DRAFT Proposed Revisions
Texas Essential Knowledge and Skills
Career and Technical Education (CTE)—Science, Technology, Engineering, and Mathematics

Prepared by the State Board of Education TEKS Review Committees

Final Recommendations, October 2014

These draft proposed revisions reflect the changes to the career and technical education (CTE) Texas Essential Knowledge and Skills (TEKS) that have been recommended by State Board of Education-appointed TEKS review committees for courses in the **Science, Technology, Engineering, and Mathematics Career Cluster**. Proposed additions are shown in green font with underlines (additions) and proposed deletions are shown in red font with strikethroughs (~~deletions~~).

Comments in the right-hand column provide explanations for the proposed changes. The following notations were used as part of the explanations:

CRS—information added or changed to align with the Texas College and Career Readiness Standards (CCRS)

MV—multiple viewpoints from within the committee

VA—information added, changed, or deleted to increase vertical alignment

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§130.368. AC/DC Electronics (One ~~to Two~~ Credits).

	TEKS with edits	Committee Comments
(a)	General requirements. This course is recommended for students in Grades 10-12. Recommended prerequisite: ~~Concepts of Engineering and Technology~~ Principles of Applied Engineering.	
(b)	Introduction.	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
~~(b)~~(3)	~~Introduction.~~ Students enrolled in this course 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 explore career opportunities, employer expectations, and educational needs in the electronics industry.	Include the last sentence for each intro class.
(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 ones' self 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.	
~~(1)~~(2)	The student demonstrates the skills necessary for success in a technical career ~~the workplace~~. The student is expected to:	
(A)	identify training, education, employment and career opportunities, including differences between	Clarifying the education and careers in

	an ~~engineering~~ electronic technician, ~~engineering~~ electronic technologist, and electrical engineer;	electronic
(B)	investigate and work toward industry certifications;	
~~(C)~~	~~demonstrate the principles of teamwork related to engineering and technology;~~	Teamwork skill, move to (2)
~~(D)~~	~~identify and use appropriate work habits;~~	Discussed in later TEKS
~~(E)~~	~~identify governmental regulations for health and safety in the workplace related to electronics;~~	Safety skill, move to (4)
~~(F)~~(C)	discuss ethical issues related to electronics;	
~~(G)~~(D)	identify and demonstrate respect for diversity in the workplace;	
~~(H)~~(E)	identify and demonstrate appropriate actions and ~~identify~~ consequences relating to discrimination, harassment, and equality;	clarification
~~(I)~~	~~demonstrate effective oral and written communication skills using a variety of software applications and media; and~~	Clarifying the types of acceptable formats
~~(J)~~(F)	explore career preparation learning experiences, including ~~but not limited to,~~ job shadowing, mentoring, and apprenticeship training~~.~~; and	
(G)	discuss ABET accreditation and implications.	
~~(2)~~(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;	From (1)
~~(A)~~(B)	apply principles of effective teamwork and problem solving including collaboration and conflict resolution; and	
~~(B)~~	~~solve problems as part of a team;~~	
(C)	~~D~~ demonstrate proper attitudes as a team leader and team member~~; and~~.	
~~(D)~~	~~demonstrate proper attitudes as a team member~~.	
~~(3)~~(4)	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)~~(5)	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 governmental and organizational regulations for health and safety in the workplace related to electronics;	Moved from 2E and clarifying types of regulations
~~(C)~~(D)	identify and classify hazardous materials ~~and wastes~~ according to Occupational Safety and Health Administration regulations and industry standards;	
~~(D)~~ (E)	dispose of hazardous materials ~~and wastes~~ appropriately;	
~~(E)~~(F)	perform maintenance on selected tools, equipment, and machines;	
~~(F)~~(G)	handle and store tools and materials correctly; and	
~~(G)~~(H)	describe the results of ~~negligent or~~ 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:	Added specific technical knowledge and skill requirements for DC
(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 but not limited to 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:	Added specific technical knowledge and skill requirements for AC
(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.	
~~(5)~~(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, ~~Kirchoff's~~ Kirchhoff's laws, and power laws to actual or simulated circuits;	Sp, added specificity to insure lab projects
(B)	build series, parallel, and combination circuits;	Add to skills
~~(B)~~(C)	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;	
~~(E)~~	~~Develop knowledge of voltage regulation devices.~~	Moved to advanced electronics
(E)	identify actual electronic components including resistors, capacitors, switches, fuses, power sources, and inductors;	Add specific knowledge requirement
(F)	explain how torque is produced in a motor; and	
(G)	explain where counter electromotive force (CEMF) comes from in a motor.	*Ron/ Charles
~~(8)~~(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 ~~electronic~~ electrical theory to generators, electric motors, and transformers; and	These are not examples of electronic devices
(C)	design analog ~~and digital~~ circuits using common components.~~; and~~	No digital knowledge and skill is developed in this TEKS, digital is a separate class
~~(D)~~	~~demonstrate knowledge of common devices in optoelectronics.~~	Moved to advanced electronics
~~(7)~~	~~The student uses engineering design methodologies. The student is expected to:~~	Remove, basic electronics does not involve the design process
~~(A)~~	~~understand and discuss principles of ideation;~~	

~~(B)~~	~~think critically, identify the system constraints, and make fact-based decisions;~~	Keep, move to (8), work skills
~~(C)~~	~~use rational thinking to develop or improve a product;~~	
~~(D)~~	~~apply decision-making strategies when developing solutions;~~	Keep, move to (8), work skills
~~(E)~~	~~use an engineering notebook to record prototypes, corrections, and mistakes in the design process; and~~	Keep, move to (9), project based skill
~~(F)~~	~~use an engineering notebook to record the final design, construction, and manipulation of finished projects.~~	
~~(8)~~ (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)	safely use tools and laboratory equipment to construct and repair circuits;	
(B)	use precision measuring instruments to analyze circuits and prototypes;	
(C)	understand the difference between current and voltage measurement;	Add specific knowledge requirement relating to a multimeter
(D)	use a multimeter to perform resistance, voltage, and current measurements;	Add a specific skill requirement related to a multimeter
~~(C)~~(E)	describe and perform measurements including period and amplitude using an oscilloscope~~s~~; ~~and~~	Added specific use requirements. People don't use oscilloscopes, they use an oscilloscope
~~(D)~~(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.	Add specific project notebook requirements
~~(9)~~(11)	The student designs ~~products~~ a circuit using appropriate design processes and techniques. The student is expected to:	Change to apply design to this class
(A)	interpret industry standard circuit schematics;	
(B)	identify areas where quality, reliability, and safety can be designed into a ~~product~~ circuit;	Change to apply design to this class
(C)	improve a ~~product~~ circuit design to meet a specified need;	Change to apply design to this class
(D)	~~produce~~ sketch schematics ~~to industry standards~~; and	
~~(E)~~	~~describe potential patents and the patenting process;~~	
~~(F)~~	~~use a variety of technologies to design components; and~~	No component level design in this class
~~(G)~~(E)	explore new technologies that may affect electronics.	
~~(10)~~(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 ~~the~~ ~~prototype~~ a final project using a variety of media.	

§130.369. Solid State ~~Advanced~~ Electronics (One Credit). ~~(Two to Three Credits).~~

	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades 11-12. Prerequisite: AC/DC Electronics.	
(b)	Introduction.	
(1)	CTE instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for s 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
~~(b)~~(3)	Students enrolled in this course will demonstrate knowledge and applications of advanced circuits, electrical measurement, and electrical implementation used in the electronics and computer industries. ~~Through use of the design process~~, 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 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 ones' self 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.	
~~(1)~~(2)	The student demonstrates the skills necessary for success in a technical career ~~the workplace~~. The student is expected to:	

