Career and Technical Education, Texas Essential Knowledge and Skills
Engineering Career Cluster
Engineering Foundations Program of Study
Work Group Final Recommendations

Prepared by the State Board of Education CTE TEKS Work Groups

Final Recommendations, January 2025

These recommendations reflect the final recommendations to the career and technical education (CTE) Texas Essential Knowledge and Skills (TEKS) for the Engineering Career Cluster that have been recommended by State Board of Education's TEKS work group for the Engineering Foundations Program of Study. Proposed additions are shown in green font with underlines (additions). Proposed deletions are shown in red font with strikethroughs (~~deletions~~). Text proposed to be moved from its current student expectation is shown in purple, italicized font with strikethrough (*~~moved text~~*) and is shown in the proposed new location in purple, italicized font with underlines (*new text location*).

Comments identified on the left-hand side link to explanations at the bottom of each page for the work group's proposed recommendations.

FINAL RECOMMENDATIONS, ENGINEERING FOUNDATIONS CTE TEKS TABLE OF CONTENTS

§127.402. Engineering Design Process (One Credit), Adopted 2025.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

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

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Engineering Career Cluster focuses on planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. This career cluster includes occupations ranging from mechanical engineer and drafter to electrical engineer and to mapping technician.

Comment [1](3) ~~Students enrolled in~~ Engineering Design Process is an engineering course applicable to all engineering fields. Students use an iterative engineering design process to solve problems, make decisions and manage a project. Professional practices are addressed including, developing a problem statement, maintaining documentation, using an engineering notebook, research, project management, internal and external communication, and creation of technical drawings and prototypes. The student delivers a professional presentation detailing the experience of working through each step of the engineering design process. ~~transition from teacher given engineering problems to problems that students find independently and creating solutions.~~

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

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

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

(A) explain the importance of dressing appropriately, speaking politely, and conducting oneself in a manner appropriate for the profession and work site;

(B) describe teamwork, group dynamics, and conflict resolution and how they can impact the collective outcome;

(C) present written and oral technical communication in a clear, concise, and effective manner for a variety of purposes and audiences;

(D) identify time-management skills such as prioritizing tasks, following schedules, and tending to goal-relevant activities and how these practices optimize efficiency and results;

(E) define work ethic and discuss the characteristics of a positive work ethic, including punctuality, dependability, reliability, and responsibility for reporting for duty and performing assigned tasks;

(F) discuss the importance of professionalism and ethics in engineering design as defined by professional organizations such as the National Society of Professional Engineers;

(G) demonstrate respect for diversity in the workplace;

[1] Drafted new course description

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) identify and discuss elements of professional codes of conduct or creeds in engineering such as the National Society of Professional Engineers Code of Ethics for Engineers;

(J) discuss the importance of safety in the workplace and why it is critical for employees and employers to maintain a safe work environment; and

(K) describe the roles and responsibilities of managers.

(2) The student understands that there are different stages of the engineering design process and the importance of working through each stage as part of an iterative process. The student is expected to:

(A) explain the importance of defining an engineering problem as an initial step in the engineering design process;

(B) describe the research stage of the engineering design process;

(C) define and discuss ideation and conceptualization's ~~conceptualization~~ ~~and discuss the~~ role ~~these processes play~~ in innovation and problem solving;

Comment [2] (D) explain the criteria for ~~explain the processes of~~ selecting an idea or concept for detailed prototype design, development, and testing;

Comment [3] (E) explain ~~describe~~ the purpose of non-technical drawings, technical drawings, models, and prototypes in designing a solution to an engineering problem;

Comment [4] (F) describe the relevance of ~~process of relevant~~ experimental design, conducting tests, collecting data, and analyzing data to evaluate potential solutions;

(G) explain how the engineering design process is iterative and the role reflection plays in developing an optimized engineering solution; and

Comment [5] (H) explain ~~describe~~ the purpose of effective communication throughout the entirety of the ~~solution as obtained through the~~ engineering design process to various audiences.

(3) The student explores and develops skills to solve problems, make decisions, and manage a project. The student is expected to:

(A) discuss strategies for managing time, setting deadlines, and prioritizing to accomplish goals;

(B) identify constraints and describe the importance of planning around constraints, including budgets, resources, and materials;

(C) define milestones and deliverables and explain the advantages of dividing a large project into smaller milestones and deliverables;

(D) identify different types of communication and explain how different types of communication lead to successful teamwork on a shared project in a professional setting; and

(E) identify strategies to solve problems and describe how problem-solving is utilized to accomplish personal and team objectives.

(4) The student understands the foundations of occupational safety and health. The student is expected to:

[2] Based on Quality Rubric feedback, we evaluated the verb.
[3] Based on Quality Rubric feedback, we evaluated the verb.
[4] Based on Quality Rubric feedback, we took out "process" to avoid confusion.
[5] Based on Quality Rubric feedback, we wanted to stress communication throughout the entire process- not just the final solution.

(A) explain and discuss the responsibilities of workers and employers to promote safety and health in the workplace and the rights of workers to a secure workplace;

(B) explain the role industrial hygiene plays in occupational safety and explain various types of industrial hygiene hazards, including physical, chemical, biological, and ergonomic;

(C) identify and explain the appropriate use of types of personal protective equipment used in industry;

Comment [6] (D) demonstrate safe practices ~~discuss the importance of safe walking and working surfaces in the workplace and best practices~~ for preventing or reducing slips, trips, and falls in the workplace;

(E) describe types of ~~electrical hazards in the workplace and the~~ risks of, ~~associated with these hazards~~ and ~~describe~~ control methods to prevent electrical hazards in the workplace; and

(F) identify workplace health and safety resources, including emergency plans and Safety Data Sheets, and discuss how these resources are used to make decisions in the workplace.

(5) The student understands the value of maintaining documentation using an engineering notebook. The student is expected to:

(A) explain the purpose and legal value of maintaining an engineering notebook as intellectual property;

(B) describe the proper implementation of an engineering notebook, including notebook type, documentation, signatures, adding external materials, sealing, and dating;

(C) create and maintain an engineering notebook by recording ideas, notes, decisions, findings, *deficiencies,* and corrections~~, including~~ ~~*deficiencies*~~ ~~in the design process, and decisions~~ throughout the entire design process; and

Comment [7] (D) communicate progress during the engineering design process at regular intervals using various methods such as written reports, informal presentations, and formal presentations.

(6) The student understands how to conduct research in the engineering design process. The student is expected to:

Comment [8] (A) describe ~~explain~~ the advantages and disadvantages of emerging technologies and practices in the research process;

(B) explain the importance of identifying and synthesizing information from a variety of sources in the research process;

(C) explain the ethical acquisition and use of digital information;

Comment [9] (D) demonstrate ~~explain how to~~ use and citation of ~~cite~~ source material ethically and appropriately;

(E) define and discuss intellectual property laws such as patents, copyrights, and proprietary information in the research process; and

Comment [10] (F) identify limitations in ~~the~~ researching ~~research~~ ~~process~~ such as outdated, conflicting, proprietary, or access to information.

[6] Based on Quality Rubric feedback, we wanted to ensure student safety
[7] Feedback from educator ESC was not incorporated because SE 15 only refers to the (final) professional presentation
[8] Addressing staff concern about verb
[9] Addressing staff concern about verb
[10] Addressing staff concern about clarity and the word "process"

(7) The student understands the process of creating and refining a problem statement in the engineering design process. The student is expected to:

(A) explain the essential components of a problem statement such as who the problem affects, when it is a problem, where the problem happens, and the magnitude of the problem;

(B) describe different methods for creating and refining a problem statement such as questioning, observation, and client ~~stakeholder~~ needs;

(C) create a problem statement that is concise, specific, and measurable;

(D) collect, analyze, and interpret information relevant to a problem statement;

Comment [11] (E) modify a problem statement ~~as necessary~~ based on information acquired from using processes or various analysis tools such as fishbone charts, root-cause analysis, 80-20 rule, heat maps, survey results, and end-user input;

Comment [12] (F) explain the purpose of a technical document that compiles ~~brings together~~ the objectives, constraints, data, alternatives, and design solutions such as a design brief or design basis, in the engineering design process; and

(G) compile a technical document that includes a problem statement, constraints, resources, budget, timeline, deliverables, and solution criteria such as quality, risk, and extent to which problem is solved.

(8) The student understands the importance of conceptualizing a solution in the engineering design process. The student is expected to:

(A) discuss the importance of creativity in engineering, innovation, and problem solving;

(B) explain and use various techniques for idea generation such as brainstorming, mapping, storyboarding, sketching, questioning, reverse engineering, natural solutions, to create solution concepts;

Comment [13] (C) explain the similarities and differences between designing a solution in the classroom versus designing a solution in the real world;

Comment [14] (D) analyze and evaluate solutions using the *established* criteria ~~*established*~~ ~~from a technical document~~;

Comment [15] (E) explain the importance of capturing client ~~stakeholder~~ feedback to refine solution concepts; and

(F) explain and use various techniques for gathering end-user input such as focus groups, interviews, and surveys to refine solution concepts.

(9) The student creates technical drawings in the engineering design process. The student is expected to:

(A) explain the role of freehand sketching, freehand modeling, technical drawing, and technical modeling in the development of a prototype or solution;

(B) create nontechnical representations such as sketches, drawings, or models of a solution with relevant annotations;

Comment [16](C) *develop a technical model of the solution* using ~~use~~ a nontechnical representation of a solution ~~to~~ ~~*develop a technical model of the solution*~~; and

[11] Based on Quality Rubric feedback, removed unnecessary words
[12] Based on staff feedback, clarified verb
[13] Based on staff feedback, more equal comparison
[14] Based on staff feedback, removed "technical document'
[15] Staff feedback was not utilized because we would lose the intent of the SE.
[16] Staff feedback, switched order for clarity

Comment [17](D) create technical drawings, including single-view projections, multi-view projections, and orthographic views, using industry standards.

(10) The student creates prototypes in the engineering design process. The student is expected to:

Comment [18] (A) identify ~~explain~~ different types *of prototypes* ~~the *role* *of prototypes*~~ and explain the *role* of a prototype in the development of a solution;

Comment [19] (B) identify and describe the steps needed to produce a prototype;

Comment [20] (C) identify and use appropriate tools, equipment, machines, and materials to produce a ~~the~~ prototype; and

Comment [21] (D) present a ~~the~~ prototype using presentation software.

(11) The student tests and evaluates a prototype or solution using experiments, data, and end-user feedback. The student is expected to:

(A) explain the purpose of conducting tests on a prototype or solution;

(B) design appropriate protocols for testing a prototype or solution;

(C) analyze, evaluate, and critique a prototype or solution by using observational testing, ~~and~~ experimental testing, empirical evidence, and statistical analysis;

(D) collect end-user feedback using appropriate protocols such as focus groups, interviews, and surveys to evaluate a prototype or solution; and

(E) identify the successes and failures of a prototype or solution based on the criteria established in the testing protocols and technical document to determine next steps in the engineering design process.

(12) The student understands the iterative nature of the engineering design process to develop a solution. The student is expected to:

(A) analyze design flaws of a prototype or solution using various tools such as fishbone charts, root-cause analysis, 80-20 rule, heat maps, survey results, and end-user feedback;

(B) iterate steps of the design process, as necessary, to improve and optimize a solution; and

(C) evaluate the potential impact of a solution on the original problem identified during the design process.

(13) The student prepares and delivers a professional presentation detailing the experience of working through each step of the engineering design process to create a viable solution. The student is expected to:

(A) prepare and deliver a presentation detailing the experience of working through each step of the engineering design process to create a viable solution;

(B) solicit and evaluate feedback on implementation of the design process and the presentation; and

(C) present learning experiences such as essential skills gained, areas of personal growth, and challenges encountered throughout the design process.

