PROGRAM CONCENTRATION: **Engineering and Technology**
CAREER PATHWAY: **Energy Systems**
COURSE TITLE: **Energy and Power Technology**

COURSE DESCRIPTION: This course is the second course in the Energy Systems Pathway. It is an introductory course that explores the relationship between force, work, energy, and power. Students study the characteristics, availability, conversion, control, transmission, and storage of energy and power. Students will explore and apply the principles of electrical, fluid, and mechanical power. Students will research renewable, non-renewable, and inexhaustible resources and conservation efforts. Students will develop an awareness of the many careers that exist in energy and related technologies.

ENGR-EP-1. Students will utilize the ideas of energy, work, power, and force to explain how systems convert, control, transmit, and/or store energy and power.

a. Describe processes by which energy stored in a system may be used to do work.
b. Use Newton's Laws to calculate the net force acting or exerted by a system.
c. Determine the amount of work done by or on a system.
d. Outline the difference between energy and power.
e. Give examples of how conduction, convection, and radiation are considered in the selection of materials for buildings and in the design of a heating system.

ACADEMIC STANDARDS:

SPS7. Students will determine relationships among force, mass, and motion.

b. Apply Newton's three laws to everyday situations by explaining the following:

- *Inertia*
- *Relationship between force, mass and acceleration*
- *Equal and opposite forces*

SPS8. Students will relate transformations and flow of energy within a system.

b. Investigate molecular motion as it relates to thermal energy changes in terms of conduction, convection, and radiation.

SP1. Students will analyze the relationships between force, mass, gravity, and the motion of objects.

d. Measure and calculate the magnitude of frictional forces and Newton's three Laws of Motion.

SP3. Students will evaluate the forms and transformations of energy.

a. Analyze, evaluate, and apply the principle of conservation of energy and measure the components of work-energy theorem by

- *describing total energy in a closed system.*

- *identifying different types of potential energy.*
- *calculating kinetic energy given mass and velocity.*
- *relating transformations between potential and kinetic energy.*

f. Analyze the relationship between temperature, internal energy, and work done in a physical system.

g. Analyze and measure power.

MM3P1 Students will solve problems (using appropriate technology).

b. Solve problems that arise in mathematics and in other contexts.

c. Apply and adapt a variety of appropriate strategies to solve problems.

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

c. Recognize and apply mathematics in contexts outside of mathematics.

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

a. Identifies messages and themes from books in all subject areas.
b. Responds to a variety of texts in multiple modes of discourse.
c. Relates messages and themes from one subject are to those in another area.
d. Evaluates the merits of texts in every subject discipline.
e. Examines the author's purpose in writing
f. Recognizes the features of disciplinary texts.

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

a. Demonstrates an understanding of contextual vocabulary in various subjects.
b. Uses content vocabulary in writing and speaking.
c. Explores understanding of new words found in subject area texts.

ENGR-EP-2. Students explain how simple machines are used to do work.

a. Calculate the mechanical advantage for different types of simple machines.
b. Show through calculation or build models how simple machines affect the amount of work necessary to complete a task.
c. Compare and contrast the ideal and actual mechanical advantage for different types of simple machines and explain the impact of these differences in the design of machine.
d. Determine the relationship of force and speed when either is changed by the advantage of a mechanical device.

ACADEMIC STANDARDS:

SP1. Students will analyze the relationships between force, mass, gravity, and the motion of objects.

d. *Measure and calculate the magnitude of frictional forces and Newton's three Laws of Motion.*

SPS7. Students will determine relationships among force, mass, and motion.

b. *Apply Newton's three laws to everyday situations by explaining the following:*
   - *Inertia*
   - *Relationship between force, mass and acceleration*
   - *Equal and opposite forces*

e. *Calculate amounts of work and mechanical advantage using simple machines.*

SPS8. Students will relate transformations and flow of energy within a system.

b. *Investigate molecular motion as it relates to thermal energy changes in terms of conduction, convection, and radiation.*

MM3P1 Students will solve problems (using appropriate technology).

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

c. *Recognize and apply mathematics in contexts outside of mathematics.*

MM3P5 Students will represent mathematics in multiple ways.

c. *Use representations to model and interpret physical, social, and mathematical phenomena.*

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a. *Demonstrates an understanding of contextual vocabulary in various subjects.*
b. *Uses content vocabulary in writing and speaking.*
c. *Explores understanding of new words found in subject area texts.*

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

a. *Explores life experiences related to subject area content.*

b. Discusses in both writing and speaking how certain words and concepts relate to multiple subjects.
c. Determines strategies for finding content and contextual meaning for unfamiliar words or concepts.