(A)	identify training, education, employment and career opportunities, including differences between an ~~engineering~~ electronic technician, ~~engineering~~ electronic technologist, and electrical engineer;	Made specific to electronics
(B)	identify employment and career opportunities;	
~~(B)~~(C)	~~investigate and prepare for~~ identify industry certifications;	
~~(C)~~	~~demonstrate the principles of teamwork related to engineering and technology;~~	Covered in TEKS 3
~~(D)~~	~~identify and use appropriate work habits;~~	Covered in new TEKS 1
~~(E)~~	~~demonstrate knowledge related to governmental regulations ; including health and;~~	Covered in TEKS 5
~~(F)~~(D)	discuss ethical issues related to electronics ~~engineering and technology~~ and incorporate proper ethics in submitted projects;	
~~(G)~~(E)	identify and demonstrate respect for diversity in the workplace;	
~~(H)~~(F)	identify ~~demonstrate~~ appropriate actions and ~~identify~~ consequences relating to discrimination, harassment, and equality;	
(G)	explore electronics career and preparation programs;	
~~(I)~~	~~demonstrate effective oral and written communication skills using a variety of software applications and media; and~~	
~~(J)~~(H)	explore career preparation learning experiences, including, but not limited to, job shadowing, mentoring, and apprenticeship training~~.~~; and	
(I)	discuss ABET accreditation and implications.	
~~(2)~~(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;	
~~(A)~~(B)	~~Understand and discuss how team functions~~ apply principles of effective teamwork and problem solving including but not limited to collaboration and conflict resolution; and	
~~(B)~~	~~use teamwork to solve problems;~~	
(C)	~~serve as a team leader~~ demonstrate proper attitudes as a team leader and team member.~~; and~~	
~~(D)~~	~~Serve as a team member while demonstrating appropriate attitudes.~~	
~~(3)~~ (4)	The student develops skills for managing a project. The student is expected to:	
(A)	use time-management techniques to develop and maintain work schedules to meet specific project objectives;	
(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)~~ (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.	
~~(5)~~(6)	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 governmental and organizational regulations for health and safety in the workplace related to electronics;	
~~(C)~~(D)	~~Recognize the classification of hazardous materials and wastes appropriately~~ identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration regulations and industry standards;	
~~(D)~~ (E)	dispose of hazardous materials and wastes appropriately;	
~~(E)~~(F)	perform maintenance on selected tools, equipment, and machines;	
~~(F)~~(G)	handle and store tools and materials correctly; and	
~~(G)~~(H)	describe the results of negligent or improper maintenance of material, tools, and equipment.	
~~(6)~~ (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 ~~such as~~ through Thevenin and Norton's theorems;	Through
~~(C)~~	~~perform advanced electrical-electronic troubleshooting assignments;~~	
~~(D)~~ (C)	apply knowledge of voltage regulation devices;	
~~(E)~~ (D)	apply knowledge of the design and use of diodes, transistors, and analog components with integrated circuits;	

~~(F)~~ (E)	implement knowledge of solid-state components and devices such as a power supply design;	
~~(G)~~ (F)	demonstrate knowledge of the similarities and differences in optoelectronic devices;	
~~(H)~~ (G)	implement knowledge of transmission theory;	
~~(I)~~ (H)	implement knowledge of microprocessor applications;	
~~(J)~~ (I)	apply electronic theory to generators, electric motors, power supplies, electronic amplifiers, electronic oscillators, communication circuits, and systems; and	
~~(K)~~ (J)	complete advanced electrical-electronic troubleshooting assignments to industry standards.	
~~(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)~~	~~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 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 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)	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 measurement techniques with analog, digital, ~~and~~ 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.	

§130.376. Digital Electronics (One Credit).		
	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades 10-12. Required prerequisites: Algebra I and Geometry. This course satisfies a high school mathematics graduation requirement.	Advanced course denoted by SBOE
(b)	Introduction.	
(1)	CTE 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.	Added across CTE classes
(2)	The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	Added across STEM classes
~~(1)~~ (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, MP3 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.	
~~(2)~~ (4)	The 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.	

~~(3)~~ (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:	Added across CTE classes
(A)	demonstrate knowledge of how to dress appropriately, speak politely, and conduct ones' self 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)	Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:	Added across math credit classes
(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 equality;	
(G)	explore electronics engineering careers and preparation programs	
(H)	explore career preparation learning experiences, including, but not limited to, job shadowing, mentoring, and apprenticeship training; and	
(I)	discuss 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 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)	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.	
(6)	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 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 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; and	
~~(1)~~ (7)	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.	
(2)(8)	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.	
~~(3)~~ (9)	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.	
~~(4)~~(10)	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.	
~~(5)~~(11)	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.	
~~(6)~~(12)	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 state 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.	
~~(7)~~(13)	The student explores microcontrollers, specifically their usefulness in real-world applications. The student is expected to:	

(A)	understand 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)	understand that realistic problem solving with a control system requires the ability to interface analog inputs and outputs with a digital device.	

§130.370. Robotics I ~~and Automation~~ (One ~~to Two~~ Credits).		
	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades ~~11-12~~ 9-10. Recommended prerequisites: ~~Concepts of Engineering and Technology~~ ~~and Electronics~~ Principles of Applied Engineering	
(b)	**Introduction.**	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
(3) ~~(b)~~	~~Students enrolled in this course will demonstrate knowledge and skills necessary for the robotic and automation industry.~~ Through implementation of the design process, students will transfer ~~advanced~~ academic skills to component designs in a project-based environment. Students will build prototypes or use simulation software to test their designs. Additionally, students 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 ones' self 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.	
~~(1)~~(2)	The student demonstrates the skills necessary for success in a technical career ~~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)	identify ~~investigate and work toward~~ industry certifications;	
~~(D)~~	~~demonstrate the principles of teamwork related to engineering and technology~~;	Duplicate from (1)
~~(E)~~	~~identify and use appropriate work habits;~~	
~~(F)~~	~~demonstrate knowledge related to governmental regulations and laws, including health, and safety;~~	
~~(G)~~(D)	discuss ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;	
~~(H)~~(E)	identify and demonstrate respect for diversity in the workplace;	
~~(I)~~(F)	identify and ~~demonstrate~~ appropriate actions and consequences relating to discrimination, harassment, and equality;	
~~(J)~~(G)	~~demonstrate effective oral and written communication skills using a variety of software applications and media; and~~	Duplicate from (1)
~~(K)~~(H)	explore robotic engineering careers and preparation programs. ~~learning experiences, including, but not limited to, job shadowing, mentoring, and apprenticeship training.~~	
(I)	explore career preparation learning experiences, including, but not limited to, job shadowing, mentoring, and apprenticeship training; and	
(J)	discuss ABET accreditation and implications.	
~~(2)~~(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	
~~(A)~~(B)	~~understand and discuss how teams function~~ apply principles of effective problem solving in teams to collaboration and conflict resolution,; and	
~~(B)~~	~~Use teamwork to solve problems; and~~	
(C)	~~serve as a team leader and a team member and demonstrate appropriate attitudes while serving in these roles.~~ demonstrate proper attitudes as a team leader and team member.	
~~(3)~~(4)	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)~~(5)	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 governmental and organizational regulations for health and safety in the workplace related to electronics;	
~~(C)~~(D)	identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration regulations;	
~~(D)~~ (E)	dispose of hazardous materials and wastes appropriately;	
~~(E)~~(F)	perform maintenance on selected tools, equipment, and machines;	Will be moved to higher level class
~~(F)~~(G)	handle and store tools and materials correctly; ~~and~~	
~~(G~~)(H)	describe the results of ~~negligent or~~ improper maintenance of material, tools, and equipment; and	
~~(5)~~(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)~~	~~demonstrate knowledge of process control factors; and~~	Replace with the one below – to remove redundancy
~~(D)~~	~~demonstrate knowledge of motors, gears, and gear trains used in the robotic or automated systems.~~	Move to TEK 6
(C)	describe feedback control loops used to provide information; and	Moved from TEK 6
(D)	describe types and functions of sensors used in robotic systems.	Moved from TEK 6
~~(6)~~(7)	The student develops an understanding of engineering principles and fundamental physics..~~the advanced concepts of physics, robotics, and automation.~~ The student is expected to:	Advanced moved to Robotics II
(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 ~~and automated~~ systems;	
~~(B)~~	~~demonstrate knowledge of torque and power factors used in the operation of robotic systems;~~	Combined with 6A
(B)	demonstrate knowledge of motors, gears, gear ratios, and gear trains used in the robotic ~~or automated~~	Moved from TEK 5