[17] Regional feedback was not utilized to avoid making the SE overly prescriptive
[18] Staff feedback- added additional content to the SE to address staff concern for 10B
[19] Addressed staff feedback in 10A
[20] Staff feedback- removed "the" and replaced with "a"
[21] Staff feedback- removed "the" and replaced with "a"

This document reflects the CTE TEKS work group final recommendations as of January 2025.

§127.404. ~~127.783.~~ Engineering Design and Presentation I (One Credit), Adopted 2025.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

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

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Engineering Career Cluster focuses on planning, designing, testing, building, and maintaining machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. This career cluster includes occupations ranging from mechanical engineer and drafter to electrical engineer and to mapping technician.

(3) Students enrolled in Engineering Design and Presentation I demonstrate knowledge and skills of the design process as it applies to engineering fields and project management using multiple software applications and tools necessary to produce and present working drawings, solid model renderings, and prototypes. Through implementation of the design process, students transfer advanced academic skills to component designs. Additionally, students explore career opportunities in engineering, technology, and drafting and what is required to gain and maintain employment in these areas.

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

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

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

(A) demonstrate dressing appropriately, speaking politely, and conducting oneself in a manner appropriate for the profession and work site;

(B) analyze how teams can produce better outcomes through cooperation, contribution, and collaboration from members of the team;

(C) present written and oral technical communication in a clear, concise, and effective manner for a variety of purposes and audiences, including explaining and justifying decisions in the design process;

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

(E) describe the importance of and demonstrate punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed;

(F) explain how engineering ethics as defined by professional organizations such as the National Society of Professional Engineers applies to engineering practice;

(G) demonstrate respect for diversity in the workplace;

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) analyze elements of professional codes of conduct or creeds in engineering such as the National Society of Professional Engineers Code of Ethics for Engineers and how they apply to the knowledge and skills of the course and the engineering profession;

(J) identify the components of a safety plan and why it is critical for employees and employers to maintain a safe work environment; and

(K) compare skills and characteristics of managers and leaders in the workplace.

(2) The student understands how to implement an engineering design process to develop a product or solution. The student is expected to:

(A) describe and implement the stages of an engineering design process to construct a model;

(B) explain how factors, including complexity, scope, resources, ethics, regulations, manufacturability, and technology, impact stages of the engineering design process;

(C) explain how stakeholders impact an engineering design process; and

(D) analyze how failure is often an essential component of the engineering design process.

(3) The student understands the value of maintaining documentation using an engineering notebook. The student is expected to:

(A) explain the legal value of maintaining an engineering notebook as intellectual property;

(B) describe the proper implementation of an engineering notebook, including notebook type, documentation, signatures, adding external materials, sealing, and dating; and

(C) create and maintain an engineering notebook by recording ideas, notes, decisions, findings, and corrections.

(4) The student explores the methods and aspects of project management in relation to projects. The student is expected to:

(A) research and explain the process and phases of project management, including initiating and planning; executing; and closing;

(B) explain the roles and responsibilities of team members, including project managers and leads;

(C) research and evaluate methods and tools available for managing a project;

(D) discuss the importance of developing and implementing a system for the organization of project documentation such as file naming conventions, document release control, and version control;

(E) describe how project requirements, constraints, and deliverables impact the project schedule and influence ~~and are influenced by~~ an engineering design;

(F) explain how a project budget is developed and maintained, including materials, equipment, and labor; and

(G) describe the importance of management of change (MOC) and how management of change (MOC) ~~it~~ applies to project planning.

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

(A) describe and compare the roles of an industry technician, engineering technologist, and engineer;

(B) identify *educational requirements* ~~employment~~ and career opportunities for engineers, ~~in~~ engineering technologists, and industry technicians ~~and describe the~~ ~~*educational requirements*~~ ~~for each~~;

(C) research and describe ~~the~~ various engineering disciplines such as mechanical, civil, aerospace, biomedical, chemical civil, computer, electrical, petroleum, and other related and emerging fields;

(D) investigate and describe the requirements of engineering licensure and industry-based certifications;

(E) investigate and describe elements of teamwork critical for success in the engineering and technology industries, such as communication, active listening, and time management;

(F) research and describe industry standards and governmental regulations such as health and safety and environmental regulations applicable to a design problem; and

(G) analyze and discuss ethical issues related to engineering and technology.

(6) The student understands the roles and responsibilities of individual team members, how successful teams function, and how to constructively contribute to the team. The student is expected to:

(A) describe the various roles and responsibilities of a project team;

(B) identify ~~describe and demonstrate how~~ the strengths ~~knowledge and skills~~ of individual team members ~~are used~~ to assign roles and distribute tasks within a team; and

(C) describe and demonstrate appropriate behaviors such as active listening and clear communication while serving as a team leader and member on projects.

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

(A) identify and explain the appropriate use of types of personal protective equipment (PPE) used in industry;

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

(C) discuss the importance of safe walking and working surfaces in the workplace and best practices for preventing or reducing slips, trips, and falls in the workplace;

(D) describe the various types of electrical hazards in the workplace and the risks associates with electrical ~~these~~ hazards;

(E) describe the various control methods to prevent electrical hazards in the workplace;

(F) identify workplace health and safety resources, including emergency plans and Safety Data Sheets, and explain how emergency plans and Safety Data Sheets ~~these resources~~ are used to make decisions in the workplace;

(G) describe the appropriate disposal of selected hazardous materials and wastes;

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

(I) demonstrate proper handling, ~~handle,~~ use, and storage of ~~store~~ tools and materials ~~correctly~~; and

(J) research and describe the consequences of negligent or improper equipment maintenance.

(8) The student understands how visual and spatial reasoning applies to engineering design. The student is expected to:

(A) describe and compare characteristics and dimensional changes of two- and three-dimensional figures;

(B) draw and manipulate geometric shapes in three dimensions;

(C) create two-dimensional views of a three-dimensional object; and

(D) explain the symmetry of figures through the proportionate transformation of objects.

(9) The student uses sketching and computer-aided design and drafting to represent three-dimensional (3D) objects in a two-dimensional (2D) format needed for manufacturing an object. The student is expected to:

- (A) use single and multi-view projections to represent 3D objects in a 2D format;
- (B) use appropriate line types in engineering drawings to represent 3D objects in a 2D format;
- (C) use orthographic and pictorial views to represent 3D objects in a 2D format;
- (D) use auxiliary views to represent 3D objects in a 2D format;
- (E) use section views to represent 3D objects in a 2D format;
- (F) prepare and revise annotated multi-dimensional production drawings in computer-aided design and drafting to industry standards;
- (G) apply best practices for file structure and management to efficiently retrieve and edit files;
- (H) use advanced dimensioning techniques, including annotation scale; and
- (I) construct and use ~~basic 3D parametric~~ computer aided design and drafting (CADD) drawings to develop a ~~3D~~ model or prototype for presentation.

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

- (A) design product components using a variety of technologies;
- (B) research and analyze the applications of different types of computer-aided *design* ~~*drafting*~~ and *drafting* ~~*design*~~ software for various engineering problems;
- (C) create ~~produce~~ and interpret engineering drawings using industry standards;
- (D) describe how quality, reliability, and safety can be designed into specific products;
- (E) identify specific requirements of *users with special needs* and modify a product design to accommodate ~~those~~ users with special needs ~~meet a specified need such as considering a broader audience of users or~~ ~~*users with special needs*~~;
- (F) research and explain the patenting process and analyze opportunities for potential patents related to a project; and
- (G) use multiple software applications for concept presentations.

(11) The student builds a prototype(s) 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) present the prototype and explain how the prototype ~~it~~ meets the project requirements; and
- (D) evaluate the successes and failures of the prototype(s) in the context of an iterative design process.

(12) 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) investigate and select *appropriate* materials ~~*appropriate*~~ for ~~to the use of~~ a particular product to be designed;

(D) explain the importance of manufacturability and maintainability when designing a product;

(E) determine ~~the~~ design constraints ~~parameters~~ such as personnel, resources, funding, feasibility, and time associated with an engineering problem;

(F) identify requirements ~~constraints~~, including health, safety, social, environmental, ethical, ~~political,~~ regulatory, and legal constraints, defining an engineering problem;

(G) identify ~~or create~~ alternative solutions to a problem using a variety of techniques such as brainstorming, reverse engineering, and researching engineered and natural solutions;

(H) test and evaluate proposed solutions using engineering practices ~~tools such as models, prototypes, and mockups and~~ ~~methods~~ such as *experiments,* simulations, ~~*critical design review,*~~ statistical analysis, and ~~*experiments*~~, *critical design review*; and

(I) *select and justify a preferred solution to a problem* using ~~apply~~ structured techniques such as a decision tree, design matrix, or cost-benefit analysis. ~~to~~ ~~*select and justify a preferred solution to a problem.*~~

(13) The student presents a solution derived through the engineering design process. The student is expected to:

(A) present the solution in a professional manner;

(B) solicit and evaluate feedback on the solution and presentation; and

(C) present learning experiences including ~~such as~~ essential skills gained, areas of personal growth, ~~and~~ challenges, and solutions encountered throughout the design process.

This document reflects the CTE TEKS work group final recommendations as of January 2025.

§127.405. ~~127.784.~~ Engineering Design and Presentation II (Two Credits), Adopted 2025.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

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

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Engineering Career Cluster focuses on planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. This career cluster includes occupations ranging from mechanical engineer and drafter to electrical engineer and to mapping technician.

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

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

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

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

(A) demonstrate dressing appropriately, speaking politely, and conducting oneself in a manner appropriate for the profession and work site;

(B) analyze how teams can produce better outcomes through cooperation, contribution, and collaboration from members of the team;

(C) present written and oral technical communication in a clear, concise, and effective manner for a variety of purposes and audiences, including explaining and justifying decisions in the design process;

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

(E) describe the importance of and demonstrate punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed;

(F) explain how engineering ethics as defined by professional organizations such as the National Society of Professional Engineers applies to engineering practice;

(G) demonstrate respect for diversity in the workplace;

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) analyze elements of professional codes of conduct or creeds in engineering such as the National Society of Professional Engineers Code of Ethics for Engineers and how they apply to the knowledge and skills of the course and the engineering profession;

(J) identify the components of a safety plan and why it is critical for employees and employers to maintain a safe work environment; and

(K) compare skills and characteristics of managers and leaders in the workplace.

(2) The student understands how to implement an engineering design process to develop a product or solution. The student is expected to:

(A) describe and implement the stages of an engineering design process to construct a model;

(B) explain how factors, including complexity, scope, resources, ethics, regulations, manufacturability, and technology, impact stages of the engineering design process;

(C) explain how interested parties ~~stakeholders~~ impact an engineering design process; and

(D) analyze how failure is often an essential component of the engineering design process.

(3) The student explores the methods and aspects of project management in relation to projects. The student is expected to:

(A) research and explain the process and phases of project management, including initiating and planning, executing, and closing;

(B) explain the roles and responsibilities of team members, including project managers and leads;

(C) research and evaluate methods and tools available for managing a project;

(D) discuss the importance of developing and implementing a system for the organization of project documentation such as file naming conventions, document release control, and version control;

(E) describe how project requirements, constraints, and deliverables impact the project schedule, influence ~~and~~ an engineering design ~~influence~~ and are influenced by an engineering design;

(F) explain how a project budget is developed and maintained, including materials, equipment, and labor; and

(G) describe the importance of management of change (MOC) and how management of change (MOC) ~~it~~ applies to project planning.

