**Course Description:**

Learners develop fundamental skills in the engineering design process, focusing on problem-solving, conceptualization, and effective communication of ideas. The course covers techniques in sketching, technical drawing interpretation, and basic modeling to visualize and plan engineering solutions without reliance on computer-aided tools. Emphasis is placed on critical thinking, creativity, and practical application of design principles.

**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 5. Pre‐Engineering: 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**

5.1.1 Define the goal of a design

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

5.1.3 Investigate to identify customer needs, constraints and criteria.

5.1.4 Develop multiple solutions and select an approach.

5.1.5 Develop a design proposal and make a model/prototype.

5.1.6 Evaluate and redesign a prototype using collected data.

5.1.7 Use process planning and improvement tools to manage the life cycle of a product.

5.1.8 Identify the potential concept and design flaws (e.g., concept model corrections, audit documentation using Design Failure Mode Effect Analysis [DFMEA]).

5.1.9 Compare design considerations for product recycling or disposal for the end of a product's life cycle.

5.1.10 Document progress and capture ideas during the development phase.

5.1.11 Develop a design using the most environmentally friendly practices available to create the product

**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.

5.2.2 Sketch possible solutions to an existing design problem.

5.2.3 Apply annotations on sketches and drawings.

5.2.4 Sketch geometric forms and shapes.

5.2.5 Translate abstract thoughts into tangible designs

5.2.6 Communicate design technical drawings to present a design solution

**Outcome 5.3. Computer-Aided Drafting and Modeling:** Create models to illustrate the design of projects and components.

**Competencies**

5.3.1 Introduce manufacturing processes to computer-aided modeling (e.g., casting, molding, forming, separating, conditioning, assembling, finishing, rapid prototyping, 3-D printing).

5.3.2 Evaluate a sketch and generate a model utilizing three-dimensional modeling.

5.3.3 Analyze assembly constraints and successfully construct an assembly drawing.

5.3.4 Use part libraries effectively during the assembly modeling process.

5.3.5 Employ subassemblies during the production of assemblies.

5.3.6 Verify drive constraints that simulate the motion of parts in assemblies.

5.3.7 Adapt design concepts during the development of sketches, drawings, features, parts, and assemblies to meet new product specifications.

5.3.8 Translate a three-dimensional drawing or model into corresponding orthographic drawing views.

5.3.9 Evaluate a model for design imperfections.

5.3.10 Create and interpret auxiliary views, orthographic projections, isometric drawings, oblique drawings, and perspective drawings.

5.3.11 Create a sectional view drawing.

5.3.12 Illustrate the types of breaks and symbols used in drawing sectional and auxiliary views.

5.3.13 Produce a reverse-engineered drawing from a solid object.

5.3.14 Add technical elements (e.g., parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings.

5.3.15 Apply tolerancing techniques and dimensioning to the computer aided design process.

**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 composites).

5.4.4 Evaluate the types and magnitude of stresses and forces.

5.4.5 Analyze material properties by destructive and nondestructive tests.

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

5.4.7 Analyze the strength of a design using a simulation.

5.4.8 Use a material and develop a product.

**Outcome 5.5. Production and Process Design:** Identify and evaluate production and process design.

**Competencies**

5.5.1 Explain methods of casting, molding, and stamping for metal and plastic manufacturing

5.5.2 Determine appropriate mold design necessary for the production process

5.5.3 Use process planning and improvement tools (e.g., flowcharts, diagrams, design for manufacturability [DFM]).

5.5.4 Identify the planning and process procedures for production (e.g., corrective preventive actions, audit documentation, Process Failure Mode Effect Analysis [PFMEA]).

5.5.5 Determine critical characteristics and establish quality controls.

5.5.6 Employ project scheduling techniques (e.g., critical path methodology [CPM], project evaluation and review technique [PERT]).

5.5.7 Identify criteria and constraints and determine how those will affect the design of the production process.

5.5.8 Estimate time, tooling, product packaging and material costs.

5.5.9 Monitor performance and compared to time, tool and material cost estimates.

5.5.10 Adjust the production as necessary to respond to variations in the manufacturing process.

5.5.11 Develop a packaging design that prepares a product for shipping.

**Outcome 5.6** **Layout and Planning:** Plan a machining process.

**Competencies**

5.6.1 Determine product requirements, dimensions and tolerances from drawing and specifications.

**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.

5.7.6 Utilize a blueprint to produce a product

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 in 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.

5.8.6 Utilize a schematic to produce a product

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