Chapter 127. Texas Essential Knowledge and Skills for Career Development and Career and Technical Education

Subchapter O. Science, Technology, Engineering, and Mathematics

Statutory Authority: The provisions of this Subchapter O issued Texas Education Code, §§7.102(c)(4); 28.002; and 28.025, unless otherwise noted.

§127.742. Implementation of Texas Essential Knowledge and Skills for Science, Technology, Engineering, and Mathematics, Adopted 2015.

(a)   The provisions of this subchapter shall be implemented by school districts beginning with the 2017-2018 school year.

(b)   No later than August 31, 2016, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills for career and technical education as adopted in §§127.743-127.760 of this subchapter.

(c)   If the commissioner makes the determination that instructional materials funding has been made available under subsection (b) of this section, §§127.743-127.760 of this subchapter shall be implemented beginning with the 2017-2018 school year and apply to the 2017-2018 and subsequent school years.

(d)   If the commissioner does not make the determination that instructional materials funding has been made available under subsection (b) of this section, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that §§127.743-127.760 of this subchapter shall be implemented for the following school year.

Source: The provisions of this §127.742 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.743. Principles of Applied Engineering (One Credit), Adopted 2015.

(a)   General requirements. This course is recommended for students in Grades 9 and 10. Students shall be awarded one credit for successful completion of this course.

(b)   Introduction.

    (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.

    (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.

    (3)   Principles of Applied Engineering provides an overview of the various fields of science, technology, engineering, and mathematics and their interrelationships. Students will develop engineering communication skills, which include computer graphics, modeling, and presentations, by using a variety of computer hardware and software applications to complete assignments and projects. Upon completing this course, students will have an understanding of the various fields of engineering and will be able to make informed career decisions. Further, students will have worked on a design team to develop a product or system. Students will use multiple software applications to prepare and present course assignments.

    (4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

    (5)   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.

(c)   Knowledge and skills.

    (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, speak, 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.

    (2)   The student investigates the components of engineering and technology systems. The student is expected to:

        (A)   investigate and report on the history of engineering science;

        (B)   identify the inputs, processes, and outputs associated with technological systems;

        (C)   describe the difference between open and closed systems;

        (D)   describe how technological systems interact to achieve common goals;

        (E)   compare and contrast engineering, science, and technology careers;

        (F)   conduct and present research on emerging and innovative technology; and

        (G)   demonstrate proficiency of the engineering design process.

    (3)   The student presents conclusions, research findings, and designs using a variety of media throughout the course. The student is expected to:

        (A)   use clear and concise written, verbal, and visual communication techniques;

        (B)   maintain a design and computation engineering notebook;

        (C)   use sketching and computer-aided drafting and design (CADD) to develop and present ideas;

        (D)   use industry standard visualization techniques and media; and

        (E)   use the engineering documentation process to maintain a paper or digital portfolio.

    (4)   The student uses appropriate tools and demonstrates safe work habits. The student is expected to:

        (A)   master relevant safety tests;

        (B)   follow lab safety guidelines as prescribed by instructor in compliance with local, state, and federal regulations;

        (C)   recognize the classification of hazardous materials and wastes;

        (D)   dispose of hazardous materials and wastes appropriately;

        (E)   maintain, safely handle, and properly store laboratory equipment;

        (F)   describe the implications of negligent or improper maintenance; and

        (G)   demonstrate the use of precision measuring instruments.

(5) The student describes the factors that affect the progression of technology and the potential intended and unintended consequences of technological advances. The student is expected to:

    (A) describe how technology has affected individuals, societies, cultures, economies, and environments;

    (B) describe how the development and use of technology influenced past events;

    (C) describe how and why technology progresses; and

    (D) predict possible changes caused by the advances of technology.

(6) The student thinks critically and applies fundamental principles of system modeling and design to multiple design projects. The student is expected to:

    (A) identify and describe the fundamental processes needed for a project, including the design process and prototype development and initiating, planning, executing, monitoring and controlling, and closing a project;

    (B) identify the chemical, mechanical, and physical properties of engineering materials;

    (C) use problem-solving techniques to develop technological solutions;

    (D) use consistent units for all measurements and computations; and

    (E) assess the risks and benefits of a design solution.

(7) The student understands the opportunities and careers in fields related to robotics, process control, and automation systems. The student is expected to:

    (A) describe applications of robotics, process control, and automation systems;

    (B) apply design concepts to problems in robotics, process control, and automation systems;

    (C) identify fields and career opportunities related to robotics, process control, and automation systems; and

    (D) identify emerging trends in robotics, process control, and automation systems.

(8) The student understands the opportunities and careers in fields related to electrical and mechanical systems. The student is expected to:

    (A) describe the applications of electrical and mechanical systems;

    (B) describe career opportunities in electrical and mechanical systems;

    (C) identify emerging trends in electrical and mechanical systems; and

    (D) describe and apply basic electronic theory.

(9) The student demonstrates the ability to function as a team member while completing a comprehensive project. The student is expected to:

    (A) apply the design process as a team participant;

    (B) assume different roles as a team member within the project;

    (C) maintain an engineering notebook for the project;

    (D) develop and test the model for the project; and

    (E) demonstrate communication skills by preparing and presenting the project.

(10) The student demonstrates a knowledge of drafting by completing a series of drawings that can be published by various media. The student is expected to:

    (A) set up, create, and modify drawings;

(B)   store and retrieve geometry;

(C)   demonstrate an understanding of the use of line-types in engineering drawings;

(D)   draw 2-D single view objects;

(E)   create multi-view working drawings using orthographic projection;

(F)   dimension objects using current American National Standards Institute (ANSI) standards;

(G)   draw single line 2-D pictorial representations;

(H)   create working drawings that include section views; and

(I)   demonstrate a knowledge of screw thread design per ANSI standards by drawing a hex head bolt with standard, square, and acme threads.

Source: The provisions of this §127.743 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.745. Principles of Technology (One Credit), Adopted 2015.

(a)   General requirements. This course is recommended for students in Grades 10-12. Prerequisites: one credit of high school science and Algebra I. 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.

(b)   Introduction.

(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.

(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.

(3)   In Principles of Technology, students will conduct laboratory and field investigations, use scientific practices during investigations, and make informed decisions using critical thinking and scientific problem solving. Various systems will be described in terms of space, time, energy, and matter. Students will study a variety of topics that include laws of motion, conservation of energy, momentum, electricity, magnetism, thermodynamics, and characteristics and behavior of waves. Students will apply physics concepts and perform laboratory experimentations for at least 40% of instructional time using safe practices.

(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 currently scientifically testable by empirical science.

(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.

(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).

(7)   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.

(8) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(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.

(c) Knowledge and skills.

(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.

(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.

(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 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 may be subject to change as new areas of science and new technologies are developed;

(D) distinguish between scientific hypotheses and scientific theories;

(E) design and implement investigative procedures, including making observations, asking well-defined questions, formulating testable hypotheses, identifying variables, selecting appropriate equipment and technology, and evaluating numerical answers for reasonableness;

(F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as multimeters (current, voltage, resistance), balances, batteries, dynamics demonstration equipment, collision apparatus, lab masses, magnets, plane mirrors, convex lenses, stopwatches, trajectory apparatus, graph paper, magnetic compasses, protractors, metric rulers, spring scales, thermometers, and slinky springs;

(G) use a wide variety of additional course equipment as appropriate such as ripple tank with wave generator, wave motion rope, tuning forks, hand-held visual spectroscopes, discharge tubes with power supply (H, He, Ne, Ar), electromagnetic spectrum charts, laser pointers, micrometer, caliper, computer, data acquisition probes, scientific calculators, graphing technology, electrostatic kits, electroscope, inclined plane, optics bench, optics kit, polarized film, prisms, pulley with table clamp, motion detectors, photogates, friction blocks, ballistic carts or equivalent, resonance tube, stroboscope, resistors, copper wire, switches, iron filings, and/or other equipment and materials that will produce the same results;

(H) make measurements and record data with accuracy and precision using scientific notation and International System (SI) units;

(I) organize, evaluate, and make inferences from data, including the use of tables, charts, and graphs;

(J) communicate valid conclusions supported by the data through various methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports; and

(K) express relationships among physical variables quantitatively, including the use of graphs, charts, and equations.

(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) analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;

(B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;

(C) explain the impacts of the scientific contributions of a variety of historical and contemporary scientists on scientific thought and society;

(D) research and describe the connections between physics and future careers; and

(E) express, manipulate, and interpret relationships symbolically to make predictions and solve problems mathematically.

(5) The student uses the scientific process to investigate physical concepts. The student is expected to:

(A) demonstrate an understanding that scientific hypotheses are tentative and testable statements that must be capable of being supported by observational evidence;

(B) demonstrate an understanding that scientific theories are based on physical phenomena and are capable of being tested by multiple independent researchers;

(C) design and implement investigative procedures;

(D) demonstrate the appropriate use and care of laboratory equipment;

(E) demonstrate accurate measurement techniques using precision instruments;

(F) record data using scientific notation and International System (SI) of units;

(G) identify and quantify causes and effects of uncertainties in measured data;

(H) organize and evaluate data, including the use of tables, charts, and graphs;

(I) communicate conclusions supported through various methods such as laboratory reports, labeled drawings, graphic organizers, journals, summaries, oral reports, or technology-based reports; and

(J) record, express, and manipulate data using graphs, charts, and equations.

(6) The student demonstrates appropriate safety techniques in the field and laboratory environments. The student is expected to:

(A) master relevant safety procedures;

(B) comply with safety guidelines as described in various manuals, instructions, and regulations;

(C) identify and classify hazardous materials and wastes; and

(D) make prudent choices in the conservation and use of resources and the appropriate disposal of hazardous materials and wastes.

(7) The student describes and applies the laws governing motion in a variety of situations. The student is expected to:

(A) generate and interpret relevant equations using graphs and charts for one- and two-dimensional motion, including:

(i) using and describing one-dimensional equations and graphical vector addition for displacement, distance, speed, velocity, average velocity, frames of reference, acceleration, and average acceleration;

(ii) using and describing two-dimensional equations for projectile and circular motion; and

(iii) using and describing vector forces and resolution; and

(B) describe and calculate the effects of forces on objects, including law of inertia and impulse and conservation of momentum, using methods, including free-body force diagrams.

(8) The student describes the nature of forces in the physical world. The student is expected to:

(A) describe the concepts of gravitational, electromagnetic, weak nuclear, and strong nuclear forces;

(B) describe and calculate the magnitude of gravitational forces between two objects;

(C) describe and calculate the magnitude of electric forces;

(D) describe the nature and identify everyday examples of magnetic forces and fields;

(E) describe the nature and identify everyday examples of electromagnetic forces and fields;

(F) characterize materials as conductors or insulators based on their electric properties; and

(G) design and construct both series and parallel circuits and calculate current, potential difference, resistance, and power of various circuits.

(9) The student describes and applies the laws of the conservation of energy and momentum. The student is expected to:

(A) describe the transformational process between work, potential energy, and kinetic energy (work-energy theorem);

(B) use examples to analyze and calculate the relationships among work, kinetic energy, and potential energy;

(C) describe and calculate the mechanical energy of, the power generated within, the impulse applied to, and the momentum of a physical system; and

(D) describe and apply the laws of conservation of energy and conservation of momentum.

(10) The student analyzes the concept of thermal energy. The student is expected to:

explain technological examples such as solar and wind energy that illustrate the four laws of thermodynamics and the processes of thermal energy transfer.

     (11)   The student analyzes the properties of wave motion and optics. The student is expected to:

         (A)   examine and describe oscillatory motion and wave propagation in various types of media;

         (B)   investigate and analyze characteristics of waves, including period, velocity, frequency, amplitude, and wavelength;

         (C)   investigate and calculate the relationship between wave speed, frequency, and wavelength;

         (D)   compare and contrast the characteristics and behaviors of transverse waves, including electromagnetic waves and the electromagnetic spectrum, and longitudinal waves, including sound waves;

         (E)   investigate behaviors of waves, including reflection, refraction, diffraction, interference, resonance, polarization, and the Doppler effect; and

         (F)   describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens.

     (12)   The student analyzes the concepts of atomic, nuclear, and quantum phenomena. The student is expected to:

         (A)   describe the photoelectric effect and the dual nature of light;

         (B)   compare and explain emission spectra produced by various atoms;

         (C)   calculate and describe the applications of mass-energy equivalence;

         (D)   describe the process of radioactive decay given an isotope and half-life;

         (E)   describe the role of mass-energy equivalence for areas such as nuclear stability, fission, and fusion; and

         (F)   explore technology applications of atomic, nuclear, and quantum phenomena using the standard model such as nuclear stability, fission, and fusion, nanotechnology, radiation therapy, diagnostic imaging, semiconductors, superconductors, solar cells, and nuclear power.

Source: The provisions of this §127.745 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.746. AC/DC Electronics (One Credit), Adopted 2015.

(a)   General requirements. This course is recommended for students in Grades 10-12. Recommended prerequisite: Principles of Applied Engineering. Students shall be awarded one credit for successful completion of this course.

(b)   Introduction.

     (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.

     (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.

     (3)   AC/DC Electronics focuses on the basic electricity principles of alternating current/direct current (AC/DC) circuits. Students will demonstrate knowledge and applications of circuits, electronic measurement, and electronic implementation. Through use of the design process, students will transfer academic skills to component designs in a project-based environment. Students will use a variety of computer hardware and software applications to complete assignments and projects. Additionally, students will explore career opportunities, employer expectations, and educational needs in the electronics industry.

(4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5)   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.

(c)   Knowledge and skills.

(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, including explaining and justifying actions;

(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.

(2)   The student demonstrates the skills necessary for success in a technical career. The student is expected to:

(A)   identify training, education, employment, and career opportunities, including differences between an electronic technician, electronic technologist, and electrical engineer;

(B)   investigate and work toward industry certifications;

(C)   discuss ethical issues related to electronics;

(D)   identify and demonstrate respect for diversity in the workplace;

(E)   identify and demonstrate appropriate actions and consequences relating to discrimination, harassment, and inequality;

(F)   explore career preparation learning experiences, including job shadowing, mentoring, and apprenticeship training; and

(G)   discuss *Accreditation Board for Engineering and Technology* (ABET) accreditation and implications.

(3)   The student participates in team projects in various roles. The student is expected to:

(A)   explain the importance of teamwork in the field of electronics;

(B)   apply principles of effective teamwork and problem solving, including collaboration and conflict resolution; and

(C)   demonstrate proper attitudes as a team leader and team member.

(4)   The student develops skills for managing a project. The student is expected to:

(A)   implement project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;

(B)   develop a project schedule and complete work according to established criteria;

(C)   participate in the organization and operation of a real or simulated engineering project; and

(D)   develop a plan for production of an individual product.

(5)   The student practices safe and proper work habits. The student is expected to:

(A)   master relevant safety tests;

(B)   comply with safety guidelines as described in various manuals, instructions, and regulations;

(C)   identify governmental and organizational regulations for health and safety in the workplace related to electronics;

(D)   identify and classify hazardous materials according to Occupational Safety and Health Administration (OSHA) regulations and industry standards;

(E)   dispose of hazardous materials appropriately;

(F)   perform maintenance on selected tools, equipment, and machines;

(G)   handle and store tools and materials correctly; and

(H)   describe the results of improper maintenance of material, tools, and equipment.

(6)   The student develops an understanding of basic direct current (DC) electricity principles. The student is expected to:

(A)   describe DC and give examples of its application and generation;

(B)   demonstrate an understanding of atomic theory and the relationship between atomic number and a material's conductivity and insulation characteristics;

(C)   identify and apply the proper use of electronic schematics and symbols, including switches, voltage, current, ground, resistors, fuses, circuit breakers, volt meters, and amp meters;

(D)   define and describe switches, voltage source, current source, ground, resistors, fuses, circuit breakers, volt meters, amp meters, voltage, current, and resistance;

(E)   identify the resistance value from the resistor color code;

(F)   express Ohm's Law in three forms with appropriate symbols and units;

(G)   express the Power Law in three forms with appropriate symbols and units;

(H)   describe series, parallel, and combination circuits;

(I)   apply Ohm's Law to calculate current, voltage drops, and resistance for each component in a multi-component series, parallel, and combination circuit;

(J)   apply the Power Law to calculate current, voltage drops, resistance, and power for each component in a multi-component series, parallel, and combination circuit; and

(K)   express current and resistance values in both scientific notation and engineering notation.

(7)   The student develops an understanding of basic alternating current (AC) electricity principles. The student is expected to:

(A)   describe AC and give examples of its application and generation;

(B)   calculate peak, peak-to-peak, average, and root mean square (RMS) voltage;

(C)   explain the relationship between mechanical load and current in a generator;

(D)   identify the purpose and application of a transformer;

(E)   identify voltage and current values relative to a turns ratio in a transformer;

(F)   describe and calculate capacitance and capacitive reactance; and

(G)   describe and calculate inductance and inductive reactance.

(8)   The student implements the concepts and skills that form the technical knowledge of electronics using project-based assessments. The student is expected to:

   (A)   apply Ohm's law, Kirchhoff's laws, and power laws to actual or simulated circuits;

   (B)   build series, parallel, and combination circuits;

   (C)   demonstrate an understanding of magnetism and induction as they relate to electronic circuits;

   (D)   perform electrical-electronic troubleshooting assignments;

   (E)   identify actual electronic components, including resistors, capacitors, switches, fuses, power sources, and inductors;

   (F)   explain how torque is produced in a motor; and

   (G)   explain where counter electromotive force (CEMF) comes from in a motor.

(9)   The student applies the concepts and skills to simulated and actual work situations. The student is expected to:

   (A)   measure and calculate resistance, current, voltage, and power in series, parallel, and complex circuits;

   (B)   apply electrical theory to generators, electric motors, and transformers; and

   (C)   design analog circuits using common components.

(10)   The student learns the function and application of the tools, equipment, and materials used in electronics through project-based assignments. The student is expected to:

   (A)   use tools and laboratory equipment in a safe manner to construct and repair circuits;

   (B)   use precision measuring instruments to analyze circuits and prototypes;

   (C)   demonstrate an understanding of the difference between current and voltage measurement;

   (D)   use a multimeter to perform resistance, voltage, and current measurements;

   (E)   describe and perform measurements, including period and amplitude, using an oscilloscope;

   (F)   use multiple software applications to simulate circuit behavior and present concepts; and

   (G)   use a project notebook to record measured values, lab observations and results, circuit operational requirements, and circuit design and modifications.

(11)   The student designs a circuit using appropriate design processes and techniques. The student is expected to:

   (A)   interpret industry standard circuit schematics;

   (B)   identify areas where quality, reliability, and safety can be designed into a circuit;

   (C)   improve a circuit design to meet a specified need;

   (D)   sketch schematics; and

   (E)   explore new technologies that may affect electronics.

(12)   The student builds a prototype circuit using the appropriate tools, materials, and techniques. The student is expected to:

   (A)   identify and describe the steps needed to produce a prototype;

   (B)   identify and use appropriate tools, equipment, machines, and materials to produce the prototype; and

(C) present a final project using a variety of media.

Source: The provisions of this §127.746 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.747. Solid State Electronics (One Credit), Adopted 2015.

(a) General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: AC/DC Electronics. Students shall be awarded one credit for successful completion of this course.

(b) Introduction.

(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.

(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.

(3) In Solid State Electronics, students will demonstrate knowledge and applications of advanced circuits, electrical measurement, and electrical implementation used in the electronics and computer industries. Students will transfer advanced academic skills to apply engineering principles and technical skills to troubleshoot, repair, and modify electronic components, equipment, and power electronic systems in a project-based environment. Additionally, students will explore career opportunities, employer expectations, and educational needs in the electronics industry.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5) 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.

(c) Knowledge and skills.

(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, including explaining and justifying actions;

(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.

(2) The student demonstrates the skills necessary for success in a technical career. The student is expected to:

(A) identify training, education, employment, and career opportunities, including differences between an electronic technician, electronic technologist, and electrical engineer;

(B) identify employment and career opportunities;

(C) identify industry certifications;

(D) discuss ethical issues related to electronics and incorporate proper ethics in submitted projects;

(E)   identify and demonstrate respect for diversity in the workplace;

(F)   identify appropriate actions and consequences relating to discrimination, harassment, and inequality;

(G)   explore electronics career and preparation programs;

(H)   explore career preparation learning experiences, including, but not limited to, job shadowing, mentoring, and apprenticeship training; and

(I)   discuss *Accreditation Board for Engineering and Technology* (ABET) accreditation and implications.

(3)   The student participates in team projects in various roles. The student is expected to:

(A)   explain the importance of teamwork in the field of electronics;

(B)   apply principles of effective teamwork and problem solving, including collaboration and conflict resolution; and

(C)   demonstrate proper attitudes as a team leader and team member.

(4)   The student develops skills for managing a project. The student is expected to:

(A)   implement project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;

(B)   develop a project schedule and complete work according to established criteria;

(C)   participate in the organization and operation of a real or simulated engineering project; and

(D)   develop a plan for production of an individual product.

(5)   The student demonstrates principles of project documentation and work flow. The student is expected to:

(A)   complete work orders and related documentation;

(B)   identify factors affecting cost and strategies to minimize costs;

(C)   prepare a project budget;

(D)   prepare a production schedule;

(E)   identify intellectual property and other legal restrictions; and

(F)   read and interpret technical drawings, manuals, and bulletins.

(6)   The student practices safe and proper work habits. The student is expected to:

(A)   master relevant safety tests;

(B)   comply with safety guidelines as described in various manuals, instructions, and regulations;

(C)   identify governmental and organizational regulations for health and safety in the workplace related to electronics;

(D)   identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations and industry standards;

(E)   dispose of hazardous materials and wastes appropriately;

(F)   perform maintenance on selected tools, equipment, and machines;

(G)   handle and store tools and materials correctly; and

(H)   describe the results of negligent or improper maintenance of material, tools, and equipment.

(7)   The student implements the concepts and skills that form advanced knowledge of electronics using project-based rubrics. The student is expected to:

(A)   apply Ohm's law, Kirchhoff's laws, and power laws to advanced circuit theory;

(B)   demonstrate advanced knowledge of the theory of direct current, alternating current, digital circuits, and semi-conductor circuits through Thevenin and Norton's theorems;

(C)   apply knowledge of voltage regulation devices;

(D)   apply knowledge of the design and use of diodes, transistors, and analog components with integrated circuits;

(E)   implement knowledge of solid-state components and devices such as a power supply design;

(F)   demonstrate knowledge of the similarities and differences in optoelectronic devices;

(G)   implement knowledge of transmission theory;

(H)   implement knowledge of microprocessor applications;

(I)   apply electronic theory to generators, electric motors, power supplies, electronic amplifiers, electronic oscillators, communication circuits, and systems; and

(J)   complete advanced electrical-electronic troubleshooting assignments to industry standards.

(8)   The student learns the function and application of the tools, equipment, and materials used in electronics through specific project-based assessments. The student is expected to:

(A)   use tools and laboratory equipment in a safe manner to construct and repair circuits;

(B)   use precision measuring instruments to analyze circuits and prototypes;

(C)   describe and perform measurement techniques with analog, digital, or storage oscilloscopes;

(D)   use multiple software applications to simulate circuit behavior and present concepts; and

(E)   identify and describe the functions of computer hardware devices.

(9)   The student designs products using appropriate design processes and techniques. The student is expected to:

(A)   interpret advanced industry standard schematics;

(B)   identify areas where quality, reliability, and safety can be designed into a product;

(C)   improve a product design to meet a specified need;

(D)   produce advanced schematics to industry standards;

(E)   discuss the process of obtaining a patent;

(F)   use a variety of technologies to design components such as computer simulation software; and

(G)   explore innovative technologies that may affect electronics.

(10)   The student builds a simulated or physical prototype using the appropriate tools, materials, and techniques. The student is expected to:

(A)   identify and describe the steps needed to produce a prototype;

(B)　　identify and use appropriate tools, equipment, machines, and materials to produce the prototype; and

(C)　　present the prototype using a variety of media to a panel.

Source: The provisions of this §127.747 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.748. Digital Electronics (One Credit), Adopted 2015.

(a)　　General requirements. This course is recommended for students in Grades 10-12. Prerequisites: Algebra I and Geometry. This course satisfies a high school mathematics graduation requirement. Students shall be awarded one credit for successful completion of this course.

(b)　　Introduction.

(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.

(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.

(3)　　Digital Electronics is the study of electronic circuits that are used to process and control digital signals. In contrast to analog electronics, where information is represented by a continuously varying voltage, digital signals are represented by two discreet voltages or logic levels. This distinction allows for greater signal speed and storage capabilities and has revolutionized the world of electronics. Digital electronics is the foundation of modern electronic devices such as cellular phones, digital audio players, laptop computers, digital cameras, and high-definition televisions. The primary focus of Digital Electronics is to expose students to the design process of combinational and sequential logic design, teamwork, communication methods, engineering standards, and technical documentation.

(4)　　The mathematical process standards describe ways in which students are expected to engage in the content. The placement of the process standards at the beginning of the knowledge and skills listed for each grade and course is intentional. The process standards weave the other knowledge and skills together so that students may be successful problem solvers and use mathematics efficiently and effectively in daily life. The process standards are integrated at every grade level and course. When possible, students will apply mathematics to problems arising in everyday life, society, and the workplace. Students will use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution. Students will select appropriate tools such as real objects, manipulatives, paper and pencil, and technology and techniques such as mental math, estimation, and number sense to solve problems. Students will effectively communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, and language. Students will use mathematical relationships to generate solutions and make connections and predictions. Students will analyze mathematical relationships to connect and communicate mathematical ideas. Students will display, explain, or justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

(5)　　Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(6)　　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.

(c)　　Knowledge and skills.

(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, including explaining and justifying actions;

(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.

(2) The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:

(A) apply mathematics to problems arising in everyday life, society, and the workplace;

(B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution;

(C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems;

(D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate;

(E) create and use representations to organize, record, and communicate mathematical ideas;

(F) analyze mathematical relationships to connect and communicate mathematical ideas; and

(G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

(3) The student demonstrates the skills necessary for success in a technical career. The student is expected to:

(A) distinguish the differences between an engineering technician, engineering technologist, and engineer;

(B) identify employment and career opportunities;

(C) identify industry certifications;

(D) discuss ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;

(E) identify and demonstrate respect for diversity in the workplace;

(F) identify and demonstrate appropriate actions and identify consequences relating to discrimination, harassment, and inequality;

(G) explore electronics engineering careers and preparation programs;

(H) explore career preparation learning experiences, including job shadowing, mentoring, and apprenticeship training; and

(I) discuss *Accreditation Board for Engineering and Technology* (ABET) accreditation and implications.

(4) The student participates in team projects in various roles. The student is expected to:

(A) explain the importance of teamwork in the field of electronics;

(B)   apply principles of effective problem solving in teams to practice collaboration and conflict resolution; and

(C)   demonstrate proper attitudes as a team leader and team member.

(5)   The student develops skills for managing a project. The student is expected to:

(A)   implement project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;

(B)   develop a project schedule and complete work according to established criteria;

(C)   participate in the organization and operation of a real or simulated engineering project; and

(D)   develop a plan for production of an individual product.

