California CTE

Building and Construction Trades

Adopted 2013

Knowledge and Performance

1 Academics 1.0

2 Communication 2.0

1 Recognize the elements of communication using a sender–receiver model. 2.1

2 Identify barriers to accurate and appropriate communication. 2.2

3 Interpret verbal and nonverbal communications and respond appropriately. 2.3

4 Demonstrate elements of written and electronic communication such as accurate spelling, grammar, and format. 2.4

5 Communicate information and ideas effectively to multiple audiences using a variety of media and formats. 2.5

6 Advocate and practice safe, legal, and responsible use of digital media information and communications technologies. 2.6

3 Career Planning and Management 3.0

1 Identify personal interests, aptitudes, information, and skills necessary for informed career decision making. 3.1

2 Evaluate personal character traits such as trust, respect, and responsibility and understand the impact they can have on career success. 3.2

3 Explore how information and communication technologies are used in career planning and decision making. 3.3

4 Research the scope of career opportunities available and the requirements for education, training, certification, and licensure. 3.4

5 Integrate changing employment trends, societal needs, and economic conditions into career planning. 3.5

6 Recognize the role and function of professional organizations, industry associations, and organized labor in a productive society. 3.6

7 Recognize the importance of small business in the California and global economies. 3.7

8 Understand how digital media are used by potential employers and postsecondary agencies to evaluate candidates. 3.8

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9 Develop a career plan that reflects career interests, pathways, and postsecondary options. 3.9

4 Technology 4.0

1 Use electronic reference materials to gather information and produce products and services. 4.1

2 Employ Web-based communications responsibly and effectively to explore complex systems and issues. 4.2

3 Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources. 4.3

4 Discern the quality and value of information collected using digital technologies, and recognize bias and intent of the associated sources. 4.4

5 Research past, present, and projected technological advances as they impact a particular pathway. 4.5

6 Assess the value of various information and communication technologies to interact with constituent populations as part of a search of the current literature or in relation to the information task. 4.6

5 Problem Solving and Critical Thinking 5.0

1 Identify and ask significant questions that clarify various points of view to solve problems. 5.1

2 Solve predictable and unpredictable work-related problems using various types of reasoning (inductive, deductive) as appropriate. 5.2

3 Use systems thinking to analyze how various components interact with each other to produce outcomes in a complex work environment. 5.3

4 Interpret information and draw conclusions, based on the best analysis, to make informed decisions. 5.4

6 Health and Safety 6.0

1 Interpret policies, procedures, and regulations for the workplace environment, including employer and employee responsibilities. 6.1

2 Use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies. 6.2

3 Set up a work area, or shop, to avoid potential health concerns and safety hazards, including but not limited to electrical (shock), wires (tripping), fumes (lung health), noise (hearing loss), fire (burns), and so forth, incorporating ergonomics. 6.3

4 Practice personal safety when lifting, bending, or moving equipment and supplies. 6.4

5 Demonstrate how to prevent and respond to work-related accidents or injuries; this includes demonstrating an understanding of ergonomics. 6.5

Maintain a safe and healthful working environment. 6.6

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7 Be informed of laws/acts pertaining to the Occupational Safety and Health Administration (OSHA). 6.7

8 Report hazards found on the job site to supervisor/teacher. 6.8

9 Locate, and adhere to, Material Safety Data Sheet (MSDS) instructions. 6.9

1 Maintain proper use of safety apparel at all times, including but not limited to, eye protection, hearing protection, skin protection, head protection, footwear and protection from airborne particulate matter. 6.10

11 Comply with the safe handling, storage and disposal of chemicals, materials and adhesives in accordance with local, state, and federal safety and environmental regulations (OSHA, Environmental Protection Agency [EPA], Hazard Communication [HazCom], Material Safety Data Sheets [MSDS], etc.). 6.11

12 Demonstrate the proper care and safe use of hand, portable and stationary power tools. 6.12

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7 Responsibility and Flexibility 7.0

1 Recognize how financial management impacts the economy, workforce, and community. 7.1

2 Explain the importance of accountability and responsibility in fulfilling personal, community, and workplace roles. 7.2

3 Understand the need to adapt to changing and varied roles and responsibilities. 7.3

4 Practice time management and efficiency to fulfill responsibilities. 7.4

5 Apply high-quality techniques to product or presentation design and development. 7.5

6 Demonstrate knowledge and practice of responsible financial management. 7.6

7 Demonstrate the qualities and behaviors that constitute a positive and professional work demeanor, including appropriate attire for the profession. 7.7

8 Explore issues of global significance and document the impact on the Building and Construction Trades sector. 7.8

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8 Ethics and Legal Responsibilities 8.0

