**Course Description**

This course develops foundational knowledge across electrical, mechanical, design, and manufacturing systems. It cultivates critical thinking, problem-solving, and analytical skills essential to engineering practice. Through hands-on activities and theoretical concepts, learners build the mental aptitude needed to tackle engineering challenges, emphasizing safety, quality, and technical precision throughout all processes.

**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.

**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).

1.3.5. Access and implement safety compliance measures (e.g. quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], U.S. Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.

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).

1.3.8. Verify compliance with computer, copyright, 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.

**Strand 2. Electrical/Electronics**

Learners apply principles of electricity and electronics related to electronic theory, alternating and direct current, electronic components, electronic skills, digital electronics and power supplies. Knowledge and skills may be applied to fundamentals of electricity, analyzing and evaluating circuits, assembling components into electrical circuits, creating circuits to perform tasks and operations, wiring components to construct a communications system and providing power to an electrical system.

**Outcome 2.1. Electrical and Electronic Theory:** Explain electrical and electronic principles and theory.

**Competencies**

2.1.1 Describe the structure of atoms and their relationship to electricity.

2.1.2 Compare electrical properties and electromagnetic effect.

2.1.3 Explain methods of producing electrical current.

2.1.4 Compare alternating current (AC) and direct current (DC).

2.1.5 Define the units of measurement for voltage, current, power and resistance.

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

2.1.7 Determine voltage, current, resistance and power in circuits using Ohm's Law, Kirchhoff's Law and Watt's Law.

**Outcome 2.2. Circuits:** Construct and analyze alternating current (AC) circuits and direct current (DC) circuits.

**Competencies**

2.2.7 Analyze wiring schematics and diagrams for accuracy, function, and performance characteristics (e.g., time constants, current flow, impedance, signal timing, etc).

**Outcome 2.3 Electronic Components:** Describe the functions and purposes of electronic components.

**Competencies**

2.3.1 Identify resistor values from color codes or other marks.

2.3.2 Compare resistor compositions and their uses.

2.3.3 Identify symbols for electronic components.

**Outcome 2.4. Electronic Connections:** Connect individual components into an electrical circuit.

**Competencies**

* + 1. Define the purpose of a connection and the differences between a good and bad connection.

2.4.2 Describe methods of electrical connections and the purpose for each method.

**Strand 3. Mechanical Systems**

Learners apply principles of motors and power, hydraulics and pneumatics, mechanical drives, pumping systems, and cleanroom vacuum systems. They gain essential knowledge and skills in installing, maintaining, and troubleshooting various mechanical systems used in engineering and manufacturing.

**Outcome 3.1 Motors and Power:** Install motors, variable-frequency drives (VFD), and power wiring.

**Competencies**

3.1.1 Identify types and components of single phase and three phase motors.

3.1.2 Interpret motor nameplate information and motor specifications.

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

**Outcome 3.2 Hydraulics and Pneumatics Systems:** Install, maintain, and Hydraulic and Pneumatic systems

**Competencies**

3.2.1 Understand and explain the fundamental principles of hydraulics and pneumatics system (e.g., Pressure, Flow, and Force)

3.2.2 Identify the major components of hydraulics and pneumatics systems (e.g., pumps, cylinders, valves, and compressors)

3.2.3 Describe the properties of fluids used in hydraulics systems including viscosity, density, and compressibility.

3.2.4 Describe the properties of gases used in pneumatic systems including viscosity, density, and compressibility.

3.2.5 Interpret a basic schematic of a basic hydraulic or pneumatic system identifying the components of that system within the schematic

3.2.6 Calculate pressures, forces, and fluid flow rates in hydraulic and pneumatic systems

**Outcome 3.3 Mechanical Drives Systems:** Install, maintain, and monitor mechanical drives systems.

**Competencies**

3.3.1 Compare types of gears, couplings, belts and chains and describe their uses.

**Outcome 3.4 Pumping Systems:** Install, maintain, and troubleshoot pumps and pumping systems.

**Competencies**

3.4.1 Understand and explain the fundamental principles of pumps and pumping systems.

3.4.2 Identify the major components of pumps and pumping systems.

3.4.3 Interpret a basic schematic of a pumping system identifying the components of that system within the schematic

**Strand 5. Design and Development**

Learners apply principles of design and development related to the design process,

sketching and visualization, modeling, drafting, materials and production and process

design.