(6)   The student practices safe and proper work habits. The student is expected to:

(A)   master relevant safety tests;

(B)   comply with safety guidelines as described in various manuals, instructions, and regulations;

(C)   identify governmental and organizational regulations for health and safety in the workplace related to electronics;

(D)   identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations;

(E)   dispose of hazardous materials and wastes appropriately;

(F)   perform maintenance on selected tools, equipment, and machines;

(G)   handle and store tools and materials correctly; and

(H)   describe the results of improper maintenance of material, tools, and equipment.

(7)   The student explores the fundamentals of analog and digital electronics. The student uses appropriate notation and understands the logic of circuit design and logic gates. The student is expected to:

(A)   use scientific notation, engineering notation, and Systems International (SI) notation to conveniently write very large or very small numbers frequently encountered when working with electronics;

(B)   describe the process of soldering and how it is used in the assembly of electronic components;

(C)   explain the different waveforms and distinctive characteristics of analog and digital signals;

(D)   identify the voltage levels of analog and digital signals;

(E)   determine whether a material is a conductor, an insulator, or a semiconductor based on its atomic structure;

(F)   analyze the three fundamental concepts of voltage, current, and resistance;

(G)   define circuit design software and explain its purpose;

(H)   identify the fundamental building block of sequential logic;

(I)   identify the components of a manufacturer's datasheet, including a logic gate's general description, connection diagram, and function table;

(J)   categorize integrated circuits by their underlying circuitry, scale of integration, and packaging style;

(K)   describe the advantages and disadvantages of the various sub-families of transistor-transistor logic (TTL) gates;

(L)   explain that a logic gate is depicted by its schematic symbol, logic expression, and truth table;

(M)   evaluate the different functions of input and output values of combinational and sequential logic;

(N)   explain combinational logic designs implemented with AND gates, OR gates, and INVERTER gates; and

(O)   identify the fundamental building block of sequential logic.

(8)   The student understands and uses multiple forms of AND-OR-Invert (AOI) logic. The student is expected to:

(A)   develop an understanding of the binary number system and its relationship to the decimal number system as an essential component in the combinational logic design process;

(B)   translate a set of design specifications into a truth table to describe the behavior of a combinational logic design by listing all possible input combinations and the desired output for each;

(C)   derive logic expressions from a given truth table;

(D)   demonstrate logic expressions in sum-of-products (SOP) form and products-of-sum (POS) form;

(E)   explain how all logic expressions, whether simplified or not, can be implemented using AND gates and INVERTER gates or OR gates and INVERTER gates; and

(F)   apply a formal design process to translate a set of design specifications into a functional combinational logic circuit.

(9)   The student understands, explains, and applies NAND and NOR Logic and understands the benefits of using universal gates. The student is expected to:

(A)   apply the Karnaugh Mapping graphical technique to simplify logic expressions containing two, three, and four variables;

(B)   define a "don't care" condition and explain its significance;

(C)   explain why NAND and NOR gates are considered universal gates;

(D)   demonstrate implementation of a combinational logic expression using only NAND gates or only NOR gates;

(E)   discuss the formal design process used for translating a set of design specifications into a functional combinational logic circuit implemented with NAND or NOR gates; and

(F)   explain why combinational logic designs implemented with NAND gates or NOR gates will typically require fewer integrated circuits (IC) than AOI equivalent implementations.

(10)   The student understands combinational logic systems, including seven-segment displays, Exclusive OR and Exclusive NOR gates, and multiplexer/de-multiplexer pairs. The student understands the relative value of various logic approaches. The student is expected to:

(A)   use seven-segment displays used to display the digits 0-9 as well as some alpha characters;

(B)   identify the two varieties of seven-segment displays;

(C)   describe the formal design process used for translating a set of design specifications into a functional combinational logic circuit;

(D) develop an understanding of the hexadecimal and octal number systems and their relationships to the decimal number system;

(E) explain the primary intended purpose of Exclusive OR (XOR) and Exclusive NOR (XNOR) gates;

(F) describe how to accomplish the addition of two binary numbers of any bit length;

(G) explain when multiplexer/de-multiplexer pairs are most frequently used;

(H) explain the purpose of using de-multiplexers in electronic displays that use multiple seven-segment displays;

(I) identify the most commonly used method for handling negative numbers in digital electronics;

(J) discuss the use of programmable logic devices and explain designs for which they are best suited; and

(K) compare and contrast circuits implemented with programmable logic devices with circuits implemented with discrete logic.

(11) The student understands and describes multiple types of sequential logic and various uses of sequential logic. The student is expected to:

(A) explain the capabilities of flip-flop and transparent latch logic devices;

(B) discuss synchronous and asynchronous inputs of flip-flops and transparent latches;

(C) explore the use of flip-flops, including designing single event detection circuits, data synchronizers, shift registers, and frequency dividers;

(D) explain how asynchronous counters are characterized and how they can be implemented;

(E) explore the use of the asynchronous counter method to implement up counters, down counters, and modulus counters;

(F) explain how synchronous counters are characterized and how they can be implemented;

(G) explore the use of the synchronous counter method to implement up counters, down counters, and modulus counters;

(H) describe a state machine;

(I) identify common everyday devices that machines are used to control such as elevator doors, traffic lights, and combinational or electronic locks; and

(J) discuss various ways state machines can be implemented.

(12) The student explores microcontrollers, specifically their usefulness in real-world applications. The student is expected to:

(A) demonstrate an understanding of the use of flowcharts as graphical organizers by technicians, computer programmers, engineers, and other professionals and the benefits of various flowcharting techniques;

(B) develop an understanding of basic programming skills, including variable declaration, loops, and debugging;

(C) identify everyday products that use microcontrollers such as robots, garage door openers, traffic lights, and home thermostats;

(D) describe a servo motor;

(E) explore the way microcontrollers sense and respond to outside stimuli;

(F) explain why digital devices are only relevant if they can interact with the real world;

(G) explain the importance of digital control devices, including microcontrollers in controlling mechanical systems; and

(H) demonstrate an understanding that realistic problem solving with a control system requires the ability to interface analog inputs and outputs with a digital device.

Source: The provisions of this §127.748 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.749. Robotics I (One Credit), Adopted 2015.

(a) General requirements. This course is recommended for students in Grades 9 and 10. Recommended prerequisite: Principles of Applied Engineering. Students shall be awarded one credit for successful completion of this course.

(b) Introduction.

(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.

(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.

(3) In Robotics I, students will transfer academic skills to component designs in a project-based environment through implementation of the design process. Students will build prototypes or use simulation software to test their designs. Additionally, students will explore career opportunities, employer expectations, and educational needs in the robotic and automation industry.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5) 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.

(c) Knowledge and skills.

(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) demonstrate 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, including explaining and justifying actions;

(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.

(2) The student demonstrates the skills necessary for success in a technical career. The student is expected to:

(A) distinguish the differences among an engineering technician, engineering technologist, and engineer;

(B) identify employment and career opportunities;

(C) identify industry certifications;

(D)   discuss ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;

(E)   identify and demonstrate respect for diversity in the workplace;

(F)   identify appropriate actions and consequences relating to discrimination, harassment, and inequality;

(G)   explore robotic engineering careers and preparation programs;

(H)   explore career preparation learning experiences, including job shadowing, mentoring, and apprenticeship training; and

(I)   discuss *Accreditation Board for Engineering and Technology* (ABET) accreditation and implications.

(3)   The student participates in team projects in various roles. The student is expected to:

(A)   explain the importance of teamwork in the field of robotics;

(B)   apply principles of effective problem solving in teams to collaboration and conflict resolution; and

(C)   demonstrate proper attitudes as a team leader and team member.

(4)   The student develops skills for managing a project. The student is expected to:

(A)   implement project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;

(B)   develop a project schedule and complete work according to established criteria;

(C)   participate in the organization and operation of a real or simulated engineering project; and

(D)   develop a plan for production of an individual product.

(5)   The student practices safe and proper work habits. The student is expected to:

(A)   master relevant safety tests;

(B)   comply with safety guidelines as described in various manuals, instructions, and regulations;

(C)   identify governmental and organizational regulations for health and safety in the workplace related to electronics;

(D)   identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations;

(E)   dispose of hazardous materials and wastes appropriately;

(F)   perform maintenance on selected tools, equipment, and machines;

(G)   handle and store tools and materials correctly; and

(H)   describe the results of improper maintenance of material, tools, and equipment.

(6)   The student develops the ability to use and maintain technological products, processes, and systems. The student is expected to:

(A)   demonstrate the use of computers to manipulate a robotic or automated system and associated subsystems;

(B)   maintain systems to ensure safe and proper function and precision operation;

(C)   describe feedback control loops used to provide information; and

(D)   describe types and functions of sensors used in robotic systems.

(7) The student develops an understanding of engineering principles and fundamental physics. The student is expected to:

    (A) demonstrate knowledge of Newton's Laws as applied to robotics such as rotational dynamics, torque, weight, friction, and traction factors required for the operation of robotic systems;

    (B) demonstrate knowledge of motors, gears, gear ratios, and gear trains used in the robotic systems;

    (C) describe the application of the six simple machines to robotics;

    (D) describe the operation of direct current (DC) motors, including control, speed, and torque; and

    (E) describe the operation of servo motors, including control, angle, and torque.

(8) The student develops an understanding of the characteristics and scope of manipulators, accumulators, and end effectors required for a robotic or automated system to function. The student is expected to:

    (A) describe the relationship between robotic arm construction and robot stability;

    (B) describe the relationship between torque and gear ratio to weight of payload in a robotic arm operation; and

    (C) demonstrate knowledge of linkages and gearing in end effectors used in a robotic arm system.

(9) The student uses engineering design methodologies. The student is expected to:

    (A) demonstrate an understanding of and discuss the design process;

    (B) think critically, identify the system constraints, and make fact-based decisions;

    (C) apply testing and reiteration strategies to develop or improve a product;

    (D) apply decision-making strategies when developing solutions;

    (E) identify quality-control issues in engineering design and production;

    (F) describe perceptions of the quality of products and how they affect engineering decisions;

    (G) use an engineering notebook to document the project design process as a legal document; and

    (H) interpret industry standard system schematics.

(10) The student learns the function and application of the tools, equipment, and materials used in robotic and automated systems through specific project-based assessments. The student is expected to:

    (A) use tools and laboratory equipment in a safe manner to construct and repair systems;

    (B) use precision measuring instruments to analyze systems and prototypes; and

    (C) use multiple software applications to simulate robot behavior and present concepts.

(11) The student produces a product using the appropriate tools, materials, and techniques. The student is expected to:

    (A) identify and describe the steps needed to produce a prototype;

    (B) identify and use appropriate tools, equipment, machines, and materials to produce the prototype;

(C) construct a robotic or automated system to perform specified operations using the design process;

(D) test and evaluate the design in relation to pre-established requirements such as criteria and constraints;

(E) refine the design of a robotic or automated system to ensure quality, efficiency, and manufacturability of the final product; and

(F) present the final product using a variety of media.

Source: The provisions of this §127.749 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.750. Robotics II (One Credit), Adopted 2015.

(a) General requirements. This course is recommended for students in Grades 10-12. Prerequisite: Robotics I. Students shall be awarded one credit for successful completion of this course.

(b) Introduction.

(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.

(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.

(3) In Robotics II, students will explore artificial intelligence and programming in the robotic and automation industry. Through implementation of the design process, students will transfer academic skills to component designs in a project-based environment. Students will build prototypes and use software to test their designs.

(4) The mathematical process standards describe ways in which students are expected to engage in the content. The placement of the process standards at the beginning of the knowledge and skills listed for each grade and course is intentional. The process standards weave the other knowledge and skills together so that students may be successful problem solvers and use mathematics efficiently and effectively in daily life. The process standards are integrated at every grade level and course. When possible, students will apply mathematics to problems arising in everyday life, society, and the workplace. Students will use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution. Students will select appropriate tools such as real objects, manipulatives, paper and pencil, and technology and techniques such as mental math, estimation, and number sense to solve problems. Students will effectively communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, and language. Students will use mathematical relationships to generate solutions and make connections and predictions. Students will analyze mathematical relationships to connect and communicate mathematical ideas. Students will display, explain, or justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

(5) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(6) 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.

(c) Knowledge and skills.

(1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

(A)   distinguish the differences among an engineering technician, engineering technologist, and engineer;

(B)   identify employment and career opportunities;

(C)   identify industry certifications;

(D)   recognize the principles of teamwork related to engineering and technology;

(E)   identify and use appropriate work habits;

(F)   locate and report on governmental regulations and laws, including health, safety, and labor codes related to engineering;

(G)   discuss ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;

(H)   demonstrate respect for diversity in the workplace;

(I)   demonstrate appropriate actions and identify consequences relating to discrimination, harassment, and inequality;

(J)   demonstrate effective oral and written communication skills using a variety of software applications and media; and

(K)   explore robotic engineering careers and preparation programs.

(2)   The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:

(A)   apply mathematics to problems arising in everyday life, society, and the workplace;

(B)   use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution;

(C)   select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems;

(D)   communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate;

(E)   create and use representations to organize, record, and communicate mathematical ideas;

(F)   analyze mathematical relationships to connect and communicate mathematical ideas; and

(G)   display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

(3)   The student learns and contributes productively as an individual and as a member of a project team. The student is expected to:

(A)   demonstrate an understanding of and discuss how teams function;

(B)   apply teamwork to solve problems;

(C)   follow directions and decisions of responsible individuals of the project team;

(D)   participate in establishing team procedures and team norms; and

(E)   work cooperatively with others to set and accomplish goals in both competitive and non-competitive situations.

(4)   The student develops skills of project management. The student is expected to:

(A)   implement project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;

(B) develop a project schedule and complete work according to established criteria;

(C) participate in the organization and operation of a real or simulated engineering project; and

(D) translate and employ a Project Management Plan for production of a product.

(5) The student practices safe and proper work habits. The student is expected to:

(A) master relevant safety tests;

(B) comply with safety guidelines as described in various manuals, instructions, and regulations;

(C) identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations;

(D) dispose of hazardous materials and wastes appropriately;

(E) comply with established guidelines for working in a lab environment;

(F) handle and store tools and materials correctly;

(G) employ established inventory control and organization procedures; and

(H) describe the results of negligent or improper maintenance.

(6) The student develops the ability to use and maintain technological products, processes, and systems. The student is expected to:

(A) demonstrate the use of computers to manipulate a robotic or automated system and associated subsystems;

(B) troubleshoot and maintain systems and subsystems to ensure safe and proper function and precision operation;

(C) implement feedback control loops used to provide information; and

(D) implement different types of sensors used in robotic or automated systems and their operations.

(7) The student demonstrates an understanding of advanced mathematics and physics in robotic and automated systems. The student is expected to:

(A) apply the concepts of acceleration and velocity as they relate to robotic and automated systems;

(B) describe the term degrees of freedom and apply it to the design of joints used in robotic and automated systems;

(C) describe angular momentum and integrate it in the design of robotic joint motion, stability, and mobility;

(D) use the impulse-momentum theory in the design of robotic and automated systems;

(E) explain translational, rotational, and oscillatory motion in the design of robotic and automated systems;

(F) apply the operation of direct current (DC) motors, including control, speed, and torque;

(G) apply the operation of servo motors, including control, angle, and torque;

(H) interpret sensor feedback and calculate threshold values;

(I) apply measurement and geometry to calculate robot navigation;

(J) implement movement control using encoders; and

(K) implement path planning using geometry and multiple sensor feedback.

(8)   The student creates a program to control a robotic or automated system. The student is expected to:

    (A)   use coding languages and proper syntax;

    (B)   use programming best practices for commenting and documentation;

    (C)   describe how and why logic is used to control the flow of the program;

    (D)   create a program flowchart and write the pseudocode for a program to perform an operation;

    (E)   create algorithms for evaluating a condition and performing an appropriate action using decisions;

    (F)   create algorithms that loop through a series of actions for a specified increment and for as long as a given condition exists;

    (G)   create algorithms that evaluate sensor data as variables to provide feedback control;

    (H)   use output commands and variables;

    (I)   use selection programming structures such as jumps, loops, switch, and case; and

    (J)   implement subroutines and functions.

(9)   The student develops an understanding of the characteristics and scope of manipulators, accumulators, and end effectors required for a robotic or automated system to function. The student is expected to:

    (A)   demonstrate knowledge of robotic or automated system arm construction;

    (B)   demonstrate an understanding and apply the concepts of torque, gear ratio, stability, and weight of payload in a robotic or automated system arm operation; and

    (C)   demonstrate an understanding and apply the concepts of linkages and gearing in end effectors and their use in a robotic or an automated arm system.

(10)   The student uses engineering design methodologies. The student is expected to:

    (A)   implement the design process;

    (B)   demonstrate critical thinking, identify the system constraints, and make fact-based decisions;

    (C)   apply formal testing and reiteration strategies to develop or improve a product;

    (D)   apply and defend decision-making strategies when developing solutions;

    (E)   identify and improve quality-control issues in engineering design and production;

    (F)   apply Six Sigma to analyze the quality of products and how it affects engineering decisions;

    (G)   use an engineering notebook to document the project design process as a legal document; and

    (H)   create and interpret industry standard system schematics.

(11)   The student learns the function and application of the tools, equipment, and materials used in robotic and automated systems through specific project-based assessments. The student is expected to:

    (A)   use and maintain tools and laboratory equipment in a safe manner to construct and repair systems;

    (B)   use precision measuring instruments to analyze systems and prototypes;

> (C)   implement a system to identify and track all components of the robotic or automated system and all elements involved with the operation, construction, and manipulative functions; and
>
> (D)   use multiple software applications to simulate robot behavior and present concepts.

(12)   The student produces a product using the appropriate tools, materials, and techniques. The student is expected to:

> (A)   use the design process to design a robotic or automated system that meets pre-established criteria and constraints;
>
> (B)   identify and use appropriate tools, equipment, machines, and materials to produce the prototype;
>
> (C)   implement sensors in the robotic or automated system;
>
> (D)   construct the robotic or automated system;
>
> (E)   use the design process to evaluate and formally test the design;
>
> (F)   refine the design of the robotic or automated system to ensure quality, efficiency, and manufacturability of the final robotic or automated system; and
>
> (G)   present the final product using a variety of media.

Source: The provisions of this §127.750 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.751. Engineering Design and Presentation I (One Credit), Adopted 2015.

(a)   General requirements. This course is recommended for students in Grades 10-12. Prerequisite: Algebra I Recommended prerequisite: Principles of Applied Engineering. Students shall be awarded one credit for successful completion of this course.

(b)   Introduction.

(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.

(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.

(3)   Engineering Design and Presentation I is a continuation of knowledge and skills learned in Principles of Applied Engineering. Students enrolled in this course will demonstrate knowledge and skills of the design process as it applies to engineering fields using multiple software applications and tools necessary to produce and present working drawings, solid model renderings, and prototypes. Students will use a variety of computer hardware and software applications to complete assignments and projects. Through implementation of the design process, students will transfer advanced academic skills to component designs. Additionally, students explore career opportunities in engineering, technology, and drafting and what is required to gain and maintain employment in these areas.

(4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5)   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.

(c)   Knowledge and skills.

(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 and work site;

        (B)   cooperate, contribute, and collaborate as a member of a group in an effort to attain agreement and achieve a collective outcome;

        (C)   present written and oral communication in a clear, concise, and effective manner, including explaining and justifying actions;

        (D)   use time-management skills in prioritizing tasks, following schedules, and tending to goal-relevant activities in a way that optimizes efficiency and results; and

        (E)   complete a consistent demonstration of punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed.

(2)   The student gains knowledge of and demonstrates the skills necessary for success in the workplace. The student is expected to:

        (A)   distinguish the differences between an engineering technician, engineering technologist, and engineer;

        (B)   identify employment and career opportunities;

        (C)   investigate and work toward industry certifications;

        (D)   demonstrate the principles of teamwork related to engineering and technology;

        (E)   identify and use appropriate work habits;

        (F)   demonstrate knowledge related to governmental regulations, including health and safety;

        (G)   discuss ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;

        (H)   demonstrate respect for diversity in the workplace;

        (I)   demonstrate appropriate actions and identify consequences relating to discrimination, harassment, and inequality;

        (J)   demonstrate effective oral and written communication skills using a variety of software applications and media; and

        (K)   explore career preparation learning experiences, including job shadowing, mentoring, and apprenticeship training.

(3)   The student participates in team projects in various roles. The student is expected to:

        (A)   demonstrate an understanding of and discuss how teams function;

        (B)   apply teamwork to solve problems; and

        (C)   serve as both a team leader and member and demonstrate appropriate attitudes while participating in team projects.

(4)   The student develops skills for managing a project. The student is expected to:

        (A)   implement project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;

        (B)   develop a project schedule and complete work according to established criteria;

        (C)   participate in the organization and operation of a real or simulated engineering project; and

        (D)   develop a plan for production of an individual product.

(5)   The student practices safe and proper work habits. The student is expected to:

        (A)   master relevant safety tests;

(B) comply with safety guidelines as described in various manuals, instructions, and regulations;

(C) identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations;

(D) dispose of hazardous materials and wastes appropriately;

(E) perform maintenance on selected tools, equipment, and machines;

(F) handle and store tools and materials correctly; and

(G) describe the results of negligent or improper maintenance.

(6) The student applies the concepts of sketching and skills associated with computer-aided drafting and design. The student is expected to:

(A) use single and multi-view projections;

(B) use orthographic and pictorial views;

(C) use auxiliary views;

(D) use section views;

(E) use advanced construction techniques;

(F) prepare and revise annotated multi-dimensional production drawings in computer-aided drafting and design to industry standards;

(G) demonstrate knowledge of effective file structure and management;

(H) use advanced dimensioning techniques;

(I) construct and use basic 3D parametric drawings; and

(J) develop and use prototype drawings for presentation.

(7) The student uses engineering design methodologies. The student is expected to:

(A) demonstrate an understanding of and discuss principles of ideation;

(B) demonstrate critical thinking, identify the system constraints, and make fact-based decisions;

(C) use rational thinking to develop or improve a product;

(D) apply decision-making strategies when developing solutions;

(E) use an engineering notebook to record prototypes, corrections, and/or mistakes in the design process; and

(F) use an engineering notebook and portfolio to record the final design, construction, and manipulation of finished projects.

(8) The student applies concepts of engineering to specific problems. The student is expected to:

(A) use a variety of technologies to design components;

(B) use tools, laboratory equipment, and precision measuring instruments to develop prototypes;

(C) research applications of different types of computer-aided drafting and design software; and

(D) use multiple software applications for concept presentations.

(9) The student designs products using appropriate design processes and techniques. The student is expected to:

      (A)   interpret engineering drawings;

      (B)   identify areas where quality, reliability, and safety can be designed into a product;

      (C)   improve a product design to meet a specified need;

      (D)   produce engineering drawings to industry standards; and

      (E)   describe potential patents and the patenting process.

   (10)   The student builds a prototype using the appropriate tools, materials, and techniques. The student is expected to:

      (A)   identify and describe the steps needed to produce a prototype;

      (B)   identify and use appropriate tools, equipment, machines, and materials to produce the prototype; and

      (C)   present the prototype using a variety of media.

Source: The provisions of this §127.751 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.752. Engineering Design and Presentation II (Two Credits), Adopted 2015.

(a)   General requirements. This course is recommended for students in Grades 11 and 12. Prerequisites: Algebra I and Geometry. Recommended prerequisite: Principles of Applied Engineering or Engineering Design and Presentation I. Students shall be awarded two credits for successful completion of this course.

(b)   Introduction.

   (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.

   (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.

   (3)   Engineering Design and Presentation II is a continuation of knowledge and skills learned in Engineering Design and Presentation I. Students enrolled in this course will demonstrate knowledge and skills of the design process as it applies to engineering fields using multiple software applications and tools necessary to produce and present working drawings, solid model renderings, and prototypes. Students will use a variety of computer hardware and software applications to complete assignments and projects. Through implementation of the design process, students will transfer advanced academic skills to component designs. Emphasis will be placed on using skills from ideation through prototyping.

   (4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

   (5)   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.

(c)   Knowledge and skills.

   (1)   The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

      (A)   distinguish the differences between an engineering technician, engineering technologist, and engineer;

      (B)   identify employment and career opportunities;

      (C)   investigate and work toward industry certifications;

      (D)   demonstrate the principles of teamwork related to engineering and technology;

(E) identify and use appropriate work habits;

(F) demonstrate knowledge related to governmental regulations, including health and safety;

(G) discuss ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;

(H) demonstrate respect for diversity in the workplace;

(I) demonstrate appropriate actions and identify consequences relating to discrimination, harassment, and inequality;

(J) demonstrate effective oral and written communication skills using a variety of software applications and media; and

(K) explore career preparation learning experiences, including job shadowing, mentoring, and apprenticeship training.

(2) The student participates in team projects in various roles. The student is expected to:

(A) demonstrate an understanding of and discuss how teams function;

(B) apply teamwork to solve problems; and

(C) serve as a team leader and member and demonstrate appropriate attitudes while participating in team projects.

(3) The student develops skills for managing a project. The student is expected to:

(A) implement project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;

(B) develop a project schedule and complete projects according to established criteria;

(C) participate in the organization and operation of a real or simulated engineering project; and

(D) develop a plan for production of an individual product.

(4) The student demonstrates principles of project documentation and work flow. The student is expected to:

(A) complete work orders and related documentation;

(B) identify factors affecting cost and strategies to minimize costs;

(C) prepare a project budget;

(D) prepare a production schedule;

(E) identify intellectual property and other legal restrictions; and

(F) read and interpret technical drawings, manuals, and bulletins.

(5) The student applies the concepts and skills of computer-aided drafting and design software to perform the following tasks. The student is expected to:

(A) prepare drawings to American National Standards Institute (ANSI) and International Organization for Standardization (*ISO*) graphic standards;

(B) customize software user interface;

(C) prepare and use advanced views such as auxiliary, section, and break-away;

(D) draw detailed parts, assembly diagrams, and sub-assembly diagrams;

(E) indicate tolerances and standard fittings using appropriate library functions;

      (F)   demonstrate understanding of annotation styles and setup by defining units, fonts, dimension styles, notes, and leader lines;

      (G)   identify and incorporate the use of advanced layout techniques and viewports using paper-space and modeling areas;

      (H)   use management techniques by setting up properties to define and control individual layers;

      (I)   create and use custom templates for advanced project management;

      (J)   prepare and use advanced development drawings;

      (K)   use advanced polar tracking and blocking techniques to increase drawing efficiency;

      (L)   create drawings that incorporate external referencing;

      (M)   create and render objects using parametric modeling tools; and

      (N)   model individual parts or assemblies and produce rendered or animated output.

    (6)   The student practices safe and proper work habits. The student is expected to:

      (A)   master relevant safety tests;

      (B)   comply with safety guidelines as described in various manuals, instructions, and regulations;

      (C)   identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations;

      (D)   dispose of hazardous materials and wastes appropriately;

      (E)   perform maintenance on selected tools, equipment, and machines;

      (F)   handle and store tools and materials correctly; and

      (G)   describe the results of negligent or improper maintenance.