	systems	
~~(C)~~	~~demonstrate knowledge of feedback control loops to provide information; and~~	Moved to TEK 5
(C)	Describe the application of the six simple machines to robotics	
~~(D)~~	~~demonstrate knowledge of different types of sensors used in robotic or automated systems and their operations.~~	Moved to TEK 5
(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.	
~~(7)~~(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 ~~demonstrate knowledge of~~ robotic ~~or automated system~~ arm construction and robot stability;	
(B)	~~understand and discuss~~ describe the relationship between ~~of~~ torque~~,~~ and gear ratio, ~~and~~ to weight of payload in a robotic ~~or automated system~~ arm operation; and	
(C)	demonstrate knowledge of ~~end effectors and their use in~~ linkages and ~~the~~ gearing in ~~of~~ end effectors used in a robotic ~~or automated~~ arm system.	
~~(8)~~(9)	The student uses engineering design methodologies. The student is expected to:	
(A)	understand and discuss the design process ~~principles of ideation~~;	
(B)	think critically, identify the system constraints, and make fact-based decisions;	
~~(C)~~ (C)	~~use rational thinking~~ apply testing and reiteration strategies to develop or improve a product;	
~~(D)~~ (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~~ document the project design process as a legal document; ~~prototypes, corrections, and or mistakes in the design process;~~ and	
(H)	interpret industry standard system schematics;	Moved from TEK 10
~~(H)~~	~~use an engineering notebook to record the final design, construction, and manipulation of finished projects.~~	Now covered in G
~~(9)~~(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)	safely use tools and laboratory equipment 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.	
~~(10)~~	~~The student designs products using appropriate design processes and techniques. The student is expected to:~~	Duplicate of TEK 8
~~(A)~~	~~interpret industry standard system 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 ;~~	Six sigma
~~(D)~~	~~understand use of sensors in a robotic or automated system;~~	Covered in robotics 2
~~(E)~~	~~produce system schematics to industry standards;~~	
~~(F)~~	~~evaluate design solutions using conceptual, physical, and mathematical models at various times during the design process to check for proper functionality and to note areas where improvements are needed;~~	
~~(G)~~	~~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~~	Moved to Robotics 2
~~(H)~~	~~describe potential patents and the patenting process.~~	
(11)	The student ~~builds a prototype~~ 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)~~	~~implement sensors in a robotic or automated system;~~	
~~(D)~~(C)	construct a robotic or automated system to perform specified operations using the design process;	
~~(E)~~(D)	test and evaluate the design in relation to pre-established requirements such as criteria and constraints ~~and refine as needed~~;	
~~(F)~~(E)	refine the design of a robotic or automated system to ensure quality, efficiency, and manufacturability of the final product; and	
~~(G)~~(F)	present the ~~prototype~~ final product using a variety of media.	

Robotics II (One Credit).		
TEKS with edits		Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades 10-12. Required prerequisites: Robotics I. This course satisfies a high school mathematics graduation requirement	Tech Apps - Robotics Programming and Design TEKS have been incorporated in this course and it currently satisfies a high school math graduation requirement. The committee recommends the Robotics II course as the stronger course because it incorporates the Robotics Programming and Design courses but it is more complete. The programming elements are redundant; however Robotics II adds engineering elements to the course. CTE course have more career investigation and application of careers. The Robotics Programming and Design courses does not address construction at the same level of depth as the Robotics II course.
(b)	**Introduction**.	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
(3)	Students 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)	Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.	
(5)	The 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	Common Math Credit class wording

	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.	
(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:	Similar to Robotics Programming and Design TEK 6
(A)	distinguish the differences between 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 equality;	
(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)	Mathematical process standards. 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 will learn and contribute productively as an individual and as member of a project team. The student is expected to:	Similar to Robotics and Programming TEK 3
(A)	understand and discuss how teams function;	
(B)	use 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)	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)	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:	Similar to Robotics Programming and Design TEK 5
(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)	follow established guidelines for safely 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:	Similar to Robotics Programming and Design TEK 5
(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	Robotics Programming and Design TEK 7I
(I)	apply measurement and geometry to calculate robot navigation	Robotics Programming and Design TEK 7L
(J)	implement movement control using encoders, and;	Robotics Programming and Design TEK 7M
(K)	Implement path planning using geometry and multiple sensor feedback.	Robotics Programming and Design TEK 7O

(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;	Similar to Robotics Programming and Design TEK 5
(F)	create algorithms that loop through a series of actions for a specified increment and for as long as a given condition exists;	Similar to Robotics Programming and Design TEK 5
(G)	create algorithms that evaluate sensor data as variables to provide feedback control;	Similar to Robotics Programming and Design TEK 5
(H)	use output commands and variables;	Robotics Programming and Design TEK 5D
(I)	use selection programming structures such as jumps, loops, switch, and case ; and	Robotics Programming and Design TEK 5E
(J)	implement subroutines and functions.	Robotics Programming and Design TEK 5F
(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:	Similar to Robotics Programming and Design TEK 7
(A)	demonstrate knowledge of robotic or automated system arm construction;	
(B)	understand and apply the concepts of torque, gear ratio, stability, and weight of payload in a robotic or automated system arm operation; and	
(C)	understand and apply the concepts of linkages and gearing in end effectors and their use in of a robotic or automated arm system.	
(10)	The student uses engineering design methodologies. The student is expected to:	Similar to Robotics Programming and Design TEK 2
(A)	implement the design process;	
(B)	think critically, 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:	Similar to Robotics Programming and Design TEK 4
(A)	safely use and maintain tools and laboratory equipment to construct and repair systems;	
(B)	use precision measuring instruments to analyze systems and prototypes; and	
(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:	Similar to Robotics Programming and Design TEKS 2, 3, 4
(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.	

§130.362. ~~Concepts~~ Principles of Applied Engineering ~~and Technology~~ (~~One-Half to~~ One Credit).

	TEKS with edits	Committee Comments
(a)	General requirements. This course is recommended for students in Grades 9-10.	
(b)	Introduction	
(1)	CTE 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)	Planning, managing and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
(3)	Description. ~~Concepts~~ Principles of Applied Engineering ~~and Technology~~ provides an overview of the various fields of science, technology, engineering, and mathematics and their interrelationships. The students will develop engineering communication skills which include computer graphics, modeling and presentations by using ~~Students will use~~ 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 ~~decisions regarding~~ career decisions. ~~a coherent sequence of subsequent courses~~. 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.	The original wording doesn't really help reader understand what they will actually learn.
(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 ones' self 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.	
~~(1)~~(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; and	
(F)	conduct and present research on emerging and innovative technology; and	
(G)	demonstrate proficiency of the Engineering Design process.	
~~(2)~~(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;	Clarification
(D)	use industry standard visualization techniques and media; and	
(E)	use the engineering documentation process to maintain a paper or digital portfolio.	
~~(3)~~(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 pr~~d~~escribed by instructor in compliance with local, state and federal ~~various manuals, instructions, and~~ regulations;	
(C)	recognize the classification of hazardous materials and wastes;	
(D)	dispose of hazardous materials and wastes appropriately;	
(E)	~~perform~~ maintain, ~~enance~~, ~~and~~ 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.	
~~(4)~~(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.	
~~(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 the design process 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:~~	The Biotechnology course doesn't require this course as a prerequisite and this isn't necessary.
~~(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.~~	

(7)(8)	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)	describe career opportunities in process control and automation systems;	
(C)(B)	apply design concepts to problems in robotics, process control and automation systems;	
(D) (C)	identify fields and career opportunities related to robotics, process control and automation systems; and	
(E) (D)	identify emerging issues trends in robotics, process control and automation systems.	
(8)(9)	The student understands the opportunities and careers in fields related to physical and electrical and mechanical systems. The student is expected to:	
(A)	describe the applications of physical and electrical and mechanical systems;	
(B)	describe career opportunities in physical and electrical and mechanical systems;	
(C)	apply design concepts to problems in physical and mechanical systems; and	Eliminated 10/28/14
(D)(C)	identify emerging trends issues in physical and electrical and mechanical systems; and	
(D)	describe and apply basic electronic theory.	
(9)(10)	The student participates in a team-based culminating project demonstrates the ability to function as a team member while completing a comprehensive project. The student is expected to:	
(A)	apply the design process in 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)	present the project using clear and concise communication skills. Demonstrate communication skills by preparing and presenting the project;	
(10)(11)	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)	setup, create and modify drawings;	
(B)	store and retrieve geometry;	
(C)	understand the use of line-types in engineering drawings;	
(D)	draw 2D single view objects;	
(E)	create Multi-view working drawings using orthographic projection;	

(F)	dimension objects using current ANSI standards;	
(G)	draw single line 2D pictorial representations;	
(H)	create working drawings which 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.	

§130.365. Engineering Design and Presentation I (One to Two Credits)		
	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades 10-12. Recommended Prerequisites: Concepts Principles of Applied Engineering. and Technology, Prerequisite: Algebra I	
(b)	**Introduction**. This course is a continuation of practices and techniques learned in Concepts of Engineering & Technology. Students enrolled in this course will demonstrate knowledge and skills of the process of design 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.	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
(3)	This course is a continuation of knowledge and skills learned in Concepts Principles of Applied Engineering & Technology. Students enrolled in this course will demonstrate knowledge and skills of the process of design 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. Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.	
(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 ones' self 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.	
(E)	Complete a consistent demonstration of punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed.	
~~(1)~~(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 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)~~(3)	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, member and demonstrate appropriate attitudes while participating in team projects.	