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

(A) identify and explain the appropriate use of types of personal protective equipment (PPE) used in industry;

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

(C) explain the importance of Lock Out Tag Out (LOTO) procedures in preventing the release of hazardous energy;

(D) explain the importance of safe walking and working surfaces in the workplace and best practices for preventing or reducing slips, trips, and falls in the workplace;

(E) describe the various types of electrical hazards in the workplace and the risks associated with electrical ~~these~~ hazards;

(F) describe the various control methods to prevent electrical hazards in the workplace;

(G) identify workplace health and safety resources, including emergency plans and Safety Data Sheets, and explain how health and safety resources ~~these resources~~ are used to make decisions in the workplace;

(H) describe the appropriate disposal of selected hazardous materials and wastes;

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

(J) handle, use, and store tools and materials correctly; and

(K) research and describe the consequences of negligent or improper equipment maintenance.

(5) The student demonstrates ~~understands~~ the roles and responsibilities of individual team members, how successful teams function, and how to constructively contribute to the team. The student is expected to:

(A) demonstrate ~~describe~~ the various roles and responsibilities of a project team;

(B) create a plan to improve team member's skillsets based on strengths ~~describe and demonstrate how the knowledge and skills~~ of individual team members ~~are used to assign roles and distribute tasks within a team~~;

(C) ~~describe and~~ demonstrate appropriate behaviors of a successful team such as active listening, developing consensus, and clear communication while serving as a team leader and member on projects; and

(D) describe and demonstrate the roles and responsibilities specific to team leaders such as assigning roles and responsibilities, facilitating decision making, tracking progress, and soliciting and providing timely feedback to team members.

(6) The student uses and documents engineering design processes. The student is expected to:

(A) use idea generation ~~solution ideation~~ *techniques* such as brainstorming, sketching, rapid prototyping, and mind mapping during conceptual stages and for resolving problems ~~*techniques*~~ of ~~for~~ an engineering project;

(B) analyze and evaluate solution constraints;

(C) develop or improve a solution using evidence ~~fact~~ -based decision-making;

(D) compare solutions using analysis tools such as a decision matrix or paired comparison analysis;

(E) create and maintain an organized engineering notebook to record findings and corrections, including deficiencies in the design process~~,~~ and decisions throughout the entire design process; and

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

(7) The student understands how systems impact the design, integration, and management of engineering solutions. The student is expected to:

(A) analyze and document ~~explain~~ systems such as electrical, mechanical, or information processes within a product or design concept in engineering;

(B) explain ethical reverse engineering;

(C) reverse engineer a multi-system product and explain how the systems work together ~~in the product~~; and

(D) modify ~~improve~~ a system design~~,~~ *to meet a* newly identified ~~specified~~ *need* or to improve performance. ~~including properties of materials selected,~~ ~~*to meet a specified need*~~.

(8) The student demonstrates proficiency using ~~uses~~ computer-aided design and drafting software as part of the engineering design process. The student is expected to:

(A) research and explain the features and benefits of different types of computer-aided design and drafting software ~~and evaluate~~ applications for use in design systems and problem solving;

(B) identify and describe industry *graphic* standards such as American National Standards Institute (ANSI) and International Organization for Standardization (ISO) ~~*graphic*~~ standards;~~,~~ ~~and~~ ~~*create drawings that meet industry standards;*~~

(C) *create drawings that meet industry standards* using computer-aided design and drafting software*;*

(D) ~~(C)~~ customize computer-aided design and drafting software user interface options such as buttons, tabs, and ribbons to match different digital work environments;

(E) ~~(D)~~ prepare and use advanced views such as auxiliary, section, and break-away using computer-aided design and drafting software;

(F) ~~(E)~~ draw detailed parts, assembly diagrams, and sub-assembly diagrams using computer-aided design and drafting software;

(G) ~~(F)~~ indicate tolerances and standard fittings using appropriate library functions within computer-aided design and drafting software;

(H) ~~(G)~~ *setup* ~~establish~~ and apply annotation styles ~~and~~ ~~*setup*~~ by defining ~~units,~~ fonts, dimension styles, ~~notes,~~ and leader lines using computer-aided design and drafting software;

(I) ~~(H)~~ identify and incorporate the use of advanced layout techniques and viewports using paper-space and modeling areas using computer-aided design and drafting software;

(J) ~~(I)~~ create and use layers to organize objects in drawings using computer-aided design and drafting software;

(K) ~~(J)~~ create and use custom templates using computer-aided design and drafting software for advanced project management;

(L) ~~(K)~~ use advanced polar tracking and blocking techniques using computer-aided design and drafting software to increase drawing efficiency;

(M) ~~(L)~~ create drawings using computer-aided design and drafting software that incorporate external referencing;

(N) ~~(M)~~ create and render objects using parametric modeling tools within computer-aided design and drafting software; and

(O) ~~(N)~~ model individual parts or assemblies and produce rendered or animated output using computer-aided design and drafting software.

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

(A) delineate and implement the steps *such as defining the problem and generating concepts* needed to produce a prototype ~~*such as defining the problem and generating concepts*~~;

(B) develop a prototype ~~prototypes~~ safely using tools, equipment, machines, or precision measuring instruments;

(C) select and justify the use of materials for prototyping and manufacturing;

(D) describe how design quality concepts, including performance, usability, accessibility, reliability, and safe use ~~safety~~, affect prototype ~~product~~ development;

(E) document ~~identify~~ quality-control requirements ~~issues~~ in the ~~engineering~~ design and production of a prototype;

(F) evaluate ~~describe perceptions of~~ prototype quality ~~product~~ and performance to meet design criteria ~~how these perceptions affect engineering decisions~~;

(G) fabricate a ~~the~~ prototype using a systems engineering approach to compare the actual prototype performance to the required performance ~~and use of materials~~; *and*

(H) present a ~~the~~ prototype and explain how the prototype ~~it~~ meets the project requirements.~~;~~ ~~*and*~~

~~(I) describe potential patents related to the prototype and the patenting process.~~

(10) The student creates justifiable solutions to open-ended real-world problems within a multitude of engineering disciplines ~~such as aerospace, bio, civil, electrical, mechanical, or structural engineering~~ using engineering design practices and processes. The student is expected to:

(A) identify and define a multi-system engineering problem ~~problems~~ requiring a complex solution from different engineering disciplines such as aerospace, biomedical ~~bio~~, chemical, civil, electrical, industrial, mechanical, petroleum, robotics, or structural engineering;

(B) formulate and document goals, objectives, and requirements to solve a ~~an~~ multi-system engineering problem;

(C) determine the design constraints ~~parameters~~ such as materials, personnel, resources, funding, manufacturability, feasibility, and time associated with a ~~an~~ multi-system engineering problem;

(D) identify parameters ~~constraints~~, including health, safety, social, environmental, ethical, ~~political,~~ regulatory, and legal constraints, defining a ~~an~~ multi-system engineering problem;

(E) identify or create alternative solutions to a multi-system engineering problem using a variety of techniques such as brainstorming, reverse engineering, and researching engineered and natural solutions;

(F) test and evaluate proposed multi-system engineering solutions using tools such as models, prototypes and mockups and methods such as simulations, critical design review, statistical analysis, and experiments; and

(G) *select and justify a preferred solution to a* multi-system engineering *problem* using ~~apply~~ a structured technique ~~problem~~ such as a decision tree, design matrix, or cost-benefit analysis ~~to~~ ~~*select and justify a preferred solution to a problem*~~.

(11) The student presents a solution derived through the engineering design process. The student is expected to:

(A) develop and deliver a presentation ~~present~~ describing the solution to a multi-system engineering problem in a professional manner to an appropriate audience such as peers, educators, potential clients, potential employers, community members, or engineering professionals;

(B) solicit and evaluate feedback from the audience on the multi-system engineering solution and presentation; and

(C) present learning experiences including ~~such as~~ essential skills gained, areas of personal growth, ~~and~~ challenges, and solutions encountered throughout the design process for a multi-system engineering solution.

This document reflects the CTE TEKS work group final recommendations as of January 2025.

§127.406. ~~127.785.~~ Engineering Design and Problem Solving (One Credit), Adopted 2025.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

(b) General requirements. This course is recommended for students in Grade ~~Grades 11 and~~ 12. Prerequisites: Algebra I, Geometry, and at least one credit in a Level ~~2~~ 3 or higher course in the Engineering ~~science, technology, engineering, and mathematics career~~ cluster. Recommended Prerequisite: Engineering Science. Corequisites: Chemistry, Physics, or Principles of Technology. This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Engineering Career Cluster focuses on planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. This career cluster includes occupations ranging from mechanical engineer and drafter to electrical engineer and to mapping technician.

(3) The Engineering Design and Problem Solving course extends students' problem solving skills by identifying needs and then devising solutions using scientific and engineering practices. Students apply prior knowledge from Algebra I, Geometry, chemistry or physics, as well as a Level 3 course from the Engineering career cluster to develop a multisystem product or solution for a complex problem. Students demonstrate project management skills by collaborating as part of a team, conducting research, and analyzing data that culminates in a comprehensive report and presentation. Technical drawings, models, and prototypes are created using the appropriate tools, materials and techniques. Structured decision making processes are used to select and justify a preferred, multisystem solution to an authentic problem. Students develop, implement and document repeated trials of experiments and tests using scientific and engineering practices to determine whether a prototype meets design requirements.

~~The Engineering Design and Problem Solving course teaches the creative process of solving problems by identifying needs and then devising solutions using scientific and engineering practices. The solution may be a product, technique, structure, or process depending on the problem. Science aims to understand the natural world, while engineering seeks to shape this world to meet human needs and wants. Various engineering disciplines address a broad spectrum of design problems using specific concepts from the sciences and mathematics to derive a solution. Engineering design takes into consideration limiting factors or "design under constraint." The design process and problem solving are inherent to all engineering disciplines.~~

(4) Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.

(5) Scientific hypotheses and theories. Students are expected to know that:

(A) hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and

(B) scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but they may be subject to change as new areas of science and new technologies are developed.

(6) Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

(A) Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.

(B) Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.

(7) Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information).

(8) Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested, while models allow for boundary specification and provide a tool for understanding the ideas presented. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

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

(10) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

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

(A) demonstrate dressing appropriately, speaking politely, and conducting oneself in a manner appropriate for the profession and work site;

(B) analyze how teams can produce better outcomes through cooperation, contribution, and collaboration from members of the team;

(C) present written and oral technical communication in a clear, concise, and effective manner for a variety of purposes and audiences, including explaining and justifying decisions in the design process;

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

(E) describe the importance of and demonstrate punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed;

(F) explain how engineering ethics as defined by professional organizations such as the National Society of Professional Engineers applies to engineering practice;

(G) demonstrate respect for diversity in the workplace;

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) analyze elements of professional codes of conduct or creeds in engineering such as the National Society of Professional Engineers Code of Ethics for Engineers and how they apply to the knowledge and skills of the course and the engineering profession;

(J) identify the components of a safety plan and why it is critical for employees and employers to maintain a safe work environment; and

(K) compare skills and characteristics of managers and leaders in the workplace.

(2) The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:

(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

(B) apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

(D) use appropriate tools such as dial caliper, micrometer, protractor, compass, scale rulers, multimeter, and circuit components;

(E) collect quantitative data using the International System of Units (SI) and United States customary units and qualitative data as evidence;

(F) organize quantitative and qualitative data using spreadsheets, engineering notebooks, graphs, and charts;

(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

(H) distinguish between scientific hypotheses, theories, and laws.

(3) The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A) identify advantages and limitations of models such as their size, scale, properties, and materials;

(B) analyze data by identifying significant statistical features, patterns, sources of error, and limitations;

(C) use mathematical calculations to assess quantitative relationships in data; and

(D) evaluate experimental and engineering designs.

(4) The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

(A) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;

(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(5) The student knows the contributions of scientists and engineers and recognizes the importance of scientific research and innovation on society. The student is expected to:

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

(B) relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content; and

(C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a STEM field.