    (7)   The student uses engineering design methodologies. The student is expected to:

      (A)   demonstrate an understanding of and discuss principles of system ideation;

      (B)   demonstrate critical thinking, identify the system constraints, and make fact-based decisions;

      (C)   use rational thinking to develop or improve a system;

      (D)   apply decision-making strategies when developing solutions;

      (E)   identify quality-control issues in engineering design and production;

      (F)   describe perceptions of the quality of products and how they affect engineering decisions;

      (G)   use an engineering notebook to record prototypes, corrections, and/or mistakes in the design process; and

      (H)   use an engineering notebook to record the final design, construction, and manipulation of finished projects.

    (8)   The student applies concepts of engineering to specific problems. The student is expected to:

      (A)   use a variety of technologies to design systems;

      (B)   use tools, laboratory equipment, and precision measuring instruments to develop prototypes;

      (C)   research applications of different types of computer-aided drafting and design software; and

(D)   use multiple software applications for concept presentations.

(9)   The student designs systems using appropriate design processes and techniques. The student is expected to:

(A)   interpret engineering drawings;

(B)   identify areas where quality, reliability, and safety can be designed into a system;

(C)   improve a system design to meet a specified need, including properties of materials selected;

(D)   produce engineering drawings to industry standards; and

(E)   describe potential patents and the patenting process.

(10)   The student builds a prototype using the appropriate tools, materials, and techniques. The student is expected to:

(A)   identify and describe the steps needed to produce a prototype;

(B)   identify and use appropriate tools, equipment, machines, and materials to produce the prototype; and

(C)   present the prototype using a variety of media.

Source: The provisions of this §127.752 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.754. Engineering Mathematics (One Credit), Adopted 2015.

(a)   General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: Algebra II. This course satisfies a high school mathematics graduation requirement. Students shall be awarded one credit for successful completion of this course.

(b)   Introduction.

(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.

(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.

(3)   Engineering Mathematics is a course where students solve and model design problems. Students will use a variety of mathematical methods and models to represent and analyze problems that represent a range of real-world engineering applications such as robotics, data acquisition, spatial applications, electrical measurement, manufacturing processes, materials engineering, mechanical drives, pneumatics, process control systems, quality control, and computer programming.

(4)   The mathematical process standards describe ways in which students are expected to engage in the content. The placement of the process standards at the beginning of the knowledge and skills listed for each grade and course is intentional. The process standards weave the other knowledge and skills together so that students may be successful problem solvers and use mathematics efficiently and effectively in daily life. The process standards are integrated at every grade level and course. When possible, students will apply mathematics to problems arising in everyday life, society, and the workplace. Students will use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution. Students will select appropriate tools such as real objects, manipulatives, paper and pencil, and technology and techniques such as mental math, estimation, and number sense to solve problems. Students will effectively communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, and language. Students will use mathematical relationships to generate solutions and make connections and predictions. Students will analyze

mathematical relationships to connect and communicate mathematical ideas. Students will display, explain, or justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

  (5) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

  (6) 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.

(c) Knowledge and skills.

  (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.

  (2) The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:

    (A) apply mathematics to problems arising in everyday life, society, and the workplace;

    (B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution;

    (C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems;

    (D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language;

    (E) create and use representations to organize, record, and communicate mathematical ideas;

    (F) analyze mathematical relationships to connect and communicate mathematical ideas; and

    (G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

  (3) The student uses mathematically based hydraulics concepts to measure and find pump output, understand pressure versus cylinder force, and understand flow rate verses cylinder speed. The student is expected to:

    (A) explain how flow rate can be measured in gallons per minute and liters per minute;

    (B) calculate and record data using actual flow rates from a flow meter chart;

    (C) calculate, measure, and illustrate the force output and speed of an extending and retracting cylinder; and

    (D) determine and depict the stroke time of a cylinder in gallons per minute.

(4)   The student uses mathematical concepts of structure design to define and describe statics, acquire data, apply concepts of moments and bending stress, and apply concepts of truss design and analysis. The student is expected to:

(A)   calculate a resultant force;

(B)   apply the concept of equilibrium to force calculations;

(C)   calculate a force using a free-body diagram;

(D)   develop an application of strain gauges that determines mathematically and experimentally the force on a structural element;

(E)   calculate the magnitude of force applied to a rotational system;

(F)   apply the moment equilibrium equation to force calculations;

(G)   calculate, measure, and illustrate a bending moment on a beam;

(H)   determine and depict the bending stress in a beam;

(I)   calculate forces in truss using a six-step problem-solving method;

(J)   apply modulus of elasticity to the deflection of beams;

(K)   calculate a beam deflection for a given load;

(L)   determine and depict the critical load for buckling using Euler's formula; and

(M)   design and apply factors of safety to column and beam design.

(5)   The student understands the role of trigonometry in spatial applications. The student is expected to:

(A)   apply trigonometric ratios, including sine, cosine, and tangent, to spatial problems; and

(B)   determine the distance and height of remote objects using trigonometry.

(6)   The student understands the concepts of design processes with multi-view computer-aided drafting and design drawings for facilities layouts, precision part design, process design, injection mold design, and computer-aided manufacturing, as applied to processes using 3D printing, laser cutting, and computer numerical control. The student is expected to:

(A)   determine a dimension of an object given a scaled drawing having no dimensions;

(B)   compare and contrast the function of production time and production rate;

(C)   calculate and apply the proper cycle time and analyze machines required to meet a specified production rate;

(D)   demonstrate the calculation and application of output shaft speed and torque in a gear train;

(E)   create a method to determine the direction of a gear train's output shaft;

(F)   design a spur gear train given speed and torque requirements;

(G)   calculate and apply the proper spacing between the centers of gears in a gear train to a specified tolerance;

(H)   apply positional tolerances to assembled parts;

(I)   predict the production cost of a product given process information and a bill of materials;

(J)   apply the correct spindle speed for a computer-aided manufacturing device by calculation;

(K)   apply the correct feed rate for a computer-aided manufacturing device by using calculation;

(L) calculate the pressure drop in an injection mold system;

(M) design a gate size in an injection mold system using the gate width and depth formulas;

(N) determine the size of a mold; and

(O) create size runners for a multi-cavity mold.

(7) The student calculates electronic quantities and uses electrical measuring instruments to experimentally test their calculations. The student is expected to:

(A) apply common electronic formulas to solve problems;

(B) use engineering notation to properly describe calculated and measured values;

(C) compare and contrast the mathematical differences between a direct current and alternating current;

(D) show the effect and give an application of an inductor in an alternating current circuit;

(E) show the effect and give an application of a capacitor in an alternating current circuit;

(F) create a resistive capacitive timing circuit in a time-delay circuit;

(G) calculate the output voltage and current load of a transformer;

(H) calculate the effective alternating current voltage root mean square given the peak alternating current voltage and the peak alternating current voltage given the root mean square value; and

(I) calculate the cost of operating an electric motor.

(8) The student applies mathematical principles of pneumatic pressure and flow to explain pressure versus cylinder force, apply and manipulate pneumatic speed control circuits, and describe maintenance of pneumatic equipment, centrifugal pump operation and characteristics, data acquisition systems, pump power, and pump system design. The student is expected to:

(A) calculate the force output of a cylinder in retraction and extension;

(B) explain how gage pressure and absolute pressure are different;

(C) explain the individual gas laws and use the ideal gas law to solve problems;

(D) convert air volumes at pressures to free air volumes;

(E) compare dew point and relative humidity to explain their importance;

(F) explain the importance of the two units of pump flow rate measurement;

(G) convert between mass and volumetric flow rate;

(H) differentiate between unit analysis such as converting units of pressure between English and SI units and dimensional analysis such as Force and Pressure;

(I) convert between units of head and pressure;

(J) explain the importance of total dynamic head in terms of suction and discharge head;

(K) demonstrate the measurement of the total head of a centrifugal pump;

(L) calculate Reynolds number and determine the type of fluid flow in a pipe, including laminar flow, transitional flow, and turbulent flow;

(M) calculate friction head loss in a given pipe length using head loss tables or charts;

(N) calculate total suction lift, total suction head, total discharge head, and the total dynamic head of a system for a given flow rate;

(O) calculate hydraulic power;

(P) calculate centrifugal pump brake horsepower given pump efficiency and hydraulic power;

(Q) calculate the effect of impeller diameter and speed on the flow rate of a centrifugal pump and pump head;

(R) predict the effect of impeller diameter on a pump head capacity curve; and

(S) calculate net positive suction head.

(9) The student applies mathematical principles of material engineering, including tensile strength analysis, data acquisition systems, compression testing and analysis, shear and hardness testing and analysis, and design evaluation. The student is expected to:

(A) calculate stress, strain, and elongation using the modulus of elasticity for a material or model with a given set of data;

(B) analyze and explain the importance of sensitivity in relation to material engineering;

(C) analyze the operation of a data-acquisition application or program;

(D) mathematically analyze a part for stress and strain under a compression load;

(E) calculate shear stress for a material with a given set of data;

(F) use the Brinell hardness number to determine the ultimate tensile strength of a material;

(G) apply factors of safety to material engineering designs; and

(H) create material testing conditions for a model using equipment such as a polariscope.

(10) The student applies mathematical principles for mechanical drives, including levers, linkages, cams, turnbuckles, pulley systems, gear drives, key fasteners, v-belt drives, and chain drives. The student is expected to:

(A) calculate the weight of an object for a given mass;

(B) analyze and calculate torque for a given application using the proper units of measurement;

(C) calculate the magnitude of force applied to a rotational system;

(D) calculate the mechanical advantage of first-, second-, and third-class levers;

(E) compare the advantages and disadvantages of the three classes of levers for different applications;

(F) calculate and analyze the coefficient of friction in its proper units of measurement;

(G) analyze and calculate mechanical advantage for simple machines using proper units of measurement;

(H) calculate the mechanical advantage of gear drive systems;

(I) compare and contrast at least two methods of loading a mechanical drive system;

(J) calculate rotary mechanical power applied to an application;

(K) analyze the mechanical efficiency of a given application;

(L) demonstrate various examples of pitch and analyze its proper application;

(M) calculate the shaft speed and torque of a belt drive and chain drive system; and

(N) calculate sprocket ratio and analyze its importance to various applications.

(11) The student applies mathematical principles of quality assurance, including using precision measurement tools, statistical process control, control chart operation, analysis of quality

assurance control charts, geometric dimensioning and tolerancing, and location, orientation, and form tolerances. The student is expected to:

(A)   evaluate the readings of dial calipers and micrometers to make precise measurements;

(B)   use at least three measures of central tendency to analyze the quality of a product;

(C)   use a manually constructed histogram to analyze a given set of data;

(D)   construct and use a mean-value-and-range chart to determine if a process remains constant over a specified range of time;

(E)   examine the maximum and minimum limits of a dimension given its tolerance; and

(F)   use position tolerance to calculate the location of a hole.

Source: The provisions of this §127.754 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.758. Scientific Research and Design (One Credit), Adopted 2015.

(a)   General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: Biology, Chemistry, Integrated Physics and Chemistry (IPC), or Physics. 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. Students may take this course with different course content for a maximum of three credits.

(b)   Introduction.

(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.

(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.

(3)   Scientific Research and Design is a broad-based course designed to allow districts and schools considerable flexibility to develop local curriculum to supplement any program of study or coherent sequence. The course has the components of any rigorous scientific or engineering program of study from the problem identification, investigation design, data collection, data analysis, formulation, and presentation of the conclusions. All of these components are integrated with the career and technical education emphasis of helping students gain entry-level employment in high-skill, high-wage jobs and/or continue their education.

(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.

(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.

(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).

(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.

(8)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(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.

(c)   Knowledge and skills.

(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.

(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.

(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 scientific 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 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 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 investigative procedures, including making observations, asking well-defined questions, formulating testable hypotheses, identifying variables, selecting appropriate equipment and technology, and evaluating numerical answers for reasonableness;

(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, and meter sticks;

        (G)   analyze, evaluate, make inferences, and predict trends from data;

        (H)   identify and quantify causes and effects of uncertainties in measured data;

        (I)   organize and evaluate data and make inferences from data, including the use of tables, charts, and graphs; and

        (J)   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.

    (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)   explain the impacts of the scientific contributions of a variety of historical and contemporary scientists on scientific thought and society;

        (E)   evaluate models according to their limitations in representing biological objects or events;

        (F)   research and describe the connections between science and future careers; and

        (G)   express and interpret relationships symbolically to make predictions and solve problems mathematically, including problems requiring proportional reasoning and graphical vector addition.

    (5)   The student formulates hypotheses to guide experimentation and data collection. The student is expected to:

        (A)   perform background research with respect to an investigative problem; and

        (B)   examine hypotheses generated to guide a research process by evaluating the merits and feasibility of the hypotheses.

    (6)   The student analyzes published research. The student is expected to:

        (A)   identify the scientific methodology used by a researcher;

        (B)   examine a prescribed research design and identify dependent and independent variables;

        (C)   evaluate a prescribed research design to determine the purpose for each of the procedures performed; and

        (D)   compare the relationship of the hypothesis to the conclusion.

    (7)   The student develops and implements investigative designs. The student is expected to:

        (A)   interact and collaborate with scientific researchers or other members of the scientific community to complete a research project;

        (B)   identify and manipulate relevant variables within research situations;

        (C)   use a control in an experimental process; and

        (D)   design procedures to test hypotheses.

    (8)   The student collects, organizes, and evaluates qualitative and quantitative data obtained through experimentation. The student is expected to:

(A)   differentiate between qualitative and quantitative data;

(B)   record observations as they occur within an investigation;

(C)   acquire, manipulate, and analyze data using appropriate equipment and technology, following the rules of significant digits;

(D)   identify sources of random error and systematic error and differentiate between both types of error;

(E)   report error of a set of measured data in various formats, including standard deviation and percent error;

(F)   construct data tables to organize information collected in an experiment; and

(G)   evaluate data using statistical methods to recognize patterns, trends, and proportional relationships.

(9)   The student knows how to synthesize valid conclusions from qualitative and quantitative data. The student is expected to:

(A)   synthesize and justify conclusions supported by research data;

(B)   consider and communicate alternative explanations for observations and results; and

(C)   identify limitations within the research process and provide recommendations for additional research.

(10)   The student communicates conclusions clearly and concisely to an audience of professionals. The student is expected to:

(A)   construct charts, tables, and graphs using technology in order to facilitate data analysis and to communicate experimental results clearly and effectively, including oral presentation of original findings of a research project, to an audience of peers and professionals; and

(B)   suggest alternative explanations from observations or trends evident within the data or from prompts provided by a review panel.

Source: The provisions of this §127.758 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.759. Practicum in Science, Technology, Engineering, and Mathematics (Two Credits), Adopted 2015.

(a)   General requirements. This course is recommended for students in Grade 12. Prerequisites: Algebra I and Geometry. Recommended prerequisites: two Science, Technology, Engineering, and Mathematics (STEM) Career Cluster credits. The practicum course is a paid or unpaid capstone experience for students participating in a coherent sequence of career and technical education courses in the STEM Career Cluster. Students shall be awarded two credits for successful completion of this course. A student may repeat this course once for credit provided that the student is experiencing different aspects of the industry and demonstrating proficiency in additional and more advanced knowledge and skills.

(b)   Introduction.

(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.

(2)   The STEM Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services such as physical science, social science, engineering, including laboratory and testing services, and research and development services.

(3)   Practicum in STEM is designed to give students supervised practical application of previously studied knowledge and skills. Practicum experiences can occur in a variety of locations appropriate to the nature and level of experience.

(4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5)   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.

(c)   Knowledge and skills.

(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, collaborate, and accept constructive criticism 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;

(E)   demonstrate punctuality, dependability, reliability, and responsibility and adhere to policies and procedures in performing assigned tasks as directed;

(F)   apply ethical reasoning to a variety of situations in order to make ethical decisions;

(G)   complete tasks with the highest standards to ensure quality products and services; and

(H)   comply with practicum setting safety rules and regulations to maintain safe and healthy working conditions and environments.

(2)   The student applies concepts of critical thinking and problem solving. The student is expected to:

(A)   analyze elements of a problem to develop creative and innovative solutions;

(B)   analyze information to determine value to the problem-solving task;

(C)   compare and contrast alternatives using a variety of problem-solving and critical-thinking skills; and

(D)   conduct technical research to gather information necessary for decision making.

(3)   The student demonstrates leadership and teamwork skills in collaborating with others to accomplish goals and objectives. The student is expected to:

(A)   analyze leadership in relation to trust, positive attitude, integrity, and willingness to accept key responsibilities in a work situation;

(B)   demonstrate teamwork processes that promote team building, consensus, continuous improvement, respect for the opinions of others, cooperation, adaptability, and conflict resolution;

(C)   demonstrate responsibility for shared group and individual work tasks;

(D)   use positive interpersonal skills to establish and maintain effective working relationships in order to accomplish objectives and tasks;

(E)   negotiate effectively to arrive at decisions; and

(F)   demonstrate respect for individuals, including those from different cultures, genders, and backgrounds and diversity.

(4)   The student demonstrates oral and written communication skills in creating, expressing, and interpreting information and ideas, including technical terminology and information. The student is expected to:

(A) demonstrate the use of content, technical concepts, and vocabulary when analyzing information and following directions;

(B) employ verbal skills when obtaining and conveying information;

(C) use informational texts, scientific websites, and technical materials to review and apply information sources for occupational tasks;

(D) evaluate the reliability of information from informational texts, scientific websites, and technical materials and resources;

(E) interpret verbal and nonverbal cues and behaviors to enhance communication;

(F) apply active listening skills to obtain and clarify information; and

(G) use academic skills to facilitate effective written and oral communication.

(5) The student demonstrates technical knowledge and skills required to pursue a career in a science, technology, engineering, and mathematics career field. The student is expected to:

(A) develop advanced technical knowledge and skills related to the student's occupational objective; and

(B) evaluate strengths and weaknesses in technical skill proficiency.

(6) The student documents technical knowledge and skills. The student is expected to:

(A) update a professional portfolio to include information such as:

(i) attainment of technical skill competencies;

(ii) licensures or certifications;

(iii) recognitions, awards, and scholarships;

(iv) extended learning experiences such as community service and active participation in career and technical student organizations and professional organizations;

(v) abstract of key points of the practicum;

(vi) resume;

(vii) samples of work; and

(viii) evaluation from the practicum supervisor; and

(B) present the portfolio to interested stakeholders.

Source: The provisions of this §127.759 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.760. Extended Practicum in Science, Technology, Engineering, and Mathematics (One Credit), Adopted 2015.

(a) General requirements. This course is recommended for students in Grade 12. The practicum course is a paid or unpaid capstone experience for students participating in a coherent sequence of career and technical education courses in the Science, Technology, Engineering, and Mathematics (STEM) Career Cluster. Prerequisites: Algebra I and Geometry. Recommended prerequisites: two credits from the courses in the STEM Career Cluster. Corequisite: Practicum in Science, Technology, Engineering, and Mathematics. This course must be taken concurrently with Practicum in Science, Technology, Engineering, and Mathematics and may not be taken as a stand-alone course. Students shall be awarded one credit for successful completion of this course. A student may repeat this course once for credit provided that the student is experiencing different aspects of the industry and demonstrating proficiency in additional and more advanced knowledge and skills.

(b) Introduction.

(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.

(2)   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.

(3)   Extended Practicum in STEM is designed to give students supervised practical application of previously studied knowledge and skills. Practicum experiences can occur in a variety of locations appropriate to the nature and level of experience.

(4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5)   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.

(c)   Knowledge and skills.

(1)   The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

(A)   participate in a paid or unpaid, laboratory- or work-based application of previously studied knowledge and skills related to STEM;

(B)   participate in training, education, or preparation for licensure, certification, or other relevant credentials to prepare for employment;

(C)   demonstrate professional standards and personal qualities needed to be employable such as self-discipline, positive attitude, integrity, leadership, appreciation for diversity, customer service, work ethic, and adaptability with increased fluency;

(D)   employ teamwork and conflict-management skills with increased fluency to achieve collective goals; and

(E)   employ planning and time-management skills and tools such as prioritizing tasks, following schedules, and performing goal-relevant activities with increased fluency to enhance results and complete work tasks.

(2)   The student applies professional communications strategies. The student is expected to:

(A)   demonstrate verbal and non-verbal communication consistently in a clear, concise, and effective manner;

(B)   apply active listening skills to obtain and clarify information;

(C)   create and deliver formal and informal presentations effectively;

(D)   analyze, interpret, and effectively communicate information, data, and observations; and

(E)   observe and interpret verbal and nonverbal cues and behaviors to enhance communication.

(3)   The student implements advanced problem-solving methods. The student is expected to:

(A)   employ critical-thinking skills with increased fluency both independently and in groups to solve problems and make decisions;

(B)   analyze elements of problems to develop creative and innovative solutions;

(C)   apply decision-making techniques with increased fluency to the selection of technological solutions; and

(D)   conduct technical research to gather information necessary for decision making.

(4)   The student understands and applies proper safety and security techniques in the workplace. The student is expected to understand and consistently follow workplace safety rules and regulations.

(5)   The student understands the professional, ethical, and legal responsibilities in STEM-related fields. The student is expected to:

   (A)   demonstrate a positive, productive work ethic by performing assigned tasks as directed;

   (B)   apply ethical reasoning to a variety of situations in order to make ethical decisions; and

   (C)   comply with all applicable rules, laws, and regulations in a consistent manner.

(6)   The student participates in a supervised STEM experience. The student is expected to:

   (A)   conduct, document, and evaluate learning activities in a supervised STEM experience;

   (B)   develop advanced technical knowledge and skills related to the student's occupational objective;

   (C)   evaluate strengths and weaknesses in technical skill proficiency; and

   (D)   collect representative work samples.

Source: The provisions of this §127.760 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.762. Computer Science I (One Credit).

(a)   General requirements. Students shall be awarded one credit for successful completion of this course. Prerequisite: Algebra I. This course is recommended for students in Grades 9-12.

(b)   Introduction.

(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.

(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.

(3)   Computer Science I will foster students' creativity and innovation by presenting opportunities to design, implement, and present meaningful programs through a variety of media. Students will collaborate with one another, their instructor, and various electronic communities to solve the problems presented throughout the course. Through data analysis, students will identify task requirements, plan search strategies, and use computer science concepts to access, analyze, and evaluate information needed to solve problems. By using computer science knowledge and skills that support the work of individuals and groups in solving problems, students will select the technology appropriate for the task, synthesize knowledge, create solutions, and evaluate the results. Students will learn digital citizenship by researching current laws and regulations and by practicing integrity and respect. Students will gain an understanding of the principles of computer science through the study of technology operations, systems, and concepts. The six strands include creativity and innovation; communication and collaboration; research and information fluency; critical thinking; problem solving, and decision making; digital citizenship; and technology operations and concepts.

(4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5)   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.

(c)   Knowledge and skills.

(1)   Creativity and innovation. The student develops products and generates new understandings by extending existing knowledge. The student is expected to:

(A) participate with electronic communities as a learner, initiator, contributor, and teacher/mentor;

(B) extend the learning environment beyond the school walls with digital products created to increase teaching and learning in the other subject areas; and

(C) participate in relevant, meaningful activities in the larger community and society to create electronic projects.

(2) Communication and collaboration. The student communicates and collaborates with peers to contribute to his or her own learning and the learning of others. The student is expected to:

(A) create and properly display meaningful output;

(B) create interactive console display interfaces, with appropriate user prompts, to acquire data from a user;

(C) use Graphical User Interfaces (GUIs) to create interactive interfaces to acquire data from a user and display program results;

(D) write programs with proper programming style to enhance the readability and functionality of the code by using meaningful descriptive identifiers, internal comments, white space, spacing, indentation, and a standardized program style;

(E) improve numeric display by optimizing data visualization;

(F) display simple vector graphics using lines, circles, and rectangles;

(G) display simple bitmap images; and

(H) seek and respond to advice from peers and professionals in evaluating quality and accuracy.

(3) Research and information fluency. The student locates, analyzes, processes, and organizes data. The student is expected to:

(A) use a variety of resources, including foundation and enrichment curricula, to gather authentic data as a basis for individual and group programming projects; and

(B) use various productivity tools to gather authentic data as a basis for individual and group programming projects.

(4) Critical thinking, problem solving, and decision making. The student uses appropriate strategies to analyze problems and design algorithms. The student is expected to:

(A) use program design problem-solving strategies to create program solutions;

(B) define and specify the purpose and goals of solving a problem;

(C) identify the subtasks needed to solve a problem;

(D) identify the data types and objects needed to solve a problem;

(E) identify reusable components from existing code;

(F) design a solution to a problem;

(G) code a solution from a program design;

(H) identify and debug errors;

(I) test program solutions with appropriate valid and invalid test data for correctness;

(J) debug and solve problems using error messages, reference materials, language documentation, and effective strategies;

(K) explore common algorithms, including finding greatest common divisor, finding the biggest number out of three, finding primes, making change, and finding the average;

(L)   analyze and modify existing code to improve the underlying algorithm;

(M)   create program solutions that exhibit robust behavior by understanding, avoiding, and preventing runtime errors, including division by zero and type mismatch;

(N)   select the most appropriate algorithm for a defined problem;

(O)   demonstrate proficiency in the use of the arithmetic operators to create mathematical expressions, including addition, subtraction, multiplication, real division, integer division, and modulus division;

(P)   create program solutions to problems using available mathematics libraries, including absolute value, round, power, square, and square root;

(Q)   develop program solutions that use assignment;

(R)   develop sequential algorithms to solve non-branching and non-iterative problems;

(S)   develop algorithms to decision-making problems using branching control statements;

(T)   develop iterative algorithms and code programs to solve practical problems;

(U)   demonstrate proficiency in the use of the relational operators;

(V)   demonstrate proficiency in the use of the logical operators; and

(W)   generate and use random numbers.

(5)   Digital citizenship. The student explores and understands safety, legal, cultural, and societal issues relating to the use of technology and information. The student is expected to:

(A)   discuss intellectual property, privacy, sharing of information, copyright laws, and software licensing agreements;

(B)   model ethical acquisition and use of digital information;

(C)   demonstrate proper digital etiquette, responsible use of software, and knowledge of acceptable use policies;

(D)   investigate measures, including passwords and virus detection/prevention, to protect computer systems and databases from unauthorized use and tampering; and

(E)   investigate how technology has changed and the social and ethical ramifications of computer usage.

(6)   Technology operations, systems, and concepts. The student understands technology concepts, systems, and operations as they apply to computer science. The student is expected to:

(A)   compare and contrast types of operating systems, software applications, and programming languages;

(B)   demonstrate knowledge of major hardware components, including primary and secondary memory, a central processing unit (CPU), and peripherals;

(C)   differentiate among current programming languages, discuss the use of those languages in other fields of study, and demonstrate knowledge of specific programming terminology and concepts;

(D)   differentiate between a high-level compiled language and an interpreted language;

(E)   understand concepts of object-oriented design;

(F)   use local and global scope access variable declarations;

(G)   encapsulate data and associated subroutines into an abstract data type;

(H)   create subroutines that do not return values with and without the use of arguments and parameters;

(I)   create subroutines that return typed values with and without the use of arguments and parameters;

(J)   understand and identify the data-binding process between arguments and parameters;

(K)   compare objects using reference values and a comparison routine;

(L)   understand the binary representation of numeric and nonnumeric data in computer systems;

(M)   understand the finite limits of numeric data;

(N)   perform numerical conversions between the decimal and binary number systems and count in the binary number system;

(O)   choose, identify, and use the appropriate data types for integer, real, and Boolean data when writing program solutions;

(P)   demonstrate an understanding of the concept of a variable;

(Q)   demonstrate an understanding of and use reference variables for objects;

(R)   demonstrate an understanding of how to represent and manipulate text data, including concatenation and other string functions;

(S)   demonstrate an understanding of the concept of scope;

(T)   identify and use the structured data type of one-dimensional arrays to traverse, search, and modify data;

(U)   choose, identify, and use the appropriate data type and structure to properly represent the data in a program problem solution; and

(V)   compare and contrast strongly typed and un-typed programming languages.

