



Montgomery County
CONSTRUCTION TRADES FOUNDATION

Heating, Ventilation and Air Conditioning

The Montgomery County Students Construction Trades Foundation, Inc has developed a comprehensive construction technology program designed to prepare students for a rewarding career in the construction industry. Students master a variety of construction skills by applying knowledge through their participation in a “student design-built” house project. In addition, each program area has articulation agreements with an apprenticeship program as well as Montgomery College.

The apprenticeship program is aligned with the National Center for Construction Education and Research (NCCER) standards. The NCCER is a not-for-profit education foundation created to help address the critical workforce shortage facing the construction industry and to develop industry driven standardized craft training program with portable credentials. For each module, students must score a minimum of 70% on module tests and complete 100% of the Competency Profiles in order to receive NCCER credit. Parentheses indicate the approximate classroom hours spent on each module. Students who enroll in the construction program beyond 2 semesters may have an opportunity to complete optional modules in Level 2 of the NCCER curriculum.

For students who earn a B grade or better, up to seven credits may be transferred to Montgomery College’s Building Trades Technology, A.A.S. or Building Trades Technology Certificate Programs.

The following describes the scope and sequence of instruction for HVAC.

NCCER Modules-Semester 1	Unit(s)
Module 03101-07	Introduction to HVAC (2.5 hours)
Module 03103-07	Copper and Plastic Piping Practices (5 hours)
Module 03104-07	Soldering and Brazing (7.5 hours)
Module 03105-07	Ferrous Metal Piping Practices (5 hours)

NCCER Modules-Semester 2	Unit(s)
Module 03102-07	Trade Mathematics (10 hours)
Module 03106-07	Basic Electricity (12.5 hours)
Module 03107-07	Introduction to Cooling (30 hours)
Module 03108-07	Introduction to Heating (15 hours)
Module 03109-07	Air Distribution Systems (10 hours)

NCCER Modules-Semester 3 (Optional)	Unit(s)
Module 03201-07	Commercial Airside Systems (10 hours)
Module 03202-07	Chimneys, Vents, and Flues (5 hours)
Module 03203-07	Introduction to Hydronic Systems (10 hours)
Module 03204-07	Air Quality Equipment (5 hours)
Module 03205-07	Leak Detection, Evacuation, Recovery, and Charging (20 hours)
Module 03206-07	Alternating Current (7.5 hours)

NCCER Modules-Semester 4 (Optional)	Unit(s)
Module 03207-07	Basic Electronics (5 hours)
Module 03208-07	Introduction to Control Circuit Troubleshooting (30 hours)
Module 03209-07	Troubleshooting Gas Heating (12.5 hours)
Module 03210-07	Troubleshooting Cooling (20 hours)
Module 03311-07	Heat Pumps (20 hours)
Module 03312-07	Basic Installation and Maintenance Practices (17.5 hours)
Module 03313-07	Sheet Metal Duct Systems (5 hours)
Module 03314-07	Fiberglass and Flexible Duct Systems (5 hours)

LEVEL 1

MODULE 03101-01 INTRODUCTION TO HVAC

1. Explain the basic principles of heating, ventilation, and air conditioning.
2. Identify career opportunities available to people in the HVAC trade.
3. Explain the purpose and objectives of an apprentice training program.
4. Describe how certified apprentice training can start in high school.
5. Describe what the Clean Air Act means to the HVAC trade.

MODULE 03103-01 TOOLS OF THE TRADE

1. Identify and state the use of the following tools:
 - Pipe wrenches
 - Torque wrenches
 - Tinner's and soft-faced hammers
 - Hand cutting snips
 - Hand and power hacksaws
 - Drill press
 - Measuring tools
2. Describe the general procedures for maintenance of most hand and power tools.
3. Describe or demonstrate the general safety precautions that must be followed when using most hand and power tools.

MODULE 03104-01 COPPER AND PLASTIC PIPING PRACTICES

1. State the precautions that must be taken when installing refrigerant piping.
2. Select the right tubing for a job.
3. Cut and bend tubing.
4. Safely join tubing by using flare and compression fittings.
5. Determine the kinds of hangers and supports needed for refrigerant piping.
6. State the basic requirements for pressure-testing a system once it has been installed.