1 Access, analyze, and implement quality assurance standards of practice. 8.1

2 Identify local, district, state, and federal regulatory agencies, entities, laws, and regulations related to the Building and Construction Trades industry sector. 8.2

3 Demonstrate ethical and legal practices consistent with Building and Construction Trades sector workplace standards. 8.3

4 Explain the importance of personal integrity, confidentiality, and ethical behavior in the workplace. 8.4

5 Analyze organizational culture and practices within the workplace environment. 8.5

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6 Adhere to copyright and intellectual property laws and regulations, and use and appropriately cite proprietary information. 8.6

7 Conform to rules and regulations regarding sharing of confidential information, as determined by Building and Construction Trades sector laws and practices. 8.7

9 Leadership and Teamwork 9.0

1 Define leadership and identify the responsibilities, competencies, and behaviors of successful leaders. 9.1

2 Identify the characteristics of successful teams, including leadership, cooperation, collaboration, and effective decision-making skills as applied in groups, teams, and career technical student organization activities. 9.2

3 Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace setting. 9.3

4 Explain how professional associations and organizations and associated leadership development and competitive career development activities enhance academic preparation, promote career choices, and contribute to employment opportunities. 9.4

5 Understand that the modern world is an international community and requires an expanded global view. 9.5

6 Respect individual and cultural differences and recognize the importance of diversity in the workplace. 9.6

7 Participate in interactive teamwork to solve real Building and Construction Trades sector issues and problems. 9.7

10 Technical Knowledge and Skills 10.0

1 Interpret and explain terminology and practices specific to the Building and Construction Trades sector. 10.1

2 Comply with the rules, regulations, and expectations of all aspects of the Building and Construction Trades sector. 10.2

3 Construct projects and products specific to the Building and Construction Trades sector requirements and expectations. 10.3

4 Collaborate with industry experts for specific technical knowledge and skills. 10.4

5 Demonstrate the basic care, proper maintenance, and use of hand, portable, and stationary tools related to the Building and Construction trades. 10.5

11 Demonstration and Application 11.0

1 Utilize work-based/workplace learning experiences to demonstrate and expand upon knowledge and skills gained during classroom instruction and laboratory practices specific to the Building and Construction Trades sector program of study. 11.1

2 Demonstrate proficiency in a career technical pathway that leads to certification, licensure, and/or continued learning at the postsecondary level. 11.2

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3. Demonstrate entrepreneurship skills and knowledge of self-employment options and innovative ventures. 11.3
4. Employ entrepreneurial practices and behaviors appropriate to Building and Construction Trades sector opportunities. 11.4
5. Create a portfolio, or similar collection of work, that offers evidence through assessment and evaluation of skills and knowledge competency as contained in the anchor standards, pathway standards, and performance indicators. 11.5

Pathway Standards

A. Cabinetry, Millwork, and Woodworking Pathway

1. Demonstrate competence in planning, design, layout, and technical drawing interpretation for practical use in cabinetmaking and millworking. A1.0
    1. Identify common sizes in relation to furniture and cabinets. A1.1
    2. Describe the relationship between the function and form of a cabinet. A1.2
    3. Calculate board, square, and linear feet. A1.3
    4. Estimate material costs. A1.4
    5. Apply design elements: shapes, textures, lines, and colors to create functional and attractive cabinets, furniture, and millwork. A1.5
    6. Apply principles of design, harmony, repetitions, balance, and proportion to create functional and attractive cabinets, furniture, and millwork. A1.6
    7. Read and interpret technical drawings A1.7
    8. Sketch a project using manual drawing techniques. A1.8
    9. Use drafting tools to create a pictorial and working drawing for a basic cabinet. A1.9
2. Differentiate between the various furniture and cabinet styles used in the cabinet and furniture industry. A2.0
    1. Identify various cabinet styles and list characteristics of traditional, provincial, and contemporary designs. A2.1
    2. Identify various kitchen, bath, and utility cabinet components. A2.2
    3. Explain the progress of cabinetry and furniture styles from the seventeenth century to today. A2.3

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3 Interpret and apply information to develop a bill of materials, estimate the cost of materials, and develop a plan of procedures to complete a project. A3.0

1 List the sequence of cutting procedures, assembly, and finishing steps. A3.1

2 Evaluate an existing bill of materials for accuracy. A3.2

3 Determine the cost of materials needed for a cabinet or furniture project. A3.3

4 Optimize available materials from a cutting diagram. A3.4

5 Compare and contrast the cost of a specific project using different materials. A3.5

6 Develop a materials list, cut list, and cost estimate from a working drawing for a specific cabinet project. A3.6

4 Demonstrate proper selection and use of woodworking tools. A4.0

1 Demonstrate the accurate use of common measuring and layout tools. A4.1

2 Select the proper layout tools for specific tasks. A4.2

3 Select the proper cutting tools for specific operations (e.g., straight cuts, curves, drilling holes). A4.3

4 Select the most appropriate blade for a given operation. A4.4

5 Select the proper boring tools for specific operations. A4.5

6 Select the proper hand-shaping tools for specific operations. A4.6

7 Select proper clamping tools for specific operations. A4.7

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5 Identify wood products and materials used in the furniture and cabinetmaking industry and describe their characteristics and uses. A5.0