Source: The provisions of this §127.762 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.763. Computer Science II (One Credit).

(a)   General requirements. Students shall be awarded one credit for successful completion of this course. Prerequisite: Algebra I and either Computer Science I or Fundamentals of Computer Science. This course is recommended for students in Grades 11 and 12.

(b)   Introduction.

(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.

(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.

(3)   Computer Science II will foster students' creativity and innovation by presenting opportunities to design, implement, and present meaningful programs through a variety of media. Students will collaborate with one another, their instructor, and various electronic communities to solve the problems presented throughout the course. Through data analysis, students will identify task requirements, plan search strategies, and use computer science concepts to access, analyze, and evaluate information needed to solve problems. By using computer science knowledge and skills that support the work of individuals and groups in solving problems, students will select the technology appropriate for the task, synthesize knowledge, create solutions, and evaluate the results. Students will learn digital citizenship by researching current laws and regulations and by practicing integrity and respect. Students will gain an understanding of computer science through the study of technology operations, systems, and concepts. The six strands include creativity and innovation; communication and collaboration; research and information fluency; critical thinking;

problem solving, and decision making; digital citizenship; and technology operations and concepts.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5) 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.

(c) Knowledge and skills.

(1) Creativity and innovation. The student develops products and generates new understandings by extending existing knowledge. The student is expected to:

(A) use program design problem-solving strategies to create program solutions;

(B) demonstrate the ability to read and modify large programs, including the design description and process development;

(C) follow the systematic problem-solving process of identifying the specifications of purpose and goals, the data types and objects needed, and the subtasks to be performed;

(D) compare and contrast design methodologies and implementation techniques such as top-down, bottom-up, and black box;

(E) analyze, modify, and evaluate existing code by performing a case study on a large program, including inheritance and black box programming;

(F) identify the data types and objects needed to solve a problem;

(G) choose, identify, and use the appropriate abstract data type, advanced data structure, and supporting algorithms to properly represent the data in a program problem solution;

(H) use object-oriented programming development methodology, data abstraction, encapsulation with information hiding, and procedural abstraction in program development and testing; and

(I) create, edit, and manipulate bitmap images that are used to enhance user interfaces and program functionality.

(2) Communication and collaboration. The student communicates and collaborates with peers to contribute to his or her own learning and the learning of others. The student is expected to:

(A) use the principles of software engineering to work in software design teams, break a problem statement into specific solution requirements, create a program development plan, code part of a solution from a program development plan while a partner codes the remaining part, team test the solution for correctness, and develop presentations to report the solution findings;

(B) create interactive console display interfaces with appropriate user prompts;

(C) create interactive human interfaces to acquire data from a user and display program results using an advanced Graphical User Interface (GUI);

(D) write programs and communicate with proper programming style to enhance the readability and functionality of the code by using meaningful descriptive identifiers, internal comments, white space, indentation, and a standardized program style;

(E) improve data display by optimizing data visualization;

(F) display simple vector graphics to interpret and display program results; and

(G) display simple bitmap images.

(3) Research and information fluency. The student locates, analyzes, processes, and organizes data. The student is expected to:

(A) use local area networks (LANs) and wide area networks (WANs), including the Internet and intranets, in research, file management, and collaboration;

(B) understand programming file structure and file access for required resources;

(C) acquire and process information from text files, including files of known and unknown sizes;

(D) manipulate data structures using string processing;

(E) manipulate data values by casting between data types;

(F) identify and use the structured data type of one-dimensional arrays to traverse, search, modify, insert, and delete data;

(G) identify and use the structured data type of two-dimensional arrays to traverse, search, modify, insert, and delete data; and

(H) identify and use a list object data structure to traverse, search, insert, and delete data.

(4) Critical thinking, problem solving, and decision making. The student uses appropriate strategies to analyze problems and design algorithms. The student is expected to:

(A) develop sequential algorithms using branching control statements, including nested structures, to create solutions to decision-making problems;

(B) develop choice algorithms using selection control statements based on ordinal values;

(C) demonstrate proficiency in the use of short-circuit evaluation;

(D) demonstrate proficiency in the use of Boolean algebra, including De Morgan's Law;

(E) develop iterative algorithms using nested loops;

(F) identify, trace, and appropriately use recursion in programming solutions, including algebraic computations;

(G) design, construct, evaluate, and compare search algorithms, including linear searching and binary searching;

(H) identify, describe, design, create, evaluate, and compare standard sorting algorithms, including selection sort, bubble sort, insertion sort, and merge sort;

(I) measure time/space efficiency of various sorting algorithms;

(J) compare and contrast search and sort algorithms, including linear, quadratic, and recursive strategies, for time/space efficiency;

(K) analyze algorithms using "big-O" notation for best, average, and worst-case data patterns;

(L) develop algorithms to solve various problems, including factoring, summing a series, finding the roots of a quadratic equation, and generating Fibonacci numbers;

(M) test program solutions by investigating boundary conditions; testing classes, methods, and libraries in isolation; and performing stepwise refinement;

(N) identify and debug compile, syntax, runtime, and logic errors;

(O) compare and contrast algorithm efficiency by using informal runtime comparisons, exact calculation of statement execution counts, and theoretical efficiency values using "big-O" notation, including worst-case, best-case, and average-case time/space analysis;

(P) demonstrate the ability to count, convert, and perform mathematical operations in the binary and hexadecimal number systems;

(Q) demonstrate knowledge of the maximum integer boundary, minimum integer boundary, imprecision of real number representations, and round-off errors;

(R)   create program solutions to problems using the mathematics library class;

(S)   use random algorithms to create simulations that model the real world;

(T)   identify, understand, and create class specifications and relationships among classes, including composition and inheritance relationships;

(U)   understand and explain object relationships among defined classes, abstract classes, and interfaces;

(V)   create object-oriented definitions using class declarations, variable declarations, constant declarations, method declarations, parameter declarations, and interface declarations;

(W)   create robust classes that encapsulate data and the methods that operate on that data and incorporate overloading to enrich the object's behavior;

(X)   design and implement a set of interactive classes;

(Y)   design, create, and evaluate multiclass programs that use abstract classes and interfaces;

(Z)   understand and implement a student-created class hierarchy;

(AA)   extend, modify, and improve existing code using inheritance;

(BB)   create adaptive behaviors, including overloading, using polymorphism;

(CC)   understand and use reference variables for object and string data types;

(DD)   understand and implement access scope modifiers;

(EE)   understand and demonstrate how to compare objects;

(FF)   duplicate objects using the appropriate deep and/or shallow copy;

(GG)   define and implement abstract classes and interfaces in program problem solutions;

(HH)   apply functional decomposition to a program solution;

(II)   create simple and robust objects from class definitions through instantiation;

(JJ)   apply class membership of variables, constants, and methods;

(KK)   examine and mutate the properties of an object using accessors and modifiers;

(LL)   understand and implement a composite class; and

(MM)   design and implement an interface.

(5)   Digital citizenship. The student explores and understands safety, legal, cultural, and societal issues relating to the use of technology and information. The student is expected to:

(A)   model ethical acquisition and use of digital information;

(B)   demonstrate proper digital etiquette, responsible use of software, and knowledge of acceptable use policies; and

(C)   investigate digital rights management.

(6)   Technology operations and concepts. The student understands technology concepts, systems, and operations as they apply to computer science. The student is expected to:

(A)   compare and contrast types of operating systems, software applications, hardware platforms, and programming languages;

(B)   demonstrate knowledge of major hardware components, including primary and secondary memory, a central processing unit (CPU), and peripherals;

(C)   demonstrate knowledge of major networking components, including hosts, servers, switches, and routers;

(D)		demonstrate knowledge of computer communication systems, including single-user, peer-to-peer, workgroup, client-server, and networked;
(E)		demonstrate knowledge of computer addressing systems, including Internet Protocol (IP) address and Media Access Control (MAC) address; and
(F)		differentiate among the categories of programming languages, including machine, assembly, high-level compiled, high-level interpreted, and scripted.

Source: The provisions of this §127.763 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.766. Discrete Mathematics for Computer Science (One Credit), Beginning with School Year 2012-2013.

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Prerequisite: Algebra II. This course is recommended for students in Grades 11 and 12.

(b) Introduction.

(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.

(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.

(3) Discrete Mathematics for Computer Science provides the tools used in most areas of computer science. Exposure to the mathematical concepts and discrete structures presented in this course is essential in order to provide an adequate foundation for further study. Discrete Mathematics for Computer Science is generally listed as a core requirement for Computer Science majors. Course topics are divided into six areas: sets, functions, and relations; basic logic; proof techniques; counting basics; graphs and trees; and discrete probability. Mathematical topics are interwoven with computer science applications to enhance the students' understanding of the introduced mathematics. Students will develop the ability to see computational problems from a mathematical perspective. Introduced to a formal system (propositional and predicate logic) upon which mathematical reasoning is based, students will acquire the necessary knowledge to read and construct mathematical arguments (proofs), understand mathematical statements (theorems), and use mathematical problem-solving tools and strategies. Students will be introduced to discrete data structures such as sets, discrete functions, and relations and graphs and trees. Students will also be introduced to discrete probability and expectations. The six strands include creativity and innovation; communication and collaboration; research and information fluency; critical thinking; problem solving, and decision making; digital citizenship; and technology operations and concepts.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5) 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.

(c) Knowledge and skills.

(1) Creativity and innovation. The student develops products and generates new understanding by extending existing knowledge. The student is expected to:

(A) model algorithms and real-world situations using formal tools of symbolic logic;

(B) model computer science problems by using graphs and trees; and

(C) calculate the probabilities of events and expectations of random variables for such problems as games of chance.

(2) Communication and collaboration. The student communicates and collaborates with peers to contribute to his or her own learning and the learning of others. The student is expected to:

(A) convert spoken language statements to appropriate statements in propositional logic;

(B) explain basic terminology of sets, functions, and relations;

(C) state the definition of the Master theorem;

(D) use the context of a particular application to interpret the meaning derived when computing the permutations and combinations of a set;

(E) interpret associated operations and terminology in context; and

(F) define and provide examples of logical equivalence, normal forms, validity, and modus ponens/modus tollens.

(3) Research and information fluency. The student locates, analyzes, processes, and organizes data. The student is expected to:

(A) construct truth tables for negation, conjunction, disjunction, implication, biconditional, and bit operators; and

(B) use truth tables to demonstrate propositional relations.

(4) Critical thinking, problem solving, and decision making. The student uses appropriate strategies to analyze problems and design algorithms. The student is expected to:

(A) analyze practical examples using appropriate models of sets, functions, and relations;

(B) compare and contrast tautology, contradiction, and contingency as related to propositional equivalences;

(C) compare and contrast examples and use of counterexamples, contrapositions, and contradictions;

(D) describe the appropriate use and limitations of predicate logic;

(E) apply formal methods of symbolic propositional and predicate logic;

(F) use formal logic proofs and logical reasoning to solve problems;

(G) outline the basic structure of proofs, including direct, indirect, contradiction, induction, existence, and constructive proofs;

(H) compare and contrast the types of problems best satisfied by direct, indirect, contradiction, induction, existence, and constructive proofs;

(I) relate mathematical induction to recursion and recursively defined structures;

(J) compare and contrast weak, strong, and structural induction, including when each is most appropriately used and examples of each;

(K) compare and contrast dependent and independent events;

(L) use recurrence equations to analyze algorithms and other practical problems;

(M) use counting techniques to analyze algorithms and other practical problems;

(N) apply probability tools to solve problems; and

(O) define, compare, and contrast simple graphs, multigraphs, and directed and undirected graphs using definitions, properties, and examples, including special cases.

(5) Digital citizenship. The student explores and understands safety, legal, cultural, and societal issues relating to the use of technology and information. The student is expected to:

(A) model ethical acquisition and use of digital information;

(B)   demonstrate proper digital etiquette, responsible use of software, and knowledge of acceptable use policies; and

(C)   investigate how the concepts of discrete mathematics are related to relevant problems and significant questions.

(6)   Technology operations and concepts. The student understands technology concepts, systems, and operations as they apply to computer science. The student is expected to:

(A)   perform operations associated with sets, functions, and relations;

(B)   apply basic counting principles, including cardinality and the pigeonhole principle;

(C)   apply appropriate precedence when using logical operators;

(D)   use appropriate strategies, including De Morgan's Laws, to identify propositional equivalences;

(E)   identify and appropriately use predicates, existential and universal quantifiers, and valid arguments;

(F)   identify possible applications of proofs, including evaluating algorithmic complexity;

(G)   state and appropriately use the product and sum rules;

(H)   compute permutations and combinations of a set;

(I)   solve a variety of basic recurrence equations;

(J)   apply the binomial theorem to independent events;

(K)   apply Bayes' theorem to dependent events;

(L)   demonstrate transversal methods for trees and graphs; and

(M)   relate graphs and trees to data structures, algorithms, and counting.

Source: The provisions of this §127.766 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.767. Game Programming and Design (One Credit).

(a)   General requirements. Students shall be awarded one credit for successful completion of this course. Prerequisite: Algebra I. This course is recommended for students in Grades 9-12.

(b)   Introduction.

(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.

(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.

(3)   Game Programming and Design will foster student creativity and innovation by presenting students with opportunities to design, implement, and present meaningful programs through a variety of media. Students will collaborate with one another, their instructor, and various electronic communities to solve gaming problems. Through data analysis, students will include the identification of task requirements, plan search strategies, and use programming concepts to access, analyze, and evaluate information needed to design games. By acquiring programming knowledge and skills that support the work of individuals and groups in solving problems, students will select the technology appropriate for the task, synthesize knowledge, create solutions, and evaluate the results. Students will learn digital citizenship by researching current laws and regulations and by practicing integrity and respect. Students will create a computer game that is presented to an evaluation panel. The six strands include creativity and innovation;

communication and collaboration; research and information fluency; critical thinking; problem solving, and decision making; digital citizenship; and technology operations and concepts.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5) 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.

(c) Knowledge and skills.

(1) Creativity and innovation. The student develops products and generates new understanding by extending existing knowledge. The student is expected to:

(A) understand the basic game design elements, including conceptual ideas, storyline, visualization, storyboard, game effects, sound elements, game play, game controls, and player tutorial;

(B) create a design concept document;

(C) create a storyboard;

(D) demonstrate an understanding of the fundamentals of game art, including the look and feel, graphics coordinate system, basics of color, and color palettes;

(E) use bitmap graphics images, including designing, creating, reading, and manipulating images;

(F) create backgrounds, including solid, image, and tiled backgrounds;

(G) write programs creating images using geometric shapes;

(H) create games using sprites by evaluating the role of sprites, creating sprites, and managing sprites;

(I) create programs using sprite sheets;

(J) demonstrate an understanding of image rendering, including transparency, refresh rate, hardware acceleration, and animation;

(K) find, create, and edit game audio sound effects and music; and

(L) implement game sound mechanics, including playing, pausing, and looping.

(2) Communication and collaboration. The student communicates and collaborates with peers to contribute to his or her own learning and the learning of others. The student is expected to:

(A) design and implement procedures to set timelines for, track the progress of, and evaluate a game product;

(B) seek and respond to input from peers and professionals in evaluating a game project;

(C) demonstrate knowledge and appropriate use of operating systems, program development tools, and networking resources;

(D) use network resources to acquire, organize, maintain, and evaluate information;

(E) collaborate to research the business of games, including the roles of developer, marketing, publisher, and retail sales; and

(F) demonstrate an understanding of and evaluate online technology, including online interaction and massive multiplayer games.

(3) Research and information fluency. The student locates, analyzes, processes, and organizes data. The student is expected to:

(A) play board games to research and collect game play data;

(B)   evaluate, analyze, and document game styles and playability; and

(C)   research the dramatic elements in games, including kinds of fun, player types, and nonlinear storytelling.

(4)   Critical thinking, problem solving, and decision making. The student uses appropriate strategies to analyze problems and design algorithms. The student is expected to:

(A)   demonstrate an understanding of the game design process, including generating ideas, brainstorming, and paper prototyping;

(B)   write programs using variables of different data types;

(C)   evaluate game rules and instructions;

(D)   demonstrate an understanding of the user experience by comparing rules and game-play patterns;

(E)   write game rules and instructions;

(F)   develop game software;

(G)   write computer game code, resolve game defects, and revise existing game code; and

(H)   test a finished game product by implementing sound testing techniques.

(5)   Digital citizenship. The student explores and understands safety, legal, cultural, and societal issues relating to the use of technology and information. The student is expected to:

(A)   explore intellectual property, privacy, sharing of information, copyright laws, and software licensing agreements;

(B)   model ethical acquisition and use of digital information;

(C)   demonstrate proper digital etiquette when using networks, responsible use of software, and knowledge of acceptable use policies;

(D)   model respect of intellectual property, including manipulating graphics, morphing graphics, editing graphics, and editing sound;

(E)   discuss and evaluate the social issues surrounding gaming; and

(F)   evaluate the cultural aspects of game design fundamentals, including rationale for games and types of games.

(6)   Technology operations and concepts. The student understands technology concepts, systems, and operations as they apply to game programming. The student is expected to:

(A)   identify basic game components, including the game engine, game play subsystems, data structures, models, and interfaces;

(B)   generate random numbers in a program;

(C)   create a program implementing conditional statements;

(D)   develop an appropriate data model;

(E)   demonstrate an understanding of and apply object-oriented game programming;

(F)   demonstrate an understanding of game programming essentials, including event-driven programming, communicating with messages, and device management;

(G)   demonstrate an understanding of the role of game events, the animation loop, and game timing;

(H)   demonstrate an understanding of the role of game engines;

(I)   demonstrate an understanding of video display flicker and double buffering;

(J) apply basic game screen design and layout, including visual controls, user interfaces, menus, and options;

(K) use game control design to understand, access, and control input devices, including keyboard, mouse, and joystick;

(L) demonstrate an understanding of and apply game animation, including the principles of animation and frame-based animation;

(M) demonstrate an understanding of decision making and types of decisions;

(N) demonstrate an understanding of game events, including listeners, triggers, and timed events;

(O) demonstrate an understanding of and implement collision detection, including bounding boxes and sprite collisions;

(P) implement a tile-based game, including loading tile maps, drawing tile maps, rendering a tile map, and layering sprites;

(Q) demonstrate an understanding of artificial intelligence and develop and implement artificial intelligence;

(R) demonstrate an understanding of game balance and tuning; and

(S) demonstrate an understanding of player progression, including leveling, linear progression, and maintaining high score data.

Source: The provisions of this §127.767 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.768. Mobile Application Development (One Credit).

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Prerequisite: Algebra I. This course is recommended for students in Grades 9-12.

(b) Introduction.

(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.

(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.

(3) Mobile Application Development will foster students' creativity and innovation by presenting opportunities to design, implement, and deliver meaningful projects using mobile computing devices. Students will collaborate with one another, their instructor, and various electronic communities to solve problems presented throughout the course. Through data analysis, students will identify task requirements, plan search strategies, and use software development concepts to access, analyze, and evaluate information needed to program mobile devices. By using software design knowledge and skills that support the work of individuals and groups in solving problems, students will select the technology appropriate for the task, synthesize knowledge, create solutions, and evaluate the results. Students will learn digital citizenship by researching current laws and regulations and by practicing integrity and respect. Students will gain an understanding of the principles of mobile application development through the study of development platforms, programming languages, and software design standards. The six strands include creativity and innovation; communication and collaboration; research and information fluency; critical thinking; problem solving, and decision making; digital citizenship; and technology operations and concepts.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5)   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.

(c)   Knowledge and skills.

(1)   Creativity and innovation. The student develops products and generates new understanding by extending existing knowledge. The student is expected to:

(A)   create effective user interfaces appropriate for a specified mobile device that is best suited for an identified purpose;

(B)   create effective user interfaces for browser-based, native, and hybrid mobile applications;

(C)   create mobile application components appropriate for identified needs;

(D)   create browser-based applications for mobile devices;

(E)   create native applications that can reside on specified mobile devices; and

(F)   create mobile applications that combine native and hybrid components.

(2)   Communication and collaboration. The student communicates and collaborates with peers to contribute to his or her own learning and the learning of others. The student is expected to:

(A)   demonstrate an understanding of and discuss how teams function;

(B)   use teamwork to solve problems;

(C)   describe the development workflow of mobile applications;

(D)   use time-management techniques to develop and maintain work schedules, meet deadlines, and establish mobile application project criteria;

(E)   describe a problem solution; and

(F)   document and share problem solutions through various media.

(3)   Research and information fluency. The student locates, analyzes, processes, and organizes data. The student is expected to:

(A)   analyze, identify, and describe mobile application project stakeholders and their perspectives;

(B)   collect and analyze available data to identify mobile application project requirements;

(C)   analyze, identify, and describe input, output, and processing requirements; and

(D)   analyze, identify, and define hardware and software specifications.

(4)   Critical thinking, problem solving, and decision making. The student uses appropriate strategies to analyze problems and design algorithms. The student is expected to:

(A)   compare and contrast design decisions based on the hardware considerations of a mobile device;

(B)   compare and contrast available mobile technologies, including platforms and their operating systems;

(C)   compare and contrast available development approaches, including application to specific technologies and platforms;

(D)   determine the most appropriate solution for the development of a given mobile application, including browser-based, native, and hybrid approaches;

(E)   compare and contrast available programming languages and how their use might be applied to specific technologies and platforms;

(F)   identify and justify the selection of an appropriate programming language, including available resources and required interfaces;

(G)   select an appropriate program development environment;

(H)   identify and use available libraries;

(I)   evaluate and justify the selection of appropriate options and components;

(J)   compare and contrast available networks and their implications for mobile application development; and

(K)   compare and contrast design strategies related to mobile network and device security.

(5)   Digital citizenship. The student explores and understands safety, legal, cultural, and societal issues relating to the use of technology and information. The student is expected to:

(A)   discuss copyright laws and issues;

(B)   model ethical acquisition and use of digital information;

(C)   cite sources using established methods;

(D)   demonstrate proper digital etiquette and knowledge of acceptable use policies;

(E)   investigate mobile device security measures such as passwords, virus detection, and virus prevention;

(F)   describe potential risks and benefits associated with the use of a mobile application;

(G)   identify current and emerging technologies related to mobile applications; and

(H)   evaluate technologies and assess their applicability to current mobile applications.

(6)   Technology operations and concepts. The student understands technology concepts, systems, and operations as they apply to computer science. The student is expected to:

(A)   demonstrate an understanding of the difference between desktop and mobile applications;

(B)   demonstrate an understanding of hardware and software structures and requirements in the design of mobile applications;

(C)   recognize multiple platforms and demonstrate an understanding of their associated requirements;

(D)   recognize various program development environments;

(E)   demonstrate an understanding of event-based programming and its appropriate use;

(F)   describe how memory management affects mobile application design;

(G)   demonstrate an understanding of how low bandwidth and the mobility of a device affect the design of mobile applications;

(H)   identify applications that are best suited for mobile devices;

(I)   demonstrate an understanding of the use of libraries when designing mobile applications;

(J)   use a simulation tool to emulate a mobile device's functionality; and

(K)   use actual mobile devices to test mobile applications.

Source: The provisions of this §127.768 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.771. Advanced Placement (AP) Computer Science A (Two Credits).

(a)   General requirements. Students shall be awarded two credits for successful completion of this course. Recommended prerequisites: Algebra I or a student should be comfortable with functions and the concepts found in the uses of functional notation such as $f(x) = x + 2$ and $f(x) = g(h(x))$.

(b)   Content requirements. Content requirements for Advanced Placement (AP) Computer Science A are prescribed in the College Board Publication Advanced Placement Course Description: Computer Science A, published by The College Board.

Source: The provisions of this §127.771 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.772. Advanced Placement (AP) Computer Science Principles (One Credit).

(a)   General requirements. Students shall be awarded one credit for successful completion of this course. Recommended prerequisite: Algebra I.

(b)   Content requirements. Content requirements for Advanced Placement (AP) Computer Science Principles are prescribed in the College Board Publication Advanced Placement® Curriculum Framework: AP Computer Science Principles, published by The College Board.

Source: The provisions of this §127.772 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.773. International Baccalaureate (IB) Computer Science Standard Level (Two Credits)

(a)   General requirements. Students shall be awarded two credits for successful completion of this course. Recommended prerequisites: Computer Science I, Algebra II.

(b)   Content requirements. Content requirements for IB Computer Science Standard Level are prescribed by the International Baccalaureate Organization. Subject guides may be obtained from International Baccalaureate of North America.

Source: The provisions of this §127.773 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.774. International Baccalaureate (IB) Computer Science Higher Level (Two Credits).

(a)   General requirements. Students shall be awarded two credits for successful completion of this course. Recommended prerequisites: Computer Science I, Algebra II.

(b)   Content requirements. Content requirements for IB Computer Science Higher Level are prescribed by the International Baccalaureate Organization. Subject guides may be obtained from International Baccalaureate of North America.

Source: The provisions of this §127.774 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.775. International Baccalaureate (IB) Information Technology in a Global Society Standard Level (Two Credits).

(a)   General requirements. Students shall be awarded two credits for successful completion of this course. Recommended prerequisites: Computer Science I, Algebra II.

(b)   Content requirements. Content requirements for IB Information Technology in a Global Society Standard Level are prescribed by the International Baccalaureate Organization. Subject guides may be obtained from International Baccalaureate of North America.

Source: The provisions of this §127.775 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.776. International Baccalaureate (IB) Information Technology in a Global Society Higher Level (Two Credits).

(a)   General requirements. Students shall be awarded two credits for successful completion of this course. Recommended prerequisites: Computer Science I, Algebra II.

(b)   Content requirements. Content requirements for IB Information Technology in a Global Society Higher Level are prescribed by the International Baccalaureate Organization. Subject guides may be obtained from International Baccalaureate of North America.

Source: The provisions of this §127.776 adopted to be effective April 7, 2022, 47 TexReg 1677.

§127.778. Principles of Bioscience (One Credit), Adopted 2021.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2023-2024 school year.

(1)   No later than August 31, 2023, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available, this section shall be implemented beginning with the 2023-2024 school year and apply to the 2023-2024 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 9 and 10. Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

(1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2)   The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services such as laboratory and testing services and research and development services.

(3)   Principles of Bioscience provides an overview of biotechnology, bioengineering, and related fields. Topics related to genetics, proteins, and nucleic acids reinforce the applications of Biology content. Students will further study the increasingly important agricultural, environmental, economic, and political roles of bioenergy and biological remediation; the roles of nanoscience and nanotechnology in biotechnology medical research; and future trends in biological science and biotechnology.