(6) The student understands how to implement an engineering design process to develop a multisystem product or solution for a complex problem. The student is expected to:

(A) ~~describe and~~ implement the stages of an engineering design process to construct a model of a multisystem product or solution;

(B) explain how factors, including complexity, scope, resources, ethics, regulations, manufacturability, maintainability, and technology, affect ~~impact~~ stages of the engineering design process;

(C) explain how interested parties ~~stakeholders~~ affect ~~impact~~ an engineering design process; and

(D) discuss ~~analyze~~ how lessons learned from failure is often an essential component of the engineering design process.

(7) The student explores and implements the methods and aspects of project management for complex, multi-phase, multi-system projects. The student is expected to:

(A) research and explain the process and phases of project management, including initiating and planning; executing; and closing;

(B) explain the roles and responsibilities of team members, including project managers and leads;

(C) create a resource-loaded project schedule for an engineering project;

(D) maintain a resource-loaded project schedule for the life of an engineering project;

~~(C)~~ ~~research and evaluate methods and tools available for managing a project;~~

(E) ~~(D)~~ develop ~~discuss the importance of developing~~ and implement ~~implementing~~ a system for the organization of project documentation such as file naming conventions, document release control, and version control;

(F) ~~(E)~~ describe how project requirements, constraints, and deliverables affect ~~impact~~ the project schedule and influence and are influenced by an engineering design;

(G) ~~(F)~~ create ~~explain how~~ a budget ~~project~~ that includes ~~is developed and maintained, including~~ materials, equipment, and labor for an engineering project;

(H) ~~(G)~~ describe the importance of management of change (MOC) and how it applies throughout the life of an engineering ~~to~~ project ~~planning~~; ~~*and*~~

(I) ~~(H)~~ create and implement a project management plan for an engineering project~~.~~*; and*

(J) describe how techniques such as Monte Carlo simulation, risk matrices, and tornado diagrams, are used to evaluate risk.

(8) The student conducts research~~,~~ and analyzes data to~~, and~~ create ~~creates~~ a problem statement in the engineering design process. The student is expected to:

(A) create ~~and maintain~~ an organized engineering notebook to record research~~,~~ findings for an engineering project ~~and corrections, including deficiencies in the design process, and~~

~~decisions throughout the entire design process~~ ~~prototypes, corrections, and/or mistakes in the design process~~;

(B) ~~identify and~~ select an open-ended real-world problem that can be solved using scientific and engineering practices and the engineering design process;

(C) collect, organize, analyze, and summarize scientific and technical articles, data, and information to support the development of a problem statement;

(D) define and use ~~identify~~ relevant scientific and engineering ~~technical~~ vocabulary as it relates to the problem statement;

(E) evaluate information from sources for quality, accuracy, completeness, and reliability and conduct additional research as appropriate in the context of an iterative design process; and

(F) create a problem statement that is concise, specific, and measurable.

(9) The student identifies potential solutions and uses structured techniques to select and justify a preferred solution using scientific and engineering practices and the engineering design process. The student is expected to:

(A) identify or create alternative solutions to a problem using a variety of techniques such as sketching, brainstorming, reverse engineering, and researching engineered and nature-based solutions;

(B) select a preferred solution to a problem by applying structured techniques such as a decision tree, design matrix, or cost-benefit analysis;

(C) evaluate whether the preferred solution meets the requirements of the problem statement in the context of an iterative design process;

(D) identify material properties that are important to the solution design such as physical, mechanical, chemical, electrical, and magnetic properties and explain how material properties affect ~~impact~~ material selection;

(E) explain how different engineering solutions can have significantly different effects ~~impacts~~ on individuals, society, and the natural world; and

(F) document concepts, solutions, findings, and structured decision-making techniques in the engineering notebook.

(10) The student creates technical drawings, models, and prototypes using the appropriate tools, materials, and techniques. The student is expected to:

(A) determine and explain the type of technical drawing that best represents the solution;

(B) create a technical drawing(s) that includes dimensions, scale, views, annotations, tolerances, legends, symbols, and material specifications;

(C) create a mathematical or physical model(s)to make predictions, identify limitations, and optimize design criteria;

(D) create a prototype for ~~physical~~ testing;

(E) evaluate the successes and failures of the prototype(s) in the context of an iterative design process; and

(F) revise technical drawings, models, and prototype(s) as the solution evolves to better meet objectives.

(11) The student develops, implements, and documents repeated trials of experiments and tests using scientific and engineering practices to determine whether a prototype meets design requirements. The student is expected to:

(A) design and conduct experiments and tests to determine whether the prototype meets the requirements of the problem statement;

(B) document and evaluate quantitative and qualitative data obtained through experiments and tests of the prototype in the engineering notebook;

(C) create and analyze charts, data tables, or graphs to organize information collected during ~~in an~~ experiments ~~experiment~~ on the prototype;

(D) determine acceptable limits of error in data from experiments and tests of the prototype;

(E) explain the purpose of regression analysis as a method to model and investigate relationships between independent and dependent variables from experiments and tests of the prototype;

(F) identify linear and nonlinear relationships in data and situations where regression is appropriate;

(G) ~~(D)~~ identify sources of random error and systematic error and differentiate between both types of error from experiments and tests of the prototype; and

~~(E) analyze data using statistical methods to recognize patterns, trends and proportional relationships; and~~

(H) ~~(F)~~ evaluate and determine whether the prototype meets the requirements of the problem statement by analysis of data collected in the context of an iterative design process.

(12) The student develops and presents a comprehensive report that describes the problem, research and information collected and analyzed, concepts and solutions considered, prototypes developed and tested, and final results. The student is expected to:

(A) create and present the comprehensive report in a professional manner to an appropriate audience such as peers, educators, potential clients, potential employers, community members, or engineering professionals;

(B) solicit and evaluate feedback from the audience on the comprehensive report and presentation;

(C) present learning experiences such as essential skills gained, areas of personal growth, and challenges and solutions encountered throughout the design process; and

(D) predict the local and global impacts or risks of an engineering solution to segments of the society such as the economy or the environment.

This document reflects the CTE TEKS work group final recommendations as of January 2025.

§127.408. Fluid Mechanics (One Credit), Adopted 2025.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

Comment [1] (b) General requirements. This course is recommended for students in Grades 11-12. Prerequisite: Algebra II and at least one credit in a course from the engineering career cluster or corequisite: Algebra II and recommended corequisite: Physics. ~~or Corequisite: Algebra II Prerequisite: Geometry.~~ This course satisfies a high school science graduation requirement. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Engineering Career Cluster focuses on planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. This career cluster includes occupations ranging from mechanical engineer and drafter to electrical engineer and to mapping technician.

(3) Students enrolled in Fluid Mechanics investigate the behavior and properties of fluids, including liquids and gasses. Through hands-on experiments, simulations, and real-world examples, students learn about concepts such as viscosity, pressure, buoyancy, and flow dynamics. Students explore how fluids interact with solid objects, understanding phenomena like lift and drag, which are critical to the operation of ships, airplanes, and vehicles. Students engage in case studies and problem-solving activities to gain insights into how fluid mechanics shape our everyday lives, technological advancements, and industrial applications. This course prepares students to progress in careers in engineering and scientific disciplines such as aerospace, mechanical, civil, chemical, materials, and physics.

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

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

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

(A) demonstrate dressing appropriately, speaking politely, and conducting oneself in a manner appropriate for the profession and work site;

(B) analyze how teams can produce better outcomes through cooperation, contribution, and collaboration from members of the team;

(C) present written and oral technical communication in a clear, concise, and effective manner for a variety of purposes and audiences, including explaining and justifying decisions in the design process;

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[1] Changing to Pre-Req or Co-Req based on ESC and the Informal recommendations that Physics be a Pre-Req. We do not believe the Physics course as a whole is required to be required prior to taking this course. There are two reasons, first, there is no single topic in physics that cannot be taught in this course necessary, and we believe we covered all requirements in the TEKS regarding forces and vectors. A co-requisite of physics does feel like it would be helpful but not critical. The second reason to not include physics, assuming some agreement to the first point, is that making Physics a Pre-Requisite will limit enrollment in this course to only seniors since Physics is typically a Junior / Senior level class. We are reducing Algebra II to a pre or co-requisite to keep this in alignment with other classes and we do not believe the full content of Algebra II is required for this class.

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

(E) describe the importance of and demonstrate punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed;

(F) explain how engineering ethics as defined by professional organizations such as the National Society of Professional Engineers applies to engineering practice;

(G) demonstrate respect for diversity in the workplace;

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) analyze elements of professional codes of conduct or creeds in engineering such as the National Society of Professional Engineers Code of Ethics for Engineers and how they apply to the knowledge and skills of the course and the engineering profession;

(J) identify the components of a safety plan and why it is critical for employees and employers to maintain a safe work environment; and

(K) compare skills and characteristics of managers and leaders in the workplace.

(2) The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:

(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

(B) apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

(D) use appropriate tools such as dial calipers, protractors, scale rulers, tape measures, load cells, micrometers, scales, tensiometer, multimeter, and thermometers;

(E) collect quantitative data using the System International (SI) and United States customary units and qualitative data as evidence;

(F) organize quantitative and qualitative data using spreadsheets, engineering notebooks, graphs, and charts;

(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

(H) distinguish between scientific hypotheses, theories, and laws.

(3) The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A) identify advantages and limitations of models such as their size, scale, properties, and materials;

(B) analyze data by identifying significant statistical features, patterns, sources of error, and limitations;

(C) use mathematical calculations to assess quantitative relationships in data; and

(D) evaluate experimental and engineering designs.

(4) The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

(A) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;

(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(5) The student knows the contributions of scientists and engineers and recognizes the importance of scientific research and innovation on society. The student is expected to:

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

(B) relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content; and

(C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a STEM field.

(6) The student explains the application of fluids in historical and modern applications. The student is expected to:

Comment [2](A) describe the efficient storage and transportation of fluids, including gravity flow and natural phenomena, such as aqueducts, water towers, winds, and currents. ~~and storage of fluids through various means such as gravity flow (aqueducts and water towers), natural phenomena (winds and currents), and compression~~;

Comment [3](B) explain the use of fluids in power generation and power transmission, such as ~~including~~ hydraulics, pneumatics, pumps, compressors, and turbomachinery; and

Comment [4](C) explain the impact of ~~how~~ lift and drag on a ~~impacts~~ moving object ~~objects~~.

(7) The student describes basic concepts of fluid mechanics. The student is expected to:

(A) differentiate and compare the properties that distinguish a solid from a fluid;

Comment [5](B) ~~*identify different types of fluids*~~ ~~and~~ define the characteristics of a fluid and *identify different types of fluids*, including gasses, liquids, Newtonian, and non-Newtonian;

Comment [6](C) define and list examples of compressible and incompressible ~~(approximately)~~ fluids;

(D) explain the properties of fluids, including density, specific weight, specific gravity, viscosity, and compressibility;

[2] Per staff recommendation, clarified the storage and transportation and changed the example list to include gravity flow and natural phenomena but keeping the specific examples as a such-as list.
[3] Per staff recommendation of clarity, we changed the including list to such as to only provide examples of the two specific topics of power generation and power transmission.
[4] Per staff comment, we attempted to clarify the use of impact for lift & drag as well as changed the objects from plural to singular.
[5]Per staff recommendation, we attempted to clarify the student objective of defining a general fluid and then identifying different types. For clarification, gasses are defined as a type of fluid.
[6] Per staff recommendation we are attempting to clarify the SE statement by eliminating “approximately”. We acknowledge that all fluids are compressible, but for this level of class, many fluids such as hydraulic oil and water are treated as incompressible in calculations.