~~(3)~~(4)	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)~~(5)	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)~~(6)	The student applies the concepts of sketching and skills associated with computer-aided drafting and design. The student is expected to:	
(A)	utilize single and multi-view projections;	Utilize because already learned in CoET(PoET)
(B)	utilize orthographic and pictorial views;	Moved to concepts of engineering & Tech
(C)	utilize auxiliary views;	Moved to concepts of engineering & Tech
(D)	utilize section views;	Moved to concepts of engineering & Tech
(E)	Utilize advanced construction techniques ~~project points and construct lines to build geometric forms;~~	Changed to include old E, F, G, H
~~(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;~~	
(F)	prepare and revise annotated multi-dimensional production drawings in computer-aided drafting and design to industry standards; and	

(G)	demonstrate knowledge of effective file structure and management; and	
(H)	utilize advanced dimensioning techniques; and	
(I)	construct and utilize basic 3D parametric drawings; and	
(J)	develop and use prototype drawings for presentation.	
~~(6)~~(7)	The student uses engineering design methodologies. The student is expected to:	
(A)	understand and discuss principles of ideation; and	
(B)	think critically, identify the system constraints, and make fact-based decisions; and	
(C)	use rational thinking to develop or improve a product; and	
(D)	apply decision-making strategies when developing solutions; and	
(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.	
~~(7)~~(8)	The student applies concepts of engineering to specific problems. The student is expected to:	
(A)	use a variety of technologies to design components; and	
(B)	use tools, laboratory equipment, and precision measuring instruments to develop prototypes; and	
(C)	research applications of different types of computer-aided drafting and design software; and	
(D)	use multiple software applications for concept presentations.	
~~(8)~~(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.	
~~(9)~~(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.	

§130.366. ~~Advanced~~ Engineering Design and Presentation II (Two ~~to Three~~ Credits)

TEKS with edits		Committee Comments
(a)	General requirements. This course is recommended for students in Grades 11-12. Recommended ~~P~~prerequisite: Principles of Applied Engineering or Engineering Design & Presentation I. Prerequisite: Algebra I and Geometry.	
(b)	Introduction. ~~This course will provide students the opportunity to master computer software applications in a variety of engineering and technical fields. This course further develops the process of engineering thought and application of the design process.~~	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
(3)	This course is a continuation of knowledge and skills learned in Engineering Design & Presentation I. Students enrolled in this course will demonstrate knowledge and skills of the process of design 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 utilization of skills from ideation through prototyping. Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.	
(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: ~~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 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 and International Standards Organization graphic standards;	
(B)	customize software user interface ~~by creating blocks, attributes, and symbol libraries~~;	
(C)	prepare and utilize 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)	~~prepare highway plan and profile drawings, including utility locations;~~ demonstrate understanding of annotation styles and setup by defining units, fonts, dimension styles, notes, leader lines;	Added advanced CADD skills.
(G)	~~prepare functional block diagrams for project management and decision making;~~ identify and incorporate the use of advanced layout techniques and viewports using paper-space and modeling areas.	
(H)	~~prepare functional wiring harness diagrams;~~ utilize management techniques by setting up properties to define and control individual layers.	
(I)	~~prepare electronic schematics to industry standards, including logic diagrams;~~ create and use custom templates for advanced project management.	
(J)	prepare and utilize advanced development drawings; ~~and~~	
(K)	~~identify the functions of computer hardware devices.~~ utilize advanced polar tracking and blocking techniques to increase drawing efficiency;	
(L)	create drawings that incorporates 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)	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.	
(7)	The student uses engineering design methodologies. The student is expected to:	
(A)	understand and discuss principles of system ideation;	
(B)	think critically, 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.	

§130.363. ~~Biotechnology~~Principles of Biosciences (One ~~to Two~~ Credit~~s~~).		
	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades 9-~~12.~~-10. ~~Recommended prerequisite: Concepts of Engineering and Technology.~~	~~Biology is more aligned with basic knowledge of this course.~~Name changed. This can be used for several different pathways.
(b)	**Introduction**. ~~This course provides an overview of biotechnology, bioengineering, and related fields. Topics include genetics, cell structure, proteins, nucleic acids, and the impact of immunological events in biotechnology. Students 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.~~	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
(3)	This course is a strong reinforcement of Biology content that provides an overview of biotechnology, bioengineering, and related fields. Topics include genetics, cell structure, proteins, nucleic acids, and the impact of immunological events in biotechnology. Students 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.	
(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 ones' self 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.	
~~(1)~~(2)	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~~ such as 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)~~(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 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)~~(4)	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~~ such as those in the agricultural and health areas.	
~~(4)~~(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; and	
(C)	investigate and report on career opportunities in the biotechnology industry sectors.	
~~(5)~~(6)	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)~~(7)	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)~~(8)	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 fields such as medicine, forensics, and law enforcement; and	
(F)	research ethical considerations, laws, and regulations governing genetic engineering and nanotechnology.	

§130.364. ~~Advanced~~ Biotechnology I (One Science Credit)

	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades 11-12. Prerequisite: Biology. Recommended ~~prerequisites: Biology~~, Principles of Biosciences and Chemistry. To receive credit in science, students must meet the 40% laboratory and fieldwork requirement identified in §74.3(b)(2)(C) of this title (relating to Description of a Required Secondary Curriculum). This course satisfies a high school science graduation requirement.	Name Changed from "Advanced Biotechnology" to "Biotechnology I". "Advanced" deleted to make names like colleges. (levels) This aligns with industry skills standards and certification.
(b)	Introduction.	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
~~(1)~~(3)	Students enrolled in this course 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, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students in Biotechnology 1 study a variety of topics that include structures and functions of cells, nucleic acids, proteins, and genetics.	
~~(2)~~	~~Students will conduct laboratory and field investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students in Biotechnology 1 study a variety of topics that include structures and functions of cells, nucleic acids, proteins, and genetics.~~	
~~(3)~~(4)	Nature of science. 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.	
~~(4)~~(5)	Scientific Inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.	

~~(5)~~(6)	Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods and ethical and social decisions that involve the application of scientific information.	
~~(6)~~(7)	Science, systems, and models. 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 ones' self 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.	
~~(1)~~(2)	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, including chemical, electrical, and fire safety, and safe handling of live and preserved organisms;	
(B)	demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials;	
(C)	demonstrate appropriate safety procedures, guidelines, and chemical hygiene plan;	

(D)	maintain required safety training, including location and understanding of interpretation of material safety data sheets;	
(E)	comply with federal and state safety regulations as specified by Occupational Safety and Health Administration and other regulatory agencies as appropriate;	
(F)	identify and obey safety symbols and signs;	
(G)	maintain clean and well organized work areas;	
(H)	dispose of equipment, glassware, and biologics according to laboratory policies;	
(I)	recognize common laboratory hazards;	
(J)	observe procedures for the safe use of instruments, gas cylinders, and chemicals; and	
(K)	maintain safety and personal protection equipment.	
~~(2)~~(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)(3) of this section;	May need to change notation to subsection if 3, 4, 5, 6 are changed above.
(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 they may be subject to change as new areas of science and new technologies are developed;	
(D)	distinguish between scientific hypotheses and scientific theories;	
(E)	plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting, handling, and maintaining appropriate equipment and technology;	
(F)	collect data individually or collaboratively, make measurements with precision and accuracy, record values using appropriate units, and calculate statistically relevant quantities to describe data, including mean, median, and range;	
(G)	demonstrate the use of course apparatus, equipment, techniques, and procedures;	
(H)	organize, analyze, evaluate, build models, make inferences, and predict trends from data;	
(I)	perform calculations using dimensional analysis, significant digits, and scientific notation; and	