(4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5)   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.

(d)   Knowledge and skills.

(1)   The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

(A)   demonstrate 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.

(2) The student explores biotechnology career opportunities. The student is expected to:

 (A) determine interests in the field of biotechnology through explorations such as career assessments, interactions with biotechnology professionals, media, and literature;

 (B) identify career options in the field of biotechnology;

 (C) identify reliable sources of career information;

 (D) research and communicate interests, knowledge, educational level, abilities, and skills needed in a biotechnology-related occupation;

 (E) identify conventional and non-conventional career opportunities that match interests and aptitudes;

 (F) research applications of biotechnology in medicine, the environment, and settings such as pharmaceutical, agricultural, and industrial;

 (G) use technology to research biotechnology topics, including identifying and selecting appropriate scholarly references; and

 (H) analyze and discuss professional publications such as academic and peer-reviewed journals and technical reports.

(3) The student evaluates ethical and legal issues in biotechnology. The student is expected to:

 (A) identify current ethical and legal issues;

 (B) describe the history of biotechnology and related ethical and legal issues;

 (C) discuss legal and technology issues for at least two biotechnology-related areas; and

 (D) analyze examples of biotechnology views supported by objective and subjective sources such as scientific data, economic data, and sociocultural contexts.

(4) The student examines federal, state, local, and industry regulations as applied to biotechnological processes through researching credible sources. The student is expected to:

 (A) identify local, state, and federal agencies responsible for regulating the biotechnology industry such as the U.S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA), the U.S. Food and Drug Administration (FDA), and the Centers for Disease Control and Prevention (CDC);

 (B) identify professional organizations participating in the development of biotechnology policies;

 (C) identify and define terms related to biotechnology regulations such as Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP), and Globally Harmonized System (GHS); and

 (D) outline the methods and procedures used in biotechnology laboratories to follow local, state, and federal regulations such as those in the agricultural and health areas.

(5) The student demonstrates knowledge of the business climate for biotechnology industry sectors in the current market. The student is expected to:

 (A) identify professional publications;

 (B) identify the various biotechnology industry sectors;

 (C) investigate and report on career opportunities in the biotechnology industry sectors; and

 (D) identify professional organizations such as those at the local, state, and national levels.

(6) The student researches and exhibits employability skills that support a career in the biotechnology industry. The student is expected to:

 (A) demonstrate verbal, non-verbal, written, and electronic communication skills;

      (B)   demonstrate skills used to secure and maintain employment;

      (C)   demonstrate appropriate workplace etiquette;

      (D)   display productive work habits and attitudes; and

      (E)   identify appropriate safety equipment and practices as outlined in Texas Education Agency-approved and industry-approved safety standards such as the use of personal protective equipment (PPE) and safety data sheets (SDS).

(7)   The student investigates how biotechnology impacts the origins of waste and resource recovery. The student is expected to:

      (A)   identify biotechnology manufacturing processes and their end products, including waste and marketable products;

      (B)   explore the impacts of waste on biotic and abiotic factors in the environment such as effects on biological life cycles and pollution from nonbiodegradable single-use materials and microplastics;

      (C)   analyze the results of manufacturing refuse;

      (D)   explain the negative impacts of waste with respect to the individual, society, and the global population;

      (E)   investigate solutions to waste through bioremediation; and

      (F)   investigate evidence supporting waste management through regulations, public policy, and technology development.

(8)   The student examines the relationship of biotechnology to the development of commercial products. The student is expected to:

      (A)   identify applications of agricultural biotechnology such as selective breeding of livestock and plants, aquaculture, horticultural products, and genetically modified organisms;

      (B)   identify applications of industrial biotechnology such as fermented food and beverages, genetically engineered proteins for industry, biocatalysts, bio polymers, biosensors, bioremediation, and biofuels;

      (C)   identify applications of medical and pharmaceutical biotechnology such as genetically modified cells, antibodies, vaccine and gene therapy, genetic testing for human disease/disorders, three-dimensional bio-printing, and medicines from plants, animals, fungi, and bacteria;

      (D)   identify applications of research and development in biotechnology such as deoxyribonucleic acid (DNA) and protein synthesis and sequencing, genetic testing and screening, DNA identification, RNAi, siRNA, miRNA, the CRISPR/Cas9 system, and synthetic biology;

      (E)   identify the applications of biotechnology in the fields of forensics, law enforcement, nanotechnology, and bioinformatics;

      (F)   research ethical considerations, laws, and regulations for biotechnological applications such as bioinformatics, genetic engineering, and nanotechnology; and

      (G)   identify the function of laboratory equipment, including a microscope, thermocycler, pH meter, hot plate stirrer, electronic balance, autoclave, centrifuge, transilluminator, micropipette, incubator, electrophoresis unit, vortex mixer, water bath, laboratory glassware, biosafety cabinet, and chemical fume hood.

Source: The provisions of this §127.778 adopted to be effective April 26, 2022, 47 TexReg 2166.

§127.779. Biotechnology I (One Credit), Adopted 2021.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2023-2024 school year.

(1)   No later than August 31, 2023, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available, this section shall be implemented beginning with the 2023-2024 school year and apply to the 2023-2024 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: one credit in biology. Recommended prerequisites: Principles of Bioscience and one credit in chemistry. This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

(1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2)   The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services such as laboratory and testing services and research and development services.

(3)   In Biotechnology I, students will apply advanced academic knowledge and skills to the emerging fields of biotechnology such as agricultural, medical, regulatory, and forensics. Students will have the opportunity to use sophisticated laboratory equipment, perform statistical analysis, and practice quality-control techniques. Students will conduct laboratory and field investigations and make informed decisions using critical thinking, scientific problem solving, and the engineering design process. Students in Biotechnology I will study a variety of topics that include structures and functions of cells, nucleic acids, proteins, and genetics.

(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 currently scientifically testable.

(5)   Students are expected to know that:

(A)   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; and

(B)   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.

(6) Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

    (A) Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.

    (B) Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models

(7) Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. 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).

(8) Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. 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, while models allow for boundary specification and provide a tool for understanding the ideas presented. 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.

(9) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(10) 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.

(d) Knowledge and skills.

(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.

(2) The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:

    (A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

(B)   apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

(C)   use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

(D)   use appropriate tools such as microscopes, thermocyclers, pH meters, hot plate stirrers, glass bulb thermometers, timing devices, electronic balances, vortex mixers, autoclaves, micropipettes, centrifuges, gel and capillary electrophoresis units, cameras, data collection probes, spectrophotometers, transilluminators, incubators, water baths, laboratory glassware, biosafety cabinets, and chemical fume hoods;

(E)   collect quantitative data using the International System of Units (SI) and United States customary units and qualitative data as evidence;

(F)   organize quantitative and qualitative data using laboratory notebooks, written lab reports, graphs, charts, tables, digital tools, diagrams, scientific drawings, and student-prepared models;

(G)   develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

(H)   distinguish between scientific hypotheses, theories, and laws.

(3)   The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A)   identify advantages and limitations of models such as their size, scale, properties, and materials;

(B)   analyze data by identifying significant statistical features, patterns, sources of error, and limitations;

(C)   use mathematical calculations to assess quantitative relationships in data; and

(D)   evaluate experimental and engineering designs.

(4)   The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

(A)   develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;

(B)   communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

(C)   engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(5)   The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:

(A)   analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing so as to encourage critical thinking by the student;

(B)   relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content; and

(C)   research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a STEM field.

(6)   The student explores the emerging field of biotechnology. The student is expected to:

(A)   define biotechnology and provide examples of biotechnology products such as recombinant proteins, fermented foods, biopharmaceuticals, and genetically modified foods;

(B)   compare applications of bioinformatics such as deoxyribonucleic acid (DNA) barcoding, sequencing, National Center for Biotechnology Information (NCBI) tools, ClinVar, Genemonon Mastermind, genetic testing, phylogenetic relationships, and the use of online databases;

(C)   research and identify career opportunities in genetics, bioinformatics, and in fields such as molecular, forensic, medical, regulatory, and agricultural biotechnology;

(D)   identify significant contributions of diverse scientists to biotechnology and explain their impact on society;

(E)   define bioethics and evaluate the applications of bioethics;

(F)   evaluate different points of view about issues and current events in biotechnology;

(G)   identify applications in agricultural biotechnology such as genetically modified organisms (GMOs), plant propagation from tissue culturing, and aquaculture hydroponics;

(H)   identify applications in medical biotechnology such as vaccines production, stem cells therapy, gene therapy, pharmaceutical production, pharmacogenetics, genomics, synthetic biology, and personalized medicine;

(I)   identify applications in forensic biotechnology such as capillary electrophoresis, real-time polymerase chain reaction, DNA fingerprinting, restriction fragment length polymorphisms (RFLP) analysis, toxicology, and serology; and

(J)   identify solutions to waste through bioremediation and non-biotechnological standard solutions such as landfills, incineration, absorbent materials, and catalytic materials.

(7)   The student summarizes biotechnology laboratory procedures and their applications in the biotechnology industry. The student is expected to:

(A)   identify the major sectors of the biotechnology industry such as medical and pharmaceutical, agricultural, industrial, forensic, and research and development;

(B)   identify the biotechnology laboratory procedures used in each sector such as selective breeding, genetic engineering, DNA analysis, and protein analysis; and

(C)   compare and contrast the different applications used in biotechnology laboratory procedures of each sector.

(8)   The student understands the role of genetics in the biotechnology industry. The student is expected to:

(A)   explain terms related to molecular biology, including nucleic acids, nitrogen bases, nucleotides, mRNA, rRNA, tRNA, ribosomes, amino acids, transcription, translation, polymerase, and protein synthesis;

(B)   compare and contrast the structures and functions of DNA and ribonucleic acid (RNA), including nitrogen bases, nucleotides, the helical nature of DNA, and hydrogen bonding between purines and pyrimidines;

(C)   distinguish between nuclear and mitochondrial DNA and their gamete sources;

(D)   describe the DNA replication process in eukaryotic and prokaryotic cells, including leading and lagging strands and Okazaki fragments;

(E)   illustrate the process of protein synthesis, including ribosomal subunits and the role of tRNA;

(F)   describe the structures and functions of proteins, including three-dimensional folding, enzymes, and antibodies;

(G)   explain the molecular structures of genes, including enhancers, promoters, exons, introns, and coding regions;

(H)   describe the different types of mutations, including inversions, deletions, duplications, and substitutions;

(I)   explain the effects of mutation types on phenotype and gene function; and

(J)   describe unique elements of the molecular structure of a chromosome such as short tandem repeats (STR), transposons, and methylation and acetylation of DNA.

(9)   The student analyzes the importance of recombinant DNA technology and genetic engineering. The student is expected to:

(A)   describe the fundamental steps in recombinant DNA technology;

(B)   explain how recombinant DNA technology such as nuclear transfer cloning is used to clone genes and create recombinant proteins;

(C)   explain the role of tissue cultures in genetic modification procedures;

(D)   describe plant- and animal-tissue culture procedures;

(E)   compare and contrast growing conditions for plant and animal tissue cultures;

(F)   explain the role of restriction enzymes; and

(G)   distinguish between vectors commonly used in biotechnology for DNA insertion, including plasmids, adenoviruses, retroviruses, and bacteriophages.

(10)   The student examines federal, state, local, and industry regulations as related to biotechnology. The student is expected to:

(A)   discuss the relationship between the local, state, and federal agencies responsible for regulation of the biotechnology industry such as the U.S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA), the U.S. Food and Drug Administration (FDA), and the Centers for Disease Control and Prevention (CDC); and

(B)   analyze policies and procedures used in the biotechnology industry such as quality assurance, standard operating procedures (SOPs), Good Manufacturing Practices (GMPs), and International Organization for Standardization (ISO) quality systems.

(11)   The student performs biotechnology laboratory procedures. The student is expected to:

(A)   measure volumes and weights to industry standards with accuracy and precision;

(B)   analyze data and perform calculations and statistical analysis as it relates to biotechnology laboratory experiments;

(C)   demonstrate proficiency in pipetting techniques;

(D)   identify microorganisms using staining methods such as the Gram stain, methylene-blue stain, and acid-fast staining;

(E)   prepare a restriction digest, isolate nucleic acids, and evaluate results using techniques such as gel and capillary electrophoresis, Northern blot analysis, and Southern blot analysis;

(F)   explain the importance of media components to the outcome of cultures;

(G)   isolate, maintain, and store microbial cultures safely;

(H)   prepare seed inoculum; and

(I)   perform plating techniques such as streak plating, spread plating, and the Kirby-Bauer method.

(12)   The student prepares solutions and reagents for the biotechnology laboratory. The student is expected to:

(A)   demonstrate aseptic techniques for establishing and maintaining a sterile work area;

(B)   prepare, dispense, and monitor physical properties of stock reagents, buffers, media, and solutions;

(C)   calculate and prepare a dilution series; and

(D)   determine optimum conditions of reagents for experimentation.

(13)   The student conducts quality-control analysis while performing biotechnology laboratory procedures. The student is expected to:

(A)   perform validation testing on laboratory reagents and equipment; and

(B)   analyze data and perform calculations and statistical analysis on results of quality-control samples.

Source: The provisions of this §127.779 adopted to be effective April 26, 2022, 47 TexReg 2166.

§127.780. Biotechnology II (One Credit), Adopted 2021.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2023-2024 school year.

(1)   No later than August 31, 2023, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available, this section shall be implemented beginning with the 2023-2024 school year and apply to the 2023-2024 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 11 and 12. Prerequisites: one credit in chemistry and Biotechnology I. This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

(1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2)   The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services such as laboratory and testing services and research and development services.

(3)   Biotechnology II has the components of any rigorous scientific or bioengineering program of study. This course applies the standard skills mastered in Biotechnology I and includes additional skills related to assay design, protein analysis, applications of genetic engineering, and quality management. After taking this course, students should be prepared for entry-level lab technician jobs.

(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 currently scientifically testable.

(5) Students are expected to know that:

    (A) 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; and

    (B) 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.

(6) Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

    (A) Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.

    (B) Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.

(7) Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. 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).

(8) Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. 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, while models allow for boundary specification and provide a tool for understanding the ideas presented. 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.

(9) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(10) 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.

(d) Knowledge and skills.

(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.

(2)   The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:

      (A)   ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

      (B)   apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

      (C)   use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

      (D)   use appropriate tools such as microscopes, thermocyclers, pH meters, hot plate stirrers, glass bulb thermometers, timing devices, electronic balances, vortex mixers, autoclaves, micropipettes, centrifuges, gel and capillary electrophoresis units, cameras, data collection probes, spectrophotometers, transilluminators, incubators, water baths, laboratory glassware, biosafety cabinets, and chemical fume hoods;

      (E)   collect quantitative data using the International System of Units (SI) and United States customary units and qualitative data as evidence;

      (F)   organize quantitative and qualitative data using laboratory notebooks, written lab reports, graphs, charts, tables, digital tools, diagrams, scientific drawings, and student-prepared models;

      (G)   develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

      (H)   distinguish between scientific hypotheses, theories, and laws.

(3)   The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

      (A)   identify advantages and limitations of models such as their size, scale, properties, and materials;

      (B)   analyze data by identifying significant statistical features, patterns, sources of error, and limitations;

      (C)   use mathematical calculations to assess quantitative relationships in data; and

      (D)   evaluate experimental and engineering designs.

(4)   The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

      (A)   develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;

      (B)   communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

(C)   engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(5)   The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:

(A)   analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing so as to encourage critical thinking by the student;

(B)   relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content; and

(C)   research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a STEM field.

(6)   The student prepares for an entry-level career in biotechnology. The student is expected to:

(A)   research and identify career opportunities in genetics, bioinformatics, and fields such as molecular, forensic, medical, regulatory, and agricultural biotechnology;

(B)   identify the significance of recent advances in molecular, forensic, medical, regulatory, and agricultural biotechnology;

(C)   discuss current bioethical issues related to the field of biotechnology;

(D)   create a job-specific resume; and

(E)   develop a career plan.

(7)   The student analyzes academic and professional journals and technical reports. The student is expected to:

(A)   identify the scientific methodology used by a researcher;

(B)   examine a prescribed research design and identify dependent and independent variables;

(C)   evaluate a prescribed protocol to determine the purpose for each of the procedures performed; and

(D)   interpret data and evaluate conclusions.

(8)   The student explores assay design in the field of biotechnology. The student is expected to:

(A)   define assay requirements and optimizations;

(B)   perform statistical analysis on assay design and experimental data such as linearity, system sustainability, limit of detection, and R2 values;

(C)   determine an unknown protein concentration using a standard curve and technique such as a Bradford assay; and

(D)   evaluate enzyme kinetics using a colorimetric assay.

(9)   The student explores applications related to protein expression in the field of biotechnology. The student is expected to:

(A)   describe the fundamental steps in recombinant deoxyribonucleic acid (DNA) technology;

(B)   produce a recombinant protein such as green fluorescent protein (GFP);

(C)   analyze proteins using techniques such as enzyme-linked immunosorbent assay (ELISA), spectrophotometry, and sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE); and

(D)   isolate a specific protein from a biological sample using techniques such as chromatography and Western blot analysis.

    (10)   The student explores applications of recombinant DNA technology and genetic engineering. The student is expected to:

        (A)   prepare and maintain tissue cultures commonly used in genetic modification procedures;

        (B)   evaluate the effects of changes to growing conditions such as pH, temperature, and growth media;

        (C)   evaluate the results of a bacterial transformation using a restriction enzyme digest and Southern blot analysis;

        (D)   compare and contrast vectors commonly used in biotechnology applications, including plasmids, adenoviruses, retroviruses, and bacteriophages;

        (E)   explain the steps and components of the polymerase chain reaction (PCR); and

        (F)   explain applications of CRISPR/Cas9 technology in gene editing and diagnostics.

    (11)   The student prepares solutions and reagents for the biotechnology laboratory. The student is expected to:

        (A)   demonstrate aseptic techniques for establishing and maintaining a sterile work area;

        (B)   prepare, dispense, and monitor physical properties of stock reagents, buffers, media, and solutions;

        (C)   calculate and prepare a dilution series;

        (D)   determine acceptability and optimum conditions of reagents for experimentation; and

        (E)   prepare multi-component solutions of given molarity or concentration and volume.

    (12)   The student investigates the role of quality in the biotechnology industry, The student is expected to:

        (A)   describe the product pipeline in the biotechnology industry;

        (B)   describe the importance of quality assurance and quality control;

        (C)   explain the importance of documentation to quality assurance and quality control;

        (D)   describe the importance of corrective and preventive action (CAPA);

        (E)   describe Quality Management Systems (QMS) components, including inspection, audit, surveillance, and prevention;

        (F)   describe Good Manufacturing Practices (GMP), Good Clinical Practices (GCP), Good Documentation Practices (GDP), Good Lab Practices (GLP), and International Organization for Standardization (ISO);

        (G)   perform validation testing on laboratory reagents and equipment;

        (H)   analyze data and perform calculations and statistical analysis on results of quality-control samples such as standard deviation and percent error; and

        (I)   apply and create industry protocols such as laboratory method protocols, standard operating procedures (SOPs), and validation forms.

Source: The provisions of this §127.780 adopted to be effective April 26, 2022, 47 TexReg 2166.

§127.781. Principles of Applied Engineering (One Credit), Adopted 2021.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2024-2025 school year.

(1)   No later than August 31, 2024, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available, this section shall be implemented beginning with the 2024-2025 school year and apply to the 2024-2025 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 9 and 10. Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

(1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(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.

(3)   Principles of Applied Engineering provides an overview of the various fields of science, technology, engineering, and mathematics and their interrelationships. Students develop engineering communication skills, which include computer graphics, modeling, and presentations, by using a variety of computer hardware and software applications to complete assignments and projects. Upon completing this course, students will have an understanding of the various fields of engineering and be able to make informed career decisions.

(4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5)   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.

(d)   Knowledge and skills.

(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, speak, and conduct oneself in a manner appropriate for the profession;

(B)   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.

(2)   The student investigates the components of engineering and technology systems. The student is expected to:

(A)   investigate and report on the history of engineering disciplines, including chemical, civil, electrical, and mechanical engineering;

(B)   identify the inputs, processes, and outputs associated with technological systems;

(C)   describe the difference between open and closed systems;

(D) describe how technological systems interact to achieve common goals;

(E) compare engineering, science, and technology career paths, including entry-level employment, military service, apprenticeships, community and technical colleges, and universities;

(F) conduct and present research on emerging and innovative technology; and

(G) demonstrate proficiency of the engineering design process.

(3) The student presents conclusions, research findings, and designs using a variety of media throughout the course. The student is expected to:

(A) use clear and concise written, verbal, and visual communication techniques;

(B) maintain a design and computation engineering notebook;

(C) develop and present ideas using sketching and computer-aided design and drafting (CADD);

(D) draw conclusions using industry-standard visualization techniques and media;

(E) maintain a paper or digital portfolio using the engineering documentation process; and

(F) use collaborative tools such as desktop or web-based applications to share and develop information.

(4) The student uses appropriate tools and demonstrates safe work habits. The student is expected to:

(A) master relevant safety tests;

(B) follow lab safety guidelines as prescribed by instructor in compliance with local, state, and federal regulations;

(C) identify industry safety terminology related to the personal work environment such as Occupational Safety and Health Administration (OSHA), American Society of Mechanical Engineers (ASME), and personal protective equipment (PPE);

(D) recognize the classification of hazardous materials and wastes;

(E) describe appropriate ways to dispose of hazardous materials and wastes;

(F) maintain, safely handle, and properly store laboratory equipment;

(G) describe the implications of negligent or improper maintenance; and

(H) demonstrate the use of precision measuring instruments.

(5) The student describes the factors that affect the progression of technology and analyzes the potential intended and unintended consequences of technological advances. The student is expected to:

(A) describe how technology has affected individuals, societies, cultures, economies, and environments;

(B) describe how the development and use of technology influenced past events;

(C) describe how and why technology progresses; and

(D) predict possible changes caused by the advances of technology.

(6) The student thinks critically and applies fundamental principles of system modeling and design to multiple design projects. The student is expected to:

(A) identify and describe an engineering design process needed for a project, including the design process and prototype development and initiating, planning, executing, monitoring and controlling, and closing a project;

(B)   identify the chemical, mechanical, and physical properties of engineering materials and identify testing methods associated with the materials;

(C)   use problem-solving techniques to develop technological solutions such as product, process, or system;

(D)   use consistent units for all measurements and computations; and

(E)   assess the risks and benefits of a design solution.

(7)   The student understands the opportunities and careers in fields related to robotics, process control, and automation systems. The student is expected to:

(A)   describe applications of robotics, process control, and automation systems;

(B)   apply design concepts to problems in robotics, process control, and automation systems;

(C)   identify fields and career opportunities related to robotics, process control, and automation systems; and

(D)   identify emerging trends in robotics, process control, and automation systems.

(8)   The student understands the opportunities and careers in fields related to electrical and mechanical systems. The student is expected to:

(A)   describe the applications of electrical and mechanical systems;

(B)   describe career opportunities in electrical and mechanical systems;

(C)   identify emerging trends in electrical and mechanical systems; and

(D)   describe and apply basic electronic theory.

(9)   The student collaborates as a team member while completing a comprehensive project. The student is expected to:

(A)   apply the design process, including decision matrices, as a team participant;

(B)   perform different roles within the project as a team member;

(C)   formulate decisions using collaborative strategies such as decision and design matrices and conflict resolution;

(D)   maintain an engineering notebook for the project;

(E)   develop and test the model for the project; and

(F)   demonstrate communication skills by preparing and presenting the project, including building consensus setback resolution and decision matrices.

(10)   The student demonstrates a knowledge of drafting by completing a series of drawings that can be published by various media. The student is expected to:

(A)   set up, create, and modify drawings;

(B)   store and retrieve geometry;

(C)   demonstrate and use appropriate line types in engineering drawings;

(D)   draw two-dimensional, single-view objects;

(E)   create multi-view working drawings using orthographic projection;

(F)   dimension objects using current American National Standards Institute (ANSI) standards;

(G)   draw single-line two-dimensional pictorial representations; and

(H)   create working drawings that include section views.

(11)   The student creates justifiable solutions to open-ended real-world problems using engineering design practices and processes. The student is expected to:

    (A)   identify and define an engineering problem;

    (B)   formulate goals, objectives, and requirements to solve an engineering problem;

    (C)   determine the design parameters such as materials, personnel, resources, funding, manufacturability, feasibility, and time associated with an engineering problem;

    (D)   establish and evaluate potential constraints, including health, safety, social, environmental, ethical, political, regulatory, and legal, pertaining to a problem;

    (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 engineering methods such as creating models, prototypes, mock-ups, or simulations or performing critical design review, statistical analysis, or experiments;

    (G)   apply structured techniques such as a decision tree, design matrix, or cost-benefit analysis to select and justify a preferred solution to a problem;

    (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.

Source: The provisions of this §127.781 adopted to be effective April 26, 2022, 47 TexReg 2166.

§127.782. Engineering Science (One Credit), Adopted 2021.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2022-2023 school year.

(1)   No later than August 31, 2022, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available, this section shall be implemented beginning with the 2022-2023 school year and apply to the 2022-2023 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 10-12. Prerequisites: Algebra I, one credit in biology, and at least one credit in a course from the science, technology, engineering, and mathematics career cluster. Recommended prerequisites: Geometry, Integrated Physics and Chemistry (IPC), one credit in chemistry, or one credit in physics. This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

(1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(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.

(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 work and communicate their solutions to their peers and members of the professional community.

(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 currently scientifically testable.

(5)   Students are expected to know that:

(A)   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; and

(B)   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.

(6)   Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

(A)   Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.

(B)   Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.

(7)   Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. 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).

(8)   Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. 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, while models allow for boundary specification and provide a tool for understanding the ideas presented. 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.

(9)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(10)   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.

(d)   Knowledge and skills.

(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.

(2)   The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:

(A)   ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

(B)   apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

(C)   use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

(D)   use appropriate tools such as dial caliper, micrometer, protractor, compass, scale rulers, multimeter, and circuit components;

(E)   collect quantitative data using the International System of Units (SI) and United States customary units and qualitative data as evidence;

(F)   organize quantitative and qualitative data using spreadsheets, engineering notebooks, graphs, and charts;

(G)   develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

(H)   distinguish between scientific hypotheses, theories, and laws.

(3)   The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A)   identify advantages and limitations of models such as their size, scale, properties, and materials;

(B)   analyze data by identifying significant statistical features, patterns, sources of error, and limitations;

(C)   use mathematical calculations to assess quantitative relationships in data; and

(D)   evaluate experimental and engineering designs.

(4) The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

   (A) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;

   (B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

   (C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(5) The student knows the contributions of scientists and engineers and recognizes the importance of scientific research and innovation on society. The student is expected to:

   (A) analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing so as to encourage critical thinking by the student;

   (B) relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content; and

   (C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a STEM field.

(6) 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.

(7) 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.

(8) 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.

(9)   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 and explain how power in a system 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.

(10)   The student understands system energy requirements and how energy sources can be combined to convert energy into useful forms. The student understands the relationships between 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 and design 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.

