Texas CTE: Science, Technology, Engineering, and Mathematics

# Engineering Science

**General requirements. This course is recommended for students in Grades 10-12. Prerequisite: Algebra I and Biology, Chemistry, Integrated Physics and Chemistry (IPC), or Physics. Recommended prerequisite: Geometry. 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.** ENG. SCI.A

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**Introduction.** ENG. SCI.B

1 **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.** ENG. SCI.B.1

2 **The Science, Technology, Engineering, and Mathematics (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.** ENG. SCI.B.2

3 **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**

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**work and communicate their solutions to their peers and members of the professional community.** ENG. SCI.B.3

4 **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 is 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.** ENG. SCI.B.4

5 **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.** ENG. SCI.B.5

6 **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).** ENG. SCI.B.6

7 **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. 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.** ENG. SCI.B.7

8 **Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.** ENG. SCI.B.8

9 **Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.** ENG. SCI.B.9

**Knowledge and skills.** ENG. SCI.C

1 **The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:** ENG. SCI.C.1

A demonstrate knowledge of how to dress appropriately, speak politely, and conduct oneself in a manner appropriate for the profession; ENG. SCI.C.1.A

B show the ability to cooperate, contribute, and collaborate as a member of a group in an effort to achieve a positive collective outcome; ENG. SCI.C.1.B

C present written and oral communication in a clear, concise, and effective manner; ENG. SCI.C.1.C

D demonstrate time-management skills in prioritizing tasks, following schedules, and performing goal-relevant activities in a way that produces efficient results; and ENG. SCI.C.1.D

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E demonstrate punctuality, dependability, reliability, and responsibility in performing assigned tasks as directed. ENG. SCI.C.1.E

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:** ENG. SCI.2

A demonstrate safe practices during laboratory and field investigations; and ENG. SCI.2.A

B demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials. ENG. SCI.2.B

3 **The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:** ENG. SCI.3

A know the definition of science and understand that it has limitations, as specified in subsection (b)(4) of this section; ENG. SCI.3.A

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; ENG. SCI.3.B

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; ENG. SCI.3.C

D distinguish between scientific hypotheses and scientific theories; ENG. SCI.3.D

E plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology; ENG. SCI.3.E

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; ENG. SCI.3.F

G analyze, evaluate, make inferences, and predict trends from data; and ENG. SCI.3.G

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. ENG. SCI.3.H

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:** ENG. SCI.4

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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; ENG. SCI.4.A

B communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials; ENG. SCI.4.B

C draw inferences based on data related to promotional materials for products and services; ENG. SCI.4.C

D evaluate the impact of scientific research on society and the environment; and ENG. SCI.4.D

E evaluate models according to their limitations in representing objects or events. ENG. SCI.4.E

5 **The student investigates engineering-related fields and career opportunities. The student is expected to:** ENG. SCI.5

A differentiate between engineering and engineering technology; ENG. SCI.5.A

B compare the roles or job descriptions for career opportunities in the fields of pure science, engineering, and engineering technology; ENG. SCI.5.B

C identify and differentiate between the different engineering disciplines; and ENG. SCI.5.C

D demonstrate appropriate oral, written, and visual forms of technical communication. ENG. SCI.5.D

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:** ENG. SCI.6

A solve design problems individually and in a team; ENG. SCI.6.A

B create solutions to existing problems using a design process; ENG. SCI.6.B

C use a design brief to identify problem specifications and establish project constraints; ENG. SCI.6.C

D use communication to achieve a desired goal within a team; and ENG. SCI.6.D

E work as a member of a team to conduct research to develop a knowledge base, stimulate creative ideas, and make informed decisions. ENG. SCI.6.E

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:** ENG. SCI.7

A explain the purpose and operation of components, including gears, sprockets, pulley systems, and simple machines; ENG. SCI.7.A

B explain how components, including gears, sprockets, pulley systems, and simple machines, make up mechanisms; ENG. SCI.7.B

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C distinguish between the six simple machines and their attributes and components; ENG. SCI.7.C

D measure forces and distances related to a mechanism; ENG. SCI.7.D

E calculate work and power in mechanical systems; ENG. SCI.7.E

F determine experimentally the efficiency of mechanical systems; and ENG. SCI.7.F

G calculate mechanical advantage and drive ratios of mechanisms. ENG. SCI.7.G

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**8 The student understands energy sources, energy conversion, and circuits and performs calculations related to work and power. The student is expected to:** ENG. SCI.8

A identify and categorize energy sources as nonrenewable, renewable, or inexhaustible; ENG. SCI.8.A

B define and calculate work and power in electrical systems; ENG. SCI.8.B

C calculate power in a system that converts energy from electrical to mechanical; and ENG. SCI.8.C

D define voltage, current, and resistance and calculate each quantity in series, parallel, and combination electrical circuits using Ohm's law. ENG. SCI.8.D

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**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:** ENG. SCI.9

