# Scope & Sequence

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| **Course Name:** Engineering Science  **TSDS PEIMS Code:** 13037500 | | **Course Credit:** 1.0  **Course Requirements:** Recommended for students in Grades 10-12. **Prerequisites:** Algebra l and Biology Chemistry, Integrated Physics, and Chemistry (IPC), or Physics.  **Recommended Prerequisite:** Geometry. |
| **Course Description:** Engineering Science is an engineering course designed to expose students to some of the major concepts and technologies that they will encounter in a postsecondary program of study in any engineering domain. Students will have an opportunity to investigate engineering and high-tech careers. In Engineering Science, students will employ science, technology, engineering, and mathematical concepts in the solution of real-world challenge situations. Students will develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges. Students will also learn how to document their work and communicate their solutions to their peers and members of the professional community. Students must meet the 40% laboratory and fieldwork requirement. This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course. | | |
| **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 Minutes**  **Total Number of Hours** | 175 Periods  7875 Minutes  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**  **130.414. (c) Knowledge and skills** |
| **Unit 1: Careers in Engineering Science**  Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions. In this unit, students will investigate careers in engineering. The culminating activity will have students present on their findings. | 10 Periods  450 Minutes | (5) The student investigates engineering-related fields and career opportunities. The student is expected to:  (A) differentiate between engineering and engineering technology;  (B) compare the roles or job descriptions for career opportunities in the fields of pure science, engineering, and engineering technology;  (C) identify and differentiate between the different engineering disciplines; and  (D) demonstrate appropriate oral, written, and visual forms of technical communication. |
| **Unit 2: What is Science?**  To understand STEM (Science, Technology, Engineering, and Math) principles of technology, students must first understand what Science is. In this unit, the student will define science and its limitations. Students will examine hypotheses generated to guide a research process by evaluating the merits and feasibility of the hypotheses. The culminating activity for this unit will have students distinguish between scientific hypotheses and scientific theories and design and implement investigative procedures. | 10 Periods  450 Minutes | (3) The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:  (A) know the definition of science and understand that it has limitations, as specified in subsection (b)(4) of this section;  (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 which have been tested over a wide variety of conditions are incorporated into theories;  (C) know 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;  (D) distinguish between scientific hypotheses and scientific theories;  (E) plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology. |
| **Unit 3: Laboratory and Field Investigations**  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 gather, organize, and measure various technological data using a variety of equipment. The culminating activity will have students evaluate the data and communicate their conclusions and inferences through various methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, and oral reports. | 10 Periods  450 Minutes | (3) The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:  (F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, electronic balances, micropipettors, hand lenses, surgical and imagining equipment, thermometers, hot plates, lab notebooks or journals, timing devices, Petri dishes, lab incubators, dissection equipment, and models, diagrams, or samples of biological specimens or structures;  (G) analyze, evaluate, make inferences, and predict trends from data; and  (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. |
| **Unit 4: Safety Precautions and Ethical Practices**  In this unit, students will comply with federal and state safety regulations. Students will identify and obey safety guidelines. The culminating activity will have students demonstrate appropriate safety and ethical procedures, including the proper disposal or recycling of materials. | 10 Periods  450 Minutes | (2) The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:  (A) demonstrate safe practices during laboratory and field investigations; and  (B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials. |
| **Unit 5: Scientific Reasoning**  Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked. In this unit, students will use critical thinking, scientific reasoning, and problem solving to make informed decisions about information extracted from various sources such as news reports, articles and social media. The unit will culminate with an activity where students will explain the connections between science and its impact on society. | 10 Periods  450 Minutes | (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:  (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;  (B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;  (C) draw inferences based on data related to promotional materials for products and services;  (D) evaluate the impact of scientific research on society and the environment; and  (E) evaluate models according to their limitations in representing objects or events. |
| **Unit 6: Investigative Designs**  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." This vast body of changing and increasing knowledge as described by physical, mathematical, and conceptual models, 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 interact with the community and perform functions such as collaborating with scientific researchers or other members of the scientific community to complete a research project. | 10 Periods  450 Minutes | (6) The student demonstrates an understanding of design problems and works individually and as a member of a team to solve design problems. The student is expected to:  (A) solve design problems individually and in a team;  (B) create solutions to existing problems using a design process;  (C) use a design brief to identify problem specifications and establish project constraints;  (D) use communication to achieve a desired goal within a team; and  (E) work as a member of a team to conduct research to develop a knowledge base, stimulate creative ideas, and make informed decisions. |