1 Define the difference between a hardwood and softwood. A5.1

2 Identify several different species of hardwood and their characteristics that are common to the cabinetmaking and millwork industry. A5.2

3 Identify several different species of softwood and their characteristics that are common to the cabinetmaking and millwork industry. A5.3

4 Identify common defects found in wood and list possible solutions. A5.4

5 Identify and be able to differentiate panel products and their uses in the cabinetmaking industry. A5.5

6 Describe the cutting and handling techniques used for sheet goods. A5.6

7 Compare and contrast the advantages and disadvantages of sheet goods versus solid wood stock. A5.7

8 Identify standard sizes and grades of various laminates. A5.8

9 Describe how the expansion and contraction of solid wood affects the design of joinery used in furniture and cabinet construction. A5.9

10 Identify the proper adhesive required for applying laminate. A5.10

11 Identify standard sizes and grades of various veneers. A5.11

12 Identify the proper adhesive(s) required for applying veneers. A5.12

13 Identify the different types of pattern matching in veneers. A5.13

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6 Compare and contrast the advantages and disadvantages of using laminates verses using veneers. A6.0

1 Demonstrate a working knowledge of joinery, fasteners, and adhesives. A6.1

2 Define the purposes for metallic fasteners in furniture and cabinetmaking. A6.2

3 Select the proper metallic fasteners for specific applications. A6.3

4 Demonstrate the proper use of metallic fasteners for specific applications. A6.4

5 Compare and contrast joints commonly used in the cabinetmaking and millworking industries (i.e., strength, appearance, and ease of construction). A6.5

6 Determine the appropriate application of a variety of joinery techniques, including dowels, biscuits, pocket holes, and mortise and tenon A6.6

7 Identify characteristics of adhesives that affect the assembly time, cure time, and strength of the product. A6.7

8 Select the proper adhesive(s) to construct wood joints used in furniture or cabinets. A6.8

9 Demonstrate initial assembly and dry clamping procedures. A6.9

10 Demonstrate the proper use and application of adhesives. A6.10

11 Demonstrate the proper cleanup procedures for specific adhesives. A6.11

12 Select the correct type of wood joint used for a specific application and material. A6.12

13 Demonstrate the ability to construct a variety of wood joints (i.e. butt, miter, compound miter, half lap, mortise and tenon). A6.13

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7 Demonstrate competence in various construction processes in the cabinetmaking, furniture making, and millworking industries. A7.0

1 Square and surface a board to a specific size. A7.1

2 Demonstrate common case construction. A7.2

3 Demonstrate common frame and panel construction. A7.3

4 Construct a case with a face frame using appropriate construction techniques. A7.4

5 Construct a frameless case using appropriate construction techniques. A7.5

6 Construct a cabinet drawer using appropriate construction techniques. A7.6

7 Construct a cabinet door using appropriate construction techniques. A7.7

8 Demonstrate the use of a jig, template, or fixture in a production project. A7.8

9 Use appropriate methods and tools to check the accuracy of a project. A7.9

10 Demonstrate the use of a mass production technique (i.e., parts duplication and assembly processes). A7.10

11 Lay out, install, and adjust the appropriate drawer hardware to include drawer slides and pulls. A7.11

12 Lay out, install, and adjust the appropriate door hardware to include European and standard hinges. A7.12

13 Apply a plastic laminate to a surface using appropriate adhesive and trim to fit. A7.13

14 Use the appropriate adhesives and fasteners to install different types of trim, moldings, or other edge treatments. A7.14

8 Utilize appropriate abrasives to prepare a project for a specific finish. A8.0

1 Select the proper abrasive for shaping and smoothing materials. A8.1

2 Select the proper grit sizes and sequences for shaping and smoothing operations. A8.2

3 Demonstrate proper selection, application, and cleaning methods for various types of filler materials. A8.3

4 Properly prepare a surface for finishing. A8.4

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9 Understand finishes and when to apply paint, stains, sealers, varnishes, and catalyzed finishes, including water- and oil-based finishes. A9.0