A explain the purpose of energy management; ENG. SCI.9.A

B evaluate system energy requirements in order to select the proper energy source; ENG. SCI.9.B

C explain how multiple energy sources can be combined to convert energy into useful forms; ENG. SCI.9.C

D describe how hydrogen fuel cells create electricity and heat and how solar cells create electricity; ENG. SCI.9.D

E measure and analyze how thermal energy is transferred via convection, conduction, and radiation; ENG. SCI.9.E

F analyze how thermal energy transfer is affected by conduction, thermal resistance values, convection, and radiation; and ENG. SCI.9.F

G calculate resistance, efficiency, and power transfer in power transmission and distribution applications for various material properties. ENG. SCI.9.G

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**10 The student understands the interaction of forces acting on a body and performs calculations related to structural design. The student is expected to:** ENG. SCI.10

A illustrate, calculate, and experimentally measure all forces acting upon a given body; ENG. SCI.10.A

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B locate the centroid of structural members mathematically or experimentally; ENG. SCI.10.B

C calculate moment of inertia of structural members; ENG. SCI.10.C

D define and calculate static equilibrium; ENG. SCI.10.D

E differentiate between scalar and vector quantities; ENG. SCI.10.E

F identify properties of a vector, including magnitude and direction; ENG. SCI.10.F

G calculate the X and Y components given a vector; ENG. SCI.10.G

H calculate moment forces given a specified axis; ENG. SCI.10.H

I calculate unknown forces using equations of equilibrium; and ENG. SCI.10.I

J alculate external and internal forces in a statically determinate truss using translational and rotational equilibrium equations. ENG. SCI.10.J

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**11 The student understands material properties and the importance of choosing appropriate materials for design. The student is expected to:** ENG. SCI.11

A conduct investigative non-destructive material property tests on selected common household products; ENG. SCI.11.A

B calculate and measure the weight, volume, mass, density, and surface area of selected common household products; and ENG. SCI.11.B

C identify the manufacturing processes used to create selected common household products. ENG. SCI.11.C

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**12 The student uses material testing to determine a product's function and performance. The student is expected to:** ENG. SCI.12

A use a design process and mathematical formulas to solve and document design problems; ENG. SCI.12.A

B obtain measurements of material samples such as length, width, height, and mass; ENG. SCI.12.B

C use material testing to determine a product's reliability, safety, and predictability in function; ENG. SCI.12.C

D identify and calculate test sample material properties using a stress-strain curve; and ENG. SCI.12.D

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. ENG. SCI.12.E

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**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:** ENG. SCI.13

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A create detailed flowcharts using a computer software application; ENG. SCI.13.A

B create control system operating programs using computer software; ENG. SCI.13.B

C create system control programs that use flowchart logic; ENG. SCI.13.C

D select appropriate input and output devices based on the need of a technological system; and ENG. SCI.13.D

E judge between open- and closed-loop systems in order to select the most appropriate system for a given technological problem. ENG. SCI.13.E

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**14 The student demonstrates an understanding of fluid power systems and calculates values in a variety of systems. The student is expected to:** ENG. SCI.14

A identify and explain basic components and functions of fluid power devices; ENG. SCI.14.A

B differentiate between pneumatic and hydraulic systems and between hydrodynamic and hydrostatic systems; ENG. SCI.14.B

C use Pascal's Law to calculate values in a fluid power system; ENG. SCI.14.C

D distinguish between gauge pressure and absolute pressure and between temperature and absolute temperature; ENG. SCI.14.D

E calculate values in a pneumatic system using the ideal gas laws; and ENG. SCI.14.E

F calculate flow rate, flow velocity, and mechanical advantage in a hydraulic system. ENG. SCI.14.F

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**15 The student demonstrates an understanding of statistics and applies the concepts to real-world engineering design problems. The student is expected to:** ENG. SCI.15

A calculate the theoretical probability that an event will occur; ENG. SCI.15.A

B calculate the experimental frequency distribution of an event occurring; ENG. SCI.15.B

C apply the Bernoulli process to events that only have two distinct possible outcomes; ENG. SCI.15.C

D apply AND, OR, and NOT logic to solve complex probability scenarios; ENG. SCI.15.D

E apply Bayes's theorem to calculate the probability of multiple events occurring; ENG. SCI.15.E

F calculate the central tendency of a data array, including mean, median, and mode; ENG. SCI.15.F

G calculate data variation, including range, standard deviation, and variance; and ENG. SCI.15.G

H create a histogram to illustrate frequency distribution. ENG. SCI.15.H

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**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:** ENG. SCI.16

A calculate distance, displacement, speed, velocity, and acceleration from data; ENG. SCI.16.A

B calculate experimentally the acceleration due to gravity given data from a free-fall device; ENG. SCI.16.B

C calculate the X and Y components of an object in projectile motion; and ENG. SCI.16.C

D determine the angle needed to launch a projectile a specific range given the projectile's initial velocity. ENG. SCI.16.D