Texas CTE

Science, Technology, Engineering, and Mathematics (2010): Grade 10

Adopted 2010

Concepts of Engineering and Technology

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

(2) 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 to present ideas; and
- (D) maintain a portfolio.

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

- (A) master relevant safety tests;
- (B) follow safety guidelines as described in various manuals, instructions, and regulations;
- (C) recognize the classification of hazardous materials and wastes;
- (D) dispose of hazardous materials and wastes appropriately;
- (E) perform maintenance and safely handle and store laboratory equipment;
- (F) describe the implications of negligent or improper maintenance; and
- (G) demonstrate the use of precision measuring instruments.

(4) 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.

(5) The student describes the importance of teamwork, leadership, integrity, honesty, ethics, work habits, and organizational skills. The student is expected to:

- (A) describe and demonstrate how teams function;
- (B) identify characteristics of good team leaders and team members;
- (C) work in a team face-to-face or in a virtual environment to solve problems;
- (D) discuss the principles of ideation;
- (E) identify employers' expectations and appropriate work habits;
- (F) differentiate between discrimination, harassment, and equality;
- (G) describe ethical behavior and decision making through use of examples;
- (H) use time-management techniques to develop team schedules to meet project objectives; and
- (I) complete projects according to established criteria.

(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 design and prototype development;
- (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 risks and benefits of a design solution.

(7) The student understands the opportunities and careers in fields related to biotechnology. The student is expected to:

(A) describe the fields of biotechnology;

(B) describe career opportunities in biotechnology;

(C) apply design concepts to problems in biotechnology;

(D) identify fields related to biotechnology; and

(E) identify currently emerging issues in biotechnology.

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

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

(B) describe career opportunities in process control and automation systems;

(C) apply design concepts to problems in process control and automation systems;

(D) identify fields related to process control and automation systems; and

(E) identify emerging issues in process control and automation systems.

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

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

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

(C) apply design concepts to problems in physical and mechanical systems; and

(D) identify emerging issues in physical and mechanical systems.

(10) The student participates in a team-based culminating project. The student is expected to:

(A) apply the design process in a team;

(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) present the project using clear and concise communication skills.

Biotechnology

(1) The student explores biotechnology career opportunities. The student is expected to:

(A) determine interests and aptitudes through conversations with biotechnology professionals;

(B) identify career options in the field of biotechnology;

(C) identify reliable sources of career information;

(D) research interests, knowledge, educational level, abilities, and skills needed in a biotechnology-related occupation;

(E) seek a mentor in the biotechnology area;

(F) identify conventional and non-conventional career opportunities that match interests and aptitudes;

(G) research applications of biotechnology and biomaterials in the areas of medicine, the environment, and pharmaceutical, agricultural, and industrial settings; and

(H) use technology to research biotechnology topics, identify pertinent scientific articles, obtain articles of interest, and write a formal research paper in the format used by academic and professional journals and magazines.

(2) 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 current issues;

(C) discuss legal and technology issues for at least two biotechnology related areas; and

(D) compare and contrast examples of objective and subjective scientific, economic, and political data and positions used to defend biotechnology views.

(3) The student examines federal, state, local, and industry regulations as applied to biotechnical processes through library research and Internet research. The student is expected to:

(A) identify local, state, and federal agencies responsible for regulating the biotechnology industry;

(B) identify professional organizations participating in the development of biotechnology policies;

(C) identify and define terms related to biotechnology regulations; and

(D) outline the methods and procedures used in biotechnology laboratories to follow and enforce local, state, and federal regulations, including those in the agricultural and health areas.

(4) 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; and

(C) investigate and report on career opportunities in the biotechnology industry sectors.

(5) The student researches and exhibits employability skills that support a career in the biotechnology industry. The student is expected to:

(A) demonstrate verbal, nonverbal, written, and electronic communication skills;

(B) demonstrate skills used to secure and maintain employment;

(C) demonstrate appropriate workplace etiquette; and

(D) display productive work habits and attitudes.

