**Course Description:**

Students learn physical principles and fundamental skills across mechanical systems in construction. Students will select materials, assemble, and test basic electrical circuits. Students will select materials and assemble simple copper and plastic plumbing applications for both supply and drains. They will perform simple maintenance of electric motors, electric fixtures and plumbing fixtures. Students will be able to select and install basic ductwork components and learn the operation and maintenance of heating and cooling equipment.

**Strand 2. Safety, Tools, and Equipment**

Learners apply principles of protection, prevention and mitigation to create and maintain safe working conditions at construction sites. Knowledge and skills may be applied in all aspects of personal and site safety, including handling materials, using tools and equipment, working with and around electricity, using personal protective equipment and operating heavy equipment.

**Outcome 2.1. Site Safety**

Handle materials, prevent accidents and mitigate hazards.

**Competencies**

2.1.1. Use Occupational Safety and Health Administration (OSHA)‐defined procedures for identifying

employer and employee responsibilities, working in confined spaces, managing worker safety

programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and

boundaries and labeling.

2.1.2. Identify and rectify or mitigate construction hazards associated with thresholds, slippery

surfaces and lighting.

2.1.3. Calculate an example of load factors for constructing scaffolding, railings, ladders and

temporary structures.

2.1.6. Identify the source of electrical hazards and use shutdown and established lock‐out/tag‐out

procedures.

2.1.7. Identify and eliminate worksite clutter in accordance with standards for cleanliness and safety.

2.1.8. Identify procedures for the handling, storage and disposal of hazardous materials.

2.1.9. Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets

(SDSs), fire alarms and exits.

2.1.10. Select and operate fire extinguishers based on the class of fire.

2.1.11. Identify the components of a hazardous materials safety plan.

2.1.12. Create a hazardous materials safety plan.

2.1.14. Describe the interactions of incompatible substances when measuring and mixing chemicals.

*An “X” indicates that the pathway applies to the outcome.*

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| Pathways | X | Design | X | Mechanical, Electrical, Plumbing  | X | Structural |

**Outcome 2.2. Personal Safety**

Practice personal safety in construction.

**Competencies**

2.2.1. Interpret personal safety rights according to the employee Right‐to‐Know plan.

2.2.2. Describe how working under the influence of drugs and alcohol increases the risk of accident,

lowers productivity, raises insurance costs, and reduces profits.

2.2.3. Select, use, store, maintain and dispose of personal protective equipment (PPE) appropriate

to job tasks, conditions and materials.

2.2.4. Identify workplace risk factors associated with lifting, operating and moving heavy objects

and establish an ergonomics process.

2.2.5. Identify, inspect and use safety equipment appropriate for the task.

2.2.6. Demonstrate first aid and cardiopulmonary resuscitation (CPR).

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**Outcome 2.3. Equipment Operation**

Operate equipment used to move materials, earth and other heavy materials.

**Competencies**

2.3.1. Select the equipment and attachments needed to complete the task.

2.3.2. Follow the manufactures’ recommendations for safety, maintenance, limitations and use.

2.3.3. Perform pre‐ and post‐operation inspections and adjustments and report malfunctions.

2.3.4. Operate levers, pedals or valves to activate power equipment.

2.3.5. Drive and maneuver equipment with and without trailers.

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**Outcome 2.4. Equipment and Machinery Preventative Maintenance**

Clean, maintain and perform planned preventative maintenance (PPM) on equipment and machinery.

**Competencies**

2.4.1. Lubricate machinery and equipment.

2.4.2. Ensure the presence and functionality of safety systems and hardware.

2.4.3. Service electrical systems (e.g., fuses, bulbs).

2.4.4. Perform machine adjustments (e.g., belts, drive chains).

2.4.5. Service filtration systems.

2.4.6. Identify, select and maintain fluid levels.

2.4.7. Maintain instrument, machinery and equipment cleanliness, appearance and safety devices.

2.4.8. Inspect and maintain fluid conveyance and storage components (e.g., hoses, lines, valves,

nozzles).

