

Engineering Problem Solving Pacing

Scope & Sequence

Course Name: Engineering Design and Problem Solving TSDS PEIMS Code: 13037300		Course Credit: 1.0 Course Requirements: Recommended for students in Grades 11-12. Prerequisites: Algebra I and Geometry. Recommended Prerequisites: Two Science, Technology, Engineering, and Mathematics Career Cluster credits.
Course Description: The Engineering Design and Problem Solving course is the creative process of solving problems by identifying needs and then devising solutions. The solution may be a product, technique, structure, or process depending on the problem. Science aims to understand the natural world, while engineering seeks to shape this world to meet human needs and wants. Engineering design takes into consideration limiting factors or "design under constraint." Various engineering disciplines address a broad spectrum of design problems using specific concepts from the sciences and mathematics to derive a solution. The design process and problem solving are inherent to all engineering disciplines. This research-based course meets one of the Distinguished Achievement Program advanced measures. This course meets the requirements for the 4th science credit.		
NOTE: This is a suggested scope and sequence for the course content. This content will work with any textbook or instructional materials. If locally adapted, make sure all TEKS are covered.		
Total Number of Periods Total Number of Hours	175 Periods 131.25 Hours	*Schedule calculations based on 175/180 calendar days. For 0.5 credit courses, schedule is calculated out of 88/90 days. Scope and sequence allows additional time for guest speakers, student presentations, field trips, remediation, extended learning activities, etc.
Unit Number, Title, and Brief Description	# of Class Periods* *(assumes 45-minute periods) Total minutes per unit	TEKS Covered 130.412. (c) Knowledge and skills
Unit 1: Exploration of the STEM Field of Engineering Design In this unit, students will further their knowledge of engineering design and problem solving. Students will explore and distinguish the varying roles in the field and experience necessary for each. The unit culminates with an activity in which students discuss the history and importance of engineering innovation on the U.S. economy and quality of life and describe the importance of patents and the protection of intellectual property rights.	15 Periods 675 Minutes 11.25 Hours	(7) The student recognizes the history, development, and practices of the engineering professions. The student is expected to: (A) identify and describe career options, working conditions, earnings, and educational requirements of various engineering disciplines such as those listed by the Texas Board of Professional Engineers; (B) recognize that engineers are guided by established codes emphasizing high ethical standards; (C) explore the differences, similarities, and interactions among engineers, scientists, and mathematicians; (D) describe how technology has evolved in the field of engineering and consider how it will continue to be a useful tool in solving engineering problems; (E) discuss the history and importance of engineering innovation on the U.S. economy and quality of life; and

Engineering Problem Solving Pacing

		<p>(F) describe the importance of patents and the protection of intellectual property rights.</p>
<p>Unit 2: Use of Scientific Method in Laboratory and Field investigations</p> <p>Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation are experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. In this unit, students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.</p>	<p style="text-align: center;">15 Periods 675 Minutes 11.25 Hours</p>	<p>(3) The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:</p> <p>(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(6) of this section;</p> <p>(B) know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories;</p> <p>(C) know that scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but they may be subject to change as new areas of science and new technologies are developed;</p> <p>(D) distinguish between scientific hypotheses and scientific theories;</p> <p>(E) plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology.</p>
<p>Unit 3: Use of Scientific Method to Develop a Solution</p> <p>This course is intended to stimulate students' ingenuity, intellectual talents, and practical skills in devising solutions to engineering design problems. Students use the engineering design process cycle to investigate, design, plan, create, and evaluate solutions. At the same time, this course fosters awareness of the social and ethical implications of technological development. The culminating activity for this unit will be for students to analyze, evaluate, make inferences, and predict trends from data and communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings,</p>	<p style="text-align: center;">15 Periods 675 Minutes 11.25 Hours</p>	<p>(3) The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:</p> <p>(F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, gel electrophoresis apparatuses, micropipettors, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, cameras, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;</p> <p>(G) analyze, evaluate, make inferences, and predict trends from data; and</p>