(6) The student investigates the origins of waste and examines the relationship of biotechnology to resource recovery. The student is expected to:

(A) investigate at least three end products from biotechnology manufacturing processes;

(B) investigate the effects of waste on environmental and biological life cycles;

(C) investigate the impacts of waste on the environment;

(D) analyze the results of manufacturing refuse;

(E) explain the negative impacts of waste with respect to the individual, society, and the global population;

(F) research solutions to biological waste with respect to commercial applications through investigation of various pollution waste treatments using natural organisms;

(G) investigate biotechnology as it relates to health and well-being; and

(H) cite evidence regarding regulations, patents and public policy, design development and testing, and safety.

(7) The student examines the relationship of biotechnology to the development of commercial products. The student is expected to:

(A) identify the ability to change or enhance genetic characteristics;

(B) identify applications of genetic engineering;

(C) identify applications of nanotechnology in biotechnology;

(D) identify applications of bioinformatics in biotechnology;

(E) identify the applications of biotechnology in medicine, forensics, and law enforcement; and

(F) research ethical considerations, laws, and regulations governing genetic engineering and nanotechnology.

Engineering Design and Presentation

(1) 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 equality;

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

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

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

(A) understand and discuss how teams function;

(B) use teamwork to solve problems; and

(C) serve as a team leader and a team 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) use time-management techniques to develop and maintain work schedules and meet deadlines;

(B) 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.

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

(A) master relevant safety tests;

(B) follow 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 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.

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

(A) sketch single- and multi-view projections;

(B) prepare orthographic and pictorial views;

(C) prepare auxiliary views;

(D) prepare section views;

(E) project points and construct lines to build geometric forms;

(F) construct true length of lines and true size of planes by the revolution method;

(G) draw developments using radial line, parallel line, and triangulation methods;

(H) construct piercing points and intersection of planes using edge-view and cutting plane methods;

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

(J) demonstrate knowledge of effective file structure and management.

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

(A) understand and discuss principles of ideation;

(B) think critically, 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 to record the final design, construction, and manipulation of finished projects.

(7) 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.

(8) 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.

(9) 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.

Electronics

(1) The student demonstrates the skills necessary for success in the workplace. The student is expected to:

(A) identify employment and career opportunities, including differences between an engineering technician, engineering technologist, and engineer;

(B) investigate and work toward industry certifications;

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

(D) identify and use appropriate work habits;

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

(F) discuss ethical issues related to electronics;

(G) demonstrate respect for diversity in the workplace;

(H) demonstrate appropriate actions and identify consequences relating to discrimination, harassment, and equality;

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

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

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

(A) apply principles of effective teamwork;

(B) solve problems as part of a team;

(C) demonstrate proper attitudes as a team leader; and

(D) demonstrate proper attitudes as a team member.

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

(A) use time-management techniques to develop and maintain work schedules and meet deadlines;

(B) 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.

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

- (A) master relevant safety tests;
- (B) follow 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 regulations and industry standards;
- (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.

(5) 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, Kirchoff's laws, and power laws;
- (B) demonstrate an understanding of magnetism and induction as they relate to electronic circuits;
- (C) demonstrate knowledge of the fundamentals of electronics theory;
- (D) perform electrical-electronic troubleshooting assignments; and
- (E) develop knowledge of voltage regulation devices.

(6) 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 electronic theory to generators, electric motors, and transformers;
- (C) design analog and digital circuits using common components; and
- (D) demonstrate knowledge of common devices in optoelectronics.

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

- (A) understand and discuss principles of ideation;
- (B) think critically, 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 mistakes in the design process; and
- (F) use an engineering notebook to record the final design, construction, and manipulation of finished projects.

(8) 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) safely use tools and laboratory equipment to construct and repair circuits;

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

(C) describe and perform measurements using oscilloscopes; and

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

(9) The student designs products 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 product;

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

(D) produce schematics to industry standards;

(E) describe potential patents and the patenting process;

(F) use a variety of technologies to design components; and

(G) explore new technologies that may affect electronics.

(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.