2.4.9. Calibrate metering, monitoring, and sensing equipment.

2.4.10. Inspect and maintain tooling and implements.

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**Strand 4. Electrical**

Learners apply principles of electricity and knowledge of building codes to construct systems to generate and deliver power in residential, commercial and industrial applications. Knowledge and skill may be applied to rough‐in and finish wiring, motors and power wiring, specialized low‐voltage systems, alternative power systems, power transmission, plant operations and coal equipment.

**Outcome 4.1. Electrical Theory**

Explain electrical principles and theories.

**Competencies**

4.1.1. Explain atomic structure and its relationship to electricity.

4.1.2. Describe the relationship between electrical effect and electromagnetic effect.

4.1.3. Explain methods of producing electrical current.

4.1.4. Describe the differences between alternating current (AC) and direct current (DC).

4.1.5. Compare and contrast conductors and insulators.

4.1.6. Describe the relationships between voltage, current, resistance and power in circuits.

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**Outcome 4.2. Circuits**

Analyze and evaluate direct current (DC) circuits and alternating current (AC) circuits.

**Competencies**

4.2.1. Identify electrical, electromechanical and solid state controls.

4.2.2. Describe the purpose of grounding and common methods used for grounding.

4.2.3. Analyze wiring schematics and diagrams to troubleshoot circuits.

4.2.4. Explain the uses of series, parallel and series‐parallel circuits.

4.2.5. Construct and troubleshoot series, parallel and series‐parallel circuits.

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**Outcome 4.4. Low Voltage Systems**

Describe specialized low‐voltage systems and components.

**Competencies**

4.4.1. Identify and describe types of data and communication systems.

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**Outcome 4.5. Electrical Wiring**

Install wiring in residential, commercial, and industrial settings in both above‐ground and below‐ground applications.

**Competencies**

4.5.1. Select materials and lay out rough‐in wiring runs according to specifications, drawings and

code requirements.

4.5.2. Identify and install fasteners, anchors, and fire stop systems.

4.5.3. Locate and mount boxes.

4.5.8. Install rough‐in wiring following specifications, drawings and code requirements.

4.5.11. Install lighting fixtures, wiring devices and covers.

4.5.13. Make conductor terminations.

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**Strand 5. Environmental Systems and Plumbing**

Learners apply principles of physics and thermodynamics to install and maintain heating, ventilation and air conditioning (HVAC) and plumbing systems in residential, commercial and industrial applications. HVAC may include mobile and fixed refrigeration and heating equipment, including environmental controls, boiler systems and ductwork; plumbing may include drainage, water supply, fuel piping, fixtures and appliances.

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**Outcome 5.1. Refrigeration**

Apply physical principles of refrigeration to the installation and maintenance of

heating, ventilation and air conditioning (HVAC) systems.

**Competencies**

5.1.2. Describe heat, heat transfer, energy and energy conversion.

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**Outcome 5.2. Heating, Ventilation, Air Conditioning/Refrigeration (HVAC/R) Systems Installation**

Install refrigeration, air conditioning, and heating systems.

**Competencies**

5.2.1. Identify the basic components of a self‐contained air conditioning unit.

5.2.2. Identify and explain the installation of a central air conditioner with heat pump.

5.2.4. Identify and explain the installation of a distribution system.

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**Outcome 5.3. Service Maintenance**

Perform service maintenance (SM) and repair on environmental controls technology equipment (e.g., electric heating equipment, air handler, air filtration equipment, humidifier/dehumidifier, air conditioner, heat pump).

**Competencies**

5.3.1. Perform routine cleaning and inspection of system and components.

5.3.2. Inspect and replace filters, belts and fluids.

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**Outcome 5.6. Sheet Metal**

Fabricate and install ductwork systems.

**Competencies**

5.6.1. Identify the components of a duct system.

5.6.2. Select materials to fabricate ductwork based on job specifications.

5.6.5. Seal and insulate ductwork.

5.6.6. Fasten and hang ductwork.

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**Outcome 5.7. Drainage**

Rough in drainage systems following plumbing codes and municipal building standards.

