

HEATING, VENTILATION & AIR CONDITIONING
(CIP: 15.0501)

SCORING RUBRIC				
The student demonstrates the specified level of competency in occupational skills:				
0	1	2	3	4
No Exposure	Introduced	Practiced	Entry-Level	Competency

0 1 2 3 4

Basic Construction Skills

- 00000 A. Orientation to the Trade
- 00000 B. Safety
- 00000 C. Math
- 00000 D. Hand Tools
- 00000 E. Power Tools
- 00000 F. Blueprints
- 00000 G. Wood Materials and Fastening

Specialization Options
(choose at least 2 sub areas)

Carpentry – Level I

- 00000 A. Rigging
- 00000 B. Tools
- 00000 C. Floor Systems
- 00000 D. Wall and Ceiling Framing
- 00000 E. Roof Framing
- 00000 F. Windows and Exterior Doors

Carpentry – Level II

- 00000 A. Reading Plans and Elevations
- 00000 B. Site Layout I: Distance Measurement and Leveling
- 00000 C. Introduction to Concrete and Reinforcing Materials
- 00000 D. Foundations and Flatwork
- 00000 E. Concrete Forms
- 00000 F. Reinforcing Concrete
- 00000 G. Handling and Placing Concrete
- 00000 H. Patented Forms
- 00000 I. Tilt-Up Wall Systems

Masonry

- 00000 A. Residential Plans and Drawing Interpretation

- 00000 B. Residential Masonry
- 00000 C. Grout and Other Reinforcement
- 00000 D. Metal Work in Masonry
- 00000 E. Advanced Laying Techniques
- 00000 F. Construction Techniques and Moisture Control
- 00000 G. Elevated Work
- 00000 H. Construction Inspection and Quality Control

Concrete Finishing

- 00000 A. Introduction to Concrete Construction and Finishing
- 00000 B. Safety Requirements
- 00000 C. Properties of Concrete
- 00000 D. Tools and Equipment
- 00000 E. Preparing and Placement
- 00000 F. Placing Concrete
- 00000 G. Finishing: Part I
- 00000 H. Curing and Protecting Concrete
- 00000 I. Introduction to Troubleshooting

Plumbing

- 00000 A. The Plumbing Trade
- 00000 B. Basic Plumbing Tools
- 00000 C. Math for Plumbers
- 00000 D. Introduction to Plumbing Blueprint Reading
- 00000 E. Reading Residential Plumbing Drawings
- 00000 F. Joining Plastic Pipe and Fittings
- 00000 G. Soldering and Brazing Copper Tubing and Fittings
- 00000 H. Cutting and Threading Carbon Steel Pipe
- 00000 I. Joining Cast-Iron Pipe and Fittings
- 00000 J. Making Flared and Compression Joints with Copper Tube
- 00000 K. Installing Traps and Interceptors
- 00000 L. Fitting and Cleanout Requirements for DWV Piping
- 00000 M. Installing Natural Gas Piping
- 00000 N. Installing LPG Piping Systems
- 00000 O. Installing Fuel Oil Piping Systems

Electrical

- 00000 A. Electrical Safety
- 00000 B. Hand Bending
- 00000 C. Anchors and Supports
- 00000 D. Electrical Theory One

- 00000 E. Electrical Theory Two
- 00000 F. Electrical Test Equipment
- 00000 G. Introduction to the National Electrical Code
- 00000 H. Raceways, Boxes, and Fittings
- 00000 I. Conductors
- 00000 J. Introduction to Electrical Blueprints
- 00000 K. Electrical Wiring: Commercial and Industrial
- 00000 L. Electrical Wiring: Residential

HAVC

- 00000 A. Trade Mathematics
- 00000 B. Tools of the Trade
- 00000 C. Copper and Plastic Piping Practices
- 00000 D. Soldering and Brazing
- 00000 E. Ferrous Metal Piping Practices
- 00000 F. Basic Electricity
- 00000 G. Introduction to Cooling
- 00000 H. Introduction to Heating

Industrial Maintenance – Level I

- 00000 A. Electrical Safety
- 00000 B. Hand Bending
- 00000 C. Fasteners and Anchors
- 00000 D. Electrical Theory One
- 00000 E. Electrical Theory Two
- 00000 F. Electrical Test Equipment
- 00000 G. Introduction to the National Electrical Code
- 00000 H. Conductors
- 00000 I. Introduction to Electrical Blueprints
- 00000 J. Oxyfuel Cutting

Industrial Maintenance – Level II

- 00000 A. Wiring: Commercial & Industrial
- 00000 B. Alternating Current
- 00000 C. Motors: Theory and Application

Directions

Evaluate the student by checking the appropriate box to indicate the degree of Competency. The rating for each task should reflect **employability readiness** rather than the grades given in class.

Rating Scale:

- 0 No Exposure**
- 1 Introduced** – the student has been exposed through non-participatory instruction (e.g. lecture, demonstration, field trip, and video).
- 2 Practiced** – the student can perform the task with direct supervision.
- 3 Entry-Level Competency** – the student can perform the task with limited supervision and/or does not perform the task to standard (a typical entry-level performance expectation).
- 4 Competency** – the student consistently performs task to standard with no supervision (on at least two occasions or at instructor’s option).

Building Trades Core Instruction

Basic Construction Skills

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- A. Orientation to the Trade**
- A.001 Describe the history of the carpentry trade.
 - A.002 Identify the stages of progress within the carpentry trade.
 - A.003 Identify the responsibilities of a person working in the construction industry.
 - A.004 State the personal characteristics of a professional.
 - A.005 Explain the importance of safety in the construction industry.

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- B. Safety**
- B.001 Describe how to avoid job-site accidents.
 - B.002 Explain the relationship between housekeeping and safety.
 - B.003 Appreciate the importance of following all safety rules and company safety policies.
 - B.004 Explain the importance of reporting all on-the-job injuries, accidents, and near misses.
 - B.005 Explain the need for evacuation procedures and the importance of following them.
 - B.006 Explain their employer’s substance abuse policy and how it relates to their safety.
 - B.007 Use proper safety practices when welding or working around welding operations.
 - B.008 Use proper safety practices when working in or near trenches and excavations.
 - B.009 Explain the term Proximity Work.
 - B.010 Follow safe practices when working near pressurized or high-

- temperature systems.
- B.011 Know and follow the safety requirements for working in confined spaces.
 - B.012 Explain and practice safe lockout-tagout procedures.
 - B.013 Know the different types of barriers and barricades, and where they should be used.
 - B.014 Recognize and explain personal protective equipment uses.
 - B.015 Inspect and care for various types of personal protective equipment.
 - B.016 Follow safe procedures for lifting heavy objects.
 - B.017 Inspect and safely work with various types of ladders and scaffolds.
 - B.018 Demonstrate an understanding of the OSHA Hazard Communication Standard.
 - B.019 Explain the function of Material Safety Data Sheets.
 - B.020 Explain the process by which fires start.
 - B.021 Practice fire prevention in dealing with various flammable materials.
 - B.022 Explain the classes of fires, and the type(s) of extinguishers to use for each.
 - B.023 Explain why injuries result when electrical contact occurs.
 - B.024 Practice safe work procedures around electrical hazards.
 - B.025 Take action if present when an electrical shock occurs.

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- C. Math**
- C.001 Add, subtract, multiply, and divide whole numbers, with and without a calculator.
 - C.002 Use a standards and metric ruler to measure.
 - C.003 Add, subtract, multiply, and divide fractions.
 - C.004 Add, subtract, multiply, and divide decimals, with and without a calculator.
 - C.005 Convert decimals to percents and percents to decimals.
 - C.006 Convert fractions to decimals and decimals to fractions.
 - C.007 Explain what the Metric System is and its importance in the construction trade.
 - C.008 Recognize and use metric units of length, weight, volume, and temperature.

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- D. Hand Tools**
- D.001 Recognize basic hand tools used in the construction trade.
 - D.002 Safely use these basic hand tools.
 - D.003 Have an awareness of basic maintenance procedures on these hand tools.