(11)   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.

(12)   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.

(13)   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.

(14)   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.

(15)   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 and experiment with flow rate, flow velocity, and mechanical advantage in a hydraulic system model.

(16)   The student demonstrates an understanding of statistics and applies the concepts to real-world engineering design problems. The student is expected to:

(A)   calculate and test 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 tendencies of a data array, including mean, median, and mode;

(G)   calculate data variations, including range, standard deviation, and variance; and

(H)   create and explain a histogram to illustrate frequency distribution.

(17)   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 and test the angle needed to launch a projectile a specific range given the projectile's initial velocity.

Source: The provisions of this §127.782 adopted to be effective April 26, 2022, 47 TexReg 2166.

§127.783. Engineering Design and Presentation I (One Credit), Adopted 2022.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2024-2025 school year.

(1)   No later than August 31, 2024, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available this section shall be implemented beginning with the 2024-2025 school year and apply to the 2024-2025 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 10-12. Prerequisite: Algebra I and at least one credit in a course from the science, technology, engineering, and mathematics career cluster. Recommended prerequisite: Principles of Applied Engineering. Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

(1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(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.

(3)   Students enrolled in Engineering Design and Presentation I will demonstrate knowledge and skills of the design process as it applies to engineering fields and project management using multiple software applications and tools necessary to produce and present working drawings, solid model renderings, and prototypes. Through implementation of the design process, students will transfer advanced academic skills to component designs. Additionally, students will explore career

opportunities in engineering, technology, and drafting and what is required to gain and maintain employment in these areas.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5) 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.

(d) Knowledge and skills.

(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 and work site;

(B) cooperate, contribute, and collaborate as a member of a group to attain agreement and achieve a collective outcome;

(C) present written and oral communication in a clear, concise, and effective manner, including explaining and justifying actions;

(D) use time-management skills in prioritizing tasks, following schedules, and tending to goal-relevant activities in a way that optimizes efficiency and results; and

(E) demonstrate punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed.

(2) The student gains knowledge of and demonstrates the skills necessary for success in the workplace. The student is expected to:

(A) distinguish between an engineering technician, engineering technologist, and engineer;

(B) identify employment and career opportunities in engineering and describe the educational requirements for each;

(C) investigate and describe the requirements of industry-based certifications in engineering;

(D) demonstrate the principles of teamwork related to engineering and technology;

(E) research and describe governmental regulations, including health and safety;

(F) analyze ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;

(G) demonstrate respect for diversity in the workplace;

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) demonstrate effective oral and written communication skills using a variety of software applications and media; and

(J) investigate and present on career preparation learning experiences, including job shadowing, mentoring, and apprenticeship training.

(3) The student participates in team projects in various roles. The student is expected to:

(A) describe the various roles on an engineering team and discuss how teams function;

(B) apply teamwork to solve problems; and

(C) serve as both a team leader and member and demonstrate appropriate attitudes while participating in team projects.

(4) The student develops skills for managing a project. The student is expected to:

(A)   implement project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;

(B)   develop a project schedule and complete work according to established criteria;

(C)   participate in the organization and operation of a real or simulated engineering project; and

(D)   develop a plan for production of an individual product.

(5)   The student practices safe and proper work habits. The student is expected to:

(A)   master relevant safety tests;

(B)   comply with safety guidelines as described in various manuals, instructions, and regulations;

(C)   identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations;

(D)   describe the appropriate disposal of hazardous materials and wastes appropriately;

(E)   perform maintenance on selected tools, equipment, and machines;

(F)   handle and store tools and materials correctly; and

(G)   describe the results of negligent or improper maintenance.

(6)   The student applies skills associated with computer-aided drafting and design. The student is expected to:

(A)   use single and multi-view projections;

(B)   use orthographic and pictorial views;

(C)   use auxiliary views;

(D)   use section views;

(E)   use advanced construction techniques;

(F)   prepare and revise annotated multi-dimensional production drawings in computer-aided drafting and design to industry standards;

(G)   apply best practices for effective file structure and management;

(H)   use advanced dimensioning techniques;

(I)   construct and use basic 3D parametric drawings; and

(J)   develop and use prototype drawings for presentation.

(7)   The student uses engineering design methodologies. The student is expected to:

(A)   describe principles of ideation and apply ideation techniques for an engineering project;

(B)   demonstrate critical thinking, identify the solution constraints, and make fact-based decisions;

(C)   develop or improve a product using rational thinking;

(D)   apply decision-making strategies when developing solutions;

(E)   use an engineering notebook to record prototypes, corrections, and/or mistakes in the design process; and

(F)   use an engineering notebook or portfolio to record the final design, construction, and manipulation of finished projects.

(8)   The student applies concepts of engineering to specific problems. The student is expected to:

(A)   design components using a variety of technologies;

(B)   investigate the applications of different types of computer-aided drafting and design software for various engineering problems; and

(C)   use multiple software applications for concept presentations.

(9)   The student designs products using appropriate design processes and techniques. The student is expected to:

(A)   interpret engineering drawings;

(B)   identify areas where quality, reliability, and safety can be designed into a product;

(C)   modify a product design to meet a specified need;

(D)   produce engineering drawings to industry standards; and

(E)   describe potential patents and the patenting process.

(10)   The student builds a prototype using the appropriate tools, materials, and techniques. The student is expected to:

(A)   identify and describe the steps needed to produce a prototype;

(B)   identify and use appropriate tools, equipment, machines, and materials to produce the prototype; and

(C)   present the prototype using a variety of media.

(11)   The student creates justifiable solutions to open-ended real-world problems using engineering design practices and processes. The student is expected to:

(A)   identify and define an engineering problem;

(B)   formulate goals, objectives, and requirements to solve an engineering problem;

(C)   determine the design parameters such as materials, personnel, resources, funding, manufacturability, feasibility, and time associated with an engineering problem;

(D)   establish and evaluate constraints, including health, safety, social, environmental, ethical, political, regulatory, and legal, pertaining to a problem;

(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 tools and methods such as models, prototypes, mock-ups, simulations, critical design review, statistical analysis, or experiments; and

(G)   apply structured techniques such as a decision tree, design matrix, or cost-benefit analysis to select and justify a preferred solution to a problem.

Source: The provisions of this §127.783 adopted to be effective June 14, 2022, 47 TexReg 3460.

§127.784. Engineering Design and Presentation II (Two Credits), Adopted 2022.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2024-2025 school year.

(1)   No later than August 31, 2024, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available this section shall be implemented beginning with the 2024-2025 school year and apply to the 2024-2025 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 11 and 12. Prerequisites: Principles of Applied Engineering or Engineering Design and Presentation I, Algebra I, and Geometry. Students shall be awarded two credits for successful completion of this course.

(c)   Introduction.

(1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(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.

(3)   Engineering Design and Presentation II is a continuation of knowledge and skills learned in Engineering Design and Presentation I. Students enrolled in this course will demonstrate advanced knowledge and skills of a system design process as it applies to engineering fields and project management using multiple software applications and tools necessary to produce and present working drawings, solid model renderings, and prototypes. Students will expand on the use of a variety of computer hardware and software applications to complete assignments and projects. Through implementation of a system design process, students will transfer advanced academic skills to component designs and engineering systems. Emphasis will be placed on transdisciplinary and integrative approaches using skills from ideation, prototyping, and project management methods.

(4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5)   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.

(d)   Knowledge and skills.

(1)   The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

(A)   distinguish between an engineering technician, engineering technologist, and engineer;

(B)   identify employment and career opportunities in engineering and describe the educational requirements for each;

(C)   investigate and describe the requirements of industry-based certifications in engineering;

(D)   demonstrate the principles of teamwork related to engineering and technology;

(E)   research and describe governmental regulations, including health and safety;

(F)   analyze ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;

(G)   demonstrate respect for diversity in the workplace;

(H)   identify consequences relating to discrimination, harassment, and inequality;

(I)   demonstrate effective oral and written communication skills using a variety of software applications and media; and

(J) investigate and present on career preparation learning experiences, including job shadowing, mentoring, and apprenticeship training.

(2) The student participates in team projects in various roles. The student is expected to:

(A) describe the various roles on an engineering team and discuss how teams function;

(B) demonstrate teamwork to solve problems; and

(C) serve as a team leader and member and demonstrate appropriate attitudes while participating in team projects.

(3) The student develops skills for managing a project. The student is expected to:

(A) create, implement, and evaluate project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;

(B) develop a project schedule and complete projects according to established criteria;

(C) use strategies such as decision matrices, flow charts, or Gantt charts to maintain the project schedule and quality of project.

(D) participate in the organization and operation of a real or simulated engineering project; and

(E) develop a plan for production of an individual product.

(4) The student demonstrates principles of project documentation, workflow, and evaluated results. The student is expected to:

(A) complete work orders and related documentation;

(B) identify and defend factors affecting cost and strategies to minimize costs;

(C) formulate a project budget;

(D) develop a production schedule;

(E) identify intellectual property and other legal restrictions; and

(F) read and interpret technical drawings, manuals, and bulletins.

(5) The student applies the concepts and skills of computer-aided drafting and design software to perform the following tasks. The student is expected to:

(A) prepare drawings to American National Standards Institute (ANSI) and International Organization for Standardization (ISO) graphic standards;

(B) customize software user interface;

(C) prepare and use advanced views such as auxiliary, section, and break-away;

(D) draw detailed parts, assembly diagrams, and sub-assembly diagrams;

(E) indicate tolerances and standard fittings using appropriate library functions;

(F) demonstrate understanding of annotation styles and setup by defining units, fonts, dimension styles, notes, and leader lines;

(G) identify and incorporate the use of advanced layout techniques and viewports using paper-space and modeling areas;

(H) use management techniques by setting up properties to define and control individual layers;

(I) create and use custom templates for advanced project management;

(J) prepare and use advanced development drawings;

(K) use advanced polar tracking and blocking techniques to increase drawing efficiency;

(L) create drawings that incorporate external referencing;

(M) create and render objects using parametric modeling tools; and

(N) model individual parts or assemblies and produce rendered or animated output.

(6) The student practices safe and proper work habits. The student is expected to:

(A) master relevant safety tests;

(B) comply with safety guidelines as described in various manuals, instructions, and regulations;

(C) identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations;

(D) describe the appropriate disposal of hazardous materials and wastes appropriately;

(E) perform maintenance on selected tools, equipment, and machines;

(F) handle and store tools and materials correctly; and

(G) describe the results of negligent or improper maintenance.

(7) The student uses engineering design methodologies. The student is expected to:

(A) describe principles of solution ideation and evaluate ideation techniques for an engineering project, including systems-based engineering and advanced prototyping;

(B) demonstrate critical thinking, identify the solution constraints, and make fact-based decisions;

(C) develop or improve a solution using rational thinking;

(D) apply decision-making strategies when developing solutions;

(E) identify quality-control issues in engineering design and production;

(F) describe perceptions of the quality of products and how they affect engineering decisions;

(G) use an engineering notebook to record prototypes, corrections, and/or mistakes in the design process; and

(H) use an engineering notebook or portfolio to record and justify the final design, construction, and manipulation of finished projects.

(8) The student applies concepts of engineering to specific problems. The student is expected to:

(A) design solutions from various engineering disciplines such as electrical, mechanical, structural, civil, or biomedical engineering;

(B) experiment with the use of tools, laboratory equipment, and precision measuring instruments to develop prototypes;

(C) research different types of computer-aided drafting and design software and evaluate their applications for use in design systems and problem solving; and

(D) use multiple software applications for concept presentations.

(9) The student addresses a need or problem using appropriate systems engineering design processes and techniques. The student is expected to:

(A) create and interpret engineering drawings;

(B) identify areas where quality, reliability, and safety and multidisciplinary optimization and stakeholder analysis can be designed into a solution such as a product, process, or system;

(C)   improve a system design, including properties of materials selected, to meet a specified need;

(D)   produce engineering drawings to industry standards; and

(E)   describe potential patents and the patenting process.

(10)   The student builds a prototype using the appropriate tools, materials, and techniques. The student is expected to:

(A)   implement and delineate the steps needed to produce a prototype such as defining the problem and generating concepts;

(B)   identify industry-appropriate tools, equipment, machines, and materials;

(C)   fabricate the prototype using a systems engineering approach to compare the performance and use of materials; and

(D)   present and validate the prototype using a variety of media and defend engineering practices used in the prototype.

(11)   The student creates justifiable solutions to open-ended real-world problems within a multitude of engineering disciplines such as mechanical, electrical, civil, structural, bio, or aerospace using engineering design practices and processes. The student is expected to:

(A)   identify and define engineering problems from different engineering disciplines such as mechanical, civil, structural, electrical, bio, or aerospace engineering;

(B)   formulate goals, objectives, and requirements to solve an engineering problem;

(C)   determine the design parameters such as materials, personnel, resources, funding, manufacturability, feasibility, and time associated with an engineering problem;

(D)   establish and evaluate constraints of systems engineering, including health, safety, social, environmental, ethical, political, regulatory, and legal, pertaining to a problem;

(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 tools and methods such as models, prototypes, mock-ups, simulations, critical design review, statistical analysis, or experiments; and

(G)   apply a structured technique problem such as a decision tree, design matrix, or cost-benefit analysis to select and justify a preferred solution to a problem.

Source: The provisions of this §127.784 adopted to be effective June 14, 2022, 47 TexReg 3460.

§127.785. Engineering Design and Problem Solving (One Credit), Adopted 2021.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2022-2023 school year.

(1)   No later than August 31, 2022, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available, this section shall be implemented beginning with the 2022-2023 school year and apply to the 2022-2023 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner

shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 11 and 12. Prerequisites: Algebra I, Geometry, and at least one credit in a Level 2 or higher course in the science, technology, engineering, and mathematics career cluster. This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

(1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2)   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.

(3)   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.

(4)   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. Additionally, the course promotes interest in and understanding of career opportunities in engineering.

(5)   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.

(6)   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 currently scientifically testable.

(7)   Scientific hypotheses and theories. Students are expected to know that:

(A)   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; and

(B)   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.

(8)   Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare

results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

    (A)   Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.

    (B)   Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.

  (9)   Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. 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).

  (10)   Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. 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, while models allow for boundary specification and provide a tool for understanding the ideas presented. 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.

  (11)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

  (12)   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.

(d)   Knowledge and skills.

  (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.

  (2)   The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:

    (A)   ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

    (B)   apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

    (C)   use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

    (D)   use appropriate tools such as dial caliper, micrometer, protractor, compass, scale rulers, multimeter, and circuit components;

(E)   collect quantitative data using the International System of Units (SI) and United States customary units and qualitative data as evidence;

(F)   organize quantitative and qualitative data using spreadsheets, engineering notebooks, graphs, and charts;

(G)   develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

(H)   distinguish between scientific hypotheses, theories, and laws.

(3)   The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A)   identify advantages and limitations of models such as their size, scale, properties, and materials;

(B)   analyze data by identifying significant statistical features, patterns, sources of error, and limitations;

(C)   use mathematical calculations to assess quantitative relationships in data; and

(D)   evaluate experimental and engineering designs.

(4)   The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

(A)   develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;

(B)   communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

(C)   engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(5)   The student knows the contributions of scientists and engineers and recognizes the importance of scientific research and innovation on society. The student is expected to:

(A)   analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing so as to encourage critical thinking by the student;

(B)   relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content; and

(C)   research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a STEM field.

(6)   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)   communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials; and

(B)   draw inferences based on data related to promotional materials for products and services.

(7)   The student applies knowledge of science and mathematics and the tools of technology to solve engineering design problems. The student is expected to:

(A)   select appropriate mathematical models to develop solutions to engineering design problems;

(B) integrate advanced mathematics and science skills as necessary to develop solutions to engineering design problems;

(C) judge the reasonableness of mathematical models and solutions;

(D) investigate and apply relevant chemical, mechanical, biological, electrical, and physical properties of materials to engineering design problems;

(E) identify the inputs, processes, outputs, control, and feedback associated with open and closed systems;

(F) describe the difference between open-loop and closed-loop control systems;

(G) evaluate different measurement tools such as dial caliper, micrometer, protractor, compass, scale rulers, and multimeter, make measurements with accuracy and precision, and specify tolerances; and

(H) use conversions between measurement systems to solve real-world problems.

(8) The student communicates through written documents, presentations, and graphic representations using the tools and techniques of professional engineers. The student is expected to:

(A) communicate visually by sketching and creating technical drawings using established engineering graphic tools, techniques, and standards;

(B) read and comprehend technical documents, including specifications and procedures;

(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;

(D) organize information for visual display and analysis using appropriate formats for various audiences, including technical drawings, graphs, and tables such as file conversion and appropriate file types, in order to collaborate with a wider audience;

(E) evaluate the quality and relevance of sources and cite appropriately; and

(F) defend a design solution in a presentation.

(9) 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 between 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

(F) describe the importance of patents and the protection of intellectual property rights.

(10) The student creates justifiable solutions to open-ended real-world problems using engineering design practices and processes. The student is expected to:

(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 creating models, prototypes, mock-ups, or simulations or performing 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.

(11)   The student manages an engineering design project. The student is expected to:

(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;

(B)   develop a plan and project schedule for completion of a project;

(C)   work in teams and share responsibilities, acknowledging, encouraging, and valuing contributions of all team members;

(D)   compare and contrast the roles of a team leader and other team member responsibilities;

(E)   identify and manage the resources needed to complete a project;

(F)   use a budget to determine effective strategies to meet cost constraints;

(G)   create a risk assessment for an engineering design project;

(H)   analyze and critique the results of an engineering design project; and

(I)   maintain an engineering notebook that chronicles work such as ideas, concepts, inventions, sketches, and experiments.

Source: The provisions of this §127.785 adopted to be effective April 26, 2022, 47 TexReg 2166.

§127.786. Introduction to Computer-Aided Design and Drafting (One Credit), Adopted 2021.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2024-2025 school year.

(1)   No later than August 31, 2024, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available, this section shall be implemented beginning with the 2024-2025 school year and apply to the 2024-2025 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 9-12. Recommended Prerequisite: Principles of Applied Engineering, Principles of Architecture and Design, or Principles of Manufacturing. Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

  (1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

  (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.

  (3)   Introduction to Computer-Aided Design and Drafting (CADD) allows students to acquire knowledge and skills needed to use design software, including an introduction to CADD equipment and software selection and interfaces. Students gain skills in setting up a CADD workstation; upgrading a computer to run advanced CADD software; working with storage devices; storing, retrieving, backing-up, and sharing databases, file servers, and local area networks (LANs); and transferring drawing files over the internet.

  (4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

  (5)   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.

(d)   Knowledge and skills.

  (1)   The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

    (A)   describe the roles, responsibilities, and dynamics of a team as applied in appropriate industry fields;

    (B)   explain employers' work expectations;

    (C)   use effective and accurate architectural or engineering vocabulary throughout design and drafting process;

    (D)   demonstrate knowledge of the concepts and skills related to health in the workplace; and

    (E)   demonstrate safety in the workplace as specified by appropriate governmental regulations.

  (2)   The student demonstrates knowledge of the CADD software. The student is expected to:

    (A)   describe computer-aided design, drafting, and CADD applications;

    (B)   demonstrate how to start and exit CADD software without corrupting files;

    (C)   use draw files;

    (D)   save, close, and open saved files;

    (E)   determine and specify drawing units and limits;

    (F)   describe and use the Cartesian coordinate system;

    (G)   use drawing snap and grid functions; and

    (H)   demonstrate the use of dynamic input and the command line.

  (3)   The student demonstrates the use of CADD tools for basic drawing and plotting. The student is expected to:

    (A)   draw objects using the line tool;

(B)　　draw circles, arcs, ellipses, and elliptical arcs;

(C)　　draw polylines, rectangles, donuts, and filled circles;

(D)　　draw true spline curves;

(E)　　create drawing templates;

(F)　　describe basic line conventions;

(G)　　create and manage layers;

(H)　　draw objects on separate layers;

(I)　　print and plot drawings;

(J)　　demonstrate organizational skills to influence the sequential process when creating drawings;

(K)　　construct geometric figures of lines, splines, circles, and arcs;

(L)　　create and edit text using appropriate style and size to annotate drawings;

(M)　　use control accuracy enhancement tools for entity positioning methods such as snap and xyz;

(N)　　use editing commands;

(O)　　use viewing commands to perform zooming and panning;

(P)　　plot drawings on media using layout and scale;

(Q)　　use query commands to interrogate database for entity characteristics, distance, area, and status;

(R)　　move, stretch, and offset objects;

(S)　　create a radius between objects;

(T)　　trim and extend objects;

(U)　　break and join objects;

(V)　　change object properties; and

(W)　　create hatching and manipulate properties such as calculating the area of an enclosed shape.

(4)　　The student demonstrates the use of CADD tools display and viewpoints. The student is expected to:

(A)　　create multiple viewpoints in the drawing window;

(B)　　select appropriate object snaps for various drawing tasks;

(C)　　create orthographic drawings;

(D)　　analyze challenges and identify solutions for design problems;

(E)　　investigate the use of space, scale, and environmental features to create three-dimensional form or the illusion of depth and form;

(F)　　prepare multi-view scaled drawings;

(G)　　select proper drawing scale, views, and layout;

(H)　　create drawings containing horizontal and vertical surfaces;

(I)　　create drawings containing circles and arcs;

(J)　　create removed details and conventional breaks using sectional drawing techniques;

(K) create assembly drawings;

(L) create detail drawings; and

(M) create technical drawings and title blocks associated with the different CAD drawings.

(5) The student demonstrates the use of software tools to properly create text within a CADD drawing. The student is expected to:

(A) use proper text standards for technical drawings;

(B) calculate drawing scale and text height using a scale ratio;

(C) apply text styles to enhance readability of drawings;

(D) demonstrate the use of tools to create multi-line text objects and single-line text;

(E) edit existing text; and

(F) create, insert, and modify tables.

(6) The student demonstrates the use of CADD editing tools within drawings. The student is expected to:

(A) draw chamfers and fillets;

(B) use editing tools to modify existing drawings;

(C) edit polylines and splines;

(D) move and copy objects;

(E) create mirror images and align objects; and

(F) scale and array objects.

(7) The student demonstrates the use of grips in drawings. The student is expected to:

(A) apply grips to stretch, move, rotate, scale, mirror, and copy objects;

(B) demonstrate the use of Quick Properties and the Properties palette to access CADD tools; and

(C) create selections by using the Quick Select dialog box.

(8) The student demonstrates the use of scale and dimension standards and practices. The student is expected to:

(A) apply standard dimensioning rules;

(B) draw scales and dimensions;

(C) create, edit, and manage dimension styles;

(D) add linear and angular dimensions to a drawing;

(E) draw datum and chain dimensions;

(F) dimension circles and arcs;

(G) control the appearance of existing dimensions and dimension text; and

(H) change dimension line spacing and alignment.

(9) The student creates and demonstrates standard blocks using tool palettes. The student is expected to:

(A) create and save text information blocks;

(B) insert blocks into a drawing;

(C) edit and update a block in a drawing;

(D) create blocks as a drawing file;

(E) construct and use a symbol library of blocks; and

(F) purge unused items from a drawing.

(10) The student prepares surface developments. The student is expected to:

(A) prepare developments of prisms, cylinders, cones, and pyramids;

(B) prepare developments of a transition piece; and

(C) prepare drawings involving intersecting pieces.

(11) The student designs and prepares basic architectural drawings. The student is expected to:

(A) solve design problems to gain new perspectives;

(B) apply critical-thinking and problem-solving skills to develop creative solutions for design problems;

(C) draw a site plan;

(D) draw a floor plan;

(E) draw interior and exterior elevations;

(F) draw a roof plan;

(G) prepare door and window schedules;

(H) draw wall sections;

(I) draw a plot plan; and

(J) draw an electrical and reflected ceiling plan.

(12) The student designs and prepares a technical drawing. The student is expected to:

(A) draw individual parts;

(B) draw the closed assembly drawings per the parts; and

(C) draw and explode the assembly with the parts list.

Source: The provisions of this §127.786 adopted to be effective April 26, 2022, 47 TexReg 2166.

§127.787. Intermediate Computer-Aided Design and Drafting (One Credit), Adopted 2021.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2024-2025 school year.

(1) No later than August 31, 2024, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2) If the commissioner makes the determination that instructional materials funding has been made available, this section shall be implemented beginning with the 2024-2025 school year and apply to the 2024-2025 and subsequent school years.

(3) If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 10-12. Prerequisite: Architectural Design I, Introduction to Computer-Aided Design and Drafting, or Engineering Design and Presentation I. Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

   (1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

   (2)   The Science, Technology, Engineering, and Science (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.

   (3)   In Intermediate Computer-Aided Design and Drafting (CADD), students develop practices and techniques used in computer-aided drafting, emphasizing the development and use of prototype drawings, construction of pictorial drawings, construction of three-dimensional drawings, interfacing two-dimensional and three-dimensional environments, and extracting data. Basic rendering techniques will also be developed. Emphasis is placed on drawing set-up; creating and modifying geometry; storing and retrieving predefined shapes; placing, rotating, and scaling objects; adding text and dimensions; using layers and coordinating systems, as well as using input and output devices.

   (4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

   (5)   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.

(d)   Knowledge and skills.

   (1)   The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

      (A)   describe the roles, responsibilities, and dynamics of a team as applied in appropriate industry fields;

      (B)   explain employers' work expectations;

      (C)   demonstrate knowledge of the concepts and skills related to health and safety in the workplace as specified by appropriate governmental regulations;

      (D)   evaluate and justify decisions based on ethical reasoning;

      (E)   evaluate alternative responses to workplace situations based on personal, professional, ethical, and legal responsibilities and employer policies;

      (F)   identify and explain personal and long-term consequences of unethical or illegal behaviors in the workplace;

      (G)   interpret and explain written organizational policies and procedures; and

      (H)   demonstrate personal responsibility, ethics, and integrity, including respect for intellectual property, when accessing information and creating design projects.

   (2)   The student demonstrates an understanding of CADD terminology, tools, and symbols. The student is expected to:

      (A)   apply the Cartesian Coordinate Systems to illustrate the application of Z coordinates;

      (B)   describe the CADD menu structure;

      (C)   differentiate between type-in commands, icons, and pulldown menus;

      (D)   manipulate the standard draw commands;

(E)   demonstrate modifying commands;

(F)   explain the various modes of viewing drawings; and

(G)   define and modify dimension styles.

(3)   The student produces hand sketches to organize ideas and communicate design ideas. The student is expected to:

(A)   demonstrate the use of graphic descriptions;

(B)   develop skill in sketching or mark making to plan, execute, and construct two-dimensional images and three-dimensional models;

(C)   demonstrate methods of projection; and

(D)   use proper drafting techniques to convert sketches into an electronic drawing using CADD.

(4)   The student demonstrates an understanding of commands in a CADD system. The student is expected to:

(A)   operate CADD software;

(B)   demonstrate draw commands;

(C)   modify drawn objects in CADD software;

(D)   create two-dimensional and three-dimensional objects;

(E)   convert two-dimensional drawings to three-dimensional drawings;

(F)   convert three-dimensional drawings to two-dimensional drawings;

(G)   prepare text blocks in CADD software;

(H)   manipulate an external reference or file;

(I)   import files of different formats into CADD;

(J)   demonstrate the plot command in print or plot drawings; and

(K)   import and export data using attributes.