1 Demonstrate proper selection and application methods of different types of stains for a specific application. A9.1

2 Demonstrate cleaning procedure for various types of stains. A9.2

3 Select the proper type of sealer and finish coat for a specific application. A9.3

4 Demonstrate proper application methods for different types of sealers and finish coats. A9.4

5 Demonstrate cleaning procedures for various types of sealer and finish coats. A9.5

6 Apply a suitable finish to a specific cabinet or millwork project. A9.6

10 Demonstrate proper techniques for cabinet installation. A10.0

1 Transport a project from one location to another without damage. A10.1

2 Lay out a cabinet installation according to a floor plan. A10.2

3 Create and adjust a layout to plumb, square, and level. A10.3

4 Install a base and upper cabinet. A10.4

5 Scribe a cabinet to fit a corner or against an irregular wall surface. A10.5

11 Identify the advantages and disadvantages for various countertop materials. A11.0

1 Identify a variety of materials used for kitchen and bath countertops and list their advantages and disadvantages. A11.1

2 Describe the methods for attaching different countertops to a cabinet. A11.2

3 Install of a variety of countertop materials using appropriate fastening methods. A11.3

4 Use a cut-in template for the installation of sink, faucets, cooktop, and other fixtures. A11.4

B. Engineering and Heavy Construction Pathway

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1. Understand soil characteristics and properties. B1.0
    1. Understand the importance of knowing a site's water table and its effect on site preparation. B1.1
    2. Understand the importance for collecting and testing soil samples. B1.2
    3. Read and interpret a soils report. B1.3
    4. Demonstrate the proper procedures to collect, prepare, and test soil samples. B1.4
    5. Understand the importance and impact of environmental concerns and regulations in relation to building site preparation. B1.5
    6. Describe various geologic structures and land forms and determine the best approach for preparing a site for construction. B1.6
    7. Match types of stakes to their correct usage and explain markings on grade stakes and benchmark (BM) stakes. B1.7
2. Demonstrate the use of survey and mapping equipment. B2.0
    1. Apply conventional engineering and heavy construction measurement processes accurately (e.g., laser transits, laser levels, geographic information system [GIS] instruments) for surveying and plan development. B2.1
    2. Use conventional engineering and heavy construction mathematical functions to calculate on-site preparation and site development and improvement materials. B2.2
    3. Identify and apply appropriate grade calculations from site plans. B2.3
    4. Demonstrate the ability to use survey equipment. B2.4
    5. Perform a level survey. B2.5
    6. Conduct a boundary survey and maintain proper field notes. B2.6
    7. Read and analyze a topographic contour map. B2.7
    8. Generate topographic contours from field notes. B2.8
3. Demonstrate a basic understanding of grading and drainage. B3.0
    1. Define selected terms associated with plan reading, grade setting, and drainage. B3.1
    2. Distinguish soil types and land cover as related to runoff, precipitation, drainage, and seepage. B3.2
    3. Recognize non-point-source (NPS) pollution, erosion, and erosion control methods. B3.3
    4. List sources of NPS and their possible impact related to water quality. B3.4
    5. Prepare site plan and grading and drainage plan. B3.5

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4 Demonstrate understanding of water and wastewater systems. B4.0

1 Explain and diagram the water cycle. B4.1

2 Describe drinking-water sources, contaminants, disposal options, regulations, and basic treatment methods. B4.2

3 Perform basic calculations for sizing pipe and pumps for the movement of water B4.3

4 Define gravity and forced systems. B4.4

5 Identify common types of heavy equipment and describe their unique features and uses. B5.0

1 Describe the basic hitch configurations and their proper connections. B5.1

2 Describe the basic load-handling safety practices. B5.2

3 Demonstrate proper use of American National Standards Institute (ANSI) hand signals. B5.3

4 Describe basic safety precautions taken into consideration while operating heavy equipment. B5.4

5 Identify the common operating controls found on various pieces of heavy equipment. B5.5

6 Identify and describe the use of slings and common rigging hardware. B5.6

7 Perform basic prestart inspection, startup, operational movement, and shutdown for heavy equipment under the guidance of an instructor. B5.7

8 Identify and explain the different types of construction cranes. B5.8

9 Describe crane operations and safety. B5.9

10 Demonstrate good lifting practices and proper rigging. B5.10

6 Demonstrate the operation of heavy equipment. B6.0

1 Operate a tractor mower. B6.1

2 Operate a forklift. B6.2

3 Operate a tractor with a box blade. B6.3

4 Operate a backhoe. B6.4

5 Operate a grader. B6.5

6 Operate a dump truck. B6.6

7 Demonstrate basic concrete maintenance and repair methods. B7.0

1 Identify and use appropriate concrete tools. B7.1

2 Construct forms for pouring concrete. B7.2

3 Understand the use and need for reinforcing concrete. B7.3

4 Mix concrete. B7.4

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5 Place concrete. B7.5

6 Finish concrete. B7.6

8 Understand project management procedures and processes as they occur in an engineering and heavy construction project. B8.0

1 Understand the roles in heavy construction of design engineers, estimators, superintendents, project managers, foremen, operators/drivers, administrators, and inspectors. B8.1