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- E. Power Tools**
- E.001 Identify commonly used power tools of the construction trade.

- E.002 Recognize safe use of power tools.
- E.003 Explain the procedures to properly maintain these power tools.

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- F. Blueprints**
- F.001 Identify and recognize basic blueprint terms and symbols.
- F.002 Relate information on prints to real parts and locations.

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- G. Wood Materials and Fastening**
- G.001 Explain the terms commonly used in discussing wood and lumber.
- G.002 State the uses of various types of hardwoods and softwoods.
- G.003 Identify various types of imperfections that are found in lumber.
- G.004 Explain how lumber is graded.
- G.005 Interpret grade markings on lumber and plywood.
- G.006 Explain how plywood is manufactured, graded, and used.
- G.007 Identify various types of building boards and identify their uses.
- G.008 Identify the uses of and safety precautions associated with pressure-treated lumber.
- G.009 Describe the proper method of caring for limber and wood building materials at the job site.
- G.010 State the uses of various types of engineered lumber.
- G.011 Calculate the quantities of lumber and wood products using industry-standards methods.
- G.012 List the basic nail and staple types and their uses.
- G.013 List the basic types of screws and their uses.
- G.014 Identify the different types of anchors and their uses.
- G.015 Describe the common types of adhesives used in construction work and explain their uses.

Specialized Options
(Choose at least 2 sub areas – e.g., A, B, C...)

Carpentry – Level I

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- A. Rigging**
- A.001 Explain and practice rigging safety.
- A.002 Identify and explain rigging equipment.
- A.003 Inspect rigging equipment.
- A.004 Identify, explain, and perform crane hand signals.
- A.005 Estimate size, weight, and center of gravity.
- A.006 Tie knots.
- A.007 Identify and explain types of derricks.
- A.008 Identify and explain types of cranes.
- A.009 Rig and move materials and equipment.

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- B. Tools**
- B.001 Identify the hand tools commonly used by carpenters and describe

their uses.

- B.002 Use hand tools in a safe and appropriate manner.
- B.003 State the general safety rules for operating all power tools, regardless of type.
- B.004 State the general rules for properly maintaining all power tools, regardless of type.
- B.005 Identify the portable power tools commonly used by carpenters and describe their uses.
- B.006 Use portable power tools in a safe and appropriate manner.
- B.007 Identify the stationary power tools commonly used by carpenters and describe their uses.
- B.008 Use stationary power tools in a safe and appropriate manner.

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C. Floor Systems

- C.001 Identify the different types of framing systems.
- C.002 Read and understand drawings and specifications to determine floor system requirements.
- C.003 Identify floor and sill framing and support members.
- C.004 Name the methods used to fasten sills to the foundation.
- C.005 Given specific floor load and span data, select the proper girder/beam size from a list of available girders/beams.
- C.006 List and recognize different types of floor joists.
- C.007 Given specific floor load and span data, select the proper joist size from a list of available joists.
- C.008 List and recognize different types of bridging.
- C.009 List and recognize different types of flooring materials.
- C.010 Explain the purposes of subflooring and underlayment.
- C.011 Match selected fasteners uses in floor framing to their correct uses.
- C.012 Estimate the amount of material needed to frame a floor assembly.
- C.013 Demonstrate the ability to:
 - Lay out and construct a floor assembly
 - Install bridging
 - Install joists for a cantilever floor
 - Install a subfloor using butt-joint plywood/OSB panels
 - Install a single floor system using tongue-and-groove plywood/OSB panels.

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D. Wall and Ceiling Framing

- D.001 Identify the components of a wall and ceiling layout.
- D.002 Describe the procedure for laying out a wood frame wall, including plates, corner posts, door and window openings, partition T's, bracing, and firestops.
- D.003 Describe the correct procedure for assembling and erecting an exterior wall.
- D.004 Describe the common materials and methods used for installing sheathing on walls.

- D.005 Lay out, assemble, erect, and brace exterior walls for a frame building.
- D.006 Describe wall-framing techniques used in masonry construction.
- D.007 Explain the use of metal studs in wall framing.
- D.008 Describe the correct procedure for laying out a ceiling.
- D.009 Cut and install ceiling joists on a wood frame building.
- D.010 Estimate the materials required to frame walls and ceilings.

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- E. Roof Framing**
- E.001 Understand the terms associated with roof framing.
 - E.002 Identify the roof-framing members used in gable and hip roofs.
 - E.003 Identify the methods used to calculate the length of a rafter.
 - E.004 Identify the various types of trusses used in roof framing.
 - E.005 Use a rafter framing square, speed square, and calculator in laying out a roof.
 - E.006 Identify various types of sheathing used in roof construction.
 - E.007 Frame a gable roof with vent openings.
 - E.008 Frame a roof opening.
 - E.009 construct a frame roof, including hips, valleys, commons, jack rafters, and sheathing.
 - E.010 Erect a gable roof using trusses.
 - E.011 Estimate the materials used in framing and sheathing a roof.

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- F. Windows and Exterior Doors**
- F.001 Identify various types of fixed, sliding, and swinging windows.
 - F.002 Identify the parts of a window installation.
 - F.003 State the requirements for a proper window installation.
 - F.004 Install a pre-hung window.
 - F.005 Identify the common types of skylights and roof windows.
 - F.006 Describe the procedure for properly installing a skylight.
 - F.007 Identify the common types of exterior doors and explain how they are constructed.
 - F.008 Identify the parts of a door installation.
 - F.009 Identify the types of thresholds used with exterior doors.
 - F.010 Install a threshold on a concrete floor.
 - F.011 Install a pre-hung exterior door with weather-stripping.
 - F.012 Identify the various types of locksets used on exterior doors and explain how they are installed.
 - F.013 Explain the correct installation procedure for a rollup garage door.
 - F.014 Install a lockset.

Carpentry - Level II

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- A. Reading Plans and Elevations**
- A.001 Describe the types of drawings usually included in a set of plans and list the information found on each type.

- A.002 Identify the different types of lines used on construction drawings.
- A.003 Identify selected architectural symbols commonly used to represent materials on plans.
- A.004 Identify selected electrical, mechanical, and plumbing symbols commonly used on plans.
- A.005 Identify selected abbreviations commonly used on plans.
- A.006 Read plans, elevations, schedules, etc., contained in basic construction drawings.
- A.007 State the purpose of written specifications.
- A.008 Understand and identify the parts of a specification.
- A.009 Demonstrate or describe how to perform a quantity takeoff for materials.

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- B. Site Layout I: Distance Measurement and Leveling**
- B.001 Describe the major responsibilities of the carpenter relative to site layout.
- B.002 Interpret site/plot drawings.
- B.003 Convert measurements stated in feet and inches to equivalent measurements stated in decimal feet and vice versa.
- B.004 Recognize, use, and properly maintain tools and equipment associated with taping.
- B.005 Use taping equipment and procedures to make distance measurements and perform site layout tasks.
- B.006 Determine approximate distances by pacing.
- B.007 Recognize, use, and properly care for tools and equipment associated with differential leveling.
- B.008 Use a builder's level or transit and differential leveling procedures to determine site and building elevations.
- B.009 Record site layout data and information in field notes using accepted practices.
- B.010 Check and/or establish 90° angles using the 3/4/5 rule.

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- C. Introduction to Concrete and Reinforcing Materials**
- C.001 Identify various types of cement and describe their uses.
- C.002 Identify types and sizes of concrete aggregates.
- C.003 Identify types of concrete admixtures and describe their uses.
- C.004 Identify special types of concrete and describe their uses.
- C.005 Identify concrete curing methods and materials.
- C.006 Identify concrete testing methods.
- C.007 Demonstrate sampling methods used for the testing of concrete.
- C.008 Perform slump testing of concrete.
- C.009 Perform casting of specimens for strength testing of concrete.
- C.010 Perform volume estimates for concrete quantity requirements.
- C.011 Identify types of concrete reinforcement bars and describe their uses.

- C.012 Identify types of reinforcement bar supports and describe their uses.
- C.013 Identify types of welded-wire fabric reinforcement material and describe their uses.