Engineering Problem Solving Pacing

<p>graphic organizers, journals, summaries, oral reports, and technology-based reports.</p>		<p>(H) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.</p>
<p>Unit 4: Safety Precautions</p> <p>This unit offers students the opportunity to demonstrate basic technical skills necessary for safety precautions in the STEM field.</p> <p>Students will adhere to and follow all guidelines and regulations to maintain a safe working environment.</p>	<p>10 Periods 450 Minutes 7.5 Hours</p>	<p>(2) The student, for at least 40% of instructional time, conducts engineering laboratory and field activities using safe, environmentally appropriate, and ethical practices. The student is expected to:</p> <p>(A) demonstrate safe practices during engineering laboratory and field activities; and</p> <p>(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.</p>
<p>Unit 5: Application of Problem Solving Skills</p> <p>Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." Physical, mathematical, and conceptual models describe this vast body of changing and increasing knowledge. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable. In this unit, students will apply problem-solving skills critical to the STEM field. Students will research history and analyze information to draw inferences based upon the data.</p>	<p>15 Periods 675 Minutes 11.25 Hours</p>	<p>(4) The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:</p> <p>(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;</p> <p>(B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;</p> <p>(C) draw inferences based on data related to promotional materials for products and services;</p> <p>(D) evaluate the impact of scientific research on society and the environment;</p> <p>(E) evaluate models according to their limitations in representing biological objects or events; and</p> <p>(F) research and describe the history of biology and contributions of scientists.</p>
<p>Unit 6: Solve Engineering Design Problems</p> <p>Engineering Design and Problem Solving reinforces and integrates skills learned in previous mathematics and science courses. This course emphasizes solving problems, moving from well-defined toward more open-ended, with real-world application. Students will apply critical-thinking skills to justify a solution from multiple design options and select appropriate mathematical models to</p>	<p>15 Periods 675 Minutes 11.25 Hours</p>	<p>(5) The student applies knowledge of science and mathematics and the tools of technology to solve engineering design problems. The student is expected to:</p> <p>(A) apply scientific processes and concepts outlined in the Texas essential knowledge and skills (TEKS) for Biology, Chemistry, or Physics relevant to engineering design problems;</p> <p>(B) apply concepts, procedures, and functions outlined in the TEKS for Algebra I, Geometry, and Algebra II relevant to engineering design problems;</p>

Engineering Problem Solving Pacing

<p>develop solutions to engineering design problems. Additionally, the course promotes interest in and understanding of career opportunities in engineering.</p>		<p>(C) select appropriate mathematical models to develop solutions to engineering design problems;</p> <p>(D) integrate advanced mathematics and science skills as necessary to develop solutions to engineering design problems;</p> <p>(E) judge the reasonableness of mathematical models and solutions.</p>
<p>Unit 7: Solve Engineering Design Problems</p> <p>Scientific decision-making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information). In this unit, students will investigate and apply relevant chemical, mechanical, biological, electrical, and physical properties of materials to engineering design problems. The culminating activity will be for students to use appropriate measurement systems, including customary and International System (SI) of units; and make measurements with accuracy and precision.</p>	<p>15 Periods 675 Minutes 11.25 Hours</p>	<p>(5) The student applies knowledge of science and mathematics and the tools of technology to solve engineering design problems. The student is expected to:</p> <p>(F) investigate and apply relevant chemical, mechanical, biological, electrical, and physical properties of materials to engineering design problems;</p> <p>(G) identify the inputs, processes, outputs, control, and feedback associated with open and closed systems;</p> <p>(H) describe the difference between open-loop and closed-loop control systems;</p> <p>(I) make measurements with accuracy and precision and specify tolerances;</p> <p>(J) use appropriate measurement systems, including customary and International System (SI) of units; and</p> <p>(K) use conversions between measurement systems to solve real-world problems.</p>
<p>Unit 8: Communication Skills in the STEM Field</p> <p>Students will now apply technical skills and knowledge of Science, Technology, Engineering, and Mathematics to analyze, evaluate, and communicate problems and solutions in this unit. Students will develop and demonstrate communication skills to relay this information to others both verbally and written.</p>	<p>15 Periods 675 Minutes 11.25 Hours</p>	<p>(6) The student communicates through written documents, presentations, and graphic representations using the tools and techniques of professional engineers. The student is expected to:</p> <p>(A) communicate visually by sketching and creating technical drawings using established engineering graphic tools, techniques, and standards;</p> <p>(B) read and comprehend technical documents, including specifications and procedures;</p> <p>(C) prepare written documents such as memorandums, emails, design proposals, procedural directions, letters, and technical reports using the formatting and terminology conventions of technical documentation;</p> <p>(D) organize information for visual display and analysis using appropriate formats for various audiences, including graphs and tables;</p> <p>(E) evaluate the quality and relevance of sources and cite appropriately; and</p> <p>(F) defend a design solution in a presentation.</p>