(E) describe methods to measure and calculate the density, specific weight, specific gravity, viscosity, and compressibility of a Newtonian fluid;

Comment [7](F) ~~measure and~~ calculate density, specific weight, and specific gravity for a variety of fluids from measured data;

Comment [8](G) explain the appropriate use ~~and differences~~ of material reference frames and spatial reference frames, including boundary conditions, control surfaces, and control volumes;

Comment [9](H) identify and explain the variables in the ideal gas law and apply the ideal gas law to constructed problems;

Comment [10](I) explain ~~and demonstrate~~ the laws of conservation of energy and conservation of mass, including the algebraic version of Reynold's Transport theorem; and

Comment [11](J) identify appropriate boundary conditions, including no-slip and ambient pressure, boundary conditions in fluid flow.

(8) The student demonstrates an understanding of pressure and hydrostatics and calculates values in a variety of systems. The student is expected to:

(A) describe the relationship between force, area, and pressure;

(B) calculate force proportionalities in hydraulic and pneumatic cylinders using Pascal's law and explain the impact of the cylinders' diameter on the resultant force[12];

(C) differentiate between atmospheric pressure, gauge pressure, and absolute pressure;

Comment [13](D) describe the working principles of a pressure gauge and measure fluid pressure using ~~with~~ dial gauges and manometers;

(E) calculate the buoyant force of floating and submerged objects according to Archimedes' principle; and

(F) define and calculate hydrostatic pressure.

(9) The student demonstrates an understanding of fluid flows in steady-state pipes, channels, and free jets. The student is expected to:

Comment [14](A) compare developing, fully-developed, and steady-state Newtonian fluid flows in pipes and channels;

(B) compare fluid flow profiles, including uniform and parabolic;

Comment [15](C) describe experimental measurements of fluid flow field lines, including stream, streak, and pathlines ~~in fluid flow~~;

[7] Modified because directly measuring density or specific weight/gravity is not reasonable with typical high school equipment. The objective is for students to take measured data or properties such as volume or weight and calculate these material properties.
[8] Per staff comment, removed the differences. The purpose of the SE is accomplished when a student describes the use of the different reference frames and the components versus having to include the differences.
[9] Per Staff comment, added the full name of the Ideal Gas law.
[10] Per staff recommendation, eliminated the requirement to demonstrate the law of conservation of mass and energy. Mass would have been easier than energy but this could create problems in the secondary school environment to successfully demonstrate 100.0% conservation. Reynolds theorem can be applied to both mass and energy of a fluid.
[11] Per staff recommendation, added comma at the end of the include list, put it after the word pressure.
[12] Per staff recommendation, clarified what the cylinder's diameter impacts.
[13] Per staff recommendation to clarify what students will be using as a measurement device.
[14] Per staff recommendation to add hyphen.
[15] Per staff recommendation, did not include the suggested comma but struck the tail 'in fluid flow' as not necessary.

Comment [16](D) calculate volumetric flow rate in a steady state system using the continuity equation and conservation of mass; ~~apply the continuity equation and conservation of mass to calculate volumetric flow rate in a steady state system;~~

(E) explain how Bernoulli's equation relates to the total energy of a steady-state system;

Comment [17](F) calculate unknown variables in varying conditions, including changes in height, velocity, and cross-sectional area of a steady state system using Bernoulli's equation and the conservation of energy; ~~apply Bernoulli's equation and the conservation of energy to calculate unknown variables in varying conditions, including changes in height, velocity, and cross-sectional area of a steady-state system;~~

(G) derive Torricelli's equation from Bernoulli's equation and calculate the exit velocity and mass flow rates of free jets;

(H) calculate fluid flows in pipes, channels, and free jets using the Reynolds Transport theorem and conservation of mass; and

(I) calculate the resultant force of a free jet at the outlet based on the density of the fluid, cross-sectional area, pressure, and velocity of the fluid.

(10) The student demonstrates an understanding of the effects of an object moving through a fluid. The student is expected to:

(A) differentiate turbulent and laminar flows;

Comment [18](B) calculate the Reynolds number of given flows to determine if the ~~they~~ flows are turbulent or laminar;

(C) define lift and drag as applied to fluid flows;

(D) explain the relationship between viscosity and shear force in a fluid flow;

(E) explain the variables of lift and drag formulas and how the variables relate to fluid flow; and

Comment [19](F) design an experiment to measure the drag coefficient for a solid body in a fluid flow.

(11) The student understands compressible flow and the relationship between sound transmission through a fluid and fluid compression. The student is expected to:

Comment [20](A) differentiate between compressible and incompressible ~~(approximately)~~ fluids and explain the effect of compressibility on the speed of sound through a fluid;

(B) explain how density impacts the speed of sound through a fluid;

Comment [21](C) calculate and use the Mach number to model a fluid as compressible or incompressible ~~(approximately)~~; and

(D) explain the effects on fluid, including shock waves, when the sound barrier is broken.

[16] Per staff recommendation, rephrasing for clarity.
[17] Per staff recommendation, the SE was changed to make Calculate the primary verb.
[18] Per staff recommendation removed pronoun and clarified the statement.
[19] Staff comment to 'design and conduct an experiment...'. We decided not to add the 'and conduct' words because science TEKS do not specify experiments and this leaves it open to the teacher which experiments to conduct. The primary objective will also be accomplished if a student can successfully design a quality experiment to measure drag.
[20] Per staff recommendation clarified the desired student expectation of the effects of compressibility on the speed of sound through a fluid. Approximately was removed though it is noted that all fluids are compressible, though the compressibility of some is so small that it is ignored at this level of fluids mechanics.
[21] Approximately was removed though it is noted that all fluids are compressible, though the compressibility of some is so small that it is ignored at this level of fluids mechanics.

(12) The student designs and analyzes fluid systems. The student is expected to:

Comment [22](A) explain the function of weirs in an open channel and describe an application of weirs such as flow control or flow measurement;

(B) calculate the fluid flow in open channels with different shapes, slopes, and weirs;

Comment [23](C) design an application of *hydrostatics* using the principle of buoyancy ~~using~~ ~~*hydrostatics*~~ such as a boat, submarine, floating dock, or hot air balloon;

(D) analyze and design a fluid device such as a clepsydra, water tower, pressure regulator, or nozzle using the principles of fluid dynamics;

(E) describe applications and processes of different types of pumps, including centrifugal pumps, peristaltic pumps, gear pumps, and positive displacement pumps;

Comment [24](F) describe the operation of a centrifugal pump and explain the data presented in a pump curve, including head, flow rate, efficiency, and power;

(G) design a hydraulics system with components, including hydraulic fluid, pump, reservoir, motor, cylinders, valves, and flow controllers;

(H) identify and compare different types of turbomachines, including pumps and turbines;

(I) describe and differentiate the applications of turbomachines, including pumps and turbines; and

Comment [25](J) explain the concept of tribology and identify the associated variables of tribology such as film thicknesses and pressures.

[22] Per staff recommendation to clarify the subject of the 'application'.
[23] Per staff recommendation clarified the reference of the such as modifier to 'principle of bouyancy'.
[24] Staff question about the include statement reference being towards pump curve or data. The include statement is referencing the pump curve so this should be acceptable.
[25] added 'of tribology' to clarify the reference of the word variables in break-outs.

This document reflects the CTE TEKS work group final recommendations as of January 2025.

§127.409. Mechanics of Materials (One Credit), Adopted 2025.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

Comment [1](b) General requirements. This course is recommended for students in Grades 10-12. Prerequisites: Algebra II, Chemistry, and *at least one credit from the Engineering Career Cluster* or corequisites: Algebra II, Chemistry and recommended corequisite: Physics, ~~Prerequisite: Algebra I,~~ ~~*at least one credit from the Engineering Career Cluster.*~~ ~~Recommended prerequisite: Geometry.~~ This course satisfies a high school science graduation requirement.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

Comment [2](2) The Engineering Career Cluster focuses on planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. This career cluster includes occupations ranging from mechanical engineer and drafter to electrical engineer and ~~to~~ mapping technician.

(3) Students enrolled in Mechanics of Materials describe the mechanical behavior of engineering materials, including metals, ceramics, polymers, composites, welds, and adhesives. Applications of load, deformation, stress and strain relationships for deformable bodies and mechanical elements relevant to engineers. The course includes axially loaded members, buckling of columns, torsional members, beams, and failure.

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

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

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

(A) demonstrate dressing appropriately, speaking politely, and conducting oneself in a manner appropriate for the profession and work site;

(B) analyze how teams can produce better outcomes through cooperation, contribution, and collaboration from members of the team;

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[1] Changing to Pre-Req or Co-Req based on ESC and the Informal recommendations that Physics be a Pre-Req. We do not believe the Physics course as a whole is required to be required prior to taking this course. There are two reasons, first, there is no single topic in physics that cannot be taught in this course necessary, and we believe we covered all requirements in the TEKS regarding forces and vectors. A co-requisite of physics does feel like it would be helpful but not critical. The second reason to not include physics, assuming some agreement to the first point, is that making Physics a Pre-Requisite will limit enrollment in this course to only seniors since Physics is typically a Junior / Senior level class. We are reducing Algebra II to a pre- or co-requisite to keep this in alignment with other classes and we do not believe the full content of Algebra II is required for this class. Chemistry is added as a pre or co-requisite since there is a strong relationship between the atomic structure of materials and their properties. Having Chemistry will improve student's understanding of the mechanics of materials content.

Added statement that the course fulfills a science requirement.

[2] Removed 'to' to improve parallelism

(C) present written and oral technical communication in a clear, concise, and effective manner for a variety of purposes and audiences, including explaining and justifying decisions in the design process;

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

(E) describe the importance of and demonstrate punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed;

(F) explain how engineering ethics as defined by professional organizations such as the National Society of Professional Engineers applies to engineering practice;

(G) demonstrate respect for diversity in the workplace;

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) analyze elements of professional codes of conduct or creeds in engineering such as the National Society of Professional Engineers Code of Ethics for Engineers and how they apply to the knowledge and skills of the course and the engineering profession;

(J) identify the components of a safety plan and why it is critical for employees and employers to maintain a safe work environment; and

(K) compare skills and characteristics of managers and leaders in the workplace.

(2) The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:

(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

(B) apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

(D) use appropriate tools such as dial calipers, protractors, scale rulers, tape measures, load cells, micrometers, scales, tensometer, multimeter, and thermometers;

(E) collect quantitative data using the System International (SI) and United States customary units and qualitative data as evidence;

(F) organize quantitative and qualitative data using spreadsheets, engineering notebooks, graphs, and charts;

(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

(H) distinguish between scientific hypotheses, theories, and laws.

(3) The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A) identify advantages and limitations of models such as their size, scale, properties, and materials;

(B) analyze data by identifying significant statistical features, patterns, sources of error, and limitations;

(C) use mathematical calculations to assess quantitative relationships in data; and

(D) evaluate experimental and engineering designs.

(4) The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

(A) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;

(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

(5) The student knows the contributions of scientists and engineers and recognizes the importance of scientific research and innovation on society. The student is expected to:

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

(B) relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists and engineers as related to the content; and

(C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a STEM field.

(6) The student examines the historical developments that led to the field of mechanics of materials and material science. The student is expected to:

Comment [3] (A) describe the contribution *to the field of mechanics* by ~~of~~ historical scientists ~~*to the field of mechanics*~~ such as Pascal, Galileo, Euler, Navier, Lame, Poisson, Hooke, and Young;

(B) describe key historical advancements related to the development of different materials such as bronze, iron, steel, Damascus steel, and Roman concrete;

Comment [4](C) explain how materials have influenced historical events and ~~or~~ products such as the steel in the Titanic, the space race, and smartphones;

Comment [5](D) evaluate and explain the impact of modern development of materials to manufacturing such as composites, nanotechnology, semi-conductors, alloys, and the effects of processes on materials such as subtractive manufacturing, additive manufacturing, and welding; and

Comment [6](E) describe the development of shapes in architectural structures ~~and architecture~~ such as columns, arches, domes, keystones, and suspension bridges.