2 Demonstrate understanding of contract administration (e.g., invoicing vendors, subcontractors), including the "draw and voucher" accounting/record system used in construction project management. B8.2

3 Estimate the cost of supplies and materials for an engineering and heavy construction project. B8.3

4 Plan all construction phases, including subcontractor schedules, clearing, rough grading, wet and dry utilities, fine grading, concrete, asphalt, inspections, and job closeout. B8.4

5 Understand the layout of utilities in regards to underground electrical, sewer, water, phone, cable, etc. B8.5

6 Demonstrate understanding of storm drainage, retention ponds, wastewater treatment, etc. B8.6

7 Understand the importance of hydroelectric, solar, wind, and alternative energy resources in the development of California infrastructure. B8.7

8 Construct projects accurately from commercial specifications and technical drawings ensuring compliance with state and local building codes. B8.8

9 Solve common construction problems (e.g., grading, drainage) by using commercial construction codes, building standards, and appropriate mathematical calculations. B8.9

9 Describe the value and necessity of practicing occupational safety in the engineering and heavy construction laboratory or shop. B9.0

1 Know the rules and responsibilities of the various governmental safety agencies and their impact on engineering and heavy construction. B9.1

2 Understand the importance of safety and safe work practices (e.g., fire safety, protective clothing) in the welding phases of engineering and heavy construction and the safe operation of heavy equipment (e.g., earth movers, graders, bulldozers). B9.2

3 Demonstrate the safe use of scaffolding and ladders. B9.3

4 Demonstrate the importance of work site safety as it pertains to hazardous waste disposal and procedures for containment of toxic and hazardous materials. B9.4

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10 Recognize the variety of building phases, systems, and techniques used in engineering and heavy construction. B10.0

1 Understand the development of building plans and schedules using processes common to engineering and heavy construction. B10.1

2 Know the appropriate processes and materials in architectural design, project development, and engineering and heavy construction (e.g., structural, electrical, mechanical, and finish phases). B10.2

11 Understand the impact of financial, technical, and environmental trends on the past and future of the construction industry. B11.0

1 Understand significant historical trends in engineering and heavy construction technology. B11.1

2 Understand environmental regulations that influence engineering and heavy construction projects. B11.2

3 Demonstrate understanding of California Environmental Quality Act (CEQA) and Environmental Impact Reports (EIRs) as they apply to heavy construction, including highway and bridge projects. B11.3

4 Identify local and state building codes as appropriate to heavy construction, especially as it relates to highway and bridge projects. B11.4

C. Mechanical Systems Installation and Repair Pathway

1 Demonstrate an understanding of the methods and devices used to improve air quality and comfort. C1.0

1 Explain the historical development and principals of air-conditioning and refrigeration. C1.1

2 Describe the differences between air-conditioning and refrigeration. C1.2

3 Explain the impact of heating, air-conditioning, and refrigeration on society. C1.3

4 Explain the differences in comfort applications (cooling/heating air) and process applications (improving air quality). C1.4

5 Describe the benefits of conditioned air and environments. C1.5

6 Explain the methods and devices used to improve air quality. C1.6

7 List several situations in which the improvement of air quality is essential. C1.7

8 Debate current issues and concerns, such as indoor air quality, the ozone layer, and computer technology, in the heating, air-conditioning, and refrigeration industry and in the environment and explain their future ramifications. C1.8

9 Describe the purpose and importance of local, state, and federal heating, air conditioning, and refrigeration codes and standards. C1.9

10 Identify various HVAC professional organizations, associations, and societies, and explain their purposes. C1.10

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2. Describe the basic components and concepts of heating, air-conditioning, and refrigeration. C2.0
    1. Demonstrate a working knowledge of the four major components of a refrigeration system. C2.1
    2. Identify and explain the characteristics of vapor compression refrigeration. C2.2
    3. Explain the advantages and disadvantages of the different refrigerants used in a vapor compression system. C2.3
    4. Distinguish between split systems and package systems. C2.4
3. Demonstrate an understanding of the scientific theories and physical properties of heat and matter. C3.0
    1. Describe and explain freezing point, critical temperature, and absolute zero. C3.1
    2. Describe matter and heat and their relation to heat transfer. C3.2
    3. Compare and contrast the characteristics of heat, humidity, and temperature. C3.3
    4. Distinguish between, and explain the characteristics of, the three different states of matter. C3.4
    5. Define the differences between latent heat and sensible heat. C3.5
4. Analyze the effects and reactions of fluids, pressures, and temperatures on refrigerants. C4.0
    1. Summarize the refrigeration cycle. C4.1
    2. Define and explain "fluid," "pressure," and "temperature." C4.2
    3. Utilize pressure and temperature charts. C4.3
    4. Demonstrate ways to measure and calculate absolute and gauge pressures according to industry standards. C4.4
    5. Identify and explain the classifications, uses, and properties of different refrigerants. C4.5
    6. Explain how fluids react and flow in a closed system versus an open system. C4.6
    7. Identify and classify the color-coding of refrigerant cylinders. C4.7
    8. Practice proper methods of storing, transferring, and recovering refrigerants. C4.8
    9. Summarize the effects of contaminants or using an improper refrigerant in a system. C4.9