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D. Foundations and Flatwork

- D.001 Recognize four kinds of footings:
 - Continuous or spread
 - Stepped
 - Pier
 - Grade beam
- D.002 Identify the parts of footing forms and explain their purpose.
- D.003 Identify the parts of pier forms and explain their purpose.
- D.004 Demonstrate the ability to lay out and construct selected footing forms, including:
 - Continuous footing
 - Pier footing
 - Pile cap
 - Grade beam
- D.005 Strip a pier footing form and prepare it for erection at another location.
- D.006 Recognize types of concrete pours that require the construction of edge forms:
 - Slabs with or without a foundation
 - Parking lots
 - Driveways and streets
 - Sidewalks
 - Approaches
- D.007 Identify the parts of edge forms and explain their purpose.
- D.008 Demonstrate the ability to construct and disassemble edge forms for:
 - A slab-on-grade with an existing foundation
 - A slab-on-grade with an integral foundation
- D.009 Explain the purpose of a screed and identify the different types of screeds.
- D.010 Demonstrate the ability to set screeds on grade.

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E. Concrete Forms

- E.001 Identify the various types of concrete forms.
- E.002 Identify the components of each type of form.
- E.003 Explain the safety procedures associated with using concrete forms.
- E.004 Construct wall, column, beam, and stair forms.

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F. Reinforcing Concrete

- F.001 Describe the applications of reinforcing bars, the uses of reinforced

structural concrete, and the basic processes involved in placing reinforcing bars.

- F.002 Recognize and identify the bar bends standardized by the American Concrete Institute.
- F.003 Read and interpret bar lists and describe the information found on a bar list.
- F.004 List the types of ties used in securing reinforcing bars.
- F.005 State the tolerances allowed in the fabrication of reinforcing bars.
- F.006 Demonstrate the use of common ties for reinforcing bars.
- F.007 Describe methods by which reinforcing bars may be cut and bent in the field.
- F.008 Identify the tools and equipment needed for installing reinforcing bars.
- F.009 Demonstrate the ability to safely use selected tools and equipment to cut, bend, and install reinforcing materials.
- F.010 Explain the necessity of concrete cover in placing reinforcing bars.
- F.011 Explain and demonstrate how to place bars in walls, columns, beams, girders, joists, and slabs.
- F.012 Identify lapped and welded splices.

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G. Handling and Placing Concrete

- G.001 Identify and state the purpose of different types of concrete joints.
- G.002 Recognize the various equipment used to transport and place concrete.
- G.003 Describe the factors that contribute to the quality of concrete placement.
- G.004 Demonstrate and/or describe the correct methods for placing and consolidating concrete into forms.
- G.005 Demonstrate and/or describe how to use a screed to strike off and level concrete to the proper grade in a form.
- G.006 Demonstrate and/or describe how to use a bullfloat and/or darby to level and smooth concrete.
- G.007 Determine what conditions permit the concrete finishing operation to start.
- G.008 Demonstrate and/or describe how to use a hand float and finishing trowel.
- G.009 Demonstrate and/or describe how to use an edger.
- G.010 Demonstrate and/or describe how to use a jointer.
- G.011 Name the factors that affect the curing of concrete and describe the methods used to achieve proper curing.
- G.012 Properly care for and safely use the hand and power tools used when working with concrete.

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H. Patented Forms

- H.001 Recognize various types of patented forms.
- H.002 Identify the components of patented wall-forming

systems.

- H.003 State the differences in construction and use for different types of forms.
- H.004 Describe how a flying form system is moved.
- H.005 Erect, plumb, and brace a patented wall form.
- H.006 Use a patented hardware system to erect forms of lumber and sheathing.
- H.007 Erect, plumb, and brace a patented column form.

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- I. Tilt-Up Wall Systems**
- I.001 Describe the history of tilt-up construction.
- I.002 Explain the advantages and disadvantages of tilt-up construction.
- I.003 Explain how aggregates are used to obtain the desired appearance in tilt-up wall panels.
- I.004 Explain and/or demonstrate the correct method for preparing a floor slab to be used in forming tilt-up panels.
- I.005 Explain and/or demonstrate the correct procedure for forming and finishing a tilt-up wall panel.
- I.006 Explain and/or demonstrate the correct procedure for preparing Footings to receive tilt-up wall panels.
- I.007 Explain and/or demonstrate the correct procedure for safely lifting and joining wall panels.
- I.008 Select and properly place lifting and bracing inserts.

II. Masonry

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- A. Residential Plans and Drawing Interpretation**
- A.001 Understand the organization of residential plans and drawings.
- A.002 Interpret dimensions and scales on drawings.
- A.003 Interpret information on residential plans.
- A.004 Estimate materials quantities from plans and drawings.

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- B. Residential Masonry**
- B.001 Understand the requirements for construction of various types of residential foundations.
- B.002 Identify and explain the characteristics, uses, and installation techniques for brick pavers.
- B.003 Lay out and construct steps, patios, and decks made from masonry units.
- B.004 Lay out and construct chimneys and fireplaces.

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- C. Grout and Other Reinforcement**

- C.001 Name and describe the primary ingredients in grout and their properties.
- C.002 Identify the different types of grout used in masonry work.
- C.003 Describe the common admixtures and their uses.
- C.004 Describe the use of steel bar reinforcement in masonry construction.
- C.005 Use the proper techniques to apply grout in low and high lifts.

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- D. Metal Work in Masonry**
- D.001 Describe the uses and installation of vertical reinforcement.
- D.002 Describe the uses and installation of different types of horizontal joint reinforcements and ties.
- D.003 Describe the uses and installation of different anchors, fasteners, and embedded items.
- D.004 Describe the installation of hollow metal frames.
- D.005 Describe the functions and installations of sills and lintels.

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- E. Advanced Laying Techniques**
- E.001 Recognize the structural principles and fundamental uses of basic types of walls.
- E.002 Recognize the requirement for, and function of, control joints and expansion joints.
- E.003 Construct various types of walls using proper reinforcement, jointing, and bonding techniques.
- E.004 Construct specialty structures such as manholes, segmented block walls, and screens.
- E.005 Identify and explain the different types of masonry arches used today.
- E.006 Construct a semicircular and jack arch.

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- F. Construction Techniques and Moisture Control**
- F.001 Explain and demonstrate techniques for constructing masonry around windows, doors, and other openings.
- F.002 Explain the requirements for wall bracing and demonstrate the techniques used to construct pilasters and other types of bracing.
- F.003 Identify the various types of insulation used in conjunction with masonry construction and explain installation techniques.
- F.004 Identify the need for moisture control in various types of masonry construction and demonstrate the techniques used to eliminate moisture problems.

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- G. Elevated Work**

- G.001 Describe the appropriate steps necessary for setting up and maintaining elevated workstations.
- G.002 Properly operate material handling and hoisting equipment.
- G.003 Describe the safety requirements and guidelines employed in elevated and high-rise construction.
- G.004 Describe basic activities that can be used on the job to prevent elevated workstation accidents.
- G.005 Understand scaffolding positioning and how it affects laying technique.

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- H. Construction Inspection and Quality Control**
- H.001 Discuss industry standards for quality control.
- H.002 Build masonry sample panels and prisms.
- H.003 Perform field tests on mortar.
- H.004 Discuss and perform field inspections.

III. CONCRETE FINISHING

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- A. Introduction to Concrete Construction and Finishing**
- A.001 Define terms associated with concrete construction.
- A.002 Identify the composition and characteristics of concrete.
- A.003 Identify the uses of concrete as a building material.
- A.004 Identify the effect of craftsmanship on finished concrete.
- A.005 Explain the concrete construction process.
- A.006 Identify site operation work requirements.
- A.007 Explain the career potentials in concrete construction and finishing.

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- B. Safety Requirements**
- B.001 Describe and wear different types of safety gear for the work site.
- B.002 State the guidelines for dressing appropriately for concrete work.
- B.003 Describe how to safely handle concrete when forming, placing, curing, and finishing.
- B.004 Describe safety precautions to follow when working in extreme heat and cold.
- B.005 Describe safety precautions to follow when working with hazardous materials.
- B.006 Describe proper procedures for handling and maintaining concrete construction tools safely.

