PROGRAM CONCENTRATION: **Engineering & Technology**
CAREER PATHWAY: **Manufacturing**
COURSE TITLE: **Foundations of Manufacturing & Materials Science**

Foundations of Manufacturing and Materials Science is the introductory course for the Manufacturing career pathway. This course provides students with opportunities to become familiar with related careers and develop fundamental technological literacy as they learn about the history, systems, and processes of manufacturing. In addition, the course will provide an overview of the safe use of tools and equipment used in the industry.

ENGR-FMMS-1. Students will explain the societal impact of manufacturing.

a. Track the evolution of manufacturing and its impact on society.
b. Explain the educational requirements and professional expectations associated with a career in manufacturing.
c. Describe the impact of governmental and political systems on manufacturing.
d. Explain the interaction between manufacturing industries and social change.
e. Explain how manufacturing made the United States a world leader.
f. Describe the relationship between manufacturing and the environment.
g. Explain the importance of a technologically literate workforce to the manufacturing industry.

Academic Standards:

SSUSH12. The student will analyze important consequences of American industrial growth.

ENGR-FMMS-2. Students will describe the history of manufacturing.

a. Identify key historical events and their impact on manufacturing.
b. List key persons who have contributed to change in manufacturing.
c. Describe the Industrial Revolution and its impact on manufacturing.
d. Identify pioneers of the manufacturing industry.
e. Describe/debate the affect that automation has had on manufacturing.

Academic Standards:

SSUSH12. The student will analyze important consequences of American industrial growth.

ENGR-FMMS-3. Students will explain the universal systems model as it relates to manufacturing.

a. Describe the processes of input, processing, output, and feedback that comprise the universal systems model.
b. Demonstrate applications of the universal systems model in manufacturing.
c. Describe the role of time, capital, people, tools and machines, energy, materials, and information within the universal systems model as it applies to manufacturing industries.

Academic Standards:

SCSh6. Students will communicate scientific investigations and information clearly.

SCSh8. Students will understand important features of the process of scientific inquiry.

ENGR-FMMS-4. Students will explain and apply safe work practices while performing tasks.

a. Identify safety equipment
b. Recognize immediate, potential, and hidden hazards.
c. Perform housekeeping tasks related to maintaining a safe work environment.
d. Pass a safety test with a perfect score prior to operating equipment.
e. Demonstrate the proper safe use of tools and equipment.
f. Identify safety color codes.

Academic Standards:

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students will use tools and instruments for observing, measuring, and manipulation scientific equipment and materials.

ENGR-FMMS-5. Students will identify materials and resources used in manufacturing.

a. Describe the seven basic technological resources.
b. Describe the properties of manufacturing materials.
c. Explain how materials are classified.
d. List, measure, and compare common mechanical properties of select materials.
e. List sources and costs where materials may be obtained.
f. Create a bill of materials.
g. Calculate production cost analysis.

Academic Standards:

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students will use tools and instruments for observing, measuring, and manipulation scientific equipment and materials.

ENGR-FMMS-6. Students will describe the essential systems and processes involved in manufacturing.

a. Compare and contrast custom, intermittent, and continuous manufacturing systems.
b. Demonstrate fundamentals of producing technical sketches.
c. Create simple two and three dimensional drawings using CAD software.
d. List common hand tools used in the maintenance, installation, and repair of equipment.
e. Identify commonly used power tools.
f. Describe primary manufacturing processes.
g. List secondary manufacturing processes.
h. Define the terms separating and forming as it relates to manufacturing.
i. Identify separating processes – traditional and non-traditional.
j. Identify forming processes including casting, molding, compression, stretching, and conditioning.
k. Differentiate between combining processes such as mixing, bonding, coating, and mechanical filtering.
l. Produce a simple part applying computer assisted production equipment.
m. Program a robot to perform a repetitive task.
n. Create a device that will perform a task using a computer controlled program.
o. Describe the advantages/disadvantages of the separation processing of materials using manual versus computer controlled machinery.
p. Describe assembling processes.
q. Explain the importance of finishing processes.
r. Describe the role of quality control in the manufacturing process.
s. Explain the importance of quality control within a manufacturing system.

Academic Standards:

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students will use tools and instruments for observing, measuring, and manipulation scientific equipment and materials.

ENGR-FMMS-7. Students will perform a pre-planned introductory manufacturing activity applying correct safety procedures, appropriate use of materials, and processing operations.

a. Use hand and power tools safely.
b. Demonstrate fundamentals of reading technical sketches.
c. Use English and/or metric measurement effectively in order to properly lay out a part for manufacturing.

d. Follow a production flow chart to produce a teacher-selected product.
e. Apply appropriate problem solving to improve an existing manufacturing system.

Academic Standards:

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students will use tools and instruments for observing, measuring, and manipulation scientific equipment and materials.

ENGR-FMMS-8. Students will use visual and verbal communication to present employment and career opportunities in manufacturing.

a. Present a technical report to an audience regarding a researched manufacturing related career using multimedia.
b. Prepare and produce a portfolio representing experiences throughout the course of study.

Academic Standards:

ELA11LSV1. The student participates in student-to-teacher, student-to-student, and group verbal interactions.

STEM Standards (Common to all Engineering &Technology Courses)

Nature of Technology

ENGR-STEM-1. Students will recognize the systems, components, and processes of a technological system.

a. Describe the core concepts of technology.
b. Identify the relationships among technologies along with connections to contemporary issues.
c. Apply lifelong learning strategies necessary to understand the characteristics and scope of technology.

Academic Standards:

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh7. Students analyze how scientific knowledge is developed.

MM3P4. Students will make connections among mathematical ideas and to other disciplines.