(J)	communicate valid conclusions using essential vocabulary and multiple modes of expression such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.	
~~(3)~~(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 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)	evaluate the impact of research and technology on scientific thought, society, and the environment;	
(E)	describe the connection between biotechnology and future careers; and	
(F)	research and describe the history of biotechnology and contributions of scientists.	
~~(4)~~(5)	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 ~~as related to new and emerging occupations;~~	
(B)	apply scientific processes and concepts outlined in the Texas Essential Knowledge and Skills (TEKS) for Biology relevant to biotechnology;	
~~(B)~~ (C)	~~explore engineering and bioinformatics;~~ explore applications of bioinformatics such as DNA barcoding, phylogenetic relationships and the use of online databases;	
~~(C)~~	~~create a timeline of historical biotechnology research and development; and~~	
(D)	research career opportunities in fields such as molecular, forensic, medical, regulatory, and agricultural biotechnology.	Previous reviewer suggested deleting the term regulatory for career options. Regulatory should be left. Careers in quality assurance, clinical trials and GMP manufacturing fall under this options and should be included.
(E)	research the history of biotechnology and contributions of scientists;	Moved from 3 (F)
(F)	define bioethics and research applications of bioethics;	Added. Needs to be broken out further. Currently no mention of bioethics in any of the biotech courses

(G)	research applications in agricultural biotechnology such as tissue culturing, genetically modified foods, plant propagation and hydroponics; and	In addition to STEM, this course is taught in a health science and ag sequence. Students should be familiar with all fields.
(H)	research applications in medical biotechnology such as vaccines, stem cells, microarrays and pharmaceutical production.	
(6)	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;	
(B)	categorize the biotechnology laboratory procedures included in each sector; and	
(C)	compare the different applications used in biotechnology laboratory procedures of each sector.	
~~(5)~~	~~The student analyzes bacterial, plant, and animal cell structures. The student is expected to:~~	Covered in 5B
~~(A)~~	~~distinguish among bacterial, plant, and animal cells;~~	
~~(B)~~	~~describe the major structures in a bacterial cell and their functions such as pili, capsule, and flagella;~~	
~~(C)~~	~~describe the major structures in a plant cell and their functions such as cell wall and chloroplasts;~~	
~~(D)~~	~~describe the major structures in an animal cell and their functions such as nucleus, nucleolus, cell membrane, mitochondria, ribosomes, Golgi apparatus, chromatin, cytoplasm, and endoplasmic reticulum; and~~	
~~(E)~~	~~identify cells using the microscope.~~	
~~(F)~~	~~Distinguish between the cellular organization of a prokaryotic cell, a eukaryotic cell and non-living entities, such as viruses~~	
~~(6)~~(7)	The student understands the role of genetics in the biotechnology industry. The student is expected to:	
(A)	explain terms related to molecular biology ~~such as~~ including nucleic acids, nitrogen bases, amino acids, transcription, translation, polymerase, and protein synthesis;	Terms are important to know all for basic knowledge and understanding.
(B)	describe the structure and function of DNA and RNA in eukaryotic and prokaryotic cells ~~of a nucleotide~~;	
(C)	~~identify~~ compare and contrast the nitrogen bases of DNA ~~deoxyribonucleic acid~~ and RNA ~~ribonucleic acid~~;	Industry terminology
(D)	explain how nucleotides join together to form a ~~double-helical deoxyribonucleic acid molecule~~ DNA double helix;	Should use industry standard terminology
(E)	describe the ~~deoxyribonucleic acid~~ DNA ~~and ribonucleic acid~~ replication process in euakytoic and prokaryotic cells;	Ribonucleic acid does not replicate in a cell under normal conditions

(F)	illustrate the process of protein synthesis;	
(G)	~~define genome and gene expression;~~ describe the structure and function of proteins, including 3D folding, enzymes and antibodies;	
~~(H)~~	~~evaluate the significance of ethics and regulations as it relates to gene expression;~~	moved
~~(I)~~	~~summarize the role of genetics in the biotechnology industry.~~	Vague. Better defined section 4
~~(7)~~(8)	The student analyzes the importance of recombinant deoxyribonucleic acid technology and genetic engineering. The student is expected to:	
(A)	~~define~~ describe the fundamental steps in recombinant deoxyribonucleic acid technology	
(B)	explain how recombinant deoxyribonucleic acid technology is used to clone genes and create recombinant proteins;	
(C)	explain the role of tissue cultures to genetic modification procedures;	
(D)	~~propagate~~ describe plant- and animal-tissue culture~~s~~ procedure;	Requires sophisticated, costly equipment and many schools may not be able to afford it.
(E)	~~maintain~~ compare and contrast proper growing conditions for plant and animal tissue cultures;	Requires sophisticated, costly equipment and many schools may not be able to afford it.
(F)	explain the role of restriction enzymes; ~~and plasmid deoxyribonucleic acid;~~	
(G)	~~describe the~~ distinguish between vectors commonly used in biotechnology for DNA insertion, including plasmids, retroviruses and bacteriophage ~~vectors;~~	
(H)	~~discuss~~ explain the steps and components of the polymerase chain reaction ~~and its application in recombinant deoxyribonucleic acid technology; and~~	
~~(I)~~	~~perform restriction digests~~	In wrong place. Moved to 9H
~~(8)~~(9)	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; and	
(B)	analyze policies and procedures used in the biotechnology industry such as ~~animal research laboratories.,~~ quality assurance, SOPs, GMPs and ISO quality systems	
~~(9)~~(10)	The student performs standard biotechnology laboratory procedures. The student is expected to:	

(A)	identify and operate laboratory equipment ~~such as~~ including a microscope, thermocycler, hood, pH meter, hot plate stirrer, balance, mixers, autoclave, power supply, ~~shakers, dry heat oven, incubators, and Bunsen burners~~; micropipette, centrifuge and electrophoresis unit;	Must know and use all of these to fulfill skills
(B)	practice measuring volumes and weights to industry standards;	
(C)	analyze data and perform calculations and statistical analysis as it relates to biotechnology laboratory experiments;	
(D)	demonstrate ~~and show~~ proficiency ~~in titration and~~ pipetting techniques;	
(E)	identify microorganisms using staining methods such as the Gram stain, methylene-blue stain, and acid-fast staining;	Not for STEM, but leave for health science course
(F)	document laboratory results; and	
~~(G)~~	~~investigate how laboratory techniques vary in different industry sectors;~~	Doesn't fit here. Not a lab procedure.Move to????
	~~Operate a microscope to study and measure cell structures and cell processes.~~	
(G)	prepare a restriction digest and analyze results using gel electrophoresis.	
~~(10)~~(11)	The student prepares solutions and reagents for the biotechnology laboratory. The student is expected to:	
(A)	~~practice aseptic technique;~~ demonstrate 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 ~~acceptability and~~ optimum conditions of reagents for experimentation.	
~~(11)~~(12)	The student performs advanced biotechnology laboratory procedures. The student is expected to:	
(A)	explain the importance of media components to the outcome of cultures;	
(B)	isolate, maintain, and store ~~pure~~ bacterial cultures;	
(C)	prepare seed inoculum;	
(D)	perform plating techniques such as the Kirby-Bauer method;	
(E)	~~precipitate and solubilize proteins;~~ analyze proteins using techniques such as ELISA, spectrophotometry and SDS-PAGE;	
(F)	isolate a specific proteins from a biological sample using chromatography;	
~~(F)~~ (G)	isolate nucleic acids and interpret ~~proteins using~~ gel electrophoresis results; and	

~~(G)~~ (H)	~~perform nucleic acid sequencing procedures.~~ perform a bacterial transformation and analyze gene expression; and	Not possible to perform DNA sequence in the classroom
~~(H)~~ (I)	amplify a DNA sequence using the polymerase chain reactions.	
~~(12)~~(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 such as trending of data.	
~~(13)~~	~~The student summarizes biotechnology laboratory procedures and their applications in the biotechnology industry. The student is expected to:~~	Moved up
~~(A)~~	~~identify the major sectors of the biotechnology industry;~~	
~~(B)~~	~~categorize the biotechnology laboratory procedures included in each sector; and~~	
~~(C)~~	~~compare the different applications used in biotechnology laboratory procedures of each sector.~~	