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- C. Properties of Concrete**
- C.001 Describe the properties of concrete.
 - C.002 Explain how the properties of concrete are used in construction.
 - C.003 Determine how the ingredients of concrete influence mix, placement, finishing, durability, and performance.
 - C.004 Describe quality-control tests on concrete ingredients, fresh concrete, and hardened concrete.
 - C.005 Mix a test batch of concrete.
 - C.006 Perform a slump test.

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- D. Tools and Equipment**
- D.001 Name the tools used in placing and finishing concrete.
 - D.002 Name the power equipment used in placing and finishing concrete.
 - D.003 Describe how each tool is used.
 - D.004 Describe how the power equipment is used.
 - D.005 Associate trade terms with the appropriate tools and equipment.

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- E. Preparing and Placement**
- E.001 Describe basic site layout using levels and measuring tools.
 - E.002 Properly locate, grade, and build forms for horizontal placement.
 - E.003 Perform compaction activities on subgrades.
 - E.004 Describe various joints and where to locate them.
 - E.005 Describe various reinforcements and how to place them.
 - E.006 Describe information needed when ordering concrete.

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- F. Placing Concrete**
- F.001 Describe how concrete is conveyed and placed.
 - F.002 Draw up a pre-placement checklist.
 - F.003 Demonstrate the use of equipment and tools for placing concrete.
 - F.004 Demonstrate the process of depositing, spreading, consolidating, and striking off concrete in a form.
 - F.005 Associate trade terms with the appropriate processes and equipment.

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- G. Finishing: Part I**
- G.001 Describe the basic finishing process.
 - G.002 Use the following finishing hand tools: float, edger, groover, and trowel.
 - G.003 Mark and cut joints with a saw.

- G.004 Apply a broom finish.
- G.005 Apply a rubbing finish.
- G.006 Associate trade terms with the appropriate processes and equipment.

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- H. Curing and Protecting Concrete**
- H.001 Describe the process of curing concrete.
- H.002 Identify methods of curing concrete.
- H.003 Describe how each method is applied.
- H.004 Identify when each method is used.
- H.005 Associate trade terms with the appropriate processes and equipment.

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- I. Introduction to Troubleshooting**
- I.001 Describe a basic troubleshooting methodology that can be used to identify a variety of concrete construction problems and their causes.
- I.002 Identify problems with fresh concrete and describe ways to prevent them.
- I.003 Identify different concrete defects such as crazing, cracking, dusting, scaling, popouts, and efflorescence, and describe ways to prevent them.

IV. PLUMBING

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- A. The Plumbing Trade**
- A.001 Discuss the historical development of the trade.
- A.002 Discuss the functions of water supply and sewage treatment systems.
- A.003 Discuss the importance of plumbers in modern society.

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- B. Basic Plumbing Tools**
- B.001 Discuss safety as it applies to plumbing tools.
- B.002 Identify the basic hand and power tools used in the plumbing trade.
- B.003 Discuss the proper maintenance procedures to be used for hand and power tools.

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- C. Math for Plumbers**
- C.001 Measure pipe using the following methods:
 - End-to-end
 - End-to-center

- Center-to-center
- End-to-face
- Face-to-face
- Face-to-crotch

- C.002 Determine end-to-end dimensions by figuring fitting allowances and make-up.
- C.003 Use a framing square to find the center of things.
- C.004 Figure 45-degree offsets using the constant method.
- C.005 Figure 45-degree offsets using a framing square and a wooden rule or tape measure.

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- D. Introduction to Plumbing Blueprint Reading**
- D.001 Discuss the various ways in which drawings can be reproduced, including blue lines, black lines, sepias, and CAD.
- D.002 Identify orthographic, oblique and isometric drawings.
- D.003 Discuss how orthographic views are used to depict information about objects.
- D.004 Explain how scale and dimensions are used to convey information on orthographic drawings.
- D.005 Identify the basic symbols used in schematic drawings of pipe assemblies.
- D.006 Discuss the characteristics of isometric drawings.
- D.007 Discuss procedures used to make piping isometrics.

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- E. Reading Residential Plumbing Drawings**
- E.001 List the types of drawings that may be included in a set of residential plans.
- E.002 Distinguish between plans and specifications.
- E.003 Interpret plumbing related information from a set of residential plans.
- E.004 Understand the relationships that exist among the various drawings.
- E.005 Apply the local code requirements to given drawings.

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- F. Joining Plastic Pipe and Fittings**
- F.001 State the precautions that must be taken when installing refrigerant piping.
- F.002 Select the right tubing for a job.
- F.003 Cut and bend tubing.
- F.004 Join tubing by using flare and compression fittings.
- F.005 Determine the kinds of hangers and support needed for refrigerant piping.
- F.006 Insulate refrigerant piping.
- F.007 State the basic requirements for pressure-testing a system once it

has been installed.

- F. 008 Follow basic safety precautions for the installation, operation and maintenance of refrigerating and air conditioning equipment.

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- G. Soldering and Brazing Copper Tubing and Fittings**
 - G. 001 Assemble and operate the tools used for soldering.
 - G. 002 Prepare tubing and fittings for soldering.
 - G. 003 Identify the purposes and use of solder and solder fluxes.
 - G. 004 Solder copper tubing and fittings.
 - G. 005 Assemble and operate the tools used for brazing.
 - G. 006 Prepare tubing and fittings for brazing.
 - G. 007 Identify the purposes and use of filler metals and fluxes used for brazing.
 - G. 008 Braze copper tubing and fittings.
 - G. 009 Identify the inert gases that can safely be used to purge tubing when brazing.

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- H. Cutting and Threading Carbon Steel Pipe**

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- I. Joining Cast-Iron Pipe and Fittings**
 - I. 001 Differentiate between cast iron hub-and spigot pipe and No-Hub pipe and fittings.
 - I. 002 Identify the labeling system used for cast iron pipe and fittings.
 - I. 003 State the sizes, weights, and availability of cast iron pipe and fittings.
 - I. 004 Identify common fittings used with cast iron pipe.

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- J. Making Flared and Compression Joints with Copper Tube**
 - J. 001 Identify fittings and soft copper tubing.
 - J. 002 Discuss the advantages of flared and compression joints.

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- K. Installing Traps and Interceptors**
 - K. 001 Describe the different types of traps and how they work.
 - K. 002 Explain the local code requirements for trap installation.
 - K. 003 Identify the critical dimensions in trap installation.

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- L. Fitting and Cleanout Requirements for DWV Piping**

- L. 001 Recognize the different types of DWV fittings.
- L. 002 Understand the application of the various kinds of DWV fittings used within the plumbing design.
- L. 003 Understand the application of the various kinds of DWV fittings in reference to code requirements.
- L. 004 Understand the use of cleanouts in the DWV piping system.
- L. 005 Become familiar with the code requirements for the size, direction and location of cleanouts.
- L. 006 Understand the placement of cleanouts on stacks, junctions and traps.
- L. 007 Understand the requirements for cleanout accessibility and clearance.
- L. 008 Understand the code requirements for manholes.

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- M. Installing Natural Gas Piping**
- M. 001 Understand how the code affects natural gas piping systems.
- M. 002 Recognize the different types of natural gas distribution materials.
- M. 003 Interpret plumbing drawings or blueprints to determine natural gas piping layouts.
- M. 004 Recognize the parts of a gas system.
- M. 005 Know testing and purging procedures.
- M. 006 Understand appliance installation.

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- N. Installing LPG Piping Systems**
- N. 001 Understand how the code affects LPG piping systems.
- N. 002 Recognize the different materials used in LPG piping systems.
- N. 003 Recognize different types of storage containers.
- N. 004 Interpret plumbing plans to determine layouts.
- N. 005 Recognize the parts of a LPG system.
- N. 006 Understand testing procedures for LPG systems.
- N. 007 Install LPG appliances.

