**Course Description:**

Students will install, troubleshoot and service residential and commercial refrigeration systems. Students will learn laws of thermodynamics, pressure and temperature relationships, the refrigeration cycle, and refrigerant management. Students will address hydronic systems, chilled water systems, package units, and cooling towers.

**Strand 1. Business Operations/21st Century Skills**

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

**Outcome 1.1. Employability Skills**

Develop career awareness and employability skills (e.g., face‐to‐face, online) needed for gaining and maintaining employment in diverse business settings.

**Competencies**

1.1.1. Identify the knowledge, skills and abilities necessary to succeed in careers.

1.1.2. Identify the scope of career opportunities and the requirements for education, training,

certification, licensure and experience.

1.1.3. Develop a career plan that reflects career interests, pathways and secondary and

postsecondary options.

1.1.4. Describe the role and function of professional organizations, industry associations and

organized labor and use networking techniques to develop and maintain professional

relationships.

1.1.5. Develop strategies for self‐promotion in the hiring process (e.g., filling out job applications,

résumé writing, interviewing skills, portfolio development).

1.1.6. Explain the importance of work ethic, accountability and responsibility and demonstrate

associated behaviors in fulfilling personal, community and workplace roles.

1.1.7. Apply problem‐solving and critical‐thinking skills to work‐related issues when making decisions

and formulating solutions.

1.1.8. Identify the correlation between emotions, behavior and appearance and manage those to

establish and maintain professionalism.

1.1.9. Give and receive constructive feedback to improve work habits.

1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.

1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect

for them.

1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits and abusive

behavior.

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

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

**Outcome 1.2. Leadership and Communications**

Process, maintain, evaluate and disseminate information in a business. Develop leadership and team building to promote collaboration.

**Competencies**

1.2.1. Extract relevant, valid information from materials and cite sources of information.

1.2.2. Deliver formal and informal presentations.

1.2.3. Identify and use verbal, nonverbal and active listening skills to communicate effectively.

1.2.4. Use negotiation and conflict‐resolution skills to reach solutions.

1.2.5. Communicate information (e.g., directions, ideas, vision, workplace expectations) for an

intended audience and purpose.

1.2.6. Use proper grammar and expression in all aspects of communication.

1.2.7. Use problem‐solving and consensus‐building techniques to draw conclusions and determine

next steps.

1.2.8. Identify the strengths, weaknesses and characteristics of leadership styles that influence

internal and external workplace relationships.

1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications

(e.g., common content for large audience, control of tone, speed, cost, lack of non‐verbal

 cues, potential for forwarding information, longevity).

1.2.10. Use interpersonal skills to provide group leadership, promote collaboration and work in a

team.

1.2.11. Write professional correspondence, documents, job applications and resumés.

1.2.12. Use technical writing skills to complete forms and create reports.

1.2.13. Identify stakeholders and solicit their opinions.

1.2.14. Use motivational strategies to accomplish goals.

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

**Outcome 1.3. Business Ethics and Law**

Analyze how professional, ethical and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

**Competencies**

1.3.1. Analyze how regulatory compliance affects business operations and organizational

performance.

1.3.2. Follow protocols and practices necessary to maintain a clean, safe and healthy work

environment.

1.3.3. Use ethical character traits consistent with workplace standards (e.g., honesty, personal

integrity, compassion, justice).

1.3.4. Identify how federal and state consumer protection laws affect products and services.

1.3.5. Access and implement safety compliance measures (e.g., quality assurance information, safety

data sheets [SDSs], product safety data sheets [PSDSs], United States Environmental

Protection Agency [EPA], United States Occupational Safety and Health Administration

[OSHA]) that contribute to the continuous improvement of the organization.

1.3.6. Identify deceptive practices (e.g., bait and switch, identity theft, unlawful door‐to‐door sales,

deceptive service estimates, fraudulent misrepresentations) and their overall impact on

organizational performance.

1.3.7. Identify the labor laws that affect employment and the consequences of noncompliance for

both employee and employer (e.g., harassment, labor, employment, employment interview,

testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal

Employment Opportunity Commission [EEOC]).

1.3.8. Verify compliance with computer and intellectual property laws and regulations.

1.3.9. Identify potential conflicts of interest (e.g., personal gain, project bidding) between personal,

organizational and professional ethical standards.

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

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

**Outcome 1.4. Knowledge Management and Information Technology**

Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.

**Competencies**

1.4.1. Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner,

public address systems).

1.4.2. Select and use software applications to locate, record, analyze and present information (e.g.,

word processing, e‐mail, spreadsheet, databases, presentation, Internet search engines).

1.4.3. Verify compliance with security rules, regulations and codes (e.g., property, privacy, access,

accuracy issues, client and patient record confidentiality) pertaining to technology specific to

the industry pathway.

1.4.4. Use system hardware to support software applications.

1.4.5. Use information technology tools to maintain, secure and monitor business records.

1.4.6. Use an electronic database to access and create business and technical information.

1.4.7. Use personal information management and productivity applications to optimize assigned

tasks (e.g., lists, calendars, address books).