(5)   The student preforms computer-aided drafting functions. The student is expected to:

(A)   create text styles, text justification, and multi-line text;

(B)   create and use multi-leaders;

(C)   edit dimensions;

(D)   work with dimension styles;

(E)   crosshatch objects;

(F)   isolate and hide objects;

(G)   use selection set methods;

(H)   use rectangular, polar, and path arrays;

(I)   use rotation reference angles;

(J)   use elements of creativity and organizational principles to create visually coherent viewports and layouts;

(K)   create and manage layers and properties;

(L)   use page setup for plotting;

(M)   create, insert, and edit reusable content such as symbols and blocks;

(N)   use specific line types using the Standard Alphabet of Lines;

(O)   create fills and gradients; and

(P)   edit hatch patterns and fills.

(6)   The student creates drawings using the CADD software. The student is expected to:

(A)   translate hand sketches into CADD software;

(B)   create projected mechanical drawings;

(C)   create drawings with external references;

(D)   complete a three-dimensional parametric model;

(E)   organize a complex assembly, including an animated exploded assembly;

(F)   compare various methods of drawing solids;

(G)   construct a composite drawing using multiple drawings;

(H)   justify correct drawing methods;

(I)   draw lines, arcs, and circles to represent plans or mechanical assemblies;

(J)   create text styles, text justification, and multi-line text;

(K)   create and use multi-leaders;

(L)   edit dimensions, including dimension styles;

(M)   isolate and hide objects;

(N)   use selection set methods;

(O)   use elements of creativity and organizational principles to create visually coherent viewports and layouts;

(P)   create and manage layers;

(Q)   use page setup for plotting; and

(R)   prepare multi-view drawings, including sectional and auxiliary views.

(7)   The student creates electrical drawings. The student is expected to:

(A)   prepare schematic drawings;

(B)   prepare printed circuit board assembly drawing packages;

(C)   prepare connection drawings;

(D)   prepare interconnection drawings;

(E)   prepare wiring drawings;

(F)   prepare cable drawings and/or harness drawings;

(G)   prepare component drawings; and

(H)   prepare logic diagrams.

(8)   The student creates mechanical drawings. The student is expected to:

(A)   prepare fastener, cam, gear, spring, and bearing drawings;

(B)   prepare detail drawings;

(C)   prepare surface developments;

(D)   prepare welding drawings;

(E)   prepare bearing drawings;

(F)   prepare casting drawings;

(G)   prepare forging drawings;

(H)   prepare tool drawings;

(I)   prepare molding diagrams;

(J)   prepare stamping drawings;

(K)   prepare numerical-control drawings;

(L)   modify drawings to include material specifications and parts list; and

(M)   identify geometric tolerances and dimensioning of specific machined surfaces.

(9)   The student prepares CADD project designs. The student is expected to:

(A)   develop a floor plan depicting all elements of the building, including BIM (building information modeling);

(B)   render a site plan that depicts all elements of the site;

(C)   render exterior and interior elevations;

(D)   draw a specified roof type within a plan;

(E)   prepare door and window schedules;

(F)   draw a wall and building section;

(G)   draw an overall site plan;

(H)   draw a building plot plan;

(I)   review and revise plans throughout the design process to refine and achieve design objective;

(J)   demonstrate flexibility and adaptability throughout the design process; and

(K)   define a basic project materials list.

Source: The provisions of this §127.787 adopted to be effective April 26, 2022, 47 TexReg 2166.

§127.788. Fundamentals of Computer Science (One Credit), Adopted 2022.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2023-2024 school year.

(1)   No later than August 1, 2023, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available this section shall be implemented beginning with the 2023-2024 school year and apply to the 2023-2024 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under subsection (a) of this section, the commissioner shall determine no later than August 1 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 9-12.Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

   (1)   Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

   (2)   The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services such as laboratory and testing services and research and development services.

   (3)   Fundamentals of Computer Science is intended as a first course for those students just beginning the study of computer science. Students will learn about the computing tools that are used every day. Students will foster their creativity and innovation through opportunities to design, implement, and present solutions to real-world problems. Students will collaborate and use computer science concepts to access, analyze, and evaluate information needed to solve problems. Students will learn computational thinking, problem-solving, and reasoning skills that are the foundation of computer science. By using computer science knowledge and skills that support the work of individuals and groups in solving problems, students will select the technology appropriate for the task, synthesize knowledge, create solutions, and evaluate the results. Students will learn digital citizenship by researching current laws, regulations, and best practices and by practicing integrity and respect. Students will gain an understanding of the principles of computer science through the study of technology operations and concepts.

   (4)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

   (5)   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.

(d)   Knowledge and skills.

   (1)   Employability. The student identifies various employment opportunities in the computer science field. The student is expected to:

      (A)   identify job and internship opportunities and accompanying job duties and tasks and contact one or more companies or organizations to explore career opportunities;

      (B)   examine the role of certifications, resumes, and portfolios in the computer science profession;

      (C)   employ effective technical reading and writing skills;

      (D)   employ effective verbal and non-verbal communication skills;

      (E)   solve problems and think critically;

      (F)   demonstrate leadership skills and function effectively as a team member;

      (G)   demonstrate an understanding of legal and ethical responsibilities in relation to the field of computer science;

      (H)   demonstrate planning and time-management skills; and

      (I)   compare university computer science programs.

   (2)   Creativity and innovation. The student develops products and generates new knowledge, understanding, and skills. The student is expected to:

      (A)   investigate and explore various career opportunities within the computer science field and report findings through various media;

      (B)   create algorithms for the solution of various problems;

      (C)   discuss methods and create and publish web pages using a web-based language such as HTML, Java Script, or XML; and

(D) use generally accepted design standards for spacing, fonts, and color schemes to create functional user interfaces, including static and interactive screens.

(3) Communication and collaboration. The student communicates and collaborates with peers to contribute to his or her own learning and the learning of others. The student is expected to:

(A) seek and respond to advice or feedback from peers, educators, or professionals when evaluating problem solutions;

(B) debug and solve problems using reference materials and effective strategies; and

(C) publish information in a variety of ways such as print, monitor display, web pages, or video.

(4) Critical thinking, problem solving, and decision making. The student uses appropriate strategies to analyze problems and design algorithms. The student is expected to:

(A) demonstrate the ability to insert external standalone objects such as scripts or widgets into web pages;

(B) communicate an understanding of binary representation of data in computer systems, perform conversions between decimal and binary number systems, and count in binary number systems;

(C) identify a problem's description, purpose, and goals;

(D) demonstrate coding proficiency in a programming language by developing solutions that create stories, games, and animations;

(E) identify and use the appropriate data type to properly represent the data in a program problem solution;

(F) communicate an understanding of and use variables within a programmed story, game, or animation;

(G) use arithmetic operators to create mathematical expressions, including addition, subtraction, multiplication, real division, integer division, and modulus division;

(H) communicate an understanding of and use sequence within a programmed story, game, or animation;

(I) communicate an understanding of and use conditional statements within a programmed story, game, or animation;

(J) communicate an understanding of and use iteration within a programmed story, game, or animation;

(K) use random numbers within a programmed story, game, or animation; and

(L) test program solutions by investigating intended outcomes.

(5) Digital citizenship. The student explores and understands safety, legal, cultural, and societal issues relating to the use of technology and information. The student is expected to:

(A) discuss privacy and copyright laws and model ethical acquisition of digital information by citing sources using established methods;

(B) compare various non-copyright asset sharing options such as open source, freeware, and public domain;

(C) demonstrate proper digital etiquette and knowledge of acceptable use policies when using networks;

(D) explain the value of strong passwords and virus detection and prevention for privacy and security;

(E) discuss and give examples of the impact of computing and computing-related advancements on society; and

(F) analyze how electronic media can affect reliability of information.

(6) Technology operations and concepts. The student understands technology concepts, systems, and operations as they apply to computer science. The student is expected to:

(A) identify and explain the function of basic computer components, including a central processing unit (CPU), storage, and peripheral devices;

(B) use system tools, including appropriate file management;

(C) compare different operating systems;

(D) describe the differences between an application and an operating system; and

(E) use various input, processing, output, and primary/secondary storage devices.

Source: The provisions of this §127.788 adopted to be effective August 7, 2022, 47 TexReg 4523.

§127.789. Computer Science I (One Credit), Adopted 2022.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2024-2025 school year.

(1) No later than August 1, 2024, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2) If the commissioner makes the determination that instructional materials funding has been made available this section shall be implemented beginning with the 2024-2025 school year and apply to the 2024-2025 and subsequent school years.

(3) If the commissioner does not make the determination that instructional materials funding has been made available under subsection (a) of this section, the commissioner shall determine no later than August 1 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b) General requirements. This course is recommended for students in Grades 9-12. Prerequisite or corequisite: Algebra I. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services such as laboratory and testing services and research and development services.

(3) Computer Science I will foster students' creativity and innovation by presenting opportunities to design, implement, and present meaningful programs through a variety of media. Students will collaborate with one another, their instructor, and various electronic communities to solve the problems presented throughout the course. Through computational thinking and data analysis, students will identify task requirements, plan search strategies, and use computer science concepts to access, analyze, and evaluate information needed to solve problems. By using computer science knowledge and skills that support the work of individuals and groups in solving problems, students will select the technology appropriate for the task, synthesize knowledge, create solutions, and evaluate the results. Students will learn digital citizenship by researching current laws, regulations, and best practices and by practicing integrity and respect. Students will gain an

understanding of the principles of computer science through the study of technology operations, systems, and concepts.

(4)　Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5)　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.

(d)　Knowledge and skills.

(1)　Employability. The student identifies various employment opportunities in the computer science field. The student is expected to:

(A)　identify job and internship opportunities and accompanying job duties and tasks and contact one or more companies or organizations to explore career opportunities;

(B)　examine the role of certifications, resumes, and portfolios in the computer science profession;

(C)　employ effective technical reading and writing skills;

(D)　employ effective verbal and non-verbal communication skills;

(E)　solve problems and think critically;

(F)　demonstrate leadership skills and function effectively as a team member;

(G)　communicate an understanding of legal and ethical responsibilities in relation to the field of computer science;

(H)　demonstrate planning and time-management skills; and

(I)　compare university computer science programs.

(2)　Communication and collaboration. The student communicates and collaborates with peers to contribute to his or her own learning and the learning of others. The student is expected to:

(A)　participate in learning communities as a learner, initiator, contributor, and teacher/mentor; and

(B)　seek and respond to advice from peers, educators, or professionals when evaluating quality and accuracy of the student's product.

(3)　Programming style and presentation. The student utilizes proper programming style and develops appropriate visual presentation of data, input, and output. The student is expected to:

(A)　create and properly label and display output;

(B)　create interactive input interfaces, with relevant user prompts, to acquire data from a user such as console displays or Graphical User Interfaces (GUIs);

(C)　write programs with proper programming style to enhance the readability and functionality of a code by using descriptive identifiers, internal comments, white space, spacing, indentation, and a standardized program style;

(D)　format data displays using standard formatting styles; and

(E)　display simple vector graphics using lines, circles, and rectangles.

(4)　Critical thinking, problem solving, and decision making. The student uses appropriate strategies to analyze problems and design algorithms. The student is expected to:

(A)　use program design problem-solving strategies such as flowchart or pseudocode to create program solutions;

(B)　create a high-level program plan using a visual tool such as a flowchart or graphic organizer;

(C)   identify the tasks and subtasks needed to solve a problem;

(D)   identify the data types and objects needed to solve a problem;

(E)   identify reusable components from existing code;

(F)   design a solution to a problem;

(G)   code a solution from a program design;

(H)   identify error types, including syntax, lexical, run time, and logic;

(I)   test program solutions with valid and invalid test data and analyze resulting behavior;

(J)   debug and solve problems using error messages, reference materials, language documentation, and effective strategies;

(K)   create and implement common algorithms such as finding greatest common divisor, finding the biggest number out of three, finding primes, making change, and finding the average;

(L)   create program solutions that address basic error handling such as preventing division by zero and type mismatch;

(M)   select the most appropriate construct for a defined problem;

(N)   create program solutions by using the arithmetic operators to create mathematical expressions, including addition, subtraction, multiplication, real division, integer division, and modulus division;

(O)   create program solutions to problems using available mathematics library functions or operators, including absolute value, round, power, square, and square root;

(P)   develop program solutions that use assignment;

(Q)   develop sequential algorithms to solve non-branching and non-iterative problems;

(R)   develop algorithms to decision-making problems using branching control statements;

(S)   develop iterative algorithms and code programs to solve practical problems;

(T)   demonstrate the appropriate use of the relational operators;

(U)   demonstrate the appropriate use of the logical operators; and

(V)   generate and use random numbers.

(5)   Digital citizenship. The student explores and understands safety, legal, cultural, and societal issues relating to the use of technology and information. The student is expected to:

(A)   discuss and explain intellectual property, privacy, sharing of information, copyright laws, and software licensing agreements;

(B)   practice ethical acquisition and use of digital information;

(C)   demonstrate proper digital etiquette, responsible use of software, and knowledge of acceptable use policies;

(D)   investigate privacy and security measures, including strong passwords, pass phrases, and other methods of authentication and virus detection and prevention; and

(E)   investigate computing and computing-related advancements and the social and ethical ramifications of computer usage.

(6)   Technology operations, systems, and concepts. The student understands technology concepts, systems, and operations as they apply to computer science. The student is expected to:

(A)   identify and describe the function of major hardware components, including primary and secondary memory, a central processing unit (CPU), and peripherals;

(B)   differentiate between current programming languages, discuss the general purpose for each language, and demonstrate knowledge of specific programming terminology and concepts and types of software development applications;

(C)   differentiate between a high-level compiled language and an interpreted language;

(D)   identify and use concepts of object-oriented design;

(E)   differentiate between local and global scope access variable declarations;

(F)   encapsulate data and associated subroutines into an abstract data type;

(G)   create subroutines that do not return values with and without the use of arguments and parameters;

(H)   create subroutines that return typed values with and without the use of arguments and parameters;

(I)   create calls to processes passing arguments that match parameters by number, type, and position;

(J)   compare data elements using logical and relational operators;

(K)   identify and convert binary representation of numeric and nonnumeric data in computer systems using American Standard Code for Information Interchange (ASCII) or Unicode;

(L)   identify finite limits of numeric data such as integer wrap around and floating point precision;

(M)   perform numerical conversions between the decimal and binary number systems and count in the binary number system;

(N)   choose, identify, and use the appropriate data types for integer, real, and Boolean data when writing program solutions;

(O)   analyze the concept of a variable, including primitives and objects;

(P)   represent and manipulate text data, including concatenation and other string functions;

(Q)   identify and use the structured data type of one-dimensional arrays to traverse, search, and modify data;

(R)   choose, identify, and use the appropriate data type or structure to properly represent the data in a program problem solution; and

(S)   compare strongly typed and un-typed programming languages.

Source: The provisions of this §127.789 adopted to be effective August 7, 2022, 47 TexReg 4523.

§127.790. Computer Science II (One Credit), Adopted 2022.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2024-2025 school year.

(1)   No later than August 1, 2024, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available this section shall be implemented beginning with the 2024-2025 school year and apply to the 2024-2025 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under subsection (a) of this section, the commissioner shall determine no later than August 1 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made

available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b) General requirements. This course is recommended for students in Grades 10-12. Prerequisites: Algebra I and Computer Science I or AP Computer Science Principles. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services such as laboratory and testing services and research and development services.

(3) Computer Science II will foster students' creativity and innovation by presenting opportunities to design, implement, and present meaningful programs through a variety of media. Students will collaborate with one another, their instructor, and various electronic communities to solve the problems presented throughout the course. Through computational thinking and data analysis, students will identify task requirements, plan search strategies, and use computer science concepts to access, analyze, and evaluate information needed to solve problems. By using computer science knowledge and skills that support the work of individuals and groups in solving problems, students will select the technology appropriate for the task, synthesize knowledge, create solutions, and evaluate the results. Students will gain an understanding of computer science through the study of technology operations, systems, and concepts.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5) 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.

(d) Knowledge and skills.

(1) Employability. The student identifies various employment opportunities in the computer science field. The student is expected to:

(A) identify job and internship opportunities and accompanying job duties and tasks and contact one or more companies or organizations to explore career opportunities;

(B) examine the role of certifications, resumes, and portfolios in the computer science profession;

(C) employ effective technical reading and writing skills;

(D) employ effective verbal and non-verbal communication skills;

(E) solve problems and think critically;

(F) demonstrate leadership skills and function effectively as a team member;

(G) identify legal and ethical responsibilities in relation to the field of computer science;

(H) demonstrate planning and time-management skills; and

(I) compare university computer science programs.

(2) Creativity and innovation. The student develops products and generates new understandings by extending existing knowledge. The student is expected to:

(A) use program design problem-solving strategies to create program solutions;

(B)   read, analyze, and modify programs and their accompanying documentation such as an application programming interface (API), internal code comments, external documentation, or readme files;

(C)   follow a systematic problem-solving process that identifies the purpose and goals, the data types and objects needed, and the subtasks to be performed;

(D)   compare design methodologies and implementation techniques such as top-down, bottom-up, and black box;

(E)   trace a program, including inheritance and black box programming;

(F)   choose, identify, and use the appropriate abstract data type, advanced data structure, and supporting algorithms to properly represent the data in a program problem solution; and

(G)   use object-oriented programming development methodology, including data abstraction, encapsulation with information hiding, inheritance, and procedural abstraction in program development.

(3)   Communication and collaboration. The student communicates and collaborates with peers to contribute to his or her own learning and the learning of others. The student is expected to:

(A)   use the principles of software development to work in software design teams;

(B)   break a problem statement into specific solution requirements;

(C)   create a program development plan;

(D)   code part of a solution from a program development plan while a partner codes the remaining part;

(E)   collaborate with a team to test a solution, including boundary and standard cases; and

(F)   develop presentations to report the solution findings.

(4)   Data literacy and management. The student locates, analyzes, processes, and organizes data. The student is expected to:

(A)   use programming file structure and file access for required resources;

(B)   acquire and process information from text files, including files of known and unknown sizes;

(C)   manipulate data using string processing;

(D)   manipulate data values by casting between data types;

(E)   use the structured data type of one-dimensional arrays to traverse, search, modify, insert, and delete data;

(F)   identify and use the structured data type of two-dimensional arrays to traverse, search, modify, insert, and delete data;

(G)   identify and use a list object data structure to traverse, search, insert, and delete data; and

(H)   differentiate between categories of programming languages, including machine, assembly, high-level compiled, high-level interpreted, and scripted.

(5)   Critical thinking, problem solving, and decision making. The student uses appropriate strategies to analyze problems and design algorithms. The student is expected to:

(A)   develop sequential algorithms using branching control statements, including nested structures, to create solutions to decision-making problems;

(B)   develop choice algorithms using selection control statements based on ordinal values;

(C)   demonstrate the appropriate use of short-circuit evaluation in certain situations;

(D) use Boolean algebra, including De Morgan's Law, to evaluate and simplify logical expressions;

(E) develop iterative algorithms using nested loops;

(F) identify, trace, and appropriately use recursion in programming solutions, including algebraic computations;

(G) trace, construct, evaluate, and compare search algorithms, including linear searching and binary searching;

(H) identify, describe, trace, evaluate, and compare standard sorting algorithms, including selection sort, bubble sort, insertion sort, and merge sort;

(I) measure time and space efficiency of various sorting algorithms, including analyzing algorithms using "big-O" notation for best, average, and worst-case data patterns;

(J) develop algorithms to solve various problems such as factoring, summing a series, finding the roots of a quadratic equation, and generating Fibonacci numbers;

(K) test program solutions by investigating boundary conditions; testing classes, methods, and libraries in isolation; and performing stepwise refinement;

(L) identify and debug compile, syntax, runtime, and logic errors;

(M) compare efficiency of search and sort algorithms by using informal runtime comparisons, exact calculation of statement execution counts, and theoretical efficiency values using "big-O" notation, including worst-case, best-case, and average-case time/space analysis;

(N) count, convert, and perform mathematical operations in the decimal, binary, octal, and hexadecimal number systems;

(O) identify maximum integer boundary, minimum integer boundary, imprecision of real number representations, and round-off errors;

(P) create program solutions to problems using a mathematics library;

(Q) use random number generator algorithms to create simulations;

(R) use composition and inheritance relationships to identify and create class definitions and relationships;

(S) explain and use object relationships between defined classes, abstract classes, and interfaces;

(T) create object-oriented class definitions and declarations using variables, constants, methods, parameters, and interface implementations;

(U) create adaptive behaviors using polymorphism;

(V) use reference variables for object and string data types;

(W) use value and reference parameters appropriately in method definitions and method calls;

(X) implement access scope modifiers;

(Y) use object comparison for content quality;

(Z) duplicate objects using the appropriate deep or shallow copy;

(AA) apply functional decomposition to a program solution;

(BB) create objects from class definitions through instantiation; and

(CC) examine and mutate the properties of an object using accessors and modifiers.

Source: The provisions of this §127.790 adopted to be effective August 7, 2022, 47 TexReg 4523.

§127.791. Computer Science III (One Credit), Adopted 2022.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2023-2024 school year.

    (1) No later than August 1, 2023, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

    (2) If the commissioner makes the determination that instructional materials funding has been made available this section shall be implemented beginning with the 2023-2024 school year and apply to the 2023-2024 and subsequent school years.

    (3) If the commissioner does not make the determination that instructional materials funding has been made available under subsection (a) of this section, the commissioner shall determine no later than August 1 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b) General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: Computer Science II, Advanced Placement (AP) Computer Science A, or International Baccalaureate (IB) Computer Science Standard Level or IB Computer Science Higher Level. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

    (1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

    (2) The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services such as laboratory and testing services and research and development services.

    (3) Computer Science III will foster students' creativity and innovation by presenting opportunities to design, implement, and present meaningful programs through a variety of media. Students will collaborate with one another, their instructor, and various electronic communities to solve the problems presented throughout the course. Through computational thinking and data analysis, students will identify task requirements, plan search strategies, and use computer science concepts to access, analyze, and evaluate information needed to solve problems. By using computer science knowledge and skills that support the work of individuals and groups in solving problems, students will select the technology appropriate for the task, synthesize knowledge, create solutions, and evaluate the results. Students will gain an understanding of advanced computer science data structures through the study of technology operations, systems, and concepts.

    (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

    (5) 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.

    (6) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(d) Knowledge and skills.

    (1) Employability. The student identifies various employment opportunities in the computer science field. The student is expected to:

        (A) identify job and internship opportunities and accompanying job duties and tasks and contact one or more companies or organizations to explore career opportunities;

(B) examine the role of certifications, resumes, and portfolios in the computer science profession;

(C) employ effective technical reading and writing skills;

(D) employ effective verbal and non-verbal communication skills;

(E) solve problems and think critically;

(F) demonstrate leadership skills and function effectively as a team member;

(G) demonstrate an understanding of legal and ethical responsibilities in relation to the field of computer science;

(H) demonstrate planning and time-management skills; and

(I) compare university computer science programs.

(2) Creativity and innovation. The student develops products and generates new understandings by extending existing knowledge. The student is expected to:

(A) apply object-oriented programming, including data abstraction, encapsulation, inheritance, and polymorphism, to manage the complexity of a project;

(B) design and implement a class hierarchy;

(C) read and write class specifications using visual organizers, including Unified Modeling Language;

(D) identify, describe, evaluate, compare, and implement standard sorting algorithms that perform sorting operations on data structures, including quick sort and heap sort; and

(E) identify and use the appropriate abstract data type, advanced data structure, and supporting algorithms to properly represent the data in a program problem solution.

(3) Communication and collaboration. The student communicates and collaborates with peers to contribute to his or her own learning and the learning of others. The student is expected to:

(A) use networked tools for file management and collaboration; and

(B) work in software design teams.

(4) Data literacy and management. The student locates, analyzes, processes, and organizes data. The student is expected to:

(A) identify and use two-dimensional ragged arrays to traverse, search, modify, insert, and delete data;

(B) describe and demonstrate proper linked list management, including maintaining the head and safe addition and deletion of linked objects;

(C) create or trace program solutions using a linked-list data structure, including unordered single, ordered single, double, and circular linked;

(D) describe composite data structures, including a linked list of linked lists;

(E) create or trace program solutions using stacks, queues, trees, heaps, priority queues, graph theory, and enumerated data types;

(F) create or trace program solutions using sets, including hash and tree-based data structures;

(G) create or trace program solutions using map style data structures; and

(H) write and modify text file data.

(5) Critical thinking, problem solving, and decision making. The student uses appropriate strategies to analyze problems and design algorithms. The student is expected to:

(A)   evaluate expressions using bitwise operators;

(B)   evaluate expressions using the ternary operator;

(C)   identify, trace, and appropriately use recursion in programming solutions, including processing binary trees;

(D)   create or trace program solutions using hashing;

(E)   explore common algorithms such as matrix addition and multiplication, fractals, Towers of Hanoi, and magic square; and

(F)   create program solutions that exhibit robust behavior by recognizing and avoiding runtime errors and handling anticipated errors.

(6)   Testing and documentation. The student demonstrates appropriate documentation and testing practices. The student is expected to:

(A)   use appropriate formatting and write documentation to support code maintenance, including pre- and post-condition statements;

(B)   write program assumptions in the form of assertions;

(C)   write a Boolean expression to test a program assertion; and

(D)   construct assertions to make explicit program invariants.

(7)   Practical application of technology. The student utilizes technology concepts, systems, and operations as they apply to computer science. The student is expected to:

(A)   analyze and create computer program workflow charts and basic system diagrams, documenting system functions, features, and operations;

(B)   gather requirements, design, and implement a process by which programs can interact with each other such as using interfaces;

(C)   create simple programs using a low-level language such as assembly;

(D)   create discovery programs in a high-level language;

(E)   create scripts for an operating system;

(F)   explore industry best practices for secure programming; and

(G)   explore emerging industry or technology trends.

Source: The provisions of this §127.791 adopted to be effective August 7, 2022, 47 TexReg 4523.

§127.792. Foundations of Cybersecurity (One Credit), Adopted 2022.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2023-2024 school year.

(1)   No later than August 1, 2023, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

(2)   If the commissioner makes the determination that instructional materials funding has been made available this section shall be implemented beginning with the 2023-2024 school year and apply to the 2023-2024 and subsequent school years.

(3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 1 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b) General requirements. This course is recommended for students in Grades 9-12.Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

   (1) Career and technical education instruction provides content aligned with challenging academic standards, industry and relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

   (2) The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services such as laboratory and testing services and research and development services.

   (3) Cybersecurity is a critical discipline concerned with safeguarding computers, networks, programs, and data from unauthorized access. As a field, it has gained prominence with the expansion of a globally connected society. As computing has become more sophisticated, so too have the abilities of adversaries looking to penetrate networks and access systems and sensitive information. Cybersecurity professionals prevent, detect, and respond to minimize disruptions to governments, organizations, and individuals.