Technology and Society

ENGR-STEM-2. Students will identify the impact of engineering and technology within global, economic, environmental, and societal contexts.

a. Describe the social, economic, and environmental impacts of a technological process, product, or system.
b. Demonstrate ethical and professional behavior in the development and use of technology.
c. Explain the influence of technology on history and the shaping of contemporary issues.

Academic Standards:

SCSh7. Students analyze how scientific knowledge is developed.

MM3P4. Students will make connections among mathematical ideas and to other disciplines.

Design

ENGR-STEM-3. Students will design technological problem solutions using scientific investigation, analysis and interpretation of data, innovation, invention, and fabrication while considering economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints.

a. Demonstrate fundamental principles of design.
b. Design and conduct experiments along with analysis and interpretation of data.
c. Identify and consider realistic constraints relevant to the design of a system, component, or process.

Academic Standards:

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SCSh8. Students will understand important features of the process of scientific inquiry.

MM3P1. Students will solve problems (using appropriate technology).

MM3P2. Students will reason and evaluate mathematical arguments.

Abilities for a Technological World

ENGR-STEM-4. Students will apply principles of science, technology, engineering, mathematics, interpersonal communication, and teamwork to the solution of technological problems.

a. Work cooperatively in multi-disciplinary teams.
b. Apply knowledge of mathematics, science, and engineering design.
c. Demonstrate strategies for identifying, formulating, and solving technological problems.
d. Demonstrate techniques, skills, and knowledge necessary to use and maintain technological products and systems.

Academic Standards:

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SCSh6. Students will communicate scientific investigations and information clearly.

SCSh8. Students will understand important features of the process of scientific inquiry.

MM3P4. Students will make connections among mathematical ideas and to other disciplines.

The Designed World

ENGR-STEM-5. Students will select and demonstrate techniques, skills, tools, and understanding related to energy and power, bio-related, communication, transportation, manufacturing, and construction technologies.

a. Use common tools correctly and safely.
b. Describe strategies for selecting materials and processes necessary for developing a technological system or artifact.
c. Demonstrate fundamental materials processing and assembly techniques.
d. Evaluate the interdependence of components in a technological system and identify those elements that are critical to correct functioning.
e. Apply analytical tools to the development of optimal solutions for technological problems.

Academic Standards:

SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

MM3P1. Students will solve problems (using appropriate technology).

MM3P2. Students will reason and evaluate mathematical arguments.

MM3P4. Students will make connections among mathematical ideas and to other disciplines.

Reading

ENGR-STEM-6. Students will enhance reading by developing vocabulary and comprehension skills associated with text materials, problem descriptions, and laboratory activities associated with engineering and technology education.

a. Read in all curriculum areas.
b. Discuss books.
c. Build vocabulary knowledge.
d. Establish context.

Academic Standards:

ELAALRC2. The student participates in discussions related to curricular learning in all subject areas.

ELAALRC3. The student acquires new vocabulary in each content area and uses it correctly.

ELAALRC4. The student establishes a context for information acquired by reading across subject areas.

Leadership Development

ENGR-STEM-7. Students will develop leadership and interpersonal problem-solving skills through participation in co-curricular activities associated with the Technology Student Association.

a. Demonstrate effective communication skills.
b. Participate in teamwork to accomplish specified organizational goals.
c. Demonstrate cooperation and understanding with persons who are ethnically and culturally diverse.

Academic Standards:

MM3P3. Students will communicate mathematically.

MM3P5. Students will represent mathematics in multiple ways.

SCSh6. Students will communicate scientific investigations and information clearly.

CTAE Foundation Skills

The Foundation Skills for Career, Technical and Agricultural Education (CTAE) are critical competencies that students pursuing any career pathway should exhibit to be successful. As core standards for all career pathways in all program concentrations, these skills link career, technical and agricultural education to the state's academic performance standards.

The CTAE Foundation Skills are aligned to the foundation of the U. S. Department of Education's 16 Career Clusters. Endorsed by the National Career Technical Education Foundation (NCTEF) and the National Association of State Directors of Career Technical Education Consortium (NASDCTEc), the foundation skills were developed from an analysis of all pathways in the sixteen occupational areas. These standards were identified and validated by a national advisory group of employers, secondary and postsecondary educators, labor associations, and other stakeholders. The Knowledge and Skills provide learners a broad foundation for managing lifelong learning and career transitions in a rapidly changing economy.

CTAE-FS-1 Technical Skills: Learners achieve technical content skills necessary to pursue the full range of careers for all pathways in the program concentration.

CTAE-FS-2 Academic Foundations: Learners achieve state academic standards at or above grade level.

CTAE-FS-3 Communications: Learners use various communication skills in expressing and interpreting information.

CTAE-FS-4 Problem Solving and Critical Thinking: Learners define and solve problems, and use problem-solving and improvement methods and tools.

CTAE-FS-5 Information Technology Applications: Learners use multiple information technology devices to access, organize, process, transmit, and communicate information.

CTAE-FS-6 Systems: Learners understand a variety of organizational structures and functions.

CTAE-FS-7 Safety, Health and Environment: Learners employ safety, health and environmental management systems in corporations and comprehend their importance to organizational performance and regulatory compliance.

CTAE-FS-8 Leadership and Teamwork: Learners apply leadership and teamwork skills in collaborating with others to accomplish organizational goals and objectives.

CTAE-FS-9 Ethics and Legal Responsibilities: Learners commit to work ethics, behavior, and legal responsibilities in the workplace.

CTAE-FS-10 Career Development: Learners plan and manage academic-career plans and employment relations.

CTAE-FS-11 Entrepreneurship: Learners demonstrate understanding of concepts, processes, and behaviors associated with successful entrepreneurial performance.