Principles of Technology

(1) The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. These investigations must involve actively obtaining and analyzing data with physical equipment, but may also involve experimentation in a simulated environment as well as field observations that extend beyond the classroom. 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.

(2) The student uses a systematic approach to answer scientific laboratory and field investigative questions. The student is expected to:

(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) 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 that 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) demonstrate the use of course apparatus, equipment, techniques, and procedures, including multimeters (current, voltage, resistance), triple beam balances, batteries, clamps, dynamics demonstration equipment, collision apparatus, data acquisition probes, discharge tubes with power supply (H, He, Ne, Ar), hand-held visual spectroscopes, hot plates, slotted and hooked lab masses, bar magnets, horseshoe magnets, plane mirrors, convex lenses, pendulum support, power supply, ring clamps, ring stands, stopwatches, trajectory apparatus, tuning forks, carbon paper, graph paper, magnetic compasses, polarized film, prisms, protractors, resistors, friction blocks, mini lamps (bulbs) and sockets, electrostatics kits, 90-degree rod clamps, metric rulers, spring scales, knife blade switches, Celsius thermometers, meter sticks, scientific calculators, graphing technology, computers, cathode ray tubes with horseshoe magnets, ballistic carts or equivalent, resonance tubes, spools of nylon thread or string, containers of iron filings, rolls of white craft paper, copper wire, Periodic Table, electromagnetic spectrum charts, slinky springs, wave motion ropes, and laser pointers;

(G) use a wide variety of additional course apparatus, equipment, techniques, materials, and procedures as appropriate such as ripple tank with wave generator, wave motion rope, micrometer, caliper, radiation monitor, computer, ballistic pendulum, electroscope, inclined plane, optics bench, optics kit, pulley with table clamp, resonance tube, ring stand screen, four-inch ring, stroboscope, graduated cylinders, and ticker timer;

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

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

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

(K) 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

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

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

(F) express and interpret relationships symbolically in accordance with accepted theories to make predictions and solve problems mathematically, including problems requiring proportional reasoning and graphical vector addition.

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

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

(B) understand that scientific theories are based on natural and 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.

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

(A) master relevant safety procedures;

(B) follow 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 disposal of hazardous materials and wastes appropriately.

(6) The student uses critical-thinking, scientific-reasoning, and problem-solving skills. The student is expected to:

(A) analyze and evaluate scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing;

(B) communicate and apply scientific information;

(C) explain the societal impacts of scientific contributions; and

(D) research and describe the connections between technologies and future career opportunities.

(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:<ol type="i">
using and describing one-dimensional equations for displacement, distance, speed, velocity, average velocity, acceleration, and average acceleration;
using and describing two-dimensional equations for projectile and circular motion; and
using and describing vector forces and resolution;

(B) describe and calculate the effects of forces on objects, including law of inertia and impulse and conservation of momentum;

(C) develop and interpret free-body force diagrams; and

(D) identify and describe motion relative to different frames of reference.

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

(A) research and describe the historical development of 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 electrical 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 electrical properties;

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

(H) investigate and describe the relationship between electric and magnetic fields in applications such as generators, motors, and transformers; and

(I) describe technological applications of the strong and weak nuclear forces in nature.

(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:

(A) describe how the macroscopic properties of a thermodynamic system such as temperature, specific heat, and pressure are related to the molecular level of matter, including kinetic or potential energy of atoms;

(B) contrast and give examples of different processes of thermal energy transfer, including conduction, convection, and radiation; and

(C) analyze and explain technological examples such as solar and wind energy that illustrate the laws of thermodynamics, including the law of conservation of energy and the law of entropy.

(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 velocity, frequency, amplitude, and wavelength;

(C) investigate and calculate the relationship between wavespeed, 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, and the Doppler effect;

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

(G) describe the role of wave characteristics and behaviors in medical and industrial technology applications.

(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) describe the significance of mass-energy equivalence and apply it in explanations of phenomena such as nuclear stability, fission, and fusion;

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

(E) explore technology applications of atomic, nuclear, and quantum phenomena such as nanotechnology, radiation therapy, diagnostic imaging, and nuclear power.