MODULE 03105-01 SOLDERING AND BRAZING

1. Assemble and operate the tools used for soldering.
2. Prepare tubing and fittings for soldering.
3. Identify the purposes and uses of solder and solder fluxes.
4. Solder copper tubing and fittings.
5. Assemble and operate the tools used for brazing.
6. Prepare tubing and fittings for brazing.
7. Identify the purposes and uses of filler metals and fluxes used for brazing.
8. Braze copper tubing and fittings.
9. Identify the inert gases that can safely be used to purge tubing when brazing.

MODULE 03102-01 TRADE MATHEMATICS

1. Identify similar units of measurement in both the inch-pound (English) and metric systems and know which units are larger.

2. Convert measured values in the inch-pound system to equivalent metric values and vice versa.
3. Express numbers as powers of ten.
4. Determine the powers and roots of numbers.
5. Solve basic algebraic equations.
6. Recognize various geometric figures.
7. Use the Pythagorean theorem to make calculations involving right triangles.
8. Convert decimal feet to feet and inches and vice versa.

MODULE 03106-01 FERROUS METAL PIPING PRACTICES

1. Identify the types of ferrous metal pipes.
2. Measure the sizes of ferrous metal pipes.
3. Identify the common malleable iron fittings.
4. Cut, ream, and thread ferrous metal pipe.
5. Join lengths of threaded pipe together and install fittings.
6. Describe the main points to consider when installing pipe runs.
7. Describe the method used to join grooved piping.

MODULE 03107-01 BASIC ELECTRICITY

1. State how electrical power is generated and distributed.
2. Describe how voltage, current, resistance, and power are related.
3. Use Ohm's law to calculate the current, voltage, and resistance in a circuit.
4. Use the power formula to calculate how much power is consumed by a circuit.
5. Describe the differences between series and parallel circuits.
6. Recognize and describe the purpose and operation of the various electrical components used in HVAC equipment.
7. State and demonstrate the safety precautions that must be followed when working on electrical equipment.
8. Make voltage, current, and resistance measurements using electrical test equipment.

MODULE 03108-01 INTRODUCTION TO COOLING

1. Explain how heat transfer occurs in a cooling system, demonstrating an understanding of the terms and concepts used in the refrigeration cycle.
2. Calculate the temperature and pressure relationships at key points in the refrigeration cycle.
3. Under supervision, use temperature- and pressure-measuring instruments to make readings at key points in the refrigeration cycle.
4. Identify commonly used refrigerants and demonstrate the procedures for handling these refrigerants.
5. Identify the major components of a cooling system and explain how each type works.
6. Identify the major accessories available for cooling systems and explain how each type works.
7. Identify the control devices used in cooling systems and explain how each type works.
8. State the correct methods to be used when piping a refrigeration system.

MODULE 03109-01 INTRODUCTION TO HEATING

1. Explain the three methods by which heat is transferred and give an example of each.
2. Describe how combustion occurs and identify the by-products of combustion.
3. Identify the various types of fuels used in heating.
4. Identify the major components and accessories of a forced-air furnace and explain the function of each component.
5. State the factors that must be considered when installing a furnace.
6. Identify the major components of a gas furnace and describe how each works.
7. With supervision, use a manometer to measure and adjust manifold pressure on a gas furnace.
8. Identify the major components of an oil furnace and describe how each works.
9. Describe how an electric furnace works.
10. With supervision, perform basic furnace preventive maintenance procedures such as cleaning and filter replacement.

LEVEL 2

MODULE 03201-07 AIR DISTRIBUTION SYSTEMS

1. Identify the differences in types of commercial all-air systems.
2. Identify the type of building in which a particular type of system is used.
3. Explain the typical range of capacities for a commercial air system.

