Maryland CTE Programs of Study

HVACR I (2025)

GENERAL REQUIREMENTS. This course is recommended for students in Grades 10-12. 1

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INTRODUCTION 2

A Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions. 2.A

B The Construction Career Cluster prepares students for careers in designing, planning, and building sustainable infrastructure. This field includes architects, engineers, construction managers, and skilled trades professionals. 2.B

C The HVACR Program of Study prepares students for a career in the HVACR trade through a comprehensive three-course sequence. Students learn to safely install, maintain, and repair heating, ventilation, air conditioning, and refrigeration systems. They master workplace safety protocols, tool usage, and trade mathematics before progressing to electrical system fundamentals and circuit analysis. Students develop hands-on skills in pipe fitting, soldering, brazing, and ductwork installation. The program advances to complex system components including compressors, heat pumps, and air quality equipment. Students learn to perform maintenance, troubleshoot systems, manage refrigerants safely, and provide professional customer service. Upon completion, they can diagnose problems, conduct repairs, and maintain HVACR systems according to industry standards. 2.C

D In the HVACR I course students will be introduced to the essential principles and practices of heating, ventilation, air conditioning, and refrigeration systems. The course begins with core concepts including HVACR theory, thermodynamics, and safety protocols, then progresses through mathematical applications specific to the trade. Students learn electrical fundamentals and circuit analysis, followed by comprehensive study of heating and cooling systems. Practical skills include air distribution system installation, piping practices with various materials (copper, plastic, and carbon steel), and specialized joining techniques like soldering and brazing. Throughout the course, students perform hands-on tasks such as measuring pressure and temperature in HVAC systems, installing basic electrical components, assembling ductwork, and creating secure pipe joints. This foundational course prepares students for more advanced HVACR applications by

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establishing both theoretical knowledge and practical skills required in the field. 2.D

E **Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.** 2.E

F **Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.** 2.F

KNOWLEDGE AND SKILLS 3

A **The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:** 3.A

1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work. 3.A.1
2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn. 3.A.2
3. Employ effective reading, writing, and technical documentation skills. 3.A.3
4. Solve problems using critical thinking techniques and structured troubleshooting methodologies. 3.A.4
5. Demonstrate leadership skills and collaborate effectively as a team member. 3.A.5
6. Implement safety procedures, including proper handling of hardware and following OSHA guidelines. 3.A.6
7. Exhibit an understanding of legal and ethical responsibilities in the construction field, following applicable laws and best practices for safety. 3.A.7
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting. 3.A.8

B **The student identifies various career pathways in the HVACR field. The student is expected to:** 3.B

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles in the HVACR field. 3.B.1
2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations. 3.B.2
3. Demonstrate effective interview skills for roles in the HVACR field. 3.B.3

C **The student identifies the issues associated with HVACR hazards found on a jobsite. The student is expected to:** 3.C

1. Demonstrate safe working procedures in a construction environment. 3.C.1
2. Explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job. 3.C.2

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3 Identify HVACR hazards and how to avoid or minimize them in the workplace. 3.C.3

4 Explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection. 3.C.4

D The student integrates core academic skills into HVACR construction practices. The student is expected to: 3.D

1 Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards. 3.D.1

2 Apply mathematical concepts including measuring distance, volume, flow, voltage, and current with industry tools and converting between standard and metric units. They solve basic calculations and simple equations to size ducts, pipes, and electrical systems. Students also read and interpret wiring diagrams, analyze circuits, and evaluate system layouts. Throughout the course, math is used for troubleshooting, system design, and ensuring safe, efficient HVACR operation. 3.D.2

3 Use scientific principles including exploring concepts such as heat transfer, thermodynamics, combustion, and electricity. They learn how energy moves through heating and cooling systems, how fuels burn and power is generated, and how air and fluids flow through pipes and ducts. Students investigate the properties of different materials, the behavior of gases and liquids under pressure, and the science behind safe system operation. 3.D.3

E The student demonstrates understanding of line voltage electrical systems in HVACR. The student is expected to: 3.E

1 Analyze power generation and distribution fundamentals for line voltage (120V-480V) applications. 3.E.1

2 Apply electrical safety practices and PPE requirements specific to line voltage work. 3.E.2

3 Calculate voltage, amperage, resistance, and power in line voltage HVACR circuits. 3.E.3

4 Evaluate line voltage electrical components including contactors, relays, and overloads. 3.E.4

5 Interpret line voltage sections of HVACR wiring diagrams and schematics to include identification of symbols, switched vs. load and circuit understanding (parallel vs. series). 3.E.5