| **Unit 7: Machines Examined**  A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in terms of 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. 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. In this unit, students will perform functions such as distinguishing between the six simple machines and their attributes and components. The culminating activity for this unit will have students determine the efficiency of mechanical systems. | 10 Periods  450 Minutes | (7) The student understands mechanisms, including simple and compound machines, and performs calculations related to mechanical advantage, drive ratios, work, and power. The student is expected to:  (A) explain the purpose and operation of components, including gears, sprockets, pulley systems, and simple machines;  (B) explain how components, including gears, sprockets, pulley systems, and simple machines, make up mechanisms;  (C) distinguish between the six simple machines and their attributes and components;  (D) measure forces and distances related to a mechanism;  (E) calculate work and power in mechanical systems;  (F) determine experimentally the efficiency of mechanical systems; and  (G) calculate mechanical advantage and drive ratios of mechanisms. |
| **Unit 8: All about Energy**  Scientific decision-making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods (science methods) and ethical and social decisions that involve science (the application of scientific information). In this unit, students will identify and categorize energy sources as nonrenewable, renewable, or inexhaustible. The culminating activity for this unit will have students define voltage, current, and resistance and calculate each quantity in series, parallel, and combination electrical circuits using Ohm's law. | 10 Periods  450 Minutes | (8) The student understands energy sources, energy conversion, and circuits and performs calculations related to work and power. The student is expected to:  (A) identify and categorize energy sources as nonrenewable, renewable, or inexhaustible;  (B) define and calculate work and power in electrical systems;  (C) calculate power in a system that converts energy from electrical to mechanical; and  (D) define voltage, current, and resistance and calculate each quantity in series, parallel, and combination electrical circuits using Ohm's law. |
| **Unit 9: Energy Management**  Students will apply math skills to real world problems as they engage in activities such as evaluating system energy requirements in order to select proper energy sources. The culminating activity for this unit will be for students to explain how multiple energy sources can be combined to convert energy into useful forms, including describing how hydrogen fuel cells create electricity and heat and how solar cells create electricity. | 10 Periods  450 Minutes | (9) The student understands system energy requirements and how energy sources can be combined to convert energy into useful forms. The student understands the relationships among material conductivity, resistance, and geometry in order to calculate energy transfer and determine power loss and efficiency. The student is expected to:  (A) explain the purpose of energy management;  (B) evaluate system energy requirements in order to select the proper energy source;  (C) explain how multiple energy sources can be combined to convert energy into useful forms;  (D) describe how hydrogen fuel cells create electricity and heat and how solar cells create electricity;  (E) measure and analyze how thermal energy is transferred via convection, conduction, and radiation;  (F) analyze how thermal energy transfer is affected by conduction, thermal resistance values, convection, and radiation; and  (G) calculate resistance, efficiency, and power transfer in power transmission and distribution applications for various material properties. |
| **Unit 10: Forces on Structural Designs**  This unit covers how forces affect structural designs. Activities include locating the centroid of structural members mathematically or experimentally and calculating moments of inertia of structural bodies. The culminating activity will have students calculate external and internal forces in a statically determinate truss using translational and rotational equilibrium equations. | 10 Periods  450 Minutes | (10) The student understands the interaction of forces acting on a body and performs calculations related to structural design. The student is expected to:  (A) illustrate, calculate, and experimentally measure all forces acting upon a given body;  (B) locate the centroid of structural members mathematically or experimentally;  (C) calculate moment of inertia of structural members;  (D) define and calculate static equilibrium;  (E) differentiate between scalar and vector quantities;  (F) identify properties of a vector, including magnitude and direction;  (G) calculate the X and Y components given a vector;  (H) calculate moment forces given a specified axis;  (I) calculate unknown forces using equations of equilibrium; and  (J) calculate external and internal forces in a statically determinate truss using translational and rotational equilibrium equations. |
| **Unit 11: Properties of Materials**  This unit has students explore the purposes of properties used for various materials. Activities will include having students test the property makeup of common household items. The culminating activity will have students identify the manufacturing processes used to create selected common household products. | 10 Periods  450 Minutes | (11) The student understands material properties and the importance of choosing appropriate materials for design. The student is expected to:  (A) conduct investigative non-destructive material property tests on selected common household products;  (B) calculate and measure the weight, volume, mass, density, and surface area of selected common household products; and  (C) identify the manufacturing processes used to create selected common household products. |