Biotechnology II (One Science Credit).		
	TEKS with edits	Committee Comments
(a)	General requirements. This course is recommended for students in Grades 11-12. Prerequisite: Biotechnology I and Chemistry. To receive credit in science, students must meet the 40% laboratory and fieldwork requirement identified in §74.3(b)(2)(C) of this title (relating to Description of a Required Secondary Curriculum). This course satisfies a high school science graduation requirement.	Biotechnology II has been as the next course sequence for further biotechnology study. This course will remain as an advanced science credit as described in HB5
(b)	**Introduction**.	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
(3)	The course has the components of any rigorous scientific or bioengineering program of study from the problem identification, investigation design, data collection, data analysis, formulation and presentation of the conclusions. This course applies the standard skills mastered in Biotechnology 1 and includes assay design. After taking this course, students should be prepared for entry-level lab technician jobs.	
(4)	Nature of science. 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. 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)	Science and social ethics. 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)	Science, systems, and models. 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 ones' self 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. 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.	
(3)	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)(1) 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)	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 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 various 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 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 science 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.	
(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 and/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 in facilitating data analysis and in communicating experimental results clearly and effectively using technology, 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.	
(11)	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, R2 values;	
(C)	determine an unknown protein concentration using techniques such as a standard curve and a spectrophotometer; and	
(D)	use a colorimetric assay to evaluate enzyme kinetics.	
(12)	The student explores protein expression systems in the field of biotechnology. The student is expected to:	
(A)	perform a recombinant protein production such as GFP;	
(B)	isolate a protein from a biological sample using hydrophobic interaction column chromatography; and	
(C)	analyze protein purification methods using spectrophotometry, SDS-PAGE and Western blotting.	
(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;	
(B)	analyze data and perform calculations and statistical analysis on results of quality-control samples such as trending of data; and	
(C)	apply and create industry protocols such as standard operating procedures (SOPs) and validation forms.	
(14)	The student prepares solutions and reagents for the biotechnology laboratory. The student is expected to:	
(A)	demonstrate 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, and/or concentration and volume.	

§130.375. ~~Principles of~~ Engineering Science (One Science Credit).

	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades ~~11~~10-12. Prerequisite – Algebra I and 1 science credit. Recommended – Geometry To receive credit in science, students must meet the 40% laboratory and fieldwork requirement identified in §74.3(b)(2)(C) of this title (relating to Description of a Required Secondary Curriculum). This course satisfies a high school science graduation requirement.	
(b)	**Introduction**.	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
~~(1)~~(3)	~~Principles of~~ Engineering Science. Engineering Science is an engineering ~~survey~~ course designed to expose students to some of the major concepts and technologies that they will encounter in a postsecondary ~~engineering course~~ program of study in any engineering domain. Students have an opportunity to investigate engineering and high-tech careers. In ~~Principles of~~ Engineering Science, students will employ science, technology, engineering, and math ~~engineering and scientific~~ concepts in the solution of real-world challenge situations. ~~engineering design problems.~~ 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.	In the course-specific paragraph (after CTE and cluster paragraphs), include verbiage to the effect that "a focus of the course is problem-solving, measurement, and experimentation skills."
~~(2)~~(4)	Nature of science. 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.	
~~(3)~~(5)	Scientific inquiry. 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.	
~~(4)~~(6)	Science and social ethics. 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).	

~~(5)~~(7)	Science, systems, and models. 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 ones' self 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)	Scientific processes. 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)	Scientific processes. 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)(2) of this section;	
(B)	know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;	

(C)	know scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but they may be subject to change as new areas of science and new technologies are developed;	
(D)	distinguish between scientific hypotheses and scientific theories;	
(E)	plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology;	
(F)	collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, animal restraints, stereoscopes, electronic balances, micropipettors, hand lenses, surgical and imagining equipment, thermometers, hot plates, lab notebooks or journals, timing devices, Petri dishes, lab incubators, dissection equipment, and models, diagrams, or samples of biological specimens or structures;	
(G)	analyze, evaluate, make inferences, and predict trends from data; and	
(H)	communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.	
(4)	Scientific processes. 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)	evaluate the impact of scientific research on society and the environment; and	
(E)	evaluate models according to their limitations in representing objects or events.~~; and~~	
~~(F)~~	~~research and describe the history of veterinary medicine and contributions of scientists in that field.~~	?? Is this part of the science foundation that is necessary to meet science standards?
(5)	Principles of engineering. The student investigates engineering-related fields and career opportunities. The student is expected to:	
~~(A)~~	~~evaluate models according to their limitations in representing objects or events;~~	Doesn't fit here and is a duplicate of 3E

(B)	differentiate between engineering and engineering technology;	
(C)	~~identify the job opportunities available in engineering and engineering technology;~~ compare the roles or job descriptions in the fields of a pure science, engineering, and engineering technology;	Broadened to include the differences between eng, eng tech and pure scientific advancement
(D)	identify and differentiate among different engineering disciplines; and	
(E)	demonstrate appropriate oral, written, and visual forms of technical communication.	
(6)	Design problems. 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.	
(7)	Energy and power. 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 how components, including gears, sprockets, pulley systems, and simple machines, make up mechanisms;	
(B)	distinguish between the six simple machines and their attributes and components;	
(C)	measure forces and distances related to a mechanism;	
(D)	calculate work and power in mechanical systems;	
(E)	determine experimentally efficiency in mechanical systems; and	Adds more laboratory component
(F)	calculate mechanical advantage and drive ratios of mechanisms.	
(8)	Energy and power. 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;	For parallelism with 6D
(C)	calculate power in a system that converts energy from electrical to mechanical; and	
(D)	define voltage, current, and resistance and calculate each using Ohm's law.	

(9)	Energy and power. The student understands system energy requirements and how energy sources can be combined to convert energy into useful forms. ~~The student calculates material conductivity, resistance, and energy transfer.~~ The student understands the relationships among material conductivity, resistance and geometry in order to calculate energy transfer and determine power loss and efficiency. The student is expected to:	
(A)	explain the purpose of energy management;	
(B)	evaluate system energy requirements in order to select the proper energy source;	
(C)	explain how multiple energy sources can be combined to convert energy into useful forms;	
(D)	describe how hydrogen fuel cells create electricity and heat and how solar cells create electricity;	
(E)	measure and analyze ~~explain~~ how thermal energy is transferred via convection, conduction, and radiation; ~~and complete calculations for conduction, R-values, and radiation; and~~	Adds more laboratory component
(F)	analyze how thermal energy transfer is affected by conduction, R-values, and radiation; and	
~~(F)~~ (G)	calculate resistance, efficiency, and power ~~energy~~ transfer, in power transmission and distribution applications for various material properties.~~and material conductivity~~.	SE is unclear. The breakout will show why.
(10)	Materials and structures. 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, ~~and~~ calculate, and experimentally measure all forces acting upon a given body;	Adds more laboratory component
(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~~, and sense of a vector~~;	
(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.	
(11)	Materials and structures. 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	Adds more laboratory component
(C)	identify the manufacturing processes used to create selected common household products.	
(12)	Materials and structures. 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, 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 ~~calculate~~ 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.	Adds more laboratory component
(13)	Control systems. 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 inputs 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.	
(14)	Materials and structures. 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 ~~perfect~~ ideal gas laws; and	
(F)	calculate flow rate, flow velocity, and mechanical advantage in a hydraulic system.	
(15)	Statistics ~~and kinematics~~. The student demonstrates an understanding of statistics ~~and kinematics~~ and applies the concepts ~~both~~ to real-world engineering design problems. The student is expected to:	
(A)	calculate the theoretical probability that an event will occur;	
(B)	calculate the experimental frequency distribution of an event occurring;	
(C)	apply the Bernoulli process to events that only have two distinct possible outcomes;	
(D)	apply AND, OR, and NOT logic to solve complex probability scenarios;	
(E)	apply Bayes's theorem to calculate the probability of multiple events occurring;	
(F)	calculate the central tendency of a data array, including mean, median, and mode;	
(G)	calculate data variation, including range, standard deviation, and variance;	
(H)	create a histogram to illustrate frequency distribution;	
~~(I)~~	~~calculate distance, displacement, speed, velocity, and acceleration from data;~~	
~~(J)~~	~~calculate acceleration due to gravity given data from a free-fall device;~~	
~~(K)~~	~~calculate the X and Y components of a projectile motion; and~~	
~~(L)~~	~~determine the angle needed to launch a projectile a specific range given the projectile's initial velocity.~~	
(16)	Kinematics. 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:	Separated kinematics from statistics to better clarify concepts
(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;	Adds experimental to help satisfy requirement of 40% laboratory instruction
(C)	calculate the X and Y components of a projectile motion; and	
(D)	determine the angle needed to launch a projectile a specific range given the projectile's initial velocity.	

§130.367. Engineering Mathematics (One Mathematics Credit).