ENGR-EP-3. Students will differentiate between fluid power systems and apply the laws that govern each.

a. Explain the difference between open fluid systems (e.g., irrigation, forced hot air system, air compressors) and closed fluid systems (e.g., force hot water system, hydraulic brakes).
b. Explain what is meant by fluid power.
c. Compare and contrast how the volume of a gas varies with the changes in pressure and temperature.
d. Describe how a fluid is able to transfer force as well as change the relationship between force and distance or speed.
e. Calculate the ability of a hydraulic system to multiply distance, force and effect directional change.
f. Solve mathematical problems involving changes in pressure, temperature, and volume in fluid power systems.

ACADEMIC STANDARDS:

SPS7. Students will determine relationships among force, mass, and motion.
b. Apply Newton's three laws to everyday situations by explaining the following:
- *Inertia*
- *Relationship between force, mass and acceleration*
- *Equal and opposite forces*

SP1. Students will analyze the relationships between force, mass, gravity, and the motion of objects.
d. Measure and calculate the magnitude of frictional forces and Newton's three Laws of Motion.

SPS5. Students will compare and contrast the phases of matter as they relate to atomic and molecular motion.
a. Compare and contrast the atomic/molecular motion of solids, liquids, gases and plasmas.
b. Relate temperature, pressure, and volume of gases to the behavior of gases.

MM3P1 Students will solve problems (using appropriate technology).
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c. Determines strategies for finding content and contextual meaning for unfamiliar words or concepts.

ENGR-EP-4. Students will differentiate between AC and DC circuits and apply Ohm's and Kirchoff's Laws
a. Compare and contrast the characteristics of alternating current and direct current and the implications of the use of each form on work and power.
b. Explain differences between series and parallel circuits.
c. Explain the relationship of voltage, current, and resistance.
d. Use Ohm's and Kirchoff's laws to calculate the rate at which work is being done by an electric component in a DC circuit.

ACADEMIC STANDARDS:

SP5. Students will evaluate relationships between electrical and magnetic forces.
a. Describe the transformation of mechanical energy into electrical energy and the transmission of electrical energy.
b. Determine the relationship among potential difference, current, and resistance in a direct current circuit.
c. Determine equivalent resistances in series and parallel circuits.

SPS10. Students will investigate the properties of electricity and magnetism.
b. Explain the flow of electrons in terms of
- *alternating and direct current.*
- *the relationship among voltage, resistance and current.*
- *simple series and parallel circuits.*

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a. Explores life experiences related to subject area content.
b. Discusses in both writing and speaking how certain words and concepts relate to multiple subjects.
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ENGR-EP-5. Students will describe the basic components of a small engine and explain the difference between a 4-stroke and 2-stroke engine.
a. Compare and contrast the advantages and disadvantages of the two and four cycle engines.
b. Explain the concept of valve timing.
c. Compare the lubrication system in a four-cycle engine to the system of a two-cycle engine.
d. Describe the two-stroke engine operation and explain the principles of two-cycle operation.
e. Disassemble and reassemble a basic small engine.

ACADEMIC STANDARDS:

SP3. Students will evaluate the forms and transformations of energy.
a. Analyze, evaluate, and apply the principle of conservation of energy and measure the components of work-energy theorem by
- *describing total energy in a closed system.*

- *identifying different types of potential energy.*
- *calculating kinetic energy given mass and velocity.*
- *relating transformations between potential and kinetic energy.*

b. Explain the relationship between matter and energy.

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

MM3P4 Students will make connections among mathematical ideas and to other disciplines.
c. Recognize and apply mathematics in contexts outside of mathematics.

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:

MM3P4 Students will make connections among mathematical ideas and to other disciplines.
c. Recognize and apply mathematics in contexts outside of mathematics.

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:

MM3P1 Students will solve problems (using appropriate technology).

a. Build new mathematical knowledge through problem solving.
b. Solve problems that arise in mathematics and in other contexts.
c. Apply and adapt a variety of appropriate strategies to solve problems.

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:

MM3P4 Students will make connections among mathematical ideas and to other disciplines.
c. Recognize and apply mathematics in contexts outside of mathematics.

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:

MM3P1 Students will solve problems (using appropriate technology).
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c. Apply and adapt a variety of appropriate strategies to solve problems.

MM3P4 Students will make connections among mathematical ideas and to other disciplines.
c. Recognize and apply mathematics in contexts outside of mathematics.

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:

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b. Discusses in both writing and speaking how certain words and concepts relate to multiple subjects.
c. Determines strategies for finding content and contextual meaning for unfamiliar words or concepts.

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.

Characteristics of Science
Habits of Mind

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

a. Exhibit the above traits in their own scientific activities.
b. Recognize that different explanations often can be given for the same evidence.
c. Explain that further understanding of scientific problems relies on the design and execution of new experiments which may reinforce or weaken opposing explanations.