Comment [7](7) The student identifies and measures different properties of an object ~~them~~. The student is expected to:

(A) classify properties of an object as geometric, structural, or material;

[3] Staff Recommendation to bring such as to historical scientists. Moved the phrase ‘to the field of mechanics’ to make reading easier.
[4] Modified per staff recommendation. We believe ‘and’ creates a stronger SE for instruction.
[5] Per staff recommendation, we attempted to clarify the verb and clarify the impact of ‘what’ in the SE.
[6] Per staff recommendation, clarified structures to architectural structures and removed architecture as a separate item because the such as items to not match the definition of architecture.
[7] Removing the word ‘them’ as it was a typo error.

Comment [8](B) identify and describe the application of tools~~ used to measure material properties~~, including rulers, calipers, micrometers, weighing scales, tensile testers (tensometers), and thermometers;

Comment [9](C) measure common properties of materials, including length, width, height, and mass;

Comment [10](D) measure and observe intrinsic properties of materials such as hardness, thermal conductivity, impact resistance;

Comment [11](E) ~~analyze data and ~~calculate density, cross-sectional area, specific gravity, thermal expansion, modulus of elasticity, Poisson's ratio, bulk modulus, yield, and ultimate stress using data from a table or graph;

(F) differentiate material properties, including ductility, malleability, resilience, toughness, and reflectivity;

(G) classify material properties as geometric (extrinsic), material (intrinsic), or structural; and

(H) classify types of materials, including metals and alloys, polymers, ceramics, biomaterials, composites, and semiconductors.

(8) The student understands various manifestations of forces acting on solids. The student is expected to:

Comment [12](A) illustrate forces, including axial, radial, normal, torsional and shear and identify different units such as newtons, pounds, and KIPS used ~~utilized~~ in force measurement;

(B) explain force intensity of distributed forces, including forces distributed over a line, area, and volume;

(C) calculate and simplify multiple loads to a single combined load;

(D) distinguish between normal forces and shear forces; and

(E) identify and calculate different types of stress, including axial stress, shear stress, and bending stress.

(9) The student evaluates the effect of temperature on the properties of a material. The student is expected to:

(A) describe engineering applications of thermo-mechanical properties such as thermometers, thermocouples, thermistors, thermostatic valves and controllers, and fuses;

Comment [13](B) explain the atomic origin of thermal expansion resulting in measurable effects such as building height change~~,~~ and material distortion;

(C) describe potential failure modes due to thermal expansion for kinematically constrained structures;

(D) explain how to accommodate thermal expansion in construction such as buckling of railroad rails, U-runs in piping, and expansion joints; and

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[8] Per Staff recommendation, removed phrase as unnecessary to bring the including list next to the tools.
[9] We do not want to take the staff recommendation to specify the unit of measurement. The science TEKS in KS 2 say the units can be either SI or US Customary and that should be applicable in this SE as well.
[10] We do not want to take the staff recommendation to specify the unit of measurement. The science TEKS in KS 2 say the units can be either SI or US Customary and that should be applicable in this SE as well.

[11] Per staff recommendation, clarified the data to be used and put the key verb at the beginning of the SE.
[12] Per staff recommendation, replaced utilized with used.
[13] Per staff recommendation, removed comma after 'change'.

(E) explain the effect of temperature on the mechanical properties of materials, including modulus of elasticity, yield strength, ductility, and toughness.

(10) The student determines the material properties from different mechanical material tests and how they are graphically represented. The student is expected to:

Comment [14](A) describe a tensile test, the various ~~different~~ possible shapes of tensile testing specimens, and tensile test ~~the~~ measurements ~~obtained in a tensile test~~, including force, elongation, and change in thickness;

(B) analyze data from a tensile test to calculate engineering stress and strain for various materials such as aluminum, brass, cast iron, steel, and nylon at significantly different temperatures;

(C) plot engineering stress and strain on a two-dimensional graph;

(D) identify regions of a stress-strain curve, including elastic deformation, plastic deformation, resilience, strain hardening, fracture, and tension toughness;

(E) estimate the values from a stress-strain curve, including 0.2% offset, modulus of elasticity, yield stress, ultimate stress, resilience, and tension toughness;

Comment [15](F) compare and explain differences in testing plots based on differences in specimen geometry and material;

(G) compare different types of material testing, including compression tests, tensile tests, and three-point bending tests;

(H) analyze testing results from compression and three-point bending tests with different specimen geometries, including length, cross-sectional shape, and cross-sectional area; and

(I) describe modern mechanical testing such as digital image correlation, thermography, acoustic emission, and x-ray diffraction.

(11) The student analyzes the impact of the cross-sectional geometry on the second moment of area for beams and shafts. The student is expected to:

(A) calculate the area and the second moment of area for primitive shapes, including rectangles, triangles, circles, and semi-circles;

Comment [16](B) explain the parallel~~-~~axis theorem and use the parallel axis theorem to calculate the second moment of area for complex shapes;

(C) calculate area, centroid, and second moment of area for complex shapes composed of primitive shapes such as an H-beam, square tubes, round tubes, and angle iron; and

(D) hypothesize the best cross-sectional shape for different types of loads such as tension, compression, torsion, bending, and combinations of these loads.

(12) The student represents point and distributed forces on a sketch and calculates the maximum deflection and factor of safety of bars, cables, columns, beams, and shafts using algebraic equations. The student is expected to:

(A) describe the consequences of stresses such as elastic deformation, plastic deformation, and fracture on solid objects with mass;

[14] Per staff recommendation, changed different to various, clarified the noun that the including statement refers to.
[15] Added 'and material' to have students compare the results of testing based on different materials which was previously lacking in this course.
[16] Per ESC recommendation, removed first hyphen in parallel axis.

Comment [17](B) calculate the maximum deflection of various homogenous prismatic beams, including simply supported, cantilever, and overhang beams, using algebraic formulas;

(C) calculate the factor of safety of various homogenous prismatic beams, including simply supported, cantilever, overhang beams, and columns, using algebraic formulas;

(D) analyze the impact of cross-sectional area and length on the potential for various homogenous prismatic columns to buckle under load;

Comment [18](E) explain the impact of and ~~or~~ the reason for using a tapered object in structural applications; and

Comment [19](F) describe why pre-stress is used ~~utilized~~ in applications such as shot-peening, tempered glass, wheel spokes, flatbed trailers, and bridges.

(13) Students demonstrate an understanding of stress, strain, and displacement fields throughout a structure, including bars and beams. The student is expected to:

(A) identify compression and tension regions in a bent beam;

(B) describe the kinematics of a bent member, including elongation due to tension, shortening due to compression, the neutral axis, and the linear displacement profile; and

(C) identify regions of compression and tension in digital image correlation data.

(14) The student understands that the mechanics of materials are required to analyze a multi-member structure for strength and stability in real-world applications. The student is expected to:

(A) compare permanent and non-permanent joints, including welding, brazing, soldering, adhesives, bolting, screwing, and riveting joints;

(B) analyze a bolted connection for pre-stress, load, factor of safety, grade, size, yield stress, and applied torque; and

(C) design a structure to support a specified load with materials of adequate properties, size, and geometry and with an appropriate factor of safety.

[17] Per staff recommendation, added a comma after overhanging beams to conclude the ’including’ list.
[18] Per staff recommendation, changed or to and to push students to explain both impact and reason.
[19] Per staff recommendation, replaced utilized with used.

§127.410. Statics (One Credit), Adopted 2025.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

Comment [1](b) General requirements. This course is recommended for students in Grades 11-12. Prerequisite: Algebra II and at least one credit in a course from the engineering career cluster or corequisite Algebra II and recommended corequisite: Physics. ~~recommended prerequisite: Physics~~

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Engineering Career Cluster focuses on planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. This career cluster includes occupations ranging from mechanical engineer and drafter to electrical engineer and to mapping technician.

Comment [2](3) ~~Introduction to~~ Statics is a gateway course into most engineering majors such as aerospace, mechanical, civil, and biomedical engineering. Students learn the elements of statics that include the forces in structures that are in equilibrium and usually not moving. This includes forces calculated in two dimensions, free-body diagrams, distributed loads, centroids, and friction as applied to cables, trusses, beams, machines, gears, and mechanisms. Students explore scenarios where objects remain stationary, emphasizing the importance of balance and stability in engineering design. This course not only equips students with theoretical knowledge but also empowers them with practical skills that are indispensable in real-world engineering scenarios.

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

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

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

(A) demonstrate dressing appropriately, speaking politely, and conducting oneself in a manner appropriate for the profession and work site;

(B) analyze how teams can produce better outcomes through cooperation, contribution, and collaboration from members of the team;

(C) present written and oral technical communication in a clear, concise, and effective manner for a variety of purposes and audiences, including explaining and justifying decisions in the design process;

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[1] Changing to Pre-Req or Co-Req based on ESC and the Informal recommendations that Physics be a Pre-Req. We do not believe the Physics course as a whole is required to be required prior to taking this course. There are two reasons, first, there is no single topic in physics that cannot be taught in this course necessary and we believe we covered all requirements in the TEKS regarding forces and vectors. A co-requisite of physics does feel like it would be helpful but not critical. The second reason to not include physics, assuming some agreement to the first point, is that making Physics a Pre-Requisite will limit enrollment in this course to only seniors since Physics is typically a Junior / Senior level class. We are reducing Algebra II to a pre or co-requisite to keep this in alignment with other classes and we do not believe the full content of Algebra II is required for this class.

[2] Removed Introduction to match the recommended name of this course. Correcting grammar to include but Also to match the non only phrase.

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

(E) describe the importance of and demonstrate punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed;

(F) explain how engineering ethics as defined by professional organizations such as the National Society of Professional Engineers applies to engineering practice;

(G) demonstrate respect for diversity in the workplace;

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) analyze elements of professional codes of conduct or creeds in engineering such as the National Society of Professional Engineers Code of Ethics for Engineers and how they apply to the knowledge and skills of the course and the engineering profession;

(J) identify the components of a safety plan and why it is critical for employees and employers to maintain a safe work environment; and

(K) compare skills and characteristics of managers and leaders in the workplace.

(2) The student describes milestones in structural design and construction throughout history. The student is expected to:

Comment [3](A) research and evaluate the significance ~~contribution~~ of pioneering ~~historical~~ structures such as the Eiffel Tower, Pyramids, Roman Aqueducts, Ferris Wheel, Sydney Opera House, and St. Louis Bridge to the field of structural design;

(B) analyze how locally available materials and technology have impacted the construction of structures through time;

Comment [4](C) identify the contributions of ~~historical~~ *structural design* pioneers ~~to the field of~~ ~~*structural design*~~ such as Archimedes, Leonardo DaVinci, Galileo, René Descartes, and Albert of Saxony; and

Comment [5](D) identify careers that use the field of statics and predict the future application of statics.

(3) The student measures and converts units in the System International (SI) units and United States (US) customary systems of measurement. The student is expected to:

(A) measure objects using different units of measurement such as feet, inches, centimeters, meters, pounds force, Newtons, slugs, and kilograms in decimal and fractional measurements;

(B) apply prefixes to units of measure and convert between units in U.S. customary and SI systems such as kgs and kips; and

(C) identify physical examples of different units of measurement, including one Newton, one pound, and one kip.