**Competencies**

5.7.1. Locate drainage system entry points, walls, and chases.

5.7.2. Identify components of a drainage system and describe their functions.

5.7.3. Describe how waste moves from a fixture through the drain system to the environment.

5.7.5. Estimate and compute length, angle of measurement, area, surface area and volume to

calculate pipe legs and pipe sizes.

5.7.10. Join pipe, pipefittings and valves of similar and dissimilar materials using solvents and

mechanical means of joining.

5.7.11. Identify and explain the installation of plumbing fixtures and appliances to a drain system.

5.7.12. Test the drainage system for leaks.

5.7.14. Describe the design, basic operation and care of a septic system.

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**Outcome 5.8. Water Systems**

Rough in water systems following plumbing codes and municipal building standards.

**Competencies**

5.8.3. Prevent freezing and mechanical damage to pipes.

5.8.4. Describe how water moves from the source through the water distribution system to the

fixture.

5.8.7. Estimate and compute length, angle of measurement, area, surface area and volume to

calculate pipe legs and pipe sizes.

5.8.8. Locate water supply system entry points, walls and chases.

5.8.9. Describe the function of the pipe, pipefittings, valves and fixtures that comprise a water

supply system.

5.8.10. Select water supply components based on their application for a given purpose.

5.8.12. Join water supply pipe, pipefittings and valves of similar and dissimilar materials using solder,

brazing, solvents and mechanical means of joining.

5.8.13. Connect water supply to plumbing fixtures and appliances.

5.8.14. Test a water supply system for leaks and pressure using soap, inert gas, electronic sensors

and fluorescent dye.

5.8.15. Perform maintenance on water supply components of plumbing fixtures and appliances.

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| Pathways | X | Design | X | Mechanical, Electrical, Plumbing  | X | Structural |

**Outcome 5.9. Fuel Piping**

Construct fuel piping systems following code and municipal building standards.

**Competencies**

5.9.1. Identify the types of fuel systems and describe the advantages and disadvantages of each.

5.9.2. Describe the physical properties and potential hazards associated with different fuel types.

5.9.3. Describe the pipe, fittings, and valves used in fuel piping systems and describe their functions.

5.9.4. Join pipe, fittings, and valves used in a piping system that transfers fuel.

5.9.5. Connect appliances to fuel piping systems.

5.9.6. Describe fuel piping testing methods and perform leak tests.

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**Strand 6. Planning and Design**

Learners apply principles of architectural and civil engineering, drawing and construction with current technology to develop, present and use construction proposals, plans and schematics. Knowledge and skill may be applied throughout the project from preconstruction design through all stages of building in residential, commercial and industrial applications.

**Outcome 6.4. Construction Drawings**

Read and interpret plans and diagrams within a construction drawing set (i.e., topographical, grading and drainage, architectural, structural, plumbing, mechanical, electrical) to organize a project work sequence.

**Competencies**

6.4.2. Read and interpret a site plan.

6.4.3. Use architect’s and engineer’s scales to read and interpret construction drawings for material

calculations and installation at the jobsite.

6.4.4. Read, interpret, and organize construction drawings, specifications and other contractual

documents.

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| Pathways | X | Design | X | Mechanical, Electrical, Plumbing  | X | Structural |

**Outcome 6.5. Construction Math**

Calculate materials needed to complete construction projects.

**Competencies**

6.5.1. Find surface area and volume for three‐dimensional objects, accurate to a specified level of

precision.

6.5.2. Apply measurement scales to layout length, width, and angle measurements.

6.5.3. Apply algebraic procedures and geometric concepts to reading construction documents.

6.5.4. Use proportional reasoning and apply indirect measurement techniques (e.g., right triangle

trigonometry, properties of similar triangles).

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| Pathways | X | Design | X | Mechanical, Electrical, Plumbing  | X | Structural |