MODULE 03202-07 CHIMNEYS, VENTS, AND FLUES

1. Describe the principles of combustion and explain complete and incomplete combustion.
2. Describe the content of flue gas and explain how it is vented.
3. Identify the components of a furnace vent system.
4. Describe how to select and install a vent system.
5. Perform the adjustments necessary to achieve proper combustion in a gas furnace.
6. Describe the techniques for venting different types of furnaces.
7. Explain the various draft control devices used with natural-draft furnaces.
8. Calculate the size of a vent required for a given application.
9. Adjust a thermostat heat anticipator.

MODULE 03203-07 INTRODUCTION TO THE HYDRONIC SYSTEMS

1. Explain the terms and concepts used when working with hot-water heating.
2. Identify the major components of hot-water heating.
3. Explain the purpose of each component of hot-water heating.
4. Demonstrate the safety precautions used when working with hot-water systems.
5. Demonstrate how to operate selected hot-water systems.
6. Demonstrate how to safely perform selected operating procedures on low-pressure systems.
7. Identify the common piping configurations used with hot-water heating.
8. Read the pressure across a water system circulating pump.
9. Calculate heating water flow rates

10. Select a pump for a given application.

MODULE 03204-07 AIR QUALITY EQUIPMENT

1. Explain why it is important to control humidity in a building.
2. Recognize the various kinds of humidifiers used with HVAC systems and explain why each is used.
3. Demonstrate how to install and service the humidifiers used in HVAC systems.
4. Recognize the kinds of air filters used with HVAC systems and explain why each is used.
5. Demonstrate how to install and service the filters used in HVAC systems.
6. Use a manometer or differential pressure gauge to measure the friction loss of an air filter.
7. Identify accessories commonly used with air conditioning systems to improve indoor air quality and reduce energy cost, and explain the function of each, including:
 - Humidity control devices
 - Air filtration devices
 - Energy conservation devices
8. Demonstrate or describe how to clean an electronic air cleaner.

MODULE 03205-07 LEAK DETECTION, EVACUATION, RECOVERY, AND CHARGING

1. Identify the common types of leak detectors and explain how each is used.
2. Perform leak detection tests using selected methods.
3. Identify the service equipment used for evacuating a system and explain why each item of equipment is used.
4. Perform system evacuation and dehydration.
5. Identify the service equipment used for recovering refrigerant from a system and for recycling the recovered refrigerant, and explain why each item of equipment is used.
6. Perform a refrigerant recovery.
7. Evacuate a system to a deep vacuum.
8. Identify the service equipment used for charging refrigerant into a system, and explain why each item of equipment is used.
9. Use nitrogen to purge a system.
10. Charge refrigerant into a system by the following methods:
 - Weight
 - Superheat
 - Subcooling
 - Charging pressure chart

MODULE 03206-07 ALTERNATING CURRENT

1. Describe the operation of various types of transformers.
2. Explain how alternating current is developed and draw a sine wave.
3. Identify single-phase and three-phase wiring arrangements.
4. Explain how phase shift occurs in inductors and capacitors.
5. Describe the types of capacitors and their applications.
6. Explain the operation of single-phase and three-phase induction motors.

7. Identify the various types of single-phase motors and their applications.
8. State and demonstrate the safety precautions that must be followed when working with electrical equipment.
9. Test AC components, including capacitors, transformers, and motors.

MODULE 03207-07 BASIC ELECTRONICS

1. Explain the basic theory of electronics and semiconductors.
2. Explain how various semiconductor devices such as diodes, LEDs, and photo diodes work, and how they are used in power and control circuits.
3. Identify different types of resistors and explain how their resistance values can be determined.
4. Describe the operation and function of thermistors and cad cells.
5. Test semiconductor components.
6. Identify the connectors on a personal computer.

MODULE 03208-07 INTRODUCTION TO CONTROL CIRCUIT TROUBLESHOOTING

1. Explain the function of a thermostat in an HVAC system.
2. Describe different types of thermostats and explain how they are used.
3. Demonstrate the correct installation and adjustment of a thermostat.
4. Explain the basic principles applicable to all control systems.
5. Identify the various types of electromechanical, electronic, and pneumatic HVAC controls, and explain their function and operation.
6. Describe a systematic approach for electrical troubleshooting of HVAC equipment and components.
7. Recognize and use equipment manufacturer's troubleshooting aids to troubleshoot HVAC equipment.
8. Demonstrate how to isolate electrical problems to faulty power distribution, load, or control circuits.
9. Identify the service instruments needed to troubleshoot HVAC electrical equipment.
10. Make electrical troubleshooting checks and measurements on circuits and components common to all HVAC equipment.
11. Isolate and correct malfunctions in a cooling system control circuit.