(4) The student develops an understanding of point and distributed forces and moments, including torque and couples and their respective units. The student is expected to:

(A) explain how Newton's third law of motion applies to static systems;

(B) explain the purpose and operation of mechanical components, including gears, sprockets, pulleys, and simple machines;

[3] Staff comment to clarify requirement of 'evaluate' so the students are evaluating significance versus a nebulous contribution.
[4] rephrased to reflect input from Staff comment about misplaced modifier.
[5] changed word b/c of suggestion from staff comment.

(C) explain how mechanical components, including gears, sprockets, pulley systems, and simple machines, are used in mechanisms;

(D) explain distributed loads and simplify distributed loads to point loads;

(E) compare a two-dimensional distributed load applied over a line to a distributed load applied over an area and a volume;

(F) calculate and use applicable units for forces, torque, distances, and mechanical advantages related to levers, gears, and pulleys;

(G) define and calculate the efficiency of mechanical systems; and

(H) identify and explain couples in a static system.

(5) The student applies vector algebra to calculate the equivalent force and moment vectors. The student is expected to:

(A) differentiate between scalar and vector quantities;

(B) identify properties of a vector, including magnitude and direction;

(C) convert forces represented graphically to vector notation;

(D) represent a force vector in its horizontal and vertical components;

(E) calculate resultant vectors from multiple vectors using a strategy, including vector addition and the parallelogram rule;

(F) simplify free-body diagrams by using strategies, including the principle of transmissibility, couples, and the summation of moments;

Comment [6](G) calculate moments of a rigid body system using strategies, including multiplying ~~the product of~~ force by the ~~and~~ perpendicular distance to a specified axis and the right-hand rule;

(H) calculate moments from component forces using Varignon's principle; and

(I) apply equivalent transformation to simplify external loads in a structural system.

(6) The student locates and applies the geometric centroid and the center of mass of homogenous and heterogeneous objects. The student is expected to:

(A) explain the difference between geometric centroid and center of mass;

(B) locate the geometric centroid of simple and complex shapes using the composite parts method; and

(C) locate the center of mass for two-dimensional and three-dimensional homogeneous and heterogeneous objects.

(7) The student determines the stability of simple and complex objects with a variety of applied forces. The student is expected to:

(A) identify potential pivot points at which objects could potentially rotate leading to a tip-over;

Comment [7](B) determine the stability of simple and complex objects with only frictional force using the relative location of the center of mass and the object pivot point; ~~use the relative location of the center of mass and object pivot point to determine the stability of simple and complex objects with only frictional force;~~

[6] Per the staff recommendation, we rephrased to attempt to make the 2-item list clearer that the product of the force & distance is one include item and the right hand rule is the second include item.

[7] Per staff recommendation, we utilized the suggested re-write of the statement.

(C) calculate the stability of simple and complex objects with external forces applied at different locations on the object and a reaction force caused by friction; and

Comment [8](D) describe how the friction reaction forces when combined with applied forces at different locations affect the stability of an object and how to stabilize ~~unstable~~ systems subject to tipping.

(8) The student differentiates supports, including fixed, pin, and roller supports, for structures. The student is expected to:

Comment [9](A) define and compare the applications of different structural supports, including fixed, pin, and roller supports, and describe which support is utilized in a cantilevered beam;

(B) explain the degrees of freedom for fixed, pin, and roller supports;

(C) describe how fixed, pin, and roller supports affect a structural system; and

(D) describe and sketch the different reaction forces and moments for structural supports, including fixed, pin, and roller supports.

(9) The student constructs free-body diagrams of particles and rigid bodies around various supports and determines the reaction forces of the static body. The student is expected to:

Comment [10](A) sketch a complete free-body diagram that ~~which~~ includes applied and reaction forces for a structure;

(B) define static equilibrium;

(C) formulate translational and rotational static equilibrium equations into a system of algebraic equations; and

(D) solve for unknown forces in a structure using equations of equilibrium.

(10) The student analyzes statically determinant plane trusses. The student is expected to:

(A) test if a plane truss is statically determinant;

Comment [11](B) apply ~~use~~ the method of sections and method of joints to calculate the internal forces of a statically determinant plane truss;

(C) explain the difference between tension and compression forces;

Comment [12](D) describe capabilities of members, including beams, cables, ropes, bars, and columns, to bear tension, compression, or both tension and compression;

(E) identify internal members as being in tension or compression, the members bearing the maximum loads, and the member most likely to fail; and

(F) design structures such as bridges, tensegrity structures, or trusses to support external loads.

(11) The student recognizes the limitations of a two-dimensional model. The student is expected to:

(A) identify the differences between a two-dimensional and three-dimensional system;

(B) explain the implications of adding a third dimension to a structure and how a two-dimensional analysis is insufficient to model a three-dimensional structure; and

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[8] Per staff recommendation, we modified the language to focus the scope for educators to understand better.
[9] Per Advisory comments, we added the cantilever beam reference to draw the association between cantilevered beams and fixed supports to ensure it is clearly notated in this section.
[10] Per staff recommendation, replaced which with that.
[11] Pers staff recommendation that use should be replaced, we selected the word apply to apply concepts or strategies to calculate internal forces.
[12] Per staff recommendation, clarified the word both for the purposes of breakouts.

(C) describe how a third dimension can cause instability in a structure.

This document reflects the CTE TEKS work group final recommendations as of January 2025.

§127.407. Environmental Engineering ~~Sustainability~~ (One Credit), Adopted 2025.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

(b) General requirements. Environmental Engineering ~~Sustainability~~ is recommended for students in Grades 10 ~~9~~-12. ~~Recommended~~ Prerequisites: At least one credit in a course from the ~~Level 2 or higher course in~~ engineering or ~~renewable~~ energy career cluster. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Engineering Career Cluster focuses on planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. This career cluster includes occupations ranging from mechanical engineer and drafter to electrical engineer and to mapping technician.

Comment [1](3) In Environmental Engineering ~~Sustainability~~, students research, develop, and design solutions related to water, land ~~management~~, and energy, ~~and food supply~~ with consideration to ethics and regulations ~~and policy~~. Using technology and the engineering design process, students devise innovative solutions to address current and future engineering challenges. ~~The student uses technology and the engineering design approach to devise solutions focused on current and future sustainability challenges.~~

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

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

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

(A) demonstrate dressing appropriately, speaking politely, and conducting oneself in a manner appropriate for the profession and work site;

(B) analyze how teams can produce better outcomes through cooperation, contribution, and collaboration from members of the team;

(C) present written and oral technical communication in a clear, concise, and effective manner for a variety of purposes and audiences, including explaining and justifying decisions in the design process;

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

(E) describe the importance of and demonstrate punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed;

[1] The course was reviewed and reframed to focus on environmental engineering and design. The broader focus is to introduce environmental concepts relevant to the practice of engineering. Conforming edits were made throughout the course.

(F) explain how engineering ethics as defined by professional organizations such as the National Society of Professional Engineers applies to engineering practice;

(G) demonstrate respect for diversity in the workplace;

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) analyze elements of professional codes of conduct or creeds in engineering such as the National Society of Professional Engineers Code of Ethics for Engineers and how they apply to the knowledge and skills of the course and the engineering profession;

(J) identify the components of a safety plan and why it is critical for employees and employers to maintain a safe work environment; and

(K) compare skills and characteristics of managers and leaders in the workplace.

(2) The student understands how to implement an engineering design process to develop a product or solution. The student is expected to:

(A) describe and implement the stages of an engineering design process to construct a model;

(B) explain how factors, including complexity, scope, resources, ethics, regulations, manufacturability, and technology, impact stages of the engineering design process;

(C) explain how stakeholders impact an engineering design process; and

(D) analyze how failure is often an essential component of the engineering design process.

(3) The student explores the methods and aspects of project management in relation to projects. The student is expected to:

(A) research and explain the process and phases of project management, including initiating and planning; executing; and closing;

(B) explain the roles and responsibilities of team members, including project managers and leads;

(C) research and evaluate methods and tools available for managing a project;

(D) discuss the importance of developing and implementing a system for the organization of project documentation such as file naming conventions, document release control, and version control;

(E) describe how project requirements, constraints, and deliverables impact the project schedule and influence and are influenced by an engineering design;

(F) explain how a project budget is developed and maintained, including materials, equipment, and labor; and

(G) describe the importance of management of change (MOC) and how it applies to project planning.

(4) Engineering ~~Sustainability~~ Ethics. The student applies ethical consideration to analyze ~~sustainable and~~ resilient engineered systems. The student is expected to:

(A) compare the Texas Engineering Practices Act to the code of ethics of other engineering societies such as the American Society of Civil Engineers and the National Society of Professional Engineers to explain how engineers demonstrate the responsibility they have to serve the public interest, his or her clients, and the profession with a high degree of honesty, integrity, and accountability;

(B) research the New London school explosion and explain how this event led to the development of the Texas Engineering Practice Act and other regulations such as odorization of natural gas;

Comment [2](C) evaluate and explain ~~assess~~ an engineering ethical dilemma between environmental limitations and the needs and wants of ~~our~~ society; and

Comment [3](D) explain how engineering solutions can have significantly different impacts~~, including environmental, economic, social, political, health, and welfare,~~ on an individual, society, and the natural world.~~; and~~

Comment [4]~~(E) identify an ethical dilemma that has positive and negative outcomes resulting from an environmental engineering decision or series of decisions.~~

(5) The student builds a model(s) using the appropriate tools, materials, and techniques. The student is expected to:

Comment [5](A) identify and describe the steps needed to produce a model of a system such as hydrological, watershed management, or geospatial analysis models;

(B) identify advantages and limitations of models such as size, scale, properties, and materials;

(C) identify and use appropriate tools, equipment, and materials to produce a model;

(D) describe the use of a model to accurately represent the key aspects of a physical system, including the identification of constraints such as cost, time, or expertise, that may influence the selection of a model;

Comment [6](E) develop a design proposal ~~present a model~~ using a variety of media to produce a model; and

(F) evaluate the successes and failures of a model(s) in the context of an iterative design process.

(6) Critical and Creative Problem-Solving. The student examines environmental challenges and gathers assumptions to synthesize a meaningful, well-defined problem and ideates multiple solutions. The student is expected to:

Comment [7](A) collect, analyze, and interpret information relevant to an environmental engineering ~~a~~ problem;

(B) document a design process according to best practices in an engineering notebook;

(C) identify and define visual, functional, and design requirements with realistic constraints against which solution alternatives can be evaluated;

Comment [8](D) list potential appropriate criteria for a defined problem that may impact the success of a design solution such as economic, environmental, ~~social, political,~~ ethical, health and safety, ~~manufacturability,~~ technical feasibility, and design ~~sustainability~~;

(E) represent concepts using a variety of visual tools such as sketches, graphs, and charts to communicate the details of an idea;

(F) develop, design, and test alternatives to generate valid quantitative data to inform decision making and demonstrate solutions; and

Comment [9](G) explain why there are often multiple viable solutions ~~and no obvious best solution~~.

[2] Clarifying SE verb choice
[3] Clarifying SE for measurability
[4] Redundant to 4.D
[5] Clarify SE intent
[6] Clarify SE intent
[7] Clarify SE intent
[8] Applicability of these topics for the environmental engineering focus of the course
[9] Streamlining SE language

(7) Critical and Creative Problem-Solving. The student selects the optimal design solution for real-world environmental problems based on engineering judgement. The student is expected to:

Comment [10] (A) ~~develop and carry out a justifiable scheme to compare and~~ evaluate competing solutions paths using a decision matrix to compare ~~and evaluate competing~~ solutions based on design criteria;

(B) formulate a risk analysis matrix using a spreadsheet to evaluate threats and opportunities, including cost, time, and environmental ~~and social~~ impacts;

(C) identify ~~the~~ data needed to address an environmental engineering research question and the appropriate tools necessary to collect, record, analyze, and evaluate the data; and

(D) evaluate evidence and arguments to identify deficiencies, limitations, and biases for appropriate next steps in the pursuit of a better solution.

