0201	**Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (HAC, HACR, HVAC, HVACR).**	A program that prepares individuals to apply technical knowledge and skills to repair, install, service and maintain the operating condition of heating, air conditioning, and refrigeration systems. Includes instruction in diagnostic techniques, the use of testing equipment and the principles of mechanics, electricity, and electronics as they relate to the repair of heating, air conditioning and refrigeration systems.

Learning Outcomes

Summary of Learning Outcomes **All outcomes essential**

MODULE I LESSON I **FUNDAMENTALS**

At the completion of this lesson, the HVAC/R student will be able to:

1-1.1 Analyze the effects of comfort factors.
1-1.2 Evaluate air samples using psychometrics
1-1.3 Create, interpret and use graphical displays and statistical measure to describe and evaluate data
1-1.4 Explain the fundamentals of forced air
1-1.5 Identify basic system components
1-1.6 Identify basic system designs
1-1.7 Discuss local and state codes
1-1.8 Discriminate between the common instrumentation and test equipment used by the HVAC technician
1-1.9 Review and interpret Blue Prints

MODULE II LESSON I **ELECTRICAL VALUES**

At the completion of this lesson the HVAC/R student will be able to:

2-1.1 Analyze and measure electrical values
2-1.2 Explain the basics of magnetism
2-1.3 Apply magnetic principles to electrical theory
2-1.4 Identify conducting and insulating materials
2.1-5 Differentiate AC circuits from DC circuits
2-1.6 Discuss and apply Ohm's Law
2-1.7 Construct and analyze basic alternating current AC/DC circuits
2-1.8 Identify and troubleshoot basic electrical, electromechanical and solid state controls
2-1.9 Measure current, voltage and resistance in AC/DC circuits
2-1.10 Use electrical test equipment
2-1.11 Compare peak (PK), root mean squares (RMS), and average values

MODULE III LESSON I **SINGLE-PHASE, SPLIT-PHASE AND THREE-PHASE CIRCUITS AND DEVICES**

At the completion of this lesson, the HVAC/R student will be able to:

3-1.1 Demonstrate knowledge of single-phase and split-phase motors

3-1.2 Explain motor starting components and sequencing
3-1.3 Analyze motor protection
3-1.4 Interpret motor nameplate information and motor specifications
3-1.6 Identify various types of three phase motors
3-1.7 Troubleshoot three phase motors
3-1.8 Discuss phase protection
3-1.9 Identify motor loads
3-1.10 Apply the use of motor assisting devices (i.e. hard start kits and capacitors)
3-1.11 Wire single phase and three phase motors and motor control devices
3-1.12 Verify motor rotation and operation
3-1.13 Interpret schematics and control diagrams
3-1.14 Explain Electronic Control Module (ECM) motors

MODULE IV LESSON 1 PHYSICAL LAWS OF REFRIGERATION

At the completion of this lesson, the HVAC/R student will be able to:

4-1.1 Record and compare temperature and pressure measurements
4-1.2 Analyze and interpolate temperature and pressure relationships
4-1.3 Explain heat and heat transfer
4-1.4 Explain energy and energy conversion
4-1.5 Differentiate sensible, latent and total heat

MODULE V LESSON 1 REFRIGERATION CYCLE AND COMPONENTS

At the completion of this module, the HVAC/R student will be able to:

5-1.1 Analyze the mechanical refrigeration cycle and components
5-1.2 Discuss the principles of thermodynamics
5-1.3 Compare and contrast the functions of evaporators, condensers, compressors and metering devices
5-1.4 Compare various refrigerants and their characteristics
5-1.5 Explain the refrigeration cycle and its components
5-1.6 Define superheating and subcooling
5-1.7 Interpret and compare temperature pressure chart relationships
5-1.8 Determine the saturation temperature of a refrigerant
5.1.9 Calculate and record superheating and subcooling
5-1.10 Discuss various refrigeration applications

MODULE VI PIPING FUNDAMENTALS

MODULE VI LESSON 1 SOLDERING AND BRAZING

At the completion of this lesson the HVAC/R student will be able to:

6-1.1 Identify and perform soldering and brazing procedures including a nitrogen purge
6-1.2 Identify different soldering and brazing materials
6-1.3 Join materials with low-temperature solder
6-1.4 Join materials with high-temperature brazing
6-1.5 Join ferrous and non-ferrous materials
.

MODULE VI LESSON 2 PIPING AND LEAK DETECTION

At the completion of this lesson, the HVAC/R student will be able to:

6-2.1 Discuss the proper use of piping materials, fabrication and application
6-2.2 Identify different types of piping and tubing
6-2.3 Demonstrate proper techniques for bending and connecting tubing and piping
6-2.4 Demonstrate proper fabrication of tubing
6-2.5 Identify and use proper tubing and piping fittings
6-2.6 Perform leak detection procedures
6-2.7 Explain common leak detection techniques (i.e. the soap bubble, inert gas, electronic and fluorescent dye technique)

MODULE VII LESSON I INSTALLATION TECHNIQUES OF REFRIGERATION AND COOLING EQUIPMENT

At the completion of this lesson, the HVAC/R student will be able to:

7-1.1 Install refrigeration and air conditioning equipment to local and state codes (i.e. a window air conditioner, central air conditioner)

MODULE VIII LESSON 1 SYSTEM MAINTENANCE

At the completion of this lesson, the HVAC/R student will be able to:

8-1.1 Perform system maintenance (SM) on related environmental controls technology equipment
8-1.2 Perform SM on: electric heating equipment, air handler, filtration equipment, humidifier/dehumidifier and indoor and outdoor sections of an air conditioner or heat pump and refrigeration systems, etc.

