**Course Description**

Students examine battery technology with a focus on design, function, and manufacturing. They explore battery chemistries, energy storage principles, and performance factors such as capacity, efficiency, and lifespan. Students study battery production processes, materials, and environmental impacts, while learning to test, select, and safely handle batteries for various applications. Emphasis is placed on emerging technologies, industry standards, and the critical role of batteries in modern electrical and electronic systems.

**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) and direct current (DC) circuits.

**Competencies**

2.2.1 Compare conductors and insulators.

2.2.5 Explain the uses of series, parallel and series-parallel circuits.

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

2.2.9 Identify and differentiate between different types of circuits (RC, RL, RCL, etc.)

2.2.10 Explain steady-state behavior and how circuits respond under different conditions

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

**Competencies**

2.3.3 Identify symbols for electronic components.

2.3.4 Compare negative positive negative (NPN) and positive negative positive (PNP) bipolar junction transistors (BJT).

2.3.5 Identify types of transistors and diodes and explain their uses (e.g., Darlington pairs, unijunction transistors, Gunn diodes, field effect transistors [FETs] and metal-oxide semiconductor field- effect transistor [MOSFETs], N- and P- channel junction field effect transistors [JFETs]).

2.3.7 Describe the purpose and operation of Zener diodes.

2.3.9 Describe the purpose and operation of photovoltaic cells.

2.3.10 Describe the purpose, and operation of photo resistors, photodiodes and phototransistors.

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

**Competencies**

2.4.1 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.

2.4.3 Select the type of electrical connection for electrical components.

2.4.4 Protect circuit boards from electrostatic discharge (ESD).

2.4.7 Design a regulated power supply for powering analog circuits, incorporating voltage regulation and filtering.

2.4.8 Use diagnostic tools to troubleshoot circuits effectively (signal generator, oscilloscope, multimeter etc.)

**Outcome 2.6 Cabling and Wiring:** Connect components to construct low-voltage, data and communication systems using coaxial or fiber optic cables and twisted pair or balanced wires.

**Competencies**

2.6.1 Describe the types, purpose, and characteristics of cables and wires and their purpose

2.6.2 Select methods for splicing and terminating cables and wires (e.g., terminal strips, and crimp connectors).

2.6.3 Splice and terminate cables and wires.

2.6.4 Test cables and wires.

**Outcome 2.7 Power Supplies:** Provide power to electrical circuits.

**Competencies**

2.7.1 Identify the differences between transformer-powered supplies and line-connected supplies.

2.7.3 Construct and install regulated power supplies.

2.7.5 Select and construct half-wave, full-wave and bridge rectifiers.

2.7.8 Design and implement AC to DC conversion circuits, including full-wave, half-wave, and bridge rectifiers.

2.7.9 Understand and apply the principles of inverters and DC-AC conversion in power electronics.

**Outcome 2.8 Battery Technology:** Understand batteries its principles and applications.

**Competencies**

2.8.1 Explain how various batteries work, including the roles of electrodes and electrolytes

2.8.2 Identify common battery types such as alkaline and lithium-ion

2.8.3 Describe key factors in battery design and how these affect their use in products (e.g., size, weight, and energy capacity)

2.8.4 Recognize the importance of testing batteries for performance and safety (e.g., capacity, lifespan, and production)

2.8.5 Identify common uses of batteries in a variety of industries (Manufacturing, Automotive, Construction etc.)

2.8.6 Research new developments in battery technology such as new materials and designs, and the impact they could have on manufacturing

2.8.7 Identify safety precautions and protocols that help to mitigate risks associated with battery manufacturing.

**Outcome 2.9 Battery Production:** Explain battery production process, considering material usage and environmental impact.

**Competencies**

2.9.1 Explain how batteries store and disperse energy.

2.9.2 Understand the various battery chemistries, including lithium-ion, nickel-metal hydride, and solid-state batteries, and their applications in manufacturing.

2.9.3 Describe the different manufacturing processes used in battery production (e.g., electrode fabrication, cell assembly, and electrolyte filling)

2.9.4 Explain the selection of appropriate materials for battery components, considering factors such as conductivity, stability, and environmental impact.

2.9.5 Describe the environmental impact of battery production, and understand sustainability practices that can help produce the technology responsibly

2.9.6 Understand the relevant regulations and standards governing battery production, including safety and transportation requirements.

2.9.7 Select a battery based on composition, environment and circuit characteristics.

**Strand 5 Design and Development:** Learners apply principles of the engineering design process, using sketching and drawing, computer-aided drafting and modeling, production and process design, and print interpretation. They gain essential knowledge and skills in analyzing and solving design problems, creating and interpreting technical drawings and models, selecting appropriate materials, and planning and evaluating production processes.

**Outcome 5.4 Material Selection:** Select materials for design projects and components.

**Competencies**

5.4.1 Compare advantages of materials used in manufacturing based on physical properties.

5.4.2 Identify the production processes used to create inputs.

5.4.3 Determine the appropriate material to be used to create a product considering production process factors and category of material (e.g., organic materials, metals, polymers, ceramics and

5.4.6 Select materials for a given application based on specified criteria (e.g., cost, availability, manufacturability).

**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 10.1 Site Safety:** Handle materials, prevent accidents and mitigate hazards.

**Competencies**

10.1.1 Knowledge of safety standards and regulations, including Hazard Communication (HAZCOM) and Occupational Safety and Health Administration (OSHA) requirements (e.g., Working at Heights, Confined Space)

10.1.2 Knowledge of risk identification, evaluation, and mitigation strategies

10.1.5 Identify source of electrical and mechanical hazards and use shut-down and established lock out/tag-out procedures.

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

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

10.1.8 Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms and exits.

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

10.1.14 Explain the role of third part certification (UL, IE, OSHA, etc.)

10.1.15 Apply information in the National Electrical Code (NEC) and other applicable codes when working on a job

**Outcome 10.2 Personal Safety:** Practice personal safety.

**Competencies**

10.2.3 Select, use, store, maintain and dispose of personal protective equipment (PPE) appropriate to job tasks, conditions and materials.

10.2.5 Identify, inspect and use safety equipment appropriate for a task.

10.2.6 Use safe practices when working with electrical, mechanical, or other equipment.