| **Unit 12: Product Functions and Performance Based on Material Makeup**  This unit will have students examine the functionality and performance of materials based upon their material composition. The culminating activity for this unit will have students identify and compare measurements and calculations of sample material properties such as elastic range, proportional limit, modulus of elasticity, and ductility using stress-strain data points. | 10 Periods  450 Minutes | (12) The student uses material testing to determine a product's function and performance. The student is expected to:  (A) use a design process and mathematical formulas to solve and document design problems;  (B) obtain measurements of material samples such as length, width, height, and mass;  (C) use material testing to determine a product's reliability, safety, and predictability in function;  (D) identify and calculate test sample material properties using a stress-strain curve; and  (E) identify and compare measurements and calculations of sample material properties such as elastic range, proportional limit, modulus of elasticity, elastic limit, resilience, yield point, plastic deformation, ultimate strength, failure, and ductility using stress-strain data points. |
| **Unit 13: Control System Operating Programs**  This unit introduces students to the concept of control systems designed to provide consentient process control and reliability. Students will use computer software to create flowcharts and control system operating programs. The culminating activity will have students judge between open- and closed-loop systems to select the most appropriate system for a given technological problem. | 10 Periods  450 Minutes | (13) The student understands that control systems are designed to provide consentient process control and reliability and uses computer software to create flowcharts and control system operating programs. The student is expected to:  (A) create detailed flowcharts using a computer software application;  (B) create control system operating programs using computer software;  (C) create system control programs that use flowchart logic;  (D) select appropriate input and output devices based on the need of a technological system; and  (E) judge between open- and closed-loop systems in order to select the most appropriate system for a given technological problem. |
| **Unit 14: Fluid Power Systems**  This unit will introduce fluid power systems to students. Students will partake in activities such as differentiating between pneumatic and hydraulic systems and hydrodynamic and hydrostatic systems. The culminating activity will include having students calculate flow rate, flow velocity, and mechanical advantage in a hydraulic system. | 10 Periods  450 Minutes | (14) The student demonstrates an understanding of fluid power systems and calculates values in a variety of systems. The student is expected to:  (A) identify and explain basic components and functions of fluid power devices;  (B) differentiate between pneumatic and hydraulic systems and between hydrodynamic and hydrostatic systems;  (C) use Pascal's Law to calculate values in a fluid power system;  (D) distinguish between gauge pressure and absolute pressure and between temperature and absolute temperature;  (E) calculate values in a pneumatic system using the ideal gas laws; and  (F) calculate flow rate, flow velocity, and mechanical advantage in a hydraulic system. |
| **Unit 15: Statistics in Real-World Engineering Design Problems**  This unit will have students use statistics to solve real-world engineering design problems. Students will partake in activities from calculating theoretical probability that an event will incur to applying the Bernoulli process to events that only have two distinct possible outcomes. The culminating activity will have students create a histogram to illustrate frequency distribution. | 10 Periods  450 Minutes | (15) The student demonstrates an understanding of statistics and applies the concepts to real-world engineering design problems. The student is expected to:  (A) calculate the theoretical probability that an event will occur;  (B) calculate the experimental frequency distribution of an event occurring;  (C) apply the Bernoulli process to events that only have two distinct possible outcomes;  (D) apply AND, OR, and NOT logic to solve complex probability scenarios;  (E) apply Bayes's theorem to calculate the probability of multiple events occurring;  (F) calculate the central tendency of a data array, including mean, median, and mode;  (G) calculate data variation, including range, standard deviation, and variance; and  (H) create a histogram to illustrate frequency distribution. |
| **Unit 16: Kinematics in Real-World Engineering Design Problems**  This unit covers the concept of kinematics in one and two dimensional engineering design problems. Students will participate in activities such as calculating distance, displacement, speed, velocity, and acceleration from data. The culminating activity will have students determine the angle needed to launch a projectile a specific range given the projectile's initial velocity. | 10 Periods  450 Minutes | (16) The student demonstrates an understanding of kinematics in one and two dimensions and applies the concepts to real-world engineering design problems. The student is expected to:  (A) calculate distance, displacement, speed, velocity, and acceleration from data;  (B) calculate experimentally the acceleration due to gravity given data from a free-fall device;  (C) calculate the X and Y components of an object in projectile motion; and  (D) determine the angle needed to launch a projectile a specific range given the projectile's initial velocity. |
| **Unit 17: Employability Skills**  This unit offers students basic technical skills necessary to fulfill careers in the workforce. 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, students will be able to show their ability to cooperate, contribute, and collaborate as a member of a group in an effort to achieve a positive collective outcome in the field of science engineering. Through group activities, students will demonstrate interpersonal skills, such as: communication, cooperation, professionalism, efficiency and dependability. The unit culminates with a peer review evaluation and reflection upon skills needed for success in the workforce. | 15 Periods  675 Minutes | (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:  (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  (E) demonstrate punctuality, dependability, reliability, and responsibility in performing assigned tasks as directed. |