MODULE 03209-07 TROUBLESHOOTING GAS HEATING

1. Describe the basic operating sequence for gas heating equipment.
2. Interpret control circuit diagrams for gas heating systems.
3. Describe the operation of various types of burner ignition methods.
4. Identify the tools and instruments used when troubleshooting gas heating systems.
5. Demonstrate using the tools and instruments required for troubleshooting gas heating systems.
6. Isolate and correct malfunctions in gas heating systems.

MODULE 03210-07 TROUBLESHOOTING COOLING

1. Describe a systematic approach for troubleshooting cooling systems and components.

2. Isolate problems to electrical and/or mechanical functions in cooling systems.
3. Recognize and use equipment manufacturer's troubleshooting aids to troubleshoot cooling systems.
4. Identify and use the service instruments needed to troubleshoot cooling systems.
5. Successfully troubleshoot selected problems in cooling equipment.
6. State the safety precautions associated with cooling troubleshooting.

MODULE 03211-07 HEAT PUMPS

1. Describe the principles of reverse-cycle heating.
2. Identify heat pumps by type and general classification.
3. Describe various types of geothermal water loops and their application.
4. List the components of heat pump systems.
5. Describe the role and basic operation of electric heat in common heat pump systems.
6. Describe common heat pump ratings, such as Coefficient of Performance (COP), Heating Season Performance Factor (HSPF), and Seasonal Energy Efficiency Ratio (SEER).
7. Demonstrate heat pump installation and service procedures.
8. Identify and install refrigerant circuit accessories commonly associated with heat pumps.
9. Analyze a heat pump control circuit.
10. Isolate and correct malfunctions in a heat pump.

MODULE 03212-01 BASIC INSTALLATION AND MAINTENANCE PRACTICES

1. Identify, explain, and install threaded and non-threaded fasteners.
2. Identify, explain, remove, and install types of gaskets, packings, and seals.
3. Identify types of lubricants, and explain their uses.
4. Use lubrication equipment to lubricate motor bearings.
5. Identify the types of belt drives, explain their uses, and demonstrate procedures used to install or adjust them.
6. Identify and explain types of couplings.
7. Demonstrate procedures used to remove, install, and align couplings.
8. Identify types of bearings, and explain their uses.
9. Explain causes of bearing failures.
10. Demonstrate procedures used to remove and install bearings.
11. Perform basic preventive maintenance inspection and cleaning procedures.
12. List ways to develop and maintain good customer relations.

MODULE 03213-07 – SHEET METAL DUCT SYSTEMS

1. Identify and describe the basic types of sheet metal.
2. Define properties of steel and aluminum alloys.
3. Describe a basic layout method and perform proper cutting.
4. Join sheet metal duct sections using proper seams and connectors.
5. Describe proper hanging and support methods for sheet metal duct.
6. Describe thermal and acoustic insulation principles.
7. Select, apply, and seal the proper insulation for sheet metal ductwork.

8. Describe guidelines for installing components such as registers, diffusers, grilles, dampers, access doors, and zoning accessories.
9. Install takeoffs and attach flexible duct to a sheet metal duct.

MODULE 03214-07 – FIBERGLASS AND FLEXIBLE DUCT SYSTEMS

1. Identify types of fiberglass duct, including flexible duct.
2. Describe fiberglass duct layout and some basic fabrication methods.
3. Describe the various closure methods for sealing fiberglass duct.
4. Fabricate selected duct modules and fittings using the appropriate tools.
5. Describe hanging and support methods for fiberglass duct.
6. Describe how to repair major and minor damage to fiberglass duct.
7. Install takeoffs and attach flexible duct to a fiberglass duct.