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- O. Installing Fuel Oil Piping Systems**
- O. 001 Understand how code affects fuel oil piping systems.
- O. 002 Recognize the different types of fuel oil distribution materials.
- O. 003 Interpret plumbing drawings or blueprints to determine fuel oil system layouts.
- O. 004 Recognize the parts of a fuel oil system.
- O. 005 Understand testing and bleeding procedures.

O. 006 Understand appliance installation.

V. ELECTRICAL

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- A. Electrical Safety**
- A. 001 Demonstrate safe working procedures in a construction environment.
- A. 002 Explain the purpose of OSHA and how it promotes safety on the job.
- A. 003 Identify electrical hazards and how to avoid or minimize them in the workplace.
- A. 004 Explain safety issues concerning lockout/tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection systems.

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- B. Hand Bending**
- B. 001 Identify the methods of hand bending conduit.
- B. 002 Identify the various methods used to install conduit.
- B. 003 Use math formulas to determine conduit bends.
- B. 004 Make 90° bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
- B. 005 Cut, ream, and thread conduit.

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- C. Anchors and Supports**
- C. 001 Identify and explain the use of threaded fasteners.
- C. 002 Identify and explain the use of non-threaded fasteners.
- C. 003 Identify and explain the use of anchors.
- C. 004 Demonstrate the correct applications for fasteners and anchors.
- C. 005 Install fasteners and anchors.

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- D. Electrical Theory One**
- D. 001 Recognize what atoms are and how they are constructed.
- D. 002 Define voltage and identify the ways in which it can be produced.
- D. 003 Explain the difference between conductors and insulators.
- D. 004 Define the units of measurement that are used to measure the properties of electricity.

- D. 005 Explain how voltage, current, and resistance are related to each other.
- D. 006 Using the formula for Ohm's Law, calculate an unknown value.
- D. 007 Explain the different types of meters used to measure voltage, current, and resistance.
- D. 008 Using the power formula, calculate the amount of power used by a circuit.
- D. 009 Explain how the relationship of work and power is applied to electrical circuits.
- D. 010 Calculate, using the power formula, the amount of power used by a circuit.

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- E. Electrical Theory Two**
- E. 001 Explain the basic characteristics of a series circuit.
- E. 002 Explain the basic characteristics of a parallel circuit.
- E. 003 Explain the basic characteristics of a series-parallel circuit.
- E. 004 Calculate, using Kirchoff's Voltage Law, the voltage drop in series, parallel, and series-parallel circuits.
- E. 005 Calculate, using Kirchoff's Current Law, the total current in parallel and series-parallel circuits.
- E. 006 Find the total amount of resistance in a series circuit.
- E. 007 Find the total amount of resistance in a parallel circuit.
- E. 008 Find the total amount of resistance in a series-parallel circuit.

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- F. Electrical Test Equipment**
- F. 001 Explain the operation of and describe the following pieces of test equipment:
 - Ammeter
 - Ohmmeter
 - Wattmeter
 - Frequency meter
 - Continuity tester
 - Recording instruments
 - Voltmeter
 - Volt-ohm-milliammeter (VOM)
 - Megohmmeter
 - Power factor meter
 - Voltage tester
 - Cable-length meters
- F. 002 Explain how to read and convert from one scale to another using the above test equipment.
- F. 003 Explain the importance of proper meter polarity.
- F. 004 Define frequency and explain the use of a frequency meter.
- F. 005 Explain the difference between digital and analog meters.

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- G. Introduction to the National Electrical Code**
- G. 001 Explain the purpose and history of the National Electrical Code (NEC).
 - G. 002 Describe the layout of the NEC.
 - G. 003 Explain how to navigate the NEC.
 - G. 004 Describe the purpose of the National Electrical Manufacturers' Association (NEMA) and the National Fire Protection Association (NFPA).
 - G. 005 Explain the role of testing laboratories.

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- H. Raceways, Boxes, and Fittings**
- H. 001 Describe various types of cable trays and raceways.
 - H. 002 Identify and select various types and sizes of raceways.
 - H. 003 Identify and select various types and sizes of cable trays.
 - H. 004 Identify and select various types of raceway fittings.
 - H. 005 Identify various methods used to install raceways.
 - H. 006 Demonstrate knowledge of NEC raceway requirements.
 - H. 007 Describe procedures for installing raceways and boxes on masonry surfaces.
 - H. 008 Describe procedures for installing raceways and boxes on concrete surfaces.
 - H. 009 Describe procedures for installing raceways and boxes in a metal stud environment.
 - H. 010 Describe procedures for installing raceways and boxes in a wood frame environment.
 - H. 011 Describe procedures for installing raceways and boxes on drywall surfaces.
 - H. 012 Recognize safety precautions that must be followed when working with boxes and raceways.

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- I. Conductors**
- I. 001 Explain the various sizes and gauges of wire in accordance with American Wire Gauge Standards.
 - I.002 Identify insulation and jacket types according to conditions and applications.
 - I. 003 Describe voltage ratings of conductors and cables.
 - I. 004 Read and identify markings on conductors and cables.
 - I. 005 Use the tables in the NEC to determine the ampacity of a

conductor.

- I. 006 State the purpose of stranded wire.
- I. 007 State the purpose of compressed conductors.
- I. 008 Describe the different materials from which conductors are made.
- I. 009 Describe the different types of conductor insulation.
- I. 010 Describe the color coding of insulation.
- I. 011 Describe instrumentation control wiring.
- I. 012 Describe the equipment required for pulling wire through conduit.
- I. 013 Describe the procedure for pulling wire through conduit.
- I. 014 Install conductors in conduit.
- I. 015 Pull conductors in a conduit system.

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- J. Introduction to Electrical Blueprints**
- J. 001 Explain the basic layout of a blueprint.
- J. 002 Describe the information included in the title block of a blueprint.
- J. 003 Identify the types of lines used on blueprints.
- J. 004 Identify common symbols used on blueprints.
- J. 005 Understand the use of architect's and engineer's scales.
- J. 006 Interpret electrical drawings, including site plans, floor plans, and detail drawings.
- J. 007 Read equipment schedules found on electrical blueprints.
- J. 008 Describe the type of information included in electrical specifications.

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- K. Electrical Wiring: Commercial & Industrial**
- K. 001 Identify and state the functions and ratings of single-pole, double-pole, three-way, four-way, dimmer, special, and safety switches.
- K. 002 Explain NEMA classifications as they relate to switches and enclosures.
- K. 003 Explain the NEC requirements concerning wiring devices.
- K. 004 Identify and state the functions and ratings of straight blade, twist lock, and pin and sleeve receptacles.
- K. 005 Identify and define receptacle terminals and disconnects.
- K. 006 Identify and define ground fault circuit interrupters.
- K. 007 Explain the box mounting requirements in the NEC.
- K. 008 Use a wire stripper to strip insulation from a wire.
- K. 009 Use a solderless connector to splice wires together.
- K. 010 Identify and state the functions of limit switches and relays.
- K. 011 Identify and state the function of switchgear.

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- L. Electrical Wiring: Residential**
- L. 001 Describe how to determine electric service requirements for dwellings.
 - L. 002 Explain the grounding requirements of a residential electric service.
 - L. 003 Calculate and select service-entrance equipment.
 - L. 004 Select the proper wiring methods for various types of residences.
 - L. 005 Explain the role of the NEC in residential wiring.
 - L. 006 Compute branch circuit loads and explain their installation requirements.
 - L. 007 Explain the types and purposes of equipment grounding conductors.
 - L. 008 Explain the purpose of ground fault circuit interrupters and tell where they must be installed.
 - L. 009 Size outlet boxes and select the proper type for different wiring methods.
 - L. 010 Describe rules for installing electric space heating and HVAC equipment.
 - L. 011 Describe the installation rules for electrical systems around swimming pools, spas, and hot tubs.
 - L. 012 Explain how wiring devices are selected and installed.
 - L. 013 Describe the installation and control of lighting fixtures.

VI. HVAC

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- A. Trade Mathematics**
- A. 001 Solve algebraic equations that relate to the HVAC trade.
 - A. 002 Calculate volume, weight, pressure, vacuum, and temperature.
 - A. 003 Construct simple geometric figures and solve basic geometry problems that relate to the HVAC trade.