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

a. Follow correct procedures for use of scientific apparatus.
b. Demonstrate appropriate technique in all laboratory situations.
c. Follow correct protocol for identifying and reporting safety problems and violations.

SCSh3. Students will identify and investigate problems scientifically.

a. Suggest reasonable hypotheses for identified problems.
b. Develop procedures for solving scientific problems.
c. Collect, organize and record appropriate data.
d. Graphically compare and analyze data points and/or summary statistics.
e. Develop reasonable conclusions based on data collected.
f. Evaluate whether conclusions are reasonable by reviewing the process and checking against other available information.

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

a. Develop and use systematic procedures for recording and organizing information.
b. Use technology to produce tables and graphs.
c. Use technology to develop, test, and revise experimental or mathematical models.

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

a. Trace the source on any large disparity between estimated and calculated answers to problems.
b. Consider possible effects of measurement errors on calculations.
c. Recognize the relationship between accuracy and precision.
d. Express appropriate numbers of significant figures for calculated data, using scientific notation where appropriate.

e. Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas as appropriate.

SCSh6. Students will communicate scientific investigations and information clearly.

a. Write clear, coherent laboratory reports related to scientific investigations.
b. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data.
c. Use data as evidence to support scientific arguments and claims in written or oral presentations.
d. Participate in group discussions of scientific investigation and current scientific issues.

The Nature of Science

SCSh7. Students analyze how scientific knowledge is developed.

Students recognize that:

a. The universe is a vast single system in which the basic principles are the same everywhere.
b. Universal principles are discovered through observation and experimental verification.
c. From time to time, major shifts occur in the scientific view of how the world works.
d. More often, however, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge. Major shifts in scientific views typically occur after the observation of a new phenomenon or an insightful interpretation of existing data by an individual or research group.
e. Hypotheses often cause scientists to develop new experiments that produce additional data.
f. Testing, revising, and occasionally rejecting new and old theories never ends.

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

Students will apply the following to inquiry learning practices:

a. Scientific investigators control the conditions of their experiments in order to produce valuable data.
b. Scientific researchers are expected to critically assess the quality of data including possible sources of bias in their investigations' hypotheses, observations, data analyses, and interpretations.
c. Scientists use practices such as peer review and publication to reinforce the integrity of scientific activity and reporting.
d. The merit of a new theory is judged by how well scientific data are explained by the new theory.
e. The ultimate goal of science is to develop an understanding of the natural universe which is free of biases.
f. Science disciplines and traditions differ from one another in what is studied, techniques used, and outcomes sought.

Reading Across the Curriculum

Reading Standard Comment

After the elementary years, students engage in reading for learning. This process sweeps across all disciplinary domains, extending even to the area of personal they experience text in all genres and modes of discourse. In the study of various disciplines of learning (language arts, mathematics, science, social studies), students must learn through reading the communities of discourse of each of those disciplines. Each subject has its own specific vocabulary, and for students to excel in all subjects, they must learn the specific vocabulary of those subject areas in context.

Beginning with the middle grades years, students begin to self-select reading materials based on personal interests established through classroom learning. Students become curious about science, mathematics, history, and literature as they form contexts for those subjects related to their personal and classroom experiences. As students explore academic areas through reading, they develop favorite subjects and become confident in their verbal discourse about those subjects.

Reading across curriculum content develops both academic and personal interests in students. As students read, they develop both content and contextual vocabulary. They also build good habits for reading, researching, and learning. The Reading Across the Curriculum standard focuses on the academic and personal skills students acquire as they read in all areas of learning.

Students will enhance reading in all curriculum areas by:

a. Reading in all curriculum areas
   - Read a minimum of 25 grade-level appropriate books per year from a variety of subject disciplines and participate in discussions related to curricular learning in all areas.
   - Read both informational and fictional texts in a variety of genres and modes of discourse.
   - Read technical texts related to various subject areas.

b. Discussing books
   - Discuss messages and themes from books in all subject areas.
   - Respond to a variety of texts in multiple modes of discourse.
   - Relate messages and themes from one subject area to messages and themes in another area.
   - Evaluate the merit of texts in every subject discipline.
   - Examine author's purpose in writing.
   - Recognize the features of disciplinary texts.

c. Building vocabulary knowledge
   - Demonstrate an understanding of contextual vocabulary in various subjects.
   - Use content vocabulary in writing and speaking.

- Explore understanding of new words found in subject area texts.

d. Establishing context
   - Explore life experiences related to subject area content.
   - Discuss in both writing and speaking how certain words are subject area related.
   - Determine strategies for finding content and contextual meaning for unknown words.

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.