**Course Description**

Learners develop skills in creating precise technical drawings and 3D models using computer-aided design (CAD) software. The course emphasizes understanding drafting standards, interpreting engineering drawings, and applying modeling techniques for design visualization and product development. Students gain hands-on experience in producing detailed plans and digital prototypes that support engineering and manufacturing 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 business enterprises related to the career field.

**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 resumes.

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.

**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, electronic 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 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 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.

**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

5.1.4 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.

5.1.8 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 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 Materials:** 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.

5.4.6 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.

**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.

5.5.7 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.

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

**Competencies**

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

5.6.2 Determine process steps (e.g., cut, drill, turn, mill, grind, heat treat).

5.6.3 Plan individual process steps based on industry standards (e.g., manufacturers' specifications, machining standards).

5.6.5 Determine the appropriate manufacturing technique that should be utilized when creating the product

**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.