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- B. Tools of the Trade**
- B. 001 Identify and demonstrate the ability to use the following tools:
 - Pipe wrenches
 - Torque wrenches
 - Tinner's and soft face hammers
 - Hand cutting snips
 - Hand and power hacksaws
 - Drill press

- Measuring Tools

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- C. Copper and Plastic Piping Practices**
- C. 001 State the precautions that must be taken when installing refrigerant piping.
 - C. 002 Select the right tubing for a job.
 - C. 003 Cut and bend tubing.
 - C. 004 Join tubing by using flare and compression fittings.
 - C. 005 Determine the kinds of hangers and support needed for refrigerant piping.
 - C. 006 Insulate refrigerant piping.
 - C. 007 State the basic requirements for pressure-testing a system once it has been installed.
 - C. 008 Follow basic safety precautions for the installation, operating and maintenance of refrigerating and air conditioning equipment.

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- D. Soldering and Brazing**
- D. 001 Assemble and operate the tools used for soldering.
 - D. 002 Prepare tubing and fittings for soldering.
 - D. 003 Identify the purposes and use of solder and solder fluxes.
 - D. 004 Solder copper tubing and fittings.
 - D. 005 Assemble and operate the tools used for brazing.
 - D. 006 Prepare tubing and fittings for brazing.
 - D. 007 Identify the purposes and use of filler metals and fluxes used for brazing.
 - D. 008 Braze copper tubing and fittings.
 - D. 009 Identify the inert gases that can safely be used to purge tubing when brazing.

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- E. Ferrous Metal Piping Practices**
- E. 001 Identify the types of ferrous metal pipes.
 - E. 002 Measure the sizes of ferrous metal pipes.
 - E. 003 Identify the common malleable iron fittings.
 - E. 004 Cut, ream and thread ferrous metal pipe.
 - E. 005 Join lengths of threaded pipe together and install fittings.
 - E. 006 Describe the main points to consider when installing pipe runs.
 - E. 007 Describe the method used to join grooved piping.

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- F. Basic Electricity**
- F. 001 State how electrical power is generated and distributed.
 - F. 002 Describe how voltage, current, resistance, and power are related.
 - F. 003 Use Ohm's Law to calculate the current, voltage, and resistance in a circuit.

- F. 004 Use the power formula to calculate how much power is consumed by a circuit.
- F. 005 Describe the differences between series and parallel circuits.
- F. 006 Recognize and describe the purpose and operation of the various electrical components used in HVAC equipment.
- F. 007 State and demonstrate the safety precaution that must be followed when working on electrical equipment.
- F. 008 Make voltage, current, and resistance measurements using electrical test equipment.

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G. Introduction to Cooling

- G. 001 Explain how heat transfer occurs in a cooling system, demonstrating an understanding of the terms and concepts used in the refrigeration cycle.
- G. 002 Calculate the temperature and pressure relationships at key points in the refrigeration cycle.
- G. 003 Under supervision, use temperature and pressure measuring instruments to make readings at key points in the refrigeration cycle.
- G. 004 Identify commonly used refrigerants and demonstrate the procedures for handling these refrigerants.
- G. 005 Recognize the major components of a cooling system and explain how each type works.
- G. 006 Recognize the major accessories available with cooling systems and explain how each type works.
- G. 007 Recognize the control devices used in cooling systems and explain how each type works.
- G. 008 Under supervision, perform basic power-off maintenance procedures applicable to cooling systems.
- G. 009 State the correct methods to be used when piping a refrigeration or cooling system.

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H. Introduction to Heating

- H. 001 Explain the three methods by which heat is transferred and give an example of each.
- H. 002 Describe how combustion occurs and identify the by products of combustion.
- H. 003 Identify the various types of fuels used in heating.
- H. 004 Recognize the major components and accessories of a forced-air furnace and explain the function of each component.
- H. 005 State the factors that must be considered when installing a furnace.
- H. 006 Identify the major components of a gas furnace and describe how each works.
- H. 007 With supervision, use a manometer to measure and adjust manifold pressure on a gas furnace.
- H. 008 Identify the major components of an oil furnace and describe

- how each works.
- H. 009 Describe how an electric furnace works.
- H. 010 With supervision, perform basic furnace preventive maintenance procedures such as cleaning and filter replacement.

VII. INDUSTRIAL MAINTENANCE – LEVEL I

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- A. Electrical Safety**
- A.001 Demonstrate safe working procedures in a construction environment.
- A.002 Explain the purpose of OSHA and how it promotes safety on the job.
- A.003 Identify electrical hazards and how to avoid or minimize them in the workplace.
- A.004 Explain safety issues concerning lockout/tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection systems.

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- B. Hand Bending**
- B.001 Identify the methods of hand bending conduit.
- B.002 Identify the various methods used to install conduit.
- B.003 Use math formulas to determine conduit bends.
- B.004 Make 90° bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
- B.005 Cut, ream, and thread conduit.

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- C. Fasteners and Anchors**
- C.001 Identify and explain the use of threaded fasteners.
- C.002 Identify and explain the use of non-threaded fasteners.
- C.003 Identify and explain the use of anchors.
- C.004 Demonstrate the correct applications for fasteners and anchors.
- C.005 Install fasteners and anchors.

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- D. Electrical Theory One**
- D.001 Recognize what atoms are and how they are constructed.
- D.002 Define voltage and identify the ways in which it can be produced.

- D.003 Explain the difference between conductors and insulators.
- D.004 Define the units of measurement that are used to measure the properties of electricity.
- D.005 Explain how voltage, current, and resistance are related to each other.
- D.006 Using the formula for Ohm's Law, calculate an unknown value.
- D.007 Explain the different types of meters used to measure voltage, current, and resistance.
- D.008 Using the power formula, calculate the amount of power used by a circuit.
- D.009 Explain how the relationship of work and power is applied to electrical circuits.
- D.010 Calculate, using the power formula, the amount of power used by a circuit.

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E. Electrical Theory Two

- E.001 Explain the basic characteristics of a series circuit.
- E.002 Explain the basic characteristics of a parallel circuit.
- E.003 Explain the basic characteristics of a series-parallel circuit.
- E.004 Calculate, using Kirchoff's Voltage Law, the voltage drop in series, parallel, and series-parallel circuits.
- E.005 Calculate, using Kirchoff's Current Law, the total current in parallel and series-parallel circuits.
- E.006 Find the total amount of resistance in a series circuit.
- E.007 Find the total amount of resistance in a parallel circuit.
- E.008 Find the total amount of resistance in a series-parallel circuit.

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F. Electrical Test Equipment

- F.001 Explain the operation of and describe the following pieces of test equipment:
 - Ammeter
 - Voltmeter
 - Ohmmeter
 - Volt-ohm-milliammeter (VOM)
 - Wattmeter
 - Megohmmeter
 - Frequency meter
 - Power factor meter
 - Continuity tester
 - Voltage tester
 - Recording instruments
 - Cable-length meters
- F.002 Explain how to read and convert from one scale to another using the above test equipment.
- F.003 Explain the importance of proper meter polarity.

- F.004 Define frequency and explain the use of a frequency meter.
- F.005 Explain the difference between digital and analog meters.

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G. Introduction to the National Electrical Code

- G.001 Explain the purpose and history of the National Electrical Code (NEC).
- G.002 Describe the layout of the NEC.
- G.003 Explain how to navigate the NEC.
- G.004 Describe the purpose of the National Electrical Manufacturers' Association (NEMA) and the National Fire Protection Association (NFPA).
- G.005 Explain the role of testing laboratories.

