**Course Description:**

Students will plan and install electrical systems in commercial settings. Students learn worksite safety and understand permitting requirements. Students interpret plans and job specifications and calculate loads and service requirements. Students install, test and repair receptacle outlet, lighting and equipment circuits. They will understand circuit protection concepts and be able to install a entrance panels. Specialty commercial circuit installation will be addressed. Students apply operating principles to the installation and troubleshooting of motors and controls.

**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.

2.1.13. Set up for ergonomic workflow.

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

**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 4.2. Circuits**

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

**Competencies**

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.

4.2.6. Determine voltage, current, frequency and phase.

4.2.7. Identify common types of transformers and list uses for each.

4.2.8. Explain step‐up/step‐down voltage methods.

4.2.9. Identify the types of motors and uses for each.

4.2.10. Identify types of capacitors and common usages for each.

4.2.11. Identify methods of varying capacitance.

4.2.12. Identify types of inductors and explain the purposes of different core materials.

4.2.13. Identify the characteristics of inductors and capacitors in series and parallel circuits.

4.2.14. Calculate true power, apparent power, reactive power and power factor.

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

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

**Outcome 4.3. Codes and Regulations**

Explain and apply the National Electrical Code (NEC) and other building codes.

**Competencies**

4.3.1. Explain the role of Underwriters Laboratory (UL), Canadian Standards Association (CSA) and

Intertek Testing Service/Edison Testing Laboratory (ITS/ETL).

4.3.2. Locate and apply the information in articles of the NEC and other applicable codes (i.e.,

Building Officials and Code Administrators [BOCA], Ohio Building Code [OBC], Life Safety

Codes) and explain how they impact job requirements (e.g., service conductors, feeders,

branch circuits, overload protection, grounding and bonding requirements).

4.3.3. Utilize National Fire Protection Association (NFPA) procedures for NFPA 70E‐arc flash

boundaries, current‐limiting fuses, live work power permits, electrically safe work

conditions, emergency worker safety programs, scheduling, energized circuits and training.

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

**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.

4.5.4. Verify the location of and install service entrance systems.

4.5.5. Install service panels, meter apparatus, grounding electrode systems, subpanels and over

current protective devices.

4.5.6. Identify and label a panel directory to reflect devices and circuits installed on each circuit.

4.5.7. Lay out and install conduit or cable runs, raceways and cable systems (e.g., electrical metallic

tubing [EMT], galvanized rigid conduit [GRC], intermediate metal conduit [IMC], polyvinyl

chloride [PVC], electrical nonmetallic tubing [ENT or ENMT], armored cable [AC], metal clad

cable [MC]).

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

4.5.9. Identify the pull needed for conductors according to specifications, drawings and code

requirements.

4.5.10. Install and service low‐voltage systems (e.g., communication systems, telephone systems,

control systems, lighting systems).

4.5.11. Install lighting fixtures, wiring devices and covers.

4.5.12. Install equipment grounding and bonding systems.

4.5.13. Make conductor terminations.

4.5.14. Connect appliances.

4.5.15. Check and test installation.

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**Outcome 4.6. Motors and Power**

Install motors and power wiring in accordance with the National Electrical Code (NEC).

**Competencies**

4.6.1. Identify types and components of single‐phase, split‐phase and three‐phase motors.

4.6.2. Interpret motor nameplate information and motor specifications.

4.6.3. Calculate motor loads.

4.6.4. Determine motor rotation needed for the installed load and explain the process for reversing

rotation (i.e., three‐phase, single‐phase).

4.6.5. Interpret schematics and control diagrams for building a motor circuit.

4.6.6. Wire single‐phase, split‐phase and three‐phase circuits and install motor control devices (i.e.,

contactors, starters, variable frequency and motor speed controls).

4.6.7. Explain the starting sequence of motor components within a given circuit.

4.6.8. Troubleshoot and repair motor starting systems to verify operation according to schematics

and control diagrams.

4.6.9. Describe how programmable controllers can be used in single‐phase, split‐phase and three- phase circuits.

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**Outcome 4.7. Alternative Power Systems**

Describe specialized power systems and components.

**Competencies**

4.7.1. Identify and describe the functions of photovoltaic (PV) systems.

4.7.2. Identify and describe the functions of wind power technologies.

4.7.3. Identify and describe the functions of standby power systems (i.e., generator, uninterrupted

power supplies [UPS] systems).

4.7.4. Identify and describe the functions of electric storage systems.

4.7.5. Perform battery maintenance functions (e.g., cleaning, checking electrolyte quality and level

and battery status).

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

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

**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.

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

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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).

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

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