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5 Demonstrate skills necessary to fabricate and service the tubing, piping, and fittings utilized in accordance with accepted industry standards. C5.0

1 Understand the basic codes in the Uniform Plumbing Codes (UPC). C5.1

2 Select materials and fittings for use in piping a system. C5.2

3 Demonstrate techniques for cutting, deburring, and bending tubing. C5.3

4 Connect tubing utilizing proper fittings and connection methods. C5.4

5 Demonstrate the ability to identify and select the appropriate materials for the soldering and brazing of tubing. C5.5

6 Explain the purposes and procedures for protecting piping materials and fittings from effects of heat. C5.6

7 Demonstrate the ability to braze and/or solder tubing, including aluminum. C5.7

8 Silver-braze bras, steels, and copper. C5.8

9 Fabricate and leak test the piping, tubing, and connections of a heating, air-conditioning, and/or refrigeration unit. C5.9

6 Demonstrate the skills necessary to service, maintain, and repair heating, air-conditioning, and refrigeration system components and accessories. C6.0

1 Explain the types, operation, use, and maintenance requirements of different compressors (e.g., reciprocating, rotary, screw, and scroll). C6.1

2 Analyze the operating condition of a compressor. C6.2

3 Explain the types, operation, use, and maintenance requirements of condensers and evaporators. C6.3

4 Explain the types, operation, use, and maintenance requirements of different metering devices. C6.4

5 Evaluate the performance of a metering device. C6.5

6 Explain the methods of compression, lubrication, and compressor loading and unloading. C6.6

7 Analyze and evaluate the proper operating condition of a compressor. C6.7

8 Locate and explain the uses of refrigerant flow accessories. C6.8

9 Locate and explain the uses of system accessories (e.g., receivers, solenoids, valves, heat exchangers, filters, and separators). C6.9

10 Analyze, troubleshoot, and correct mechanical problems in a heating, air-conditioning, and refrigeration system. C6.10

11 Evaluate system performance. C6.11

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7 Demonstrate a practical knowledge of basic electricity and skills necessary to service and maintain the electrical components of heating, air-conditioning, and refrigeration equipment. C7.0

1 Explain the principles and properties of electricity. C7.1

2 Compare and contrast single-phase versus three-phase electrical distribution. C7.2

3 Define and distinguish amps, ohms, volts, and watts. C7.3

4 Demonstrate the ways to measure watts, voltage, amperage, and resistance using appropriate instruments while adhering to industry standards. C7.4

5 Illustrate and summarize a wiring schematic diagram for a heating or cooling system. C7.5

6 Analyze and troubleshoot the protection devices, such as fuses and breakers, in an electrical system. C7.6

7 Interpret charts and tables from the National Electrical Codes (NEC). C7.7

8 Troubleshoot electrical control systems, motors, and their components. C8.0

1 Identify and explain the operations of electrical control systems and their components. C8.1

2 Install and troubleshoot electrical control systems. C8.2

3 Describe the operation and function of different types of electromechanical thermostats. C8.3

4 Analyze operational problems with different types of electromechanical thermostats. C8.4

5 Describe the electrical and mechanical operations of a basic heat pump. C8.5

6 Demonstrate the ability to wire a basic heating, air-conditioning, and/or refrigeration system. C8.6

7 Identify and explain the functions of various types of motors and their individual components. C8.7

8 Describe the differences between single-phase and three-phase motors. C8.8

9 Analyze and test motors using a variety of different methods. C8.9

10 Assess an electric motor for proper function and repair as necessary. C8.10

9 Demonstrate a practical knowledge of solid-state electronics. C9.0

1 Explain the basic principles and functions of Direct Digital Control (DDC). C9.1

2 Describe basic solid-state circuits and boards. C9.2

3 Identify, analyze, and replace solid-state circuit boards. C9.3

4 Explain the major functions of a building-management system. C9.4

5 Install and program a programmable thermostat. C9.5

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10 Demonstrate a practical knowledge of combustion heating systems. C10.0