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H. Conductors

- H.001 Explain the various sizes and gauges of wire in accordance with American Wire Gauge standards.
- H.002 Identify insulation and jacket types according to conditions and applications.
- H.003 Describe voltage ratings of conductors and cables.
- H.004 Read and identify markings on conductors and cables.
- H.005 Use the tables in the NEC to determine the ampacity of a conductor.
- H.006 State the purpose of stranded wire.
- H.007 State the purpose of compressed conductors.
- H.008 Describe the different materials from which conductors are made.
- H.009 Describe the different types of conductor insulation.
- H.010 Describe the color coding of insulation.
- H.011 Describe instrumentation control wiring.
- H.012 Describe the equipment required for pulling wire through conduit.
- H.013 Describe the procedure for pulling wire through conduit.
- H.014 Install conductors in conduit.
- H.015 Pull conductors in a conduit system.

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I. Introduction to Electrical Blueprints

- I.001 Explain the basic layout of a blueprint
- I.002 Describe the information included in the title block of a blueprint.
- I.003 Identify the types of lines used on blueprints.

- I.004 Identify common symbols used on blueprints.
- I.005 Understand the use of architect’s and engineer’s scales.
- I.006 Interpret electrical drawings, including site plans, floor plans, and detail drawings.
- I.007 Read equipment schedules found on electrical blueprints.
- I.008 Describe the type of information included in electrical specifications.

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- J. Oxyfuel Cutting**
- J.001 Explain oxyfuel cutting safety.
- J.002 Identify and explain oxyfuel cutting equipment.
- J.003 Set up oxyfuel equipment.
- J.004 Light and adjust an oxyfuel torch.
- J.005 Shut down oxyfuel cutting equipment.
- J.006 Disassemble oxyfuel equipment.
- J.007 Change empty cylinders.
- J.008 Perform oxyfuel cutting:
 - Straight line and square shapes
 - Piercing and slot cutting
 - Bevels
 - Washing
 - Gouging

VIII. INDUSTRIAL MAINTENANCE – LEVEL II

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- A. Wiring: Commercial & Industrial**
- A.001 Identify and state the functions and ratings of single-pole, double-pole, three-way, four-way, dimmer, special, and safety switches.
- A.002 Explain NEMA classifications as they relate to switches and enclosures.
- A.003 Explain the NEC requirements concerning wiring devices.
- A.004 Identify and state the functions and ratings of straight blade, twist lock, and pin and sleeve receptacles.
- A.005 Identify and define receptacle terminals and disconnects.
- A.006 Identify and define ground fault circuit interrupters.
- A.007 Explain the box mounting requirements in the NEC.
- A.008 Use a wire stripper to strip insulation from a wire.
- A.009 Use a solderless connector to splice wires together.
- A.010 Identify and state the functions of limit switches and relays.

A.011 Identify and state the function of switchgear.

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B. Alternating Current

- B.001 Calculate the peak and effective voltage or current values for an AC waveform.
- B.002 Calculate the phase relationship between two AC waveforms.
- B.003 Describe the voltage and current phase relationship in a resistive AC circuit.
- B.004 Describe the voltage and current transients that occur in an inductive circuit.
- B.005 Define inductive reactance and state how it is affected by frequency.
- B.006 Describe the voltage and current transients that occur in a capacitive circuit.
- B.007 Define capacitive reactance and state how it is affected by frequency.
- B.008 Explain the relationship between voltage and current in the following types of AC circuits:
- RL circuit
 - RC circuit
 - LC circuit
 - RLC circuit
- B.009 Describe the effect that resonant frequency has on impedance and current flow in a series or parallel resonant circuit.
- B.010 Define bandwidth and describe how it is affected by resistance in a series or parallel resonant circuit.
- B.011 Explain the following terms as they relate to AC circuits:
- True power
 - Apparent power
 - Reactive power
 - Power factor
- B.012 Explain basic transformer action.

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C. Motors: Theory and Application

- C.001 Define the following terms:
- Ampacity
 - NEMA design letter
 - Branch circuit
 - Nonautomatic
 - Circuit breaker
 - Overcurrent
 - Controller
 - Overload
 - Duty
 - Power factor
 - Equipment
 - Rated full-load speed
 - Full-load amps
 - Rated horsepower
 - Ground fault circuit interrupter

- Interrupting switch
- Motor circuit switch
- Thermal protector
- Service factor
- Thermal cutout
- Remote control circuit

- C.002 Describe the various types of motor enclosures.
- C.003 Describe how the rated voltage of a motor differs from the system voltage.
- C.004 Describe the basic construction and components of a three-phase squirrel cage induction motor.
- C.005 Explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor.
- C.006 Describe how torque is developed in an induction motor.
- C.007 Explain how and why torque varies with rotor reactance and slip.
- C.008 Define percent slip and speed regulation.
- C.009 Explain how the direction of a three-phase motor is reversed.
- C.010 Describe the component parts and operating characteristics of a three-phase wound rotor induction motor.
- C.011 Describe the component parts and operating characteristics of a three-phase synchronous motor.
- C.012 Define torque, starting current, and armature reaction as they apply to DC motors.
- C.013 Explain how the direction of rotation of a DC motor is changed.
- C.014 Describe the design and characteristics of a DC shunt, series, and compound motor.
- C.015 Describe dual-voltage motors and their applications.
- C.016 Describe the methods for determining various motor connections.
- C.017 Describe general motor protection requirements as delineated in the NEC.

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- D. Grounding**
- D.001 Explain the purpose of grounding and the scope of NEC Article 250.
- D.002 Distinguish between a short circuit and a ground fault.
- D.003 Define the NEC ground-related terms.
- D.004 Distinguish between system grounding and equipment grounding.
- D.005 Use NEC Table 250-66 to size the grounding electrode conductor for various AC systems.
- D.006 Explain the NEC requirements for the installation and physical protection of grounding electrode conductors.
- D.007 Explain the function of the grounding electrode system and determine which grounding electrodes must be used.
- D.008 Define made electrodes and explain the resistance requirements for made electrodes using NEC Section 250-52.

- D.009 Use NEC Table 250-122 to size the equipment grounding conductor for raceways and equipment.
- D.010 Explain the function of the main bonding jumper in the grounding system and size the main bonding jumper for various applications.
- D.011 Size the main bonding jumper for a service utilizing multiple service disconnecting means.
- D.012 Explain the NEC requirements for bonding of enclosures and equipment.
- D.013 Explain the NEC requirements for grounding of enclosures and equipment.
- D.014 Explain effectively grounded and its importance in clearing ground faults and short circuits.
- D.015 Explain the purposes of the grounded conductor (neutral) in the operation of overcurrent devices.
- D.016 Explain the NEC requirements for grounding separately derived systems, including transformers and generators.
- D.017 Explain the NEC requirements for grounding at more than one building.
- D.018 Explain the NEC grounding requirements for systems over 600 volts.

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E. Boxes and Fittings

- E.001 Describe the different types of nonmetallic and metallic boxes.
- E.002 Understand the NEC requirements for box fill.
- E.003 Calculate the required box size for any number and size of conductors.
- E.004 Explain the NEC regulations for volume required per conductor in outlet boxes.
- E.005 Properly locate, install, and support boxes of all types.
- E.006 Describe the NEC regulations governing pull and junction boxes.
- E.007 Explain the radius rule when installing conductors in pull boxes.
- E.008 Understand the NEC requirements for boxes supporting lighting fixtures.
- E.009 Describe the purpose of conduit bodies and Type FS boxes.
- E.010 Install the different types of fittings used in conjunction boxes.
- E.011 Describe the installation rules for installing boxes and fittings in hazardous areas.
- E.012 Explain how boxes and fittings are selected and installed.
- E.013 Describe the various types of box supports.

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- F. Cable Tray**
- F.001 Describe the components that make up a cable tray assembly.
 - F.002 Explain the methods used to hang and secure cable tray.
 - F.003 Describe how cable enters and exits cable tray.
 - F.004 Select the proper cable tray fitting for the situation.
 - F.005 Explain the NEMA standards for cable tray installations.
 - F.006 Explain the NEC requirements for cable tray installations.
 - F.007 Select the required fittings to ensure equipment grounding continuity in cable tray systems.
 - F.008 Interpret electrical working drawings showing cable tray fittings.
 - F.009 Size cable tray for the number and type of conductors contained in the system.
 - F.010 Select rollers and sheaves for pulling cable in specific cable tray situations.
 - F.011 Designate the required locations of rollers and sheaves for a specific cable pull.
 - F.012 Fabricate an offset for a cable tray.

