**Course Description**

Learners explore the fundamental principles and practical applications of digital electronics. The course covers numbering systems, Boolean algebra, logic gates, combinational and sequential circuits, and memory devices. Students develop skills in designing, constructing, and troubleshooting digital circuits and systems. Emphasis is placed on interpreting schematics, using diagnostic tools, and understanding digital communication and power supply components essential for digital electronics applications.

**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).

1.3.4. 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], 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 [EEOC]).

**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.

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

2.1.9 Evaluate frequency and phase for singular and multi-phase systems.

2.1.10 Understand the principles of singular and multi-phase power systems including their operation and applications.

2.1.11 Determine impedance.

2.1.12 Compare peak (PK), root mean square (RMS) and average values.

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

**Competencies**

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

2.2.6 Construct and troubleshoot 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).

2.2.8 Use circuit theorems in circuit analysis (e.g., Maximum power transfer, Thevenin, Source Transformation).

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

2.2.11 Understand and apply the principles of operational amplifiers (Op-Amps) in electronic circuits

2.2.12 Use analysis techniques in circuit analysis (e.g., mesh, loop, superposition, single & double subscript notation).

2.2.13 Analyze the behavior of capacitors and inductors in AC circuits, including time constants and Impedance.

2.2.14 Design and implement simple analog filters using capacitors, inductors, and resistors.

**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]).

2.3.6 Compare the purpose and function of thyristors (e.g., diacs, triacs, and varistors).

2.3.7 Describe the purpose and operation of Zener diodes.

2.3.8 Describe the purpose and operation of optical interface devices (e.g., light emitting diodes [LEDs], liquid crystal displays [LCDs]).

2.3.12 Describe the purpose and operation of audio amplifiers and their frequency response.

2.3.13 Explain the purpose and operation of common emitter (CE) amplifiers, common base (CB) amplifiers and common collector (CC) or emitter follower amplifiers.

2.3.14 Explain the role of operational amplifiers in analog circuits, including their use in amplifiers, filters, and other analog applications.

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

**Competencies**

2.4.5 Combine components per wiring schematics, block diagrams, and flow charts.

2.4.6 Select and install terminal strip according to wiring diagram and/or schematics.

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 2.5 Digital Electronics:** Create circuits to perform tasks and operations.

**Competencies**

2.5.1 Identify the numbering systems, codes, arithmetic operations, Boolean operations, and simplification methods used in digital electronics.

2.5.2 Convert number systems (e.g., binary coded decimal (BCD) to decimal, and decimal to BCD) and perform arithmetic operations.

2.5.3 Understand and apply DeMorgan’s Theorem to simplify logic expressions and digital circuits using basic logic gates, demonstrating the ability to analyze and modify circuit designs

2.5.4 Describe the purpose and use of logic gates (e.g., discrete and medium scale integration [MSI] gates, latches, flip-flops) and demonstrate understanding through the use of truth tables.

2.5.5 Design and implement combinational logic circuits (e.g., adders, subtractors, multiplexers, demultiplexers, encoders, decoders), including the use of Arithmetic Logic Units (ALUs) for solving arithmetic and logical problems.

2.5.6 Simplify Boolean expressions using methods like Karnaugh Maps (K-Maps) and apply them in the design of combinational logic circuits (e.g., decoders, adders, subtractors, multiplexers).

2.5.7 Design and implement sequential circuits using flip-flops, counters, and shift registers.

2.5.8 Understand and explain the purpose and operation of asynchronous and synchronous counters in digital systems.

2.5.9 Design and troubleshoot digital circuits based on schematics, using both solder and solderless techniques.

2.5.10 Identify and explain the purpose of memory in control systems, including types like RAM, ROM, and EEPROM.

2.5.11 Design and analyze digital-to-analog and analog-to-digital circuits.

2.5.12 Explain the operation of digital buses and demonstrate their use in connecting components in digital systems.

2.5.13 Explain and apply the use of pulsers, logic probes, and other diagnostic tools in troubleshooting digital circuits.

2.5.15 Determine fan-out, propagation delays, and their impact on the performance of digital circuits.

2.5.16 Analyze and optimize power consumption in digital circuits, particularly in embedded systems.

2.5.17 Utilize counters in circuits for operations like counting, timing, and data sequencing.

2.5.18 Troubleshoot and modify digital circuits based on schematics and circuit diagrams.

2.5.19 Determine and calculate the output frequency and performance of digital circuits.

2.5.20 Utilize memory in a control system for storing and accessing data.

**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.

2.7.7 Design, analyze, and demonstrate an understanding of basic filter circuits (low-pass, high-pass, band-pass, and band-stop filters).

**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 5.8 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 of schematics.

5.8.5 Identify discrepancies or errors in a schematic.

5.8.6 Utilize a schematic to produce a product

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

**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.

10.1.14 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.

10.2.8 Safely operate manual, electrical‐powered and pneumatic tools.