MODULE IX TROUBLESHOOTING

MODULE IX LESSON 1 TROUBLESHOOTING – A/C

At the completion of this lesson the HVAC/R student will be able to:

9-1.1 Troubleshoot refrigeration and air conditioning equipment
9-1.2 Connect a hermetic/semi-hermetic compressor to a power supply
9-1.3 Check circuitry of a compressor, protector relay, capacitor and hard start kit
9-1.4 Connect manifold and gauges to service valves and access fittings and check pressures
9-1.5 Examine unit operation, oil level and sight glass moisture indicator

9-1.6 Identify circuitry of refrigeration defrost
9-1.7 Check and adjust refrigeration control thermostat and pressure and safety controls
9-1.8 Check condensate pump and drain
9-1.9 Verify proper operation of metering devices
9-1.10 Check systems for compressor burnout and perform clean-up

MODULE IX LESSON II TROUBLESHOOTING - HEATING

At the completion of this lesson the HVAC/R student will be able to:

9-2.1 Troubleshoot and service heating systems
9-2.2 Check furnace and boiler components (i.e. power supply, fuel supply, ignition assembly, wall thermostat, gas train assembly, electronic ignition system on gas unit, limit control, heat exchanger, oil ignition system, pump pressure, combustion analyzer and carbon monoxide meter)
9-2.3 Check and adjust: incoming gas manifold pressure, blower systems, and fan control
9-2.4 Perform combustion analysis and combustion air test
9-2.5 Verify operation of safety circuits
9-2.6 Remove and replace all applicable components

MODULE X SERVICE AND REPAIR

MODULE X LESSON I SERVICE

At the completion of this lesson the HVAC/R student will be able to:

10-1.1 Service and repair refrigeration and air conditioning equipment
10-1.2 Recover refrigerant from a system
10-1.3 Evaluate and recharge system
10-1.4 Pump down a system
10-1.5 Repair all leaks in a system
10-1.6 Isolate system components
10-1.7 Match oil to refrigerants in a system
10-1.8 Demonstrate use of a digital charging scale, vacuum pump and micron gauge

MODULE X LESSON II FORCED AIR

At the completion of this lesson the HVAC/R student will be able to:

10-2.1 Identify and install residential forced air heating systems
10-2.2 Fabricate and install a distribution system
10-2.3 Install a gas, electric and oil heating unit
10-2.4 Utilize proper combustion, venting and ventilation tables
10-2.5 Identify components of an air-to-air heat pump
10-2.6 Identify components of a geothermal system
10-2.7 Apply a manometer, psychrometer and other air analyzing instruments to determine proper air flow

MODULE X LESSON III HYDRONIC SYSTEMS

At the completion of this lesson the HVAC/R student will be able to:

10-3.1 Explain the application, selection and installation of hydronic system components
10-3.2 Explain the operation of a hydronics system
10-3.3 Identify components of a hydronics system
10-3.4 Select major components of a hydronics system
10-3.5 Review and test safety controls

MODULE X LESSON IV LOW PRESSURE STEAM SYSTEMS

At the completion of this lesson the HVAC/R student will be able to:

10-4.1 Explain the application, selection and installation of low pressure steam systems
10-4.2 Identify basic system components and designs
10-4.3 Review state codes related to boilers and piping
10-4.4 Explain the operation of a steam system
10-4.5 Identify and explain safety controls

MODULE X LESSON V SHEET METAL/DUCT WORK

At the completion of this lesson the HVAC/R student will be able to:

10-5.1 Demonstrate sheet metal layout and fabrication procedures
10-5.2 Apply cutting and shearing, bending and folding, forming and assembly, and sealing and insulating procedures
10-5.3 Identify various methods of fastening sheet metal and different methods of fastening and hanging
10-5.4 Assemble duct work in accordance to the appropriate manufacturer's specification

MODULE XVI LESSON I WORK SEQUENCE, ASSIGNMENTS AND CLIENTS

At the completion of this lesson the HVAC/R student will be able to:

11-1.1 Create work sequences for tasks and units of work
11-1.2 Discuss: sequence of activities on an environmental control project, logical sequences for different types of projects with space limitations, and the impact of project planning
11-1.3 Develop a timeline for sequencing activities for an entire project
11-1.4 Explain adjustments to special issues related to project startup and close
11-1.5 Identify different types of duct materials
11-1.6 Create work assignments for crew and individuals
11-1.7 Determine what constitutes a "unit of Work" and its role in construction economics
11-1.8 Discuss typical tasks, needed skills and task assignments
11-1.9 Coordinate and negotiate the work of tradespersons
11-1.10 Determine personnel needs and develop a plan to monitor progress and quality

11-1.11 Clarify client expectations
11-1.12 Communicate mutual goals of client and construction team
11-1.13 Maintain client communications
11-1.14 Implement conflict resolution
11-1.15 Employ proper use of change orders
11-1.16 Maintain ethical relationships
11-1.17 Confirm client satisfaction

HVAC Design/Writing Panel Members

Faculty and Teachers

Kevin Couch	Drage Career Center Stark County
Tamara Crain	Ashland County West Holmes Career Center
Dirk DeCoy	Belmont Technical College
Jim Fry	Owens Community College
Scott Killy	Owens Community College
Terry Krogman	Upper Valley Joint Vocational School
Amy Leedy	Miami Valley Career and Technical Center
Russell Marcks	Sinclair Community College
Raymond Miller	University of Cincinnati
Stephen Morgan	Belmont Technical College
Scott Naill	Upper Valley Joint Vocational School
Mike Sizemore	Miami Valley Career and Technical Center
Louis Warren	Miami Valley Career and Technical Center

Contributors

Gayle Ashbridge	Ohio Board of Regents
Les Brinkley	Ohio Department of Education