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- G. Conductor Terminations**
- G.001 Describe how to make a good conductor termination.
 - G.002 Prepare cable ends for terminations and splices.
 - G.003 Install lugs and connectors onto conductors.
 - G.004 Train cable at termination points.
 - G.005 Explain the role of the NEC in making cable terminations and splices.
 - G.006 Explain why mechanical stress should be avoided at cable termination points.
 - G.007 Describe the importance of using proper bolt torque when bolting lugs onto busbars.
 - G.008 Describe crimping techniques.
 - G.009 Select the proper lug or connector for the job.
 - G.010 Describe splicing techniques.
 - G.011 Describe the installation rules for parallel conductors.
 - G.012 Explain how to use hand and power crimping tools.

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- H. Installation of Electric Services**
- H.001 Describe various types of electric services for commercial and industrial installations.

- H.002 Read electrical blueprints and diagrams describing service installations.
- H.003 Calculate and select service-entrance equipment.
- H.004 Explain the role of the NEC in service installations.
- H.005 Install main disconnect switches, panelboards, and overcurrent protection devices.
- H.006 Identify the circuit loads, number of circuits required, and installation requirements for distribution panels.
- H.007 Explain the types and purposes of service grounding.
- H.008 Explain the purpose of ground fault circuit interrupters and where they must be installed.
- H.009 Describe single-phase service connections.
- H.010 Describe both wye- and delta-connected three-phase services.

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I. Circuit Breakers and Fuses

- I.001 Explain the necessity of overcurrent protection devices in electrical circuits.
- I.002 Define the terms associated with fuses and circuit breakers.
- I.003 Describe the operation of a circuit breaker.
- I.004 Select the most suitable overcurrent device for the application.
- I.005 Explain the role of the NEC in specifying overcurrent devices.
- I.006 Describe the operation of single-element and time-delay fuses.
- I.007 Explain how ground fault circuit interrupters (GFCIs) can save lives.
- I.008 Replace a renewable fuse link.
- I.009 Calculate short circuit currents.
- I.010 Describe troubleshooting and maintenance techniques for overcurrent devices.

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J. Contactors and Relays

- J.001 Describe the operating principles of contactors and relays.
- J.002 Select contactors and relays for use in specific electrical systems.
- J.003 Explain how mechanical contractors operate.
- J.004 Explain how solid-state contactors operate.
- J.005 Install contactors and relays according to the NEC requirements.
- J.006 Select and install contactors and relays for lighting control.
- J.007 Read wiring diagrams involving contactors and relays.
- J.008 Describe how overload relays operate.
- J.009 Connect a simple control circuit.
- J.010 Test control circuits.

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- K. Lubrication**
- K.001 Explain OSHA standards.
 - K.002 Read and interpret an MSDS.
 - K.003 Explain the EPA program.
 - K.004 Explain lubricant storage.
 - K.005 Explain lubricant classification.
 - K.006 Explain lubricant film protection.
 - K.007 Explain properties of lubricants.
 - K.008 Explain properties of greases.
 - K.009 Explain how to select lubricants.
 - K.010 Identify and explain types of additives.
 - K.011 Identify and explain types of lubricating oils.
 - K.012 Identify and use lubrication equipment to apply lubricants.
 - K.013 Read and interpret a lubrication chart.

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- L. Introduction to Bearings**
- L.001 Identify and explain plain bearings.
 - L.002 Identify and explain ball bearings.
 - L.003 Identify and explain roller bearings.
 - L.004 Identify and explain thrust bearings.
 - L.005 Identify and explain guide bearings.
 - L.006 Identify and explain flanged bearings.
 - L.007 Identify and explain pillow block bearings.
 - L.008 Identify and explain takeup bearings.
 - L.009 Identify and explain bearing materials.
 - L.010 Explain bearing designation.

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- M. Copper and Plastic Piping Practices**
- M.001 State the precautions that must be taken when installing refrigerant piping.
 - M.002 Select the right tubing for a job.
 - M.003 Cut and bend tubing.
 - M.004 Join tubing by using flare and compression fittings.
 - M.005 Determine the kinds of hangers and support needed for refrigerant piping.
 - M.006 Insulate refrigerant piping.
 - M.007 State the basic requirements for pressure-testing a system once it has been installed.

M.008 Follow basic safety precautions for the installation, operation and maintenance of refrigerating and air conditioning equipment.

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N. Ferrous Metal Piping Practices

- N.001 Identify the types of ferrous metal pipes.
- N.002 Measure the sizes of ferrous metal pipes.
- N.003 Identify the common malleable iron fittings.
- N.004 Cut, ream and thread ferrous metal pipe.
- N.005 Join lengths of threaded pipe together and install fittings.
- N.006 Describe the main points to consider when installing pipe runs.
- N.007 Describe the method used to join grooved piping.

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O. Piping Systems

- O.001 Identify and explain the types of piping systems.
- O.002 Identify piping systems according to color-coding.
- O.003 Explain thermal expansion.
- O.004 Explain types and applications of pipe insulation.

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P. SMAW Equipment and Setup

- P.001 Identify and explain SMAW safety.
- P.002 Identify and explain welding electrical current.
- P.003 Identify and explain arc welding machines.
- P.004 Explain setting up arc welding equipment.
- P.005 Identify and explain tools for weld cleaning.

Occupational Skills

The student demonstrates the specified level of competency in occupational skills.

0	1	2	3	4
No exposure	Introduced	Practiced	Entry-Level	Competency

Core Instruction

- | | |
|--|-------------------------------------|
| 0 1 2 3 4 | |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | A. Basic Construction Skills |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | A. Orientation to the Trade |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | B. Safety |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | C. Math |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | D. Hand Tools |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | E. Power Tools |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | F. Blueprints |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | G. Wood Materials and Fastening |

Specialization Options (choose at least 2 sub areas)

- | | |
|--|-------------------------------|
| Carpentry – Level I | |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | A. Rigging |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | B. Tools |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | C. Floor Systems |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | D. Wall and Ceiling Framing |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | E. Roof Framing |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | F. Windows and Exterior Doors |

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|--|---|
| Carpentry – Level II | |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | A. Reading Plans and Elevations |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | B. Site Layout I: Distance Measurement and Leveling |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | C. Introduction to Concrete and Reinforcing Materials |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | D. Foundations and Flatwork |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | E. Concrete Forms |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | F. Reinforcing Concrete |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | G. Handling and Placing Concrete |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | H. Patented Forms |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | I. Tilt-Up Wall Systems |

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|--|---|
| Masonry | |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | A. Residential Plans and Drawing Interpretation |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | B. Residential Masonry |
| <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | C. Grout and Other Reinforcement |

- K. Electrical Wiring: Commercial and Industrial
- L. Electrical Wiring: Residential

HAVC

- A. Trade Mathematics
- B. Tools of the Trade
- C. Copper and Plastic Piping Practices
- D. Soldering and Brazing
- E. Ferrous Metal Piping Practices
- F. Basic Electricity
- G. Introduction to Cooling
- H. Introduction to Heating

Industrial Maintenance – Level I

- A. Electrical Safety
- B. Hand Bending
- C. Fasteners and Anchors
- D. Electrical Theory One
- E. Electrical Theory Two
- F. Electrical Test Equipment
- G. Introduction to the National Electrical Code
- H. Conductors
- I. Introduction to Electrical Blueprints
- J. Oxyfuel Cutting

Industrial Maintenance – Level II

- A. Wiring: Commercial & Industrial
- B. Alternating Current
- C. Motors: Theory and Application
- D. Grounding
- E. Boxes and Fittings
- F. Cable Tray
- G. Conductor Terminations
- H. Installation of Electric Services
- I. Circuit Breakers and Fuses
- J. Contactors and Relays
- K. Lubrication
- L. Introduction to Bearings
- M. Copper and Plastic Piping Practices
- N. Ferrous Metal Piping Practices
- O. Piping Systems
- P. SMAW Equipment and Setup