**Course Description:**

Students will acquire knowledge and skills in problem solving, teamwork and innovation. Students explore STEM careers as they participate in a project-based learning process, designed to challenge and engage the natural curiosity and imagination of middle school students. Teams design and test their ideas using modeling, automation, robotics, mechanical and computer control systems, while exploring energy and the environment.

**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, resume 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.

1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits and abusive behavior.

**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 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 1.6. Business Literacy:** Develop foundational skills and knowledge in entrepreneurship, financial literacy and business operations.

**Competencies**

1.6.6. Identify the target market served by the organization, the niche that the organization fills and an outlook of the industry.

1.6.7. Identify the effect of supply and demand on products and services.

**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 and electromagnetic effect.

2.1.3. Explain methods of producing electrical current.

2.1.4. Explain how batteries store and disperse energy.

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

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

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

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

**Competencies**

2.2.1. Compare conductors and insulators.

2.2.2. Identify common types of transformers and list uses for each.

**Outcome 2.6. Digital Electronics:** Create circuits to perform tasks and operations.

**Competencies**

2.6.1. Convert number systems (e.g. binary coded decimal (BCD) to decimal, and decimal to BCD).

2.6.2. Determine the output frequency of circuits.

2.6.3. Describe the purpose and use of logic gates (e.g. discrete and medium scale integration [MSI] gates, latches, flip‐flops).

2.6.4. Design a paradigm for combinational logic problems.

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

5.1.2. Conduct an investigation to identify customer needs, constraints and criteria.

5.1.3. Develop multiple solutions and select an approach.

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

5.1.5. Evaluate and redesign a prototype using collected data.

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

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

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

5.1.9. Document progress and capture ideas during the development phase.

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

**Competencies**

5.2.1. Compare technical sketching and drawing.

5.2.2. Sketch possible solutions to an existing design problem.

5.2.3. Apply tolerancing techniques when dimensioning.

5.2.4. Apply annotations on sketches and drawings.

5.2.5. Create sketches using integration sketching techniques and styles.

5.2.6. Apply coordinate systems (e.g. absolute, relative, user, cylindrical, Cartesian).

5.2.7. Sketch geometric forms and shapes.

5.2.8. Describe geometric constraints (e.g. geometric dimension and tolerancing [GD&T], run out, location, and form).

5.2.9. Select a view to graphically communicate a design solution.

5.2.10. Use reverse engineering to determine the strengths and weaknesses of a design.

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

5.3.1. Apply 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. Compare conceptual, physical and mathematical design models used to check proper design.

5.3.4. Perform part manipulation during the creation of an assembly model.

5.3.5. Analyze assembly constraints and successfully construct an assembly drawing.

5.3.6. Utilize part libraries effectively during the assembly modeling process.

5.3.7. Employ subassemblies during the production of assemblies.

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

5.3.9. Apply adaptive design concepts during the development of sketches, drawings, features, parts and assemblies.

5.3.10. Translate a three‐dimensional drawing or model into corresponding orthographic drawing views.

5.3.11. Evaluate the accuracy of mass properties calculations.

5.3.12. Evaluate a model for design imperfections.

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

5.3.14. Create a sectional view drawing.

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

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

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

**Competencies**

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

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

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

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

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

5.5.8. Monitor performance and compare to time, tool and material cost estimates.

**Strand 6. Precision and Advanced Machining**

Learners apply principles of precision machining to measuring work pieces, drawing interpretation, inspection, bench work and layout, power saws, drilling machines, lathes and turning machines, milling machines and grinding machines.

**Outcome 6.1. Measurement and Interpretation:** Interpret drawings and documentation and perform measurements.

**Competencies**

6.1.1. Identify measuring tools and gradations used in precision machining and their purposes.

6.1.2. Identify typical measurements in precision machining (e.g. angles, diameter, hardness).

6.1.3. Identify measuring systems and convert between systems.

6.1.4. Identify information and symbols provided in drawings and specifications.

6.1.5. Measure and inspect work pieces according to product specifications.

**Outcome 6.2. Layout and Planning:** Plan a machining process.

**Competencies**

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

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

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