   (4) In the Foundations of Cybersecurity course, students will develop the knowledge and skills needed to explore fundamental concepts related to the ethics, laws, and operations of cybersecurity. Students will examine trends and operations of cyberattacks, threats, and vulnerabilities. Students will review and explore security policies designed to mitigate risks. The skills obtained in this course prepare students for additional study in cybersecurity. A variety of courses are available to students interested in this field. Foundations of Cybersecurity may serve as an introductory course in this field of study.

   (5) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

   (6) 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.

(d) Knowledge and skills.

   (1) Employability skills. The student demonstrates necessary skills for career development and successful completion of course outcomes. The student is expected to:

      (A) identify and demonstrate employable work behaviors such as regular attendance, punctuality, maintenance of a professional work environment, and effective written and verbal communication;

      (B) identify and demonstrate positive personal qualities such as authenticity, resilience, initiative, and a willingness to learn new knowledge and skills;

      (C) solve problems and think critically;

      (D) demonstrate leadership skills and function effectively as a team member; and

      (E) demonstrate an understanding of ethical and legal responsibilities and ramifications in relation to the field of cybersecurity.

   (2) Professional awareness. The student identifies various employment opportunities and requirements in the cybersecurity field. The student is expected to:

      (A) identify job and internship opportunities and accompanying job duties and tasks;

      (B) research careers in cybersecurity and information security and develop professional profiles that match education and job skills required for obtaining a job in both the public and private sectors;

      (C) identify and discuss certifications for cybersecurity-related careers; and

(D)   explain the different types of services and roles found within a cybersecurity functional area such as a security operations center (SOC).

(3)   Ethics and laws. The student understands ethical and current legal standards, rights and restrictions governing technology, technology systems, digital media, and the use of social media. The student is expected to:

(A)   demonstrate and advocate for ethical and legal behaviors both online and offline among peers, family, community, and employers;

(B)   investigate and analyze local, state, national, and international cybersecurity laws such as the USA PATRIOT Act of 2001, General Data Protection Regulation, Digital Millennium Copyright Act, Computer Fraud and Abuse Act, and Health Insurance Portability and Accountability Act of 1996 (HIPAA);

(C)   investigate and analyze noteworthy incidents or events regarding cybersecurity;

(D)   communicate an understanding of ethical and legal behavior when presented with various scenarios related to cybersecurity activities;

(E)   define and identify tactics used in an incident such as social engineering, malware, denial of service, spoofing, and data vandalism; and

(F)   identify and use appropriate methods for citing sources.

(4)   Ethics and laws. The student differentiates between ethical and malicious hacking. The student is expected to:

(A)   identify motivations and perspectives for hacking;

(B)   distinguish between types of threat actors such as hacktivists, criminals, state-sponsored actors, and foreign governments;

(C)   identify and describe the impact of cyberattacks on the global community, society, and individuals;

(D)   differentiate between industry terminology for types of hackers such as black hats, white hats, and gray hats; and

(E)   determine and describe possible outcomes and legal ramifications of ethical versus malicious hacking practices.

(5)   Ethics and laws. The student identifies and defines cyberterrorism and counterterrorism. The student is expected to:

(A)   define cyberterrorism, state-sponsored cyberterrorism, and hacktivism;

(B)   compare and contrast physical terrorism and cyberterrorism, including domestic and foreign actors;

(C)   define and explain intelligence gathering;

(D)   explain the role of cyber defense in protecting national interests and corporations;

(E)   explain the role of cyber defense in society and the global economy; and

(F)   explain the importance of protecting public infrastructures such as electrical power grids, water systems, pipelines, transportation, and power generation facilities from cyberterrorism.

(6)   Digital citizenship. The student understands and demonstrates the social responsibility of end users regarding significant issues related to digital technology, digital hygiene, and cyberbullying. The student is expected to:

(A)   identify and understand the nature and value of privacy;

(B)   analyze the positive and negative implications of a digital footprint and the maintenance and monitoring of an online presence;

(C)   discuss the role and impact of technology on privacy;

(D)   identify the signs, emotional effects, and legal consequences of cyberbullying and cyberstalking; and

(E)   identify and discuss effective ways to deter and report cyberbullying.

(7)   Digital citizenship. The student understands the implications of sharing information and access with others. The student is expected to:

(A)   define personally identifiable information (PII);

(B)   evaluate the risks and benefits of sharing PII;

(C)   describe the impact of granting applications unnecessary permissions such as mobile devices accessing camera and contacts;

(D)   describe the risks of granting third parties access to personal and proprietary data on social media and systems; and

(E)   describe the risks involved with accepting Terms of Service (ToS) or End User License Agreements (EULA) without a basic understanding of the terms or agreements.

(8)   Cybersecurity skills. The student understands basic cybersecurity concepts and definitions. The student is expected to:

(A)   define cybersecurity and information security;

(B)   identify basic risk management and risk assessment principles related to cybersecurity threats and vulnerabilities, including the Zero Trust model;

(C)   explain the fundamental concepts of confidentiality, integrity, and availability (CIA triad);

(D)   describe the trade-offs between convenience and security;

(E)   identify and analyze cybersecurity breaches and incident responses;

(F)   identify and analyze security challenges in domains such as physical, network, cloud, and web;

(G)   define and discuss challenges faced by cybersecurity professionals such as internal and external threats;

(H)   identify indicators of compromise such as common risks, warning signs, and alerts of compromised systems;

(I)   explore and discuss the vulnerabilities of network-connected devices such as Internet of Things (IoT);

(J)   use appropriate cybersecurity terminology;

(K)   explain the concept of penetration testing, including tools and techniques; and

(L)   explore and identify common industry frameworks such as MITRE ATT&CKTM, MITRE Engage TM, and Cyber Kill Chain, and the Diamond Model.

(9)   Cybersecurity skills. The student understands and explains various types of malicious software (malware). The student is expected to:

(A)   define malware, including spyware, ransomware, viruses, and rootkits;

(B)   identify the transmission and function of malware such as trojan horses, worms, and viruses;

(C)   discuss the impact of malware and the model of "as a service";

(D)   explain the role of reverse engineering for the detection of malware and viruses; and

(E)   describe free and commercial antivirus and anti-malware software also known as Endpoint Detection and Response software.

(10)   Cybersecurity skills. The student understands and demonstrates knowledge of techniques and strategies to prevent a system from being compromised. The student is expected to:

(A)   define system hardening;

(B)   use basic system administration privileges;

(C)   explain the importance of patching operating systems;

(D)   explain the importance of software updates;

(E)   describe standard practices to configure system services;

(F)   explain the importance of backup files;

(G)   research and explain standard practices for securing computers, networks, and operating systems, including the concept of least privilege; and

(H)   identify vulnerabilities caused by a lack of cybersecurity awareness and training such as weaknesses posed by individuals within an organization.

(11)   Cybersecurity skills. The student understands basic network operations. The student is expected to:

(A)   identify basic network devices, including routers and switches;

(B)   define network addressing;

(C)   analyze incoming and outgoing rules for traffic passing through a firewall;

(D)   identify well known ports by number and service provided, including port 22 (Secure Shell Protocol/ssh), port 80 (Hypertext Transfer Protocol/http), and port 443 (Hypertext Transfer Protocol Secure/https);

(E)   identify commonly exploited ports and services, including ports 20 and 21 (File Transfer Protocol/ftp), port 23 (telnet protocol), and port 3389 (Remote Desktop Protocol/rdp); and

(F)   identify common tools for monitoring ports and network traffic.

(12)   Cybersecurity skills. The student identifies standard practices of system administration. The student is expected to:

(A)   define what constitutes a secure password;

(B)   create a secure password policy, including length, complexity, account lockout, and rotation;

(C)   identify methods of password cracking such as brute force and dictionary attacks; and

(D)   examine and configure security options to allow and restrict access based on user roles.

(13)   Cybersecurity skills. The student demonstrates necessary steps to maintain user access on the system. The student is expected to:

(A)   identify different types of user accounts and groups on an operating system;

(B)   explain the fundamental concepts and standard practices related to access control, including authentication, authorization, and auditing;

(C) compare methods for single- and multi-factor authentication such as passwords, biometrics, personal identification numbers (PINs), secure tokens, and other passwordless authentication methods;

(D) define and explain the purpose and benefits of an air-gapped computer; and

(E) explain how hashes and checksums may be used to validate the integrity of transferred data.

(14) Cybersecurity skills. The student explores the field of digital forensics. The student is expected to:

(A) explain the importance of digital forensics to organizations, private citizens, and the public sector;

(B) identify the role of chain of custody in digital forensics;

(C) explain the four steps of the forensics process, including collection, examination, analysis, and reporting;

(D) identify when a digital forensics investigation is necessary;

(E) identify information that can be recovered from digital forensics investigations such as metadata and event logs; and

(F) analyze the purpose of event logs and identify suspicious activity.

(15) Cybersecurity skills. The student explores the operations of cryptography. The student is expected to:

(A) explain the purpose of cryptography and encrypting data;

(B) research historical uses of cryptography;

(C) review and explain simple cryptography methods such as shift cipher and substitution cipher;

(D) define and explain public key encryption; and

(E) compare and contrast symmetric and asymmetric encryption.

(16) Vulnerabilities, threats, and attacks. The student understands vulnerabilities, threats, and attacks. The student is expected to:

(A) explain how computer vulnerabilities leave systems open to cyberattacks;

(B) explain how users are the most common vehicle for compromising a system at the application level;

(C) define and describe vulnerability, payload, exploit, port scanning, and packet sniffing;

(D) identify internal threats to systems such as logic bombs and insider threats;

(E) define and describe cyberattacks, including man-in-the-middle, distributed denial of service, spoofing, and back-door attacks;

(F) differentiate types of social engineering techniques such as phishing; web links in email, instant messaging, social media, and other online communication with malicious links; shoulder surfing; and dumpster diving; and

(G) identify various types of application-specific attacks such as cross-site scripting and injection attacks.

(17) Vulnerabilities, threats, and attacks. The student evaluates the vulnerabilities of networks. The student is expected to:

(A) compare vulnerabilities associated with connecting devices to public and private networks;

       (B)   explain device vulnerabilities and security solutions on networks such as supply chain security and counterfeit products;

       (C)   compare and contrast protocols such as HTTP versus HTTPS;

       (D)   debate the broadcasting or hiding of a wireless service set identifier (SSID); and

       (E)   research and discuss threats such as mandatory access control (MAC) spoofing and packet sniffing.

(18)   Vulnerabilities, threats, and attacks. The student analyzes threats to computer applications. The student is expected to:

       (A)   define application security;

       (B)   identify methods of application security such as secure development policies and practices;

       (C)   explain the purpose and function of vulnerability scanners;

       (D)   explain how coding errors may create system vulnerabilities such as buffer overflows and lack of input validation; and

       (E)   analyze the risks of distributing insecure programs.

(19)   Risk assessment. The student understands risk and how risk assessment and risk management defend against attacks. The student is expected to:

       (A)   define commonly used risk assessment terms, including risk, asset, and inventory;

       (B)   identify risk management strategies, including acceptance, avoidance, transference, and mitigation; and

       (C)   compare and contrast risks based on an industry accepted rubric or metric such as Risk Assessment Matrix.

Source: The provisions of this §127.792 adopted to be effective August 7, 2022, 47 TexReg 4523.

§127.793. Digital Forensics (One Credit), Adopted 2022.

(a)   Implementation. The provisions of this section shall be implemented by school districts beginning with the 2023-2024 school year.

    (1)   No later than August 1, 2023, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

    (2)   If the commissioner makes the determination that instructional materials funding has been made available this section shall be implemented beginning with the 2023-2024 school year and apply to the 2023-2024 and subsequent school years.

    (3)   If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 1 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b)   General requirements. This course is recommended for students in Grades 9-12. Prerequisite: Foundations of Cybersecurity. Students shall be awarded one credit for successful completion of this course.

(c)   Introduction.

    (1)   Career and technical education instruction provides content aligned with challenging academic standards, industry relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2)   The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services, such as laboratory and testing services and research and development services.

(3)   Digital forensics is a critical discipline concerned with analyzing anomalous activity on computers, networks, programs, and data. As a discipline, it has grown with the expansion of a globally connected digital society. As computing has become more sophisticated, so too have the abilities to access systems and sensitive information. Digital forensics professionals investigate and craft appropriate responses to disruptions to governments, organizations, and individuals. Whereas cybersecurity takes a proactive approach to information assurance to minimize harm, digital forensics takes a reactive approach to incident response.

(4)   Digital Forensics introduces students to the knowledge and skills of digital forensics. The course provides a survey of the field of digital forensics and incident response.

(5)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(6)   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.

(d)   Knowledge and skills.

(1)   Employability skills. The student identifies necessary skills for career development and employment opportunities. The student is expected to:

(A)   investigate the need for digital forensics;

(B)   research careers in digital forensics along with the education and job skills required for obtaining a job in both the public and private sector;

(C)   identify job and internship opportunities and accompanying job duties and tasks and contact one or more companies or organizations to explore career opportunities;

(D)   identify and discuss certifications for digital forensics careers;

(E)   explain ethical and legal responsibilities in relation to the field of digital forensics;

(F)   identify and describe businesses and government agencies that use digital forensics;

(G)   identify and describe the kinds of crimes investigated by digital forensics specialists; and

(H)   solve problems and think critically.

(2)   Employability skills. The student communicates and collaborates effectively. The student is expected to:

(A)   apply effective teamwork strategies;

(B)   collaborate with a community of peers and professionals;

(C)   create, review, and edit a report summarizing technical findings; and

(D)   present technical information to a non-technical audience.

(3)   Ethics and laws. The student recognizes and analyzes ethical and current legal standards, rights, and restrictions related to digital forensics. The student is expected to:

(A)   develop a plan to advocate for ethical and legal behaviors both online and offline among peers, family, community, and employers;

(B)   research and discuss local, state, national, and international law such as the Electronic Communications Privacy Act of 1986, Title III (Pen Register Act); USA PATRIOT Act of 2001; and Digital Millennium Copyright Act;

(C)   research and discuss historic cases or events regarding digital forensics or cybersecurity;

(D)   analyze ethical and legal behavior when presented with confidential or sensitive information in various scenarios related to cybersecurity activities;

(E)   analyze case studies of computer incidents;

(F)   use the findings of a computer incident investigation to reconstruct a computer incident;

(G)   identify and discuss intellectual property laws, issues, and use;

(H)   contrast legal and illegal aspects of information gathering;

(I)   contrast ethical and unethical aspects of information gathering;

(J)   analyze emerging legal and societal trends affecting digital forensics; and

(K)   discuss how technological changes affect applicable laws.

(4)   Digital citizenship. The student understands and demonstrates the social responsibility of end users regarding digital technology, safety, digital hygiene, and cyberbullying. The student is expected to:

(A)   identify and use digital information responsibly;

(B)   use digital tools responsibly;

(C)   identify and use valid and reliable sources of information; and

(D)   gain informed consent prior to investigating incidents.

(5)   Digital forensics skills. The student locates, processes, analyzes, and organizes data. The student is expected to:

(A)   identify sources of data;

(B)   analyze and report data collected;

(C)   discuss how to maintain data integrity such as by enabling encryption;

(D)   examine and describe metadata of a file; and

(E)   examine and describe how multiple data sources can be used for digital forensics, including investigating malicious software (malware) and email threats.

(6)   Digital forensics skills. The student understands software concepts and operations as they apply to digital forensics. The student is expected to:

(A)   compare software applications as they apply to digital forensics;

(B)   describe the purpose of various application types such as email, web, file sharing, security applications, and data concealment tools;

(C)   identify the different purposes of data formats such as pdf, wav, jpeg, and exe;

(D)   describe how application logs and metadata are used for investigations such as Security Information and Event Management (SIEM) reports;

(E)   describe digital forensics tools;

(F)   select the proper software tool based on appropriateness, effectiveness, and efficiency for a given digital forensics scenario;

(G)   describe components of applications such as configurations settings, data, supporting files, and user interface; and

(H)   describe how the "as a service" model applies to incident response.

(7)   Digital forensics skills. The student understands operating systems concepts and functions as they apply to digital forensics. The student is expected to:

(A)   compare various operating systems;

(B)   describe file attributes, including access and creation times;

(C)   describe how operating system logs are used for investigations;

(D)   compare and contrast the file systems of various operating systems;

(E)   compare various primary and secondary storage devices; and

(F)   differentiate between volatile and non-volatile memory.

(8)   Digital forensics skills. The student understands networking concepts and operations as they apply to digital forensics. The student is expected to:

(A)   examine networks, including Internet Protocol (IP) addressing and subnets;

(B)   describe the Open Systems Interconnection (OSI) model;

(C)   describe the Transmission Control Protocol/Internet Protocol (TCP/IP) model;

(D)   use network forensic analysis tools to examine network traffic data from sources such as firewalls, routers, intrusion detection systems (IDS), and remote access logs; and

(E)   identify malicious or suspicious network activities such as mandatory access control (MAC) spoofing and rogue wireless access points.

(9)   Digital forensics skills. The student explains the principles of access controls. The student is expected to:

(A)   define the principle of least privilege;

(B)   describe the impact of granting access and permissions;

(C)   identify different access components such as passwords, tokens, key cards, and biometric verification systems;

(D)   explain the value of an access log to identify suspicious activity;

(E)   describe the risks of granting third parties access to personal and proprietary data on social media and systems;

(F)   describe the risks involved with accepting Terms of Service (ToS) or End User License Agreements (EULA) without a basic understanding of the terms or agreements; and

(G)   identify various access control methods such as mandatory access control (MAC), attribute-based access control (ABAC), role-based access control (RBAC), and discretionary access control (DAC).

(10)   Incident response. The student follows a methodological approach to prepare for and respond to an incident. The student is expected to:

(A)   define the components of the incident response cycle, including preparation; detection and analysis; containment, eradication, and recovery; and post-incident activity;

(B)   describe incident response preparation;

(C)   discuss incident response detection and analysis;

(D)   discuss containment and eradication of and recovery from an incident;

(E)   describe post-incident activities such as reflecting on lessons learned, using collected incident data, and retaining evidence of an incident;

(F)   develop an incident response plan; and

(G)   describe ways a user may compromise the validity of existing evidence.

(11)   Incident response. The student objectively analyzes collected data from an incident. The student is expected to:

    (A) identify the role of chain of custody in digital forensics;

    (B) describe safe data handling procedures;

    (C) explain the fundamental concepts of confidentiality, integrity, availability, authentication, and authorization;

    (D) identify and report information conflicts or suspicious activity;

    (E) identify events of interest and suspicious activity by examining network traffic; and

    (F) identify events of interest and suspicious activity by examining event logs.

  (12) Incident response. The student analyzes the various ways systems can be compromised. The student is expected to:

    (A) analyze the different signatures of cyberattacks;

    (B) identify points of weakness and attack vectors such as online spoofing, phishing, and social engineering; and

    (C) differentiate between simple versus multistage attacks.

Source: The provisions of this §127.793 adopted to be effective August 7, 2022, 47 TexReg 4523.

§127.794. Cybersecurity Capstone (One Credit), Adopted 2022.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2023-2024 school year.

  (1) No later than August 1, 2023, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills identified in this section.

  (2) If the commissioner makes the determination that instructional materials funding has been made available this section shall be implemented beginning with the 2023-2024 school year and apply to the 2023-2024 and subsequent school years.

  (3) If the commissioner does not make the determination that instructional materials funding has been made available under this subsection, the commissioner shall determine no later than August 1 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that this section shall be implemented for the following school year.

(b) General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: Foundations of Cybersecurity. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

  (1) Career and technical education instruction provides content aligned with challenging academic standards, industry relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging foundations.

  (2) The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services such as laboratory and testing services, and research and development services.

  (3) Cybersecurity is a critical discipline concerned with safeguarding computers, networks, programs, and data from unauthorized access. As a field, it has gained prominence with the expansion of a globally connected society. As computing has become more sophisticated, so too have the abilities of adversaries looking to penetrate networks and access sensitive information. Cybersecurity professionals prevent, detect, and respond to minimize disruptions to governments, organizations, and individuals.

(4)   In the Cybersecurity Capstone course, students will develop the knowledge and skills needed to explore advanced concepts related to the ethics, laws, and operations of cybersecurity. Students will examine trends and operations of cyberattacks, threats, and vulnerabilities. Students will develop security policies to mitigate risks. The skills obtained in this course prepare students for additional study toward industry certification. A variety of courses are available to students interested in the cybersecurity field. Cybersecurity Capstone may serve as a culminating course in this field of study.

(5)   Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(6)   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.

(d)   Knowledge and skills.

(1)   Employability skills. The student demonstrates necessary skills for career development and successful completion of course outcomes. The student is expected to:

    (A)   identify and demonstrate employable work behaviors such as regular attendance, punctuality, maintenance of a professional work environment, and effective written and verbal communication;

    (B)   identify and demonstrate positive personal qualities such as authenticity, resilience, initiative, and a willingness to learn new knowledge and skills;

    (C)   solve problems and think critically;

    (D)   demonstrate leadership skills and function effectively as a team member; and

    (E)   communicate an understanding of ethical and legal responsibilities in relation to the field of cybersecurity.

(2)   Employability skills. The student identifies various employment opportunities in the cybersecurity field. The student is expected to:

    (A)   develop a personal career plan along with the education, job skills, and experience necessary to achieve career goals;

    (B)   develop a resume or a portfolio appropriate to a chosen career plan; and

    (C)   demonstrate interview skills for successful job placement.

(3)   Ethics and laws. The student evaluates ethical and current legal standards, rights, and restrictions governing technology, technology systems, digital media and information technology, and the use of social media in the context of today's society. The student is expected to:

    (A)   analyze and apply to a scenario local, state, national, and international cybersecurity laws such as David's Law and Digital Millennium Copyright Act;

    (B)   evaluate noteworthy incidents or events regarding cybersecurity; and

    (C)   evaluate compliance requirements such as Section 508 of the Rehabilitation Act of 1973, Family Educational Rights and Privacy Act of 1974 (FERPA), Health Insurance Portability and Accountability Act of 1996 (HIPAA), Gramm-Leach-Bliley Act (GLBA), and Cybersecurity Maturity Model Certification (CMMC).

(4)   Digital citizenship. The student understands and demonstrates the social responsibility of end users regarding significant issues relating to digital technology, safety, digital hygiene, and cyberbullying. The student is expected to:

    (A)   debate the relationship between privacy and security; and

    (B)   differentiate between ethical and unethical behavior when presented with various scenarios related to cybersecurity activities.

     (5)   Cybersecurity skills. The student simulates the process of penetration testing. The student is expected to:

          (A)   illustrate the phases of penetration testing, including plan, discover, attack, and report;

          (B)   design a plan to gain authorization for penetration testing;

          (C)   evaluate commonly used vulnerability scanning tools such as port scanning, packet sniffing, and password crackers;

          (D)   develop a list of exploits based on results of scanning tool reports; and

          (E)   prioritize a list of mitigations based on results of scanning tool reports.

     (6)   Cybersecurity skills. The student understands common cryptographic methods. The student is expected to:

          (A)   evaluate symmetric and asymmetric algorithms such as substitution cipher, Advanced Encryption Standard (AES), Diffie-Hellman, and Rivest-Shamir-Adleman (RSA);

          (B)   interpret the purpose of hashing algorithms, including blockchain;

          (C)   demonstrate password salting;

          (D)   explain and create a digital signature; and

          (E)   illustrate steganography.

     (7)   Cybersecurity skills. The student understands the concept of system defense. The student is expected to:

          (A)   explain the purpose of establishing system baselines;

          (B)   evaluate the role of physical security;

          (C)   evaluate the functions of network security devices such as firewalls, intrusion detection systems (IDS), intrusion prevention systems (IPS), intrusion detection prevention systems (IDPS), and security information and event management (SIEM) systems;

          (D)   analyze log files for anomalies; and

          (E)   develop a plan demonstrating the concept of defense in depth.

     (8)   Cybersecurity skills. The student demonstrates an understanding of secure network design. The student is expected to:

          (A)   explain the benefits of network segmentation, including sandboxes, air gaps, and virtual local area networks (VLAN);

          (B)   investigate and discuss the role of software-managed networks, including virtualization and cloud architecture;

          (C)   evaluate the role of honeypots and honeynets in networks; and

          (D)   create an incoming and outgoing network policy for a firewall.

     (9)   Cybersecurity skills. The student integrates principles of digital forensics. The student is expected to:

          (A)   identify cyberattacks by their signatures, indicators, or patterns;

          (B)   explain proper data acquisition;

          (C)   examine evidence from devices for suspicious activities; and

          (D)   critique current cybercrime cases involving digital forensics.

     (10)   Cybersecurity skills. The student explores expanding and emerging technology. The student is expected to:

(A) describe the concept of Security as a Service and the role of managed security service providers (MSSP);

(B) describe the integration of artificial intelligence and machine learning in cybersecurity;

(C) investigate impacts made by predictive analytics on cybersecurity; and

(D) research and investigate other emerging trends such as augmented reality and quantum computing.

(11) Cybersecurity skills. The student uses various operating system environments. The student is expected to:

(A) select and execute appropriate commands via the command line interface (CLI) such as ls, cd, pwd, cp, mv, chmod, ps, sudo, and passwd;

(B) describe the file system structure for multiple operating systems;

(C) manipulate and edit files within the CLI; and

(D) determine network status using the CLI with commands such as ping, ifconfig/ipconfig, traceroute/tracert, and netstat.

(12) Cybersecurity skills. The student clearly and effectively communicates technical information. The student is expected to:

(A) collaborate with others to create a technical report;

(B) create, review, and edit a report summarizing technical findings; and

(C) present technical information to a non-technical audience.

(13) Risk assessment. The student understands risk and how risk assessment and risk management defend against attacks. The student is expected to:

(A) differentiate types of attacks, including operating systems, software, hardware, network, physical, social engineering, and cryptographic;

(B) explain blended threats such as combinations of software, hardware, network, physical, social engineering, and cryptographic;

(C) discuss types of risk, including business, operational, security, and financial;

(D) discuss risk response techniques, including accept, transfer, avoid, and mitigate;

(E) develop a plan of preventative measures based on discovered vulnerabilities and the likelihood of a cyberattack;

(F) identify and discuss common vulnerability disclosure websites;

(G) describe common web vulnerabilities such as cross-site scripting, buffer overflow, injection, spoofing, and denial of service;

(H) describe common data destruction and media sanitation practices such as wiping, shredding, and degaussing; and

(I) develop an incident response plan for a given scenario or attack.

(14) Risk assessment. The student understands risk management processes and concepts. The student is expected to:

(A) describe Zero Trust, least privilege, and various access control methods such as mandatory access control (MAC), role-based access control (RBAC), and discretionary access control (DAC);

(B) develop and defend a plan for multi-factor access control using components such as biometric verification systems, key cards, tokens, and passwords; and

(C)   review and appraise a disaster recovery plan (DRP) that includes backups, redundancies, system dependencies, and alternate sites.

(15)   Risk assessment. The student investigates the role and effectiveness of environmental controls. The student is expected to:

(A)   explain commonly used physical security controls, including lock types, fences, barricades, security doors, and mantraps; and

(B)   describe the role of embedded systems such as fire suppression; heating, ventilation, and air conditioning (HVAC) systems; security alarms; and video monitoring.

Source: The provisions of this §127.794 adopted to be effective August 7, 2022, 47 TexReg 4523.