6 Troubleshoot line voltage faults in HVACR systems using appropriate measuring instruments. 3.E.6

F The students demonstrates understanding of low voltage electrical systems in HVACR. The student is expected to: 3.F

1 Explain control circuit principles and low voltage (under 50V) applications in HVACR. 3.F.1

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2 Differentiate between various low voltage control strategies including digital, pneumatic, and electronic. 3.F.2

3 Test low voltage components including thermostats, sensors, and control boards. 3.F.3

4 Understand communication protocols used in modern HVACR control systems. 3.F.4

5 Interpret low voltage control sections of HVACR wiring diagrams and schematics. 3.F.5

6 Construct basic low voltage control circuits following manufacturer specifications. 3.F.6

G The student demonstrates understanding of combustion heating systems. The student is expected to: 3.G

1 Analyze fundamental concepts of combustion science and fuel properties. 3.G.1

2 Evaluate combustion efficiency and proper combustion testing procedures. 3.G.2

3 Evaluate the application of heat transfer theory as applicable to combustion heating systems. 3.G.3

4 Install (mock-up as appropriate) and service gas-fired furnaces according to manufacturer specifications and code requirements. 3.G.4

5 Diagnose combustion-related problems in heating equipment. 3.G.5

6 Apply safety protocols related to fuel handling and combustion processes. 3.G.6

H The student demonstrates understanding of forced air heating systems. The student is expected to: 3.H

1 Troubleshoot forced air heating system components including heat exchangers, blowers, and controls. 3.H.1

2 Evaluate the application of heat transfer theory as applicable to forced air heating systems. 3.H.2

3 Compare and identify the characteristics of different types of forced air systems. 3.H.3

4 Maintain air distribution systems for proper heating operation. 3.H.4

5 Assess airflow requirements and duct sizing for efficient system operation. 3.H.5

I The student demonstrates understanding of hydronic heating systems. The student is expected to: 3.I

1 Design basic hydronic heating system layouts based on building requirements. 3.I.1

2 Evaluate the application of heat transfer theory as applicable to hydronic heating systems. 3.I.2

Install (mock-up as appropriate) hydronic system components including boilers, pumps, and terminal units. 3.I.3

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4 Test hydronic systems for proper operation, pressure, and flow. 3.I.4

5 Diagnose common hydronic heating system faults and their causes. 3.I.5

6 Evaluate different hydronic heating configurations and their applications. 3.I.6

J The student demonstrates understanding of cooling systems. The student is expected to: 3.J

1 Analyze fundamental concepts of refrigeration cycles. 3.J.1

2 Identify common refrigerants and their characteristics. 3.J.2

3 Install (mock-up as appropriate) and maintain major cooling system components. 3.J.3

4 Explain the impact of latent heat and humidity on cooling systems. 3.J.4

5 Test common cooling system controls. 3.J.5

K The student applies knowledge of air distribution systems. The student is expected to: 3.K

1 Analyze factors affecting air movement and measurement. 3.K.1

2 Identify and explain the requirements of a building envelope, fresh air requirements and their importance. 3.K.2

3 Install (mock-up as appropriate) mechanical equipment for air distribution systems. 3.K.3

4 Evaluate different approaches to system design and energy conservation. 3.K.4

L The student demonstrates copper and plastic piping practices. The student is expected to: 3.L

1 Identify types of copper tubing and fittings. 3.L.1

2 Install mechanical joints in copper tubing including safe press fittings. 3.L.2

3 Install joints in various types of plastic piping. 3.L.3

4 Install pressed fittings related to water and refrigeration. 3.L.4

M The student demonstrates soldering and brazing techniques. The student is expected to: 3.M

1 Perform safe soldering processes on copper tubing. 3.M.1

2 Perform safe brazing processes on copper tubing. 3.M.2

N The student demonstrates carbon steel piping practices. The student is expected to: 3.N

1 Identify steel pipe types and fittings. 3.N.1

2 Use tools to cut and thread steel pipe. 3.N.2

3 Install mechanical joints in steel pipe. 3.N.3