	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades 11-12. Prerequisite: Algebra II. This course satisfies one high school mathematics credit for graduation requirements.	
(b)	**Introduction**. ~~Engineering Mathematics is a course where students solve and model robotic design problems while emphasizing the mathematical applications. Students use a variety of mathematical methods and models to represent and analyze problems involving 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 robotics with and computer programming.~~	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
(3)	Engineering Mathematics is a course where students solve and model ~~robotic~~ design problems ~~while emphasizing the mathematical applications~~. Students use a variety of mathematical methods and models to represent and analyze problems ~~involving~~ 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 robotics with~~ and computer programming.	Moved from introduction so it has changes in colors. Follows introduction format.
(4)	Mathematical processing skills. The 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 ones' self 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)	Mathematical process standards. 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.	
~~(1)~~(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.	
~~(2)~~(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.	
~~(3)~~(5)	The student understands the properties 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.	
~~(4)~~(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 ~~for lathe~~,as applied to processes utilizing 3D printing, laser cutting, and	General thought to adapt this section to make it open to a wider range of design tools and manufacturing concepts such as laser cutting and 3D printing. Committee 2 made some similar wording changes for one

	computer numerical control manufacturing process. ~~and injection mold design~~. The student is expected to:	of their courses. Could get some information from them on wording.
(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~~, analyze,~~ 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.	
~~(5)~~(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 ~~and give an application~~;	
(E)	show the effect and give an application of a capacitor in an alternating current circuit ~~and give an application~~;	
(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.	
~~(6)~~(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)	~~demonstrate~~ explain how gage pressure and absolute pressure are different;	
(C)	~~consider and analyze Boyle's Law to explain its significance;~~ 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)	~~analyze~~ 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[=]$\frac{\bar{M}\cdot\bar{L}}{\bar{t}^2}$ and Pressure[=]$\frac{\bar{M}}{\bar{L}\cdot\bar{t}^2}$	
~~(H)~~(I)	convert between units of head and pressure;	
~~(I)~~(J)	explain the importance of total dynamic head in terms of suction and discharge head;	
~~(J)~~(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;	
~~(K)~~(M)	calculate friction head loss in a given pipe length using head loss tables and/or charts;	
~~(L)~~(N)	calculate total suction lift, total suction head, total discharge head, and the total dynamic head of a system for a given flow rate;	
~~(M)~~	~~analyze and explain the importance of sensitivity in relation to pumps;~~	
~~(N)~~	~~use a data acquisition system to measure and mathematically analyze pressure drop characteristics in a pipe;~~	
~~(O)~~	~~analyze a flat plate orifice flow meter for operation and demonstrate an application;~~	

(P)	use a data acquisition system to measure and analyze mathematically data from a flat plate orifice flow meter;	
(Q)(O)	calculate hydraulic power;	
(R)	explain the importance of brake horsepower and centrifugal pump efficiency;	
(S)(P)	calculate centrifugal pump brake horsepower given pump efficiency and hydraulic power;	
(T)(Q)	calculate the effect of impeller diameter and speed on the flow rate of a centrifugal pump and pump head;	
(U)(R)	predict the effect of impeller diameter on a pump head capacity curve; and	
(V)	calculate the effect of impeller speed on the flow rate of a centrifugal pump and pump head;	Added to SE (Q)
(W)(S)	calculate net positive suction head available and required result to explain its importance; and.	
(X)	analyze the proper size of a centrifugal pump for a given application.	
(7)	The student applies mathematical principles of manufacturing processes in lathe operations and computer numerical control mill programming and calculates speeds and feeds for machining tools, including special cutting tools. The student is expected to:	With 7 (C) and (D) removed, this strand only had 2 remaining SEs. With the amount of material presented in strand 6, this strand is recommended for deletion.
(A)	calculate the diameter of a tap drill given the thread specifications for a given application;	
(B)	analyze and set the point reference zero and the tool offsets in a computer numerical control mill;	
(C)	calculate spindle speeds for various machine tools; and	This is covered in 4
(D)	calculate and select the proper feed rate for machine tool operations.	This is covered in 4
(8)(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 formula 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)	~~design and~~ apply factors of safety to material engineering designs; and	“design factors of safety” does not make sense
(H)	create material testing conditions for a model using equipment such as a polariscope.	
~~(9)~~(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 ~~and contrast~~ the advantages and disadvantages of the three classes of levers for different applications;	“to compare” shows similarities and dis-similarities; “to contrast” only shows dissimilarities
(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 importance to various applications.	
~~(10)~~(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 a 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.	
~~(11)~~	~~The student applies mathematical principles of robotics and computer programming of robotic mechanisms in point-to-point assembly, calculating working envelope and computer system conversions. The student is expected to:~~	They may not know how to program a robot.
~~(A)~~	~~create a pallet load configuration and program a robot to execute the operation;~~	
~~(B)~~	~~calculate the working envelope of a robotic arm; and~~	
~~(C)~~	~~convert between the hexadecimal, binary, and decimal number systems.~~	

§130.372. Scientific Research and Design (One Science Credit).		
TEKS with edits		Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades 11-12. Prerequisite: one ~~unit~~ credit of high school science. To receive credit in science, students must meet the 40% laboratory and fieldwork requirement identified in §74.3(b)(2)(C) of this title (relating to Description of a Required Secondary Curriculum). This course satisfies a high school science graduation requirement.	
(b)	**Introduction**.	
(1)	CTE 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.	Consistency of structure: Statement for consistency amongst CTE courses
(2)	The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	Consistency of structure: Statement for consistency amongst courses in the STEM cluster
(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 to continue their education.	Consistency of structure: Course description
~~(1)~~ (4)	Nature of science. 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.	Consistency of structure: Due to course being approved for science credit
~~(2)~~ (5)	Scientific inquiry. 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.	
~~(3)~~ (6)	Science and social ethics. 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).	
~~(4)~~ (7)	~~Scientific systems~~ Science, systems, and models. 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.	Consistency of structure: Statement for consistency amongst CTE courses
(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.	Consistency of structure: Statement for consistency amongst CTE courses
(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 ones' self 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.	
~~(1)~~(2)	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)~~(3)	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 Introduction (b)(4).	
(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;	Word not needed
(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;	Rewrite for better understanding
(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.	Changed equipment – the list has equipment that is not for measurement so they have been separated.
(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 various methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.	
~~(3)~~(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 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 science 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)~~(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.	
~~(5)~~(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.	
~~(6)~~(7)	The student develops and implements investigative designs. The student is expected to:	
(A)	interact and collaborate with scientific researchers and/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.	
~~(7)~~(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;	Aligns to CCRS – Math VI B 1
~~(A)~~ (B)	record observations ~~and events~~ as they occur within an investigation;	Observations are recorded; if an event occurs and isn't observed, no way to record
~~(B)~~(C)	acquire, manipulate, and analyze data using appropriate equipment and technology following the rules of significant digits;	Adds alignment to CCRS – Math IV A 1, Science II A 7, and Science II F 2
(D)	identify sources of random error and systematic error and differentiate between both types of error;	Aligns to CCRS – Math X B 2 Aligns to CCRS – Science II E 1
(E)	report error of a set of measured data in various formats, including standard deviation and percent error;	Aligns to CCRS – Math VI B 3 and VI C 2 Aligns to CCRS – Cross-Disc II D 2
~~(C)~~ (F)	construct data tables to organize information collected in an experiment; and	
~~(D)~~ (G)	evaluate data using statistical methods to recognize patterns, trends, and proportional relationships.	

~~(8)~~(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;	Multiple levels of complexity desired
(B)	consider and communicate alternative explanations for observations and results; and	
(C)	identify limitations within the research process and provide recommendations for additional research.	
~~(9)~~(10)	The student communicates conclusions clearly and concisely to an audience of professionals. The student is expected to:	
(A)	construct charts, tables, and graphs in facilitating data analysis and in communicating experimental results clearly and effectively using technology, including oral presentation of original findings of a research project to an audience of peers and professionals; and	Aligns to CCRS – Cross-Disc II C 8 and Cross-Disc II D 3
(B)	suggest alternative explanations from observations or trends evident within the data or from prompts provided by a review panel.	