1 Explain combustion theory. C10.1

2 Identify and explain the various types, operations, and functions of various types of gas valves and regulators. C10.2

3 Determine the suitable application, and analyze the proper functioning, of gas valves and regulators. C10.3

4 Demonstrate the installation, maintenance, testing, and repair of a gas operated heating system. C10.4

5 Create a wiring schematic for a gas furnace. C10.5

6 Sketch the proper gas flow for a gas furnace. C10.6

7 Analyze, troubleshoot, and correct problems in a combustion-type heating system. C10.7

11 Demonstrate practical knowledge of systems designed to improve air quality. C11.0

1 Explain the scientific principles of psychrometrics. C11.1

2 Define relative, specific, and absolute humidity. C11.2

3 Distinguish between dew point, dry bulb, and wet bulb temperature. C11.3

4 Summarize concerns related to indoor air quality. C11.4

5 Compare and contrast the benefits of air-filtration, air-handling, and ventilation systems. C11.5

6 Create, analyze, and maintain a system designed to improve air quality. C11.6

D. Residential and Commercial Construction Pathway

1 Recognize the impact of financial, technical, environmental, and labor trends on the past and future of the construction industry. D1.0

1 Understand significant historical trends in the construction industry. D1.1

2 Understand the environmental regulations that influence residential and commercial design. D1.2

3 Demonstrate knowledge of the California Environmental Quality Act (CEQA) and Environmental Impact Review (EIRs) impacts on residential and commercial construction. D1.3

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2 Apply the appropriate mathematical calculations used in the construction trades. D2.0

1 Apply formulas to determine area, volume, lineal, board, and square feet. D2.1

2 Apply the Pythagorean Theorem to calculate pipe offsets, roof slope, and check for square. D2.2

3 Estimate the materials needed to complete a specific task. D2.3

4 Determine the total developed length of the water supply piping system. D2.4

5 Calculate the residual pressure at the highest outlet per the requirements of the Plumbing Code. D2.5

6 Calculate the total fixture unit demand from the fixtures indicated on the construction drawings using the tables of the plumbing code. D2.6

7 Calculate the proper slope for drain, waste and vent (DWV) piping. D2.7

8 Apply Ohm's Law to calculate resistance, current flow, and voltage in series, parallel, and combination circuits. D2.8

9 Calculate the load on an electrical system from general lighting and small and large appliances. D2.9

3 Interpret and apply information from technical drawings, schedules, and specifications used in the construction trades. D3.0

1 Identify the elements used in technical drawings, including types of lines, symbols, details, and views. D3.1

2 Identify and interpret the elements of technical drawings, including plan, elevation, section, and detail views. D3.2

3 Interpret technical drawings specifications. D3.3

4 Identify plumbing, electrical, and mechanical symbols and other abbreviations used in construction drawings. D3.4

5 Interpret and scale dimensions from a set of plans using an architect's scale. D3.5

6 Interpret sectional and detail drawings to determine construction details such as corners, rough openings, stairs, and roof systems. D3.6

7 Understand the sequencing and phases of residential and commercial construction projects. D3.7

4 Demonstrate techniques for proper site preparation. D4.0

1 Use leveling devices to check for elevation, level, and plumb. D4.1

2 Demonstrate how to establish grades using survey instruments. D4.2

3 Install batter boards. D4.3

4 Check site layout for square using the diagonal method. D4.4

5 Describe excavation and backfill methods. D4.5

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6 Identify different methods and equipment used for compaction. D4.6

7 Identify types of backfill materials and how they are used. D4.7

5 Demonstrate foundation layout techniques to include setting forms, placing reinforcements, and placing concrete according to construction drawings, specifications, and building codes. D5.0

1 Describe the sequencing procedures for placing large and small slabs. D5.1

2 Demonstrate how to establish elevations for concrete structures. D5.2

3 Lay out location and elevation of concrete/masonry structures based on construction drawings. D5.3

4 Develop a material take-off in accordance with construction drawings and specifications. D5.4

5 Lay out location for reinforcements, expansion joints, openings, and embedded items based on construction drawings, specifications, and building codes. D5.5

6 Construct, place, and brace forms for concrete as detailed in construction drawings for footings, slab, and raised floors. D5.6

7 Place and secure reinforcement as detailed by construction drawings, building codes, and industry standards. D5.7

8 Place secure embedded hardware as detailed on construction drawings. D5.8

9 Demonstrate proper removal and care of concrete forms. D5.9

10 Use appropriate tools and techniques for placing, compacting, screeding, and finishing consolidating concrete in slabs and footings. D5.10

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6 Demonstrate carpentry techniques for the construction of a single-family residence. D6.0