**Outcome 5.1 The Design Process:** Use the engineering design process and quality assurance principles to analyze and solve design problems.

**Competencies**

5.1.2 Describe the role of research, development and experimentation in design problem solving.

**Outcome 5.2 Sketching, Drawing, and Visualization:** Conceptualize, sketch, and draw design projects and components.

**Competencies**

5.2.1 Compare & contrast technical sketches and drawings.

**Outcome 5.7** **Blueprint Interpretation:** Read, interpret, and utilize blueprints to produce accurate products.

**Competencies**

5.7.1 Identify and interpret standard symbols used in blueprints.

5.7.2 Demonstrate the ability to read and convert measurements from scaled drawings.

5.7.3 Differentiate between various line types (e.g., solid, dashed) and their meanings in a blueprint.

5.7.4 Analyze and interpret dimensions, tolerances, and annotations effectively.

5.7.5 Utilize reference notes and legends to clarify details and specifications in blueprints.

5.7.7 Interpret work from multiview drawings, and to visualize shapes and objects in multiple views.

**Outcome 5.8 Schematic Interpretation:** Read, interpret, and utilize schematics to produce accurate products.

**Competencies**

5.8.1 Identify and interpret standard symbols used in schematics.

5.8.2 Recognize and label key components and systems within a schematic

5.8.3 Trace the flow of systems of schematic diagrams.

5.8.4 Utilize reference notes and legends to clarify details and specifications in schematics.

5.8.5 Identify discrepancies or errors in a schematic.

5.8.7 Differentiate between different styles and standards in schematics (e.g., international, US)

**Strand 9 Technical Math and Science**

Technical Math and Science: Learners develop a comprehensive understanding of the fundamental principles and applications of technical mathematics and scientific concepts. Learners will perform precise measurements, interpret technical drawings, and apply scientific principles to solve engineering and manufacturing problems.

**Outcome 9.1 Physics of Engineering:** Learn the fundamentals of physics as it relates to engineering.

**Competencies**

9.1.1 Display and interpret numbers in scientific notation and logarithmic scales

9.1.2 Describe and convert SI and US system units of measurement.

9.1.3 Identify and use both metric and inch rules.

9.1.4 Express physical quantities with an appropriate number of significant digits, units and dimensions.

9.1.5 Perform operations on whole numbers, fractions and mixed numbers.

9.1.6 Analyze measurements and perform technical calculations.

9.1.7 Read and interpret charts and tables to analyze data and formulate outcomes.

9.1.8 Quantitatively describe the units used in pressure measurement, such as Torr, and convert between units.

9.1.9 Quantitatively describe the units used in temperature measurement and convert between units (e.g. Fahrenheit, Celsius, Kelvin)

9.1.10 Quantitatively describe the units used in density measurement and convert between units (e.g. g/mL, g/cm3, g/L, kg/L, kg/m3)

9.1.14 Identify/differentiate engineering drawings.

9.1.15 Interpret basic schematics or diagrams, including a parts list.

9.1.17 Compare and contrast weight vs mass

9.1.18 Explain Newton's three laws of motion and identify their relationship to a specified topic

**Strand 10 Maintenance and Safety**

Learners apply principles of protection, prevention and mitigation to create and maintain safe working conditions at manufacturing 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 and using personal protective equipment.

**Outcome 10.6 Quality:** Ability to ensure product quality, implement quality control measures, and continuously improve product inspection processes to meet or exceed quality requirements

**Competencies**

10.6.1 Identify quality control systems (e.g., Statistical Process Control (SPC), Six Sigma, Total Quality Management (TQM), Lean Management, “Plan‐Do‐Check‐Act” etc).

10.6.2 Troubleshoot manufacturing defects.

10.6.3 Tag and segregate non‐conforming material.

10.6.4 Use statistical process control (SPC) to detect and address faults in the manufacturing process

10.6.5 Explain the basic principles and purpose of Quality Control and Quality Systems

10.6.6 Describe the seven basic tools of quality control.

10.6.7 Describe data set characteristics.

10.6.8 Describe types of variation and control charts.

10.6.9 Interpret a variety of charts and diagrams used in Statistical Process Control (SPC).