§130.373. Engineering Design and Problem Solving (One Science Credit).		
	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades 11-12. Prerequisites: Algebra 1, Geometry, ~~Algebra II, Chemistry, and Physics~~ <u>and 2 STEM credits.</u> <u>To receive credit in science, students must meet the 40% laboratory and fieldwork requirement identified in §74.3(b)(2)(C) of this title (relating to Description of a Required Secondary Curriculum). This course satisfies a high school science graduation requirement</u>	
(b)	Introduction.	
<u>(1)</u>	<u>CTE 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.</u>	
<u>(2)</u>	<u>The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.</u>	
~~(1)~~<u>(3)</u>	Engineering design is the creative process of solving problems by identifying needs and then devising solutions. This solution may be a product, technique, structure, process, or many other things 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.	
~~(2)~~<u>(4)</u>	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 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.	
~~(3)~~<u>(5)</u>	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.	
<u>(6)</u>	<u>Nature of science. 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.</u>	

(7)	Scientific inquiry. 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.	
(8)	Science and social ethics. 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).	
(9)	Science, systems, and models. 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	
(10)	Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.	
(11)	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 ones' self 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.	
~~(1)~~(2)	The student, for at least 40% of instructional time, conducts engineering field and laboratory activities using safe, environmentally appropriate, and ethical practices. The student is expected to:	
(A)	demonstrate safe practices during engineering field and laboratory activities; and	
(B)	make informed choices in the use and conservation of resources, recycling of materials, and the safe and legal disposal of materials.	
~~(2)~~(3)	The student applies knowledge of science and mathematics and the tools of technology to solve engineering design problems. The student is expected to:	
(A)	apply scientific processes and concepts outlined in the Texas Essential Knowledge and Skills (TEKS) for Biology, Chemistry, or Physics relevant to engineering design problems;	Students have already had these subjects.

(B)	apply concepts, procedures, and functions outlined in the TEKS for Algebra I, Geometry, and Algebra II relevant to engineering design problems;	Not necessary here or above.
(C)	select appropriate mathematical models to develop solutions to engineering design problems;	
(D)	integrate advanced mathematics and science skills as necessary to develop solutions to engineering design problems;	
(E)	judge the reasonableness of mathematical models and solutions;	
(F)	investigate and apply relevant chemical, mechanical, biological, electrical, and physical properties of materials to engineering design problems;	
(G)	identify the inputs, processes, outputs, control, and feedback associated with open and closed systems;	
(H)	describe the difference between open-loop and closed-loop control systems;	
(I)	make measurements and specify tolerances with minimum necessary accuracy and precision;	
(J)	use appropriate measurement systems, including customary and International System (SI) of units; and	
(K)	use conversions between measurement systems to solve real-world problems.	
~~(3)~~(4)	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, but not limited to, graphs and tables;	
(E)	evaluate the quality and relevance of sources and cite appropriately; and	
(F)	defend a design solution in a presentation.	
~~(4)~~(5)	The student recognizes the history, development, and practices of the engineering professions. The student is expected to:	
(A)	identify and describe career options, working conditions, earnings, and educational requirements of various engineering disciplines such as those listed by the Texas Board of Professional Engineers;	

(B)	recognize that engineers are guided by established codes emphasizing high ethical standards;	
(C)	explore the differences, similarities, and interactions among engineers, scientists, and mathematicians;	
(D)	describe how technology has evolved in the field of engineering and consider how it will continue to be a useful tool in solving engineering problems;	
(E)	discuss the history and importance of engineering innovation on the United States economy and quality of life; and	
(F)	describe the importance of patents and the protection of intellectual property rights.	
~~(5)~~(6)	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, but not limited to, health, safety, social, environmental, ethical, political, regulatory, and legal;	
(E)	identify or create alternative solutions to a problem using a variety of techniques such as brainstorming, reverse engineering, and researching engineered and natural solutions;	
(F)	test and evaluate proposed solutions using methods such as models, prototypes, mock-ups, simulations, critical design review, statistical analysis, or experiments;	
(G)	apply structured techniques to select and justify a preferred solution to a problem such as a decision tree, design matrix, or cost-benefit analysis;	
(H)	predict performance, failure modes, and reliability of a design solution; and	
(I)	prepare a project report that clearly documents the designs, decisions, and activities during each phase of the engineering design process.	
~~(6)~~(7)	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;	
(B)	develop a plan and timeline 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 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.	

§130.374. Practicum in Science, Technology, Engineering, and Mathematics (Two to Three Credits).		
	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grade 12. Prerequisite: Algebra I, Geometry, and 2 STEM 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 science, technology, engineering, and mathematics career cluster.	
(1)	A student shall be awarded two credits for successful completion of this course, when the student participates in at least an average of 10 hours, but less than 15 hours, per week of a paid or unpaid, laboratory- or work-based application of previously studied knowledge and skills related to the STEM Career Cluster.	
(2)	A student shall be awarded three credits for successful completion of this course, when the student participates in an average of 15 hours per week of a paid or unpaid, laboratory- or work-based application of previously studied knowledge and skills related to the Career Cluster.	
(b)	**Introduction**. ~~The practicum 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.~~	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
(3)	The practicum 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 ones' self 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.	
~~(1)~~(2)	The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:	Same as KS (1)
(A)	adhere to policies and procedures;	
(B)	demonstrate positive work behaviors and attitudes, including punctuality, time management, initiative, and cooperation;	
(C)	accept constructive criticism;	
(D)	apply ethical reasoning to a variety of situations in order to make ethical decisions;	
(E)	complete tasks with the highest standards to ensure quality products and services;	
(F)	model professional appearance, including dress, grooming, and personal protective equipment as appropriate; and	
(G)	comply with practicum setting safety rules and regulations to maintain safe and healthful working conditions and environments.	
~~(2)~~(3)	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)	critically 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)~~(4)	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 skills through working cooperatively with others to achieve tasks;	
(C)	demonstrate teamwork processes that promote team building, consensus, continuous improvement, respect for the opinions of others, cooperation, adaptability, and conflict resolution;	
(D)	demonstrate responsibility for shared group and individual work tasks;	
(E)	establish and maintain effective working relationships in order to accomplish objectives and tasks;	

(F)	demonstrate effective working relationships using interpersonal skills;	
(G)	use positive interpersonal skills to work cooperatively with others;	
(H)	negotiate effectively to arrive at decisions;	
(I)	demonstrate respect for individuals, including those from different cultures, genders, ~~and~~ backgrounds~~;~~, and value diversity.	
(J)	~~demonstrate sensitivity to and value for diversity.~~	Moved item above.
~~(4)~~(5)	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, Internet websites, and technical materials to review and apply information sources for occupational tasks;	
(D)	evaluate the reliability of information from informational texts, Internet 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)~~(6)	The student demonstrates technical knowledge and skills required to pursue a career in the science, technology, engineering, and mathematics cluster. The student is expected to:	
(A)	develop advanced technical knowledge and skills related to the student's occupational objective;	
(B)	evaluate strengths and weaknesses in technical skill proficiency. ~~and~~	
(C)	~~accept critical feedback provided by the supervisor.~~	Duplicate of (1)(C)
(6)	The student documents technical knowledge and skills. The student is expected to:	
(A)	update a professional portfolio to include:	
(i)	attainment of technical skill competencies;	
(ii)	licensures or certifications;	
(iii)	recognitions, awards, and scholarships;	
(iv)	extended learning experiences such as community service, active participation in career and technical student organizations and professional organizations;	

(v)	abstract of key points of the practicum;	
(vi)	resumé;	
(vii)	samples of work; and	
(viii)	evaluation from the practicum supervisor; and	
(B)	present the portfolio to all interested stakeholders such as in a poster presentation or evaluation panel of experts.	

§130.371. Principles of Technology (One Science Credit).

	TEKS with edits	Committee Comments
(a)	**General requirements**. This course is recommended for students in Grades 10-12. Prerequisites: one ~~unit~~ credit of high school science and Algebra I. To receive credit in science, students must meet the 40% laboratory and fieldwork requirement identified in §74.3(b)(2)(C) of this title (relating to Description of a Required Secondary Curriculum). This course satisfies a high school science graduation requirement.	
(b)	**Introduction**.	
(1)	CTE 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 (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.	
~~(1)~~(3)	~~Principles of Technology.~~ In Principles of Technology, students conduct laboratory and field investigations, use scientific methods 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.	
~~(2)~~(4)	Nature of science. 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.	
~~(3)~~(5)	Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.	
~~(4)~~(6)	Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods and ethical and social decisions that involve the application of scientific information.	
~~(5)~~(7)	~~Scientific systems~~. Science, systems, and models. 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 ones' self 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.	
~~(1)~~(2)	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)~~(3)	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~~ science has limitations, as specified in subsection (b)~~(2)~~ (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 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~~ such as 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 and record 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.	
~~(3)~~(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 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)~~(5)	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)~~(6)	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)~~(7)	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)~~(8)	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 for displacement, distance, speed, velocity, average velocity, 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;	
(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)~~(9)	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)~~(10)	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)~~(11)	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)~~(12)	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)~~(13)	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.	