1.4.8. Use electronic media to communicate and follow network etiquette guidelines.

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

**Outcome 1.5. Global Environment**

Evaluate how beliefs, values, attitudes and behaviors influence organizational strategies and goals.

**Competencies**

1.5.1. Describe how cultural understanding, cultural intelligence skills and continual awareness are

interdependent.

1.5.2. Describe how cultural intelligence skills influence the overall success and survival of an

organization.

1.5.3. Use cultural intelligence to interact with individuals from diverse cultural settings.

1.5.4. Recognize barriers in cross‐cultural relationships and implement behavioral adjustments.

1.5.5. Recognize the ways in which bias and discrimination may influence productivity and

profitability.

1.5.6. Analyze work tasks for understanding and interpretation from a different cultural perspective.

1.5.7. Use intercultural communication skills to exchange ideas and create meaning.

1.5.8. Identify how multicultural teaming and globalization can foster development of new and

improved products and services and recognition of new opportunities.

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**Outcome 1.6. Business Literacy**

Develop foundational skills and knowledge in entrepreneurship, financial literacy and business operations.

**Competencies**

1.6.1. Identify business opportunities.

1.6.2. Assess the reality of becoming an entrepreneur, including advantages and disadvantages (e.g.,

risk versus reward, reasons for success and failure).

1.6.3. Explain the importance of planning your business.

1.6.4. Identify types of businesses, ownership and entities (i.e., individual proprietorships,

partnerships, corporations, cooperatives, public, private, profit, not‐for‐profit).

1.6.5. Describe organizational structure, chain of command, the roles and responsibilities of the

organizational departments and interdepartmental interactions.

1.6.6. Identify the target market served by the organization, the niche that the organization fills and

an outlook of the industry.

1.6.7. Identify the effect of supply and demand on products and services.

1.6.8. Identify the features and benefits that make an organization’s product or service competitive.

1.6.9. Explain how the performance of an employee, a department and an organization is assessed.

1.6.10. Describe the impact of globalization on an enterprise or organization.

1.6.11. Describe how all business activities of an organization work within the parameters of a

budget.

1.6.12. Describe classifications of employee benefits, rights, deductions and compensations.

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

**Outcome 1.7. Entrepreneurship/Entrepreneurs**

Analyze the environment in which a business operates and the economic factors and opportunities associated with self‐employment.

**Competencies**

1.7.1. Compare and contrast the four types of business ownership (i.e., individual proprietorships,

partnerships, corporations, cooperatives).

1.7.2. Explain the role of profit as the incentive to entrepreneurs in a market economy.

1.7.3. Identify the factors that contribute to the success and failure of entrepreneurial ventures.

1.7.4. Assess the roles of nonprofit and for‐profit businesses.

1.7.5. Develop a business plan.

1.7.6. Describe life cycles of an entrepreneurial business and an entrepreneur.

1.7.7. Create a list of personal strengths, weaknesses, skills and abilities needed to be successful as

an entrepreneur.

1.7.8. Explain pathways used to become an entrepreneur.

1.7.9. Conduct a self‐assessment to determine entrepreneurial potential.

1.7.10. Describe techniques for obtaining experience (e.g., apprenticeship, co‐operative [co‐op]

education, work placement, internship, job shadowing) related to an entrepreneurial

objective.

1.7.11. Identify initial steps in establishing a business (e.g., limited liability company [LLC], tax ID,

permits, insurance, licensing).

1.7.12. Identify resources available to entrepreneurs (e.g., Small Business Administration, mentors,

information resources, educational opportunities).

1.7.13. Protect intellectual property and knowledge (e.g., copyright, patent, trademark, trade secrets,

processes).

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

**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).

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

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

**Outcome 2.4. 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.

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

**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.

**Outcome 5.1. Refrigeration**

Apply physical principles of refrigeration to the installation and maintenance of

heating, ventilation and air conditioning (HVAC) systems.

**Competencies**

5.1.1. Record, analyze, and interpret temperature and pressure measurements and their

relationship.

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

5.1.3. Differentiate between sensible, latent and total heat.

5.1.4. Describe the thermodynamic cycle in the refrigeration process.

5.1.5. Compare and contrast the functions of evaporators, condensers, compressors and metering

devices of the basic refrigeration cycle.

5.1.6. Compare and contrast the characteristics of refrigerants.

5.1.7. Describe, calculate, and record superheating and subcooling.

5.1.8. Calculate and record the saturation temperature of a refrigerant.

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

**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.

5.2.3. Identify and explain the installation of a refrigeration condensing unit with a remote

evaporator.

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

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

**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.

5.3.3. Recover, recharge and reclaim refrigerant from refrigeration and air conditioning equipment

according to Environmental Protection Agency (EPA) regulations.

5.3.4. Troubleshoot and service refrigeration and air conditioning equipment.

5.3.5. Troubleshoot and service heating systems.

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

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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.

*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.

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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 |