Engineering Problem Solving Pacing

<p>Unit 9: Formulating Solutions</p> <p>The STEM Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services, including laboratory and testing services, and research and development services. In this unit, students will identify and define an engineering problem AND formulate goals, objectives, and requirements to solve an engineering problem. The culminating activity will have students prepare a project report that clearly documents the designs, decisions, and activities during each phase of the engineering design process.</p>	<p>15 Periods 675 Minutes 11.25 Hours</p>	<p>(8) The student creates justifiable solutions to open-ended real-world problems using engineering design practices and processes. The student is expected to:</p> <ul style="list-style-type: none"> (A) identify and define an engineering problem; (B) formulate goals, objectives, and requirements to solve an engineering problem; (C) determine the design parameters associated with an engineering problem such as materials, personnel, resources, funding, manufacturability, feasibility, and time; (D) establish and evaluate constraints pertaining to a problem, including health, safety, social, environmental, ethical, political, regulatory, and legal; (E) identify or create alternative solutions to a problem using a variety of techniques such as brainstorming, reverse engineering, and researching engineered and natural solutions; (F) test and evaluate proposed solutions using methods such as models, prototypes, mock-ups, simulations, critical design review, statistical analysis, or experiments; (G) apply structured techniques to select and justify a preferred solution to a problem such as a decision tree, design matrix, or cost-benefit analysis; (H) predict performance, failure modes, and reliability of a design solution; and (I) prepare a project report that clearly documents the designs, decisions, and activities during each phase of the engineering design process.
<p>Unit 10: Employability Skills</p> <p>This unit offers students basic technical skills necessary to fulfill careers in the workforce. Through group activities, students will demonstrate interpersonal skills, such as: communication, professionalism, time management, and collaboration. The unit culminates with a peer review evaluation and reflection upon skills needed for success in the workforce.</p>	<p>15 Periods 675 Minutes 11.25 Hours</p>	<p>(1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:</p> <ul style="list-style-type: none"> (A) demonstrate knowledge of how to dress appropriately, speak politely, and conduct oneself in a manner appropriate for the profession; (B) show the ability to cooperate, contribute, and collaborate as a member of a group in an effort to achieve a positive collective outcome; (C) present written and oral communication in a clear, concise, and effective manner; (D) demonstrate time-management skills in prioritizing tasks, following schedules, and performing goal-relevant activities in a way that produces efficient results; and

Engineering Problem Solving Pacing

		(E) demonstrate punctuality, dependability, reliability, and responsibility in performing assigned tasks as directed.
<p>Unit 11: Teamwork in STEM</p> <p>In this unit students will demonstrate teamwork processes that promote team building, consensus, continuous improvement, respect for the opinions of others, cooperation, adaptability, and conflict resolution. Students will collaborate to work together efficiently, using positive interpersonal skills to establish and maintain effective working relationships in order to accomplish objectives and tasks. The culminating activity will require students to develop a plan and project schedule for completion of a project.</p>	<p>15 Periods 675 Minutes 11.25 Hours</p>	<p>(9) The student manages an engineering design project. The student is expected to:</p> <p>(A) participate in the design and implementation of a real-world or simulated engineering project using project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;</p> <p>(B) develop a plan and project schedule for completion of a project;</p> <p>(C) work in teams and share responsibilities, acknowledging, encouraging, and valuing contributions of all team members;</p> <p>(D) compare and contrast the roles of a team leader and other team responsibilities.</p>
<p>Unit 12: Extended Learning Experience</p> <p>In this unit, students are encouraged to expand their learning experiences through avenues such as STEM organizations and other leadership or extracurricular organizations. By connecting with these networks and/or their peers in the previous unit, students will be able to participate in a real or simulated engineering project. The culminate project will have students develop a plan needed to complete an individual product.</p>	<p>15 Periods 675 Minutes 11.25 Hours</p>	<p>(9) The student manages an engineering design project. The student is expected to:</p> <p>(E) identify and manage the resources needed to complete a project;</p> <p>(F) use a budget to determine effective strategies to meet cost constraints;</p> <p>(G) create a risk assessment for an engineering design project;</p> <p>(H) analyze and critique the results of an engineering design project; and</p> <p>(I) maintain an engineering notebook that chronicles work such as ideas, concepts, inventions, sketches, and experiments.</p>