1 Properly place a moisture barrier and pest control guard on a foundation. D6.1

2 Attach a sill plate at top of concrete foundation. D6.2

3 Lay out, cut, and install joist supports, rim joists, and floor joists as specified on construction plans. D6.3

4 Install a subfloor. D6.4

5 Demonstrate wall and plate layout, including rough openings. D6.5

6 Measure, cut, and assemble wall components using appropriate tools and fasteners. D6.6

7 Demonstrate the ability to square wall systems and install wall bracing and shear panels according to code. D6.7

8 Stand, square, plumb, and brace walls. D6.8

9 Describe the applications and uses of metal stud framing. D6.9

10 Lay out, cut, and install ceiling joists and common and jack rafters. D6.10

11 Frame and erect shed and gable roof systems. D6.11

12 Lay out and install trusses "on-center" with specified hardware. D6.12

13 Install appropriate blocking, bracing, lookouts, fascia, and drip edge. D6.13

14 Frame for roof penetrations and attic access. D6.14

15 Apply roof sheathing and install appropriate flashings. D6.15

16 Understand different roofing materials and methods of application. D6.16

7 Demonstrate proper installation techniques of interior finish materials and protective finishes. D7.0

1 Identify types and uses of wall finishing materials. D7.1

2 Cut, fit, and install gypsum wallboard onto a framed wall using appropriate fasteners. D7.2

3 Describe the finishes and textures for gypsum wallboard. D7.3

4 Properly prepare walls to receive protective finishes. D7.4

5 Apply finishes according to specifications and industry standards. D7.5

6 Identify types and application of finish flooring materials. D7.6

7 Install pre-hung interior doors. D7.7

8 Install interior trim and case work. D7.8

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8. Demonstrate the application of exterior finish materials and protective finishes in building construction. D8.0
    1. Describe the installation procedures and techniques of masonry siding materials. D8.1
    2. Install wood, vinyl, and/or manufactured siding. D8.2
    3. Demonstrate preparation techniques for applying exterior paint and stain. D8.3
    4. Apply exterior paint and stain according to specifications. D8.4
    5. Describe various types and uses of doors and windows used in building construction. D8.5
    6. Install pre-hung windows and doors using appropriate flashing and trim. D8.6
    7. Caulk and seal joints to prevent air and moisture infiltration and increase energy efficiency. D8.7
    8. Install vents for efficient attic and crawl space ventilation. D8.8
    9. Install various types of floor, wall, and ceiling thermal insulation. D8.9
    10. Describe mold-prevention techniques. D8.10
9. Understand, integrate, and employ sustainable construction practices in the building trades. D9.0
    1. Identify design and energy solutions for improving building energy efficiency. D9.1
    2. Identify materials used in building construction to increase energy efficiency and sustainability. D9.2
    3. Calculate energy requirements and loads for buildings and structures. D9.3
    4. Demonstrate the application of constructing materials intended to improve building efficiency and sustainability. D9.4
    5. Analyze and evaluate buildings for energy efficiency and performance. D9.5
    6. Develop solutions to improve building energy performance and efficiency. D9.6

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10 Demonstrate skills necessary to complete a plumbing system in a single-family residence in accordance with accepted industry standards. D10.0

1 Demonstrate techniques for cutting, deburring, and joining metallic and nonmetallic water piping. D10.1

2 Lay out and install hot and cold water piping to fixture locations as indicated on the construction documents. D10.2

3 Perform pressure test of an installed piping system. D10.3

4 Install fastened in-place fixture valves and shut-off valves as indicated on construction drawings. D10.4

5 Install and secure proper drainage piping to fixture locations. D10.5

6 Determine the proper slope for DWV piping using hand levels, laser levels, and transits. D10.6

7 Install traps and vents as indicated by construction drawings, specifications, and government codes. D10.7

8 Install angle stops at water supply stub outs. D10.8

9 Install plumbing fixtures. D10.9

10 Connect the water supply to faucets and water closets. D10.10

11 Connect fixture tailpieces to fixtures and to traps. D10.11

12 Check for the proper functioning of fixtures. D10.12

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11 Demonstrate skills necessary to complete an electrical system in a single-family residence in accordance with accepted industry standards. D11.0

1 Determine whether or not an electrical circuit is "live." D11.1

2 Prepare rough framing for the installation of electrical cables and conduit. D11.2

3 Lay out components to the tolerances indicated on the construction drawings, specifications, and government codes. D11.3

4 Install typical devices, junction boxes, and panels. D11.4

5 Install lighting and ceiling fan support boxes according to the National Electrical Code (NEC). D11.5

6 Install conduit typical of residential construction and pull conductors through conduit as required by the NEC. D11.6

7 Splice and tap conductors for the installation of fixtures and devices. D11.7

8 Install low voltage control and communication cables. D11.8

9 Demonstrate grounding techniques for all electrical boxes, cabinets, and enclosures. D11.9

10 Terminate electrical connections to receptacles, switches, lighting fixtures, large appliances, and other devices. D11.10

11 Select receptacles and switches based on load requirements. D11.11

12 Terminate equipment grounding and neutral conductor at the electrical service. D11.12

13 Terminate communication and control wiring. D11.13