(8) Engineering Tools and Technology (ETT). The student uses a variety of techniques to measure and report quantities appropriate for an environmental analysis. The student is expected to:

(A) research and determine appropriate units of measure, including acres, miles, and hectares, for environmental analysis;

(B) measure and estimate a large-scale area such as a wetland, streamline, or floodplain using maps or digital resources;

(C) perform dimensional analysis and unit conversions to transform data to units appropriate for a particular purpose or model; and

(D) select and effectively use ~~the~~ appropriate tools ~~tool~~ for accurately measuring specific volumes.

(9) Water Resources. The student analyzes environmental factors related to safe drinking water. The student is expected to:

Comment [11] (A) *research and describe the Texas State Water Plan, including the sources of water, floodplain management, and recycling*;~~.~~

(B) ~~(A)~~ analyze the relationship between population growth and water resources;

(C) ~~(B)~~ describe how human health is affected by the quality of drinking water sources;

Comment [12] (D) *describe and compare the most common sources of drinking water such as desalination, aquifers, surface water,* and *reclaimed water in developed and developing countries;*

(E) ~~(C)~~ explain the characteristics of potable ~~clean~~ water;

Comment [13] ~~(D) explain why clean water is necessary for survival;~~

(F) ~~(E)~~ describe common sources of drinking water contamination, including stormwater runoff;

(G) ~~(F)~~ explain contaminant cycling through an ecosystem; and

Comment [14] ~~(G) describe the types of water found on Earth and the relative amounts of each type;~~

~~(H)~~ ~~*describe and compare the most common sources of drinking water such as desalination, aquifers, surface water,* glacial water, *reclaimed water in developed and developing countries;*~~

[10] Improve conciseness of SE
[11] Moved from 9.J to emphasize the importance of this SE
[12] Moved from 9.H. Additionally, glacial water does not apply to Texas.
[13] Implied knowledge from other SEs
[14] Implied knowledge from other SEs

(H) ~~(I)~~ describe the infrastructure components of private wells and public drinking water systems.~~; and~~

~~*(J) research and describe the Texas State Water Plan, including the sources of water, floodplain management, and recycling.*~~

(10) Water Quality. The student evaluates water quality and uses a variety of chemical and biological assays to describe water quality. The student is expected to:

(A) research and describe Environmental Protection Agency (EPA) and Texas Commission on Environmental Quality (TCEQ) surface water quality standards for rivers, lakes, and estuaries;

(B) research and describe annual water quality compliance reports and compare water quality between the different reports;

(C) explain how water quality is quantitatively measured using chemical and biologically based testing processes;

(D) perform and analyze a culture assay to detect coliform in water;

(E) collect a water sample and determine water turbidity and pH;

(F) outline the stages of treatment that a typical modern sewage treatment plant uses to treat sewage water;

(G) explain the role of bacteria in wastewater treatment;

(H) research and describe emerging contaminants such as microplastics and pharmaceuticals in water;

(I) describe the interacting roles of bacteria, protozoa, and rotifers in a wastewater treatment ecosystem;

(J) describe and provide examples of how physical, chemical and biological processes work in the process of purifying contaminated water;

(K) explain how plants remove nitrates from contaminated water;

(L) use the engineering design process to design, build, and test a water filtration system;

(M) design and perform an experiment to use phytoremediation to remove contaminants from water; and

(N) design and conduct a scientific experiment to test a variable affecting the bacteria's ability to decompose oil.

Comment [15]~~(11) Food Security. The student explains the meaning and value of food security and analyzes environmentally and socially sustainable and unsustainable food production methods. The student is expected to:~~

~~(A) analyze the advantages and disadvantages of genetically modified crops;~~

~~(B) research and explain the use of genetically modified crops as animal feed such as cottonseed for livestock;~~

~~(C) list and explain potential ways that crop plants might be improved through genetic modification;~~

~~(D) explain how transgenic plants could lead to positive and negative consequences to the environment and local ecosystem;~~

[15] Food security was included in the original innovative course. It is not relevant to an introductory level course in environmental engineering.

~~(E) describe the economic and socio-political issues associated with genetically modified food crops;~~

~~(F) investigate and summarize the ethical ramifications of genetic engineering and recombinant DNA technologies;~~

~~(G) analyze socially sustainable and unsustainable food production methods;~~

~~(H) describe food deserts and how food security exists with all people; and~~

~~(I) research and explain the impact to food security when food sources are used as energy sources.~~

(11) ~~(12)~~Energy. The student demonstrates a working knowledge of various sources of energy and their environmental and economic impact. The student is expected to:

(A) explain the differences between renewable and non-renewable sources of energy and provide examples of each;

(B) identify and measure the amount and types of energy that students use in their daily lives;

(C) calculate the carbon footprint of a household;

Comment [16](D) compare the fuel efficiency ~~carbon intensity~~ of various ~~fossil fuels and alternative~~ fuel sources ~~terms of the short and long-term effects on the atmospheric carbon cycle~~;

Comment [17]~~(E) explain the similarities and differences between fossil fuels and alternative sources;~~

~~(F) explain the differences between renewable and non-renewable sources of energy and provide examples of each;~~

(G) analyze the results of software simulations and models that vary the amounts and types of energy used to predict future energy needs;

(H) perform a full life cycle assessment (LCA) of material and energy sources; and

(I) identify the variables and the methods for completing an LCA.

Comment [18](12) ~~(13)~~ Engineering resilient systems. ~~Climate~~. The student understands the environmental impacts to infrastructure systems and the need to support system performance with resilient solutions. ~~of human activities on climate.~~ The student is expected to:

~~(A) research and explain net embodied carbon;~~

~~(B) research and explain greenhouse gas emissions;~~

~~(C) identify common sources of air pollution and describe the impacts of air pollution to human health;~~

(D) describe mitigation techniques for air pollutants and greenhouse gas emissions;

(E) analyze the impact on humans of naturally occurring extreme weather events such as flooding, hurricanes, tornadoes, and thunderstorms;

(F) research and explain how engineering design can be more resilient to environmental impacts ~~climate change~~ to limit additional impacts to the natural environment; and

~~(G) describe and analyze the impacts of climate to renewable energy resources; and~~

(H) research and explain elements of natural environmental resilience.

[16] Fuel efficiency is a more pertinent requirement for the energy needs for an environmental engineering challenge.
[17] Redundancy of content
[18] Environmental engineering focuses more on resiliency of systems as a response to environmental issues.

Comment [19](13) ~~(14)~~ Land management. The student understands land management and land management practices. ~~the practice of using land resources to meet needs while also protecting the environment and ensuring the land's long-term productivity.~~ The student is expected to:

(A) explain the value of a healthy ecosystem and the impact of biodiversity on the environment;

Comment [20](B) research and explain ecological value of the land such as direct products and provisioning, regulating, supporting, and cultural services; ~~and explain how to conserve the ecology of the land~~;

(C) identify ~~develop~~ land conservation and preservation restorative measures using industry practice standards such as the United States Department of Agriculture (USDA) National Resources Conservation Services (NRCS) Conservation Practice Standards for a given land area;

(D) research changes in land use and land cover over time using geospatial tools;

(E) analyze and report environmental impacts due to changes in land use such as urbanization over time; and

(F) explain the role of protected areas and lands to safeguard natural ecosystems.

(14) ~~(15)~~Waste management. The student understands the role and importance of waste management. The student is expected to:

(A) analyze the impacts of reduction, reuse, and recycling in waste management ~~for environmental sustainability~~;

(B) explain the impact of individual practices of waste reduction on resource management;

Comment [21](C) explain the capture and use of methane gas from landfills;

(D) ~~(C)~~ analyze the waste breakdown cycle of various waste products that enter landfills; and

(E) ~~(D)~~ research and describe hazardous waste products and impacts on the environment, including long-term storage needs and pollution.

(15) ~~(16)~~Regulations ~~Policy~~. The student understands the role of global, national, and local standards ~~policies~~ and regulations in environmental design ~~sustainability~~. The student is expected to:

~~(A) research and analyze the United Nations (UN) sustainability development goals (SDG);~~

(A) ~~(B)~~ research and describe the ~~origins and~~ functions of the EPA and U.S. Fish and Wildlife Service;

(B) research and describe the functions of the TCEQ and the Texas Parks and Wildlife Department (TPWD); and

(C) describe the relationship between the National Environmental Policy Act (NEPA), the EPA, and TCEQ.~~; and~~

~~(D) describe how policy can develop, incentivize, and maintain environmentally sustainable practices.~~

(16) ~~(17)~~Future ~~sustainability~~ challenges in environmental engineering. The student discusses and analyzes some of the persistent environmental ~~global~~ engineering challenges to sustain growing populations, the natural environment, and improve quality of life. The student is expected to:

[19] Simply KS intent
[20] Clarifying SE intent
[21] Identified essential content

(A) explain why some environmental engineering challenges are persistent such as providing access to clean water, ~~providing a sustainable food supply,~~ energy, sanitation, and health ~~care~~ to growing populations;

Comment [22]~~(B) identify and describe the environmental sustainability elements within the "Grand Challenges" defined by the National Academy of Engineering;~~

~~(C) analyze the environmental sustainability elements within the "Grand Challenges" to determine the potential implications for society;~~

(B) ~~(D)~~ create a ~~sustainable~~ solution to a current challenge to meet the needs of society without compromising the ability to meet the needs of the future ~~society~~;

(C) ~~(E)~~ identify principles that help guide development of ~~sustainable~~ solutions with considerations for sustainable development to include people and ~~,~~ planet~~, and profit~~; and

(D) ~~(F)~~ describe the life cycle of a product or service and identify energy consumption, wastes, and emissions that are produced in the process.

[22] B and C were overly prescriptive. Focus on essential environmental engineering knowledge and skills.

This document reflects the CTE TEKS work group final recommendations as of January 2025.

§127.403. Programming for Engineers (One Credit), Adopted 2025.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

(b) General requirements. This course is recommended for students in Grades 9-12. Prerequisite: Algebra I and Principles of Applied Engineering, Physics for Engineering, Introduction to Computer-Aided Design and Drafting, Introduction to Engineering Design, or Engineering Essentials. Students shall be awarded one credit for successful completion of this course.

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Engineering Career Cluster focuses on planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. This career cluster includes occupations ranging from mechanical engineer and drafter to electrical engineer and to mapping technician.

(3) Students enrolled in Programming for Engineers focus on understanding, writing, evaluating and troubleshooting code to solve engineering problems. Students use the engineering process and computational thinking to write computer programs for real-world solutions. Students explore autonomous systems, sensors, and careers to integrate computational thinking within their engineering mindset. Students spend at least 40% of the instructional time completing hands-on, real-world projects.

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

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

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

(A) demonstrate dressing appropriately, speaking politely, and conducting oneself in a manner appropriate for the profession and work site;

(B) analyze how teams can produce better outcomes through cooperation, contribution, and collaboration from members of the team;

(C) present written and oral technical communication in a clear, concise, and effective manner for a variety of purposes and audiences, including explaining and justifying decisions in the design process;

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

(E) describe the importance of and demonstrate punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed;

(F) explain how engineering ethics as defined by professional organizations such as the National Society of Professional Engineers applies to engineering practice;

(G) demonstrate respect for diversity in the workplace;

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) analyze elements of professional codes of conduct or creeds in engineering such as the National Society of Professional Engineers Code of Ethics for Engineers and how they apply to the knowledge and skills of the course and the engineering profession;

(J) identify the components of a safety plan and why it is critical for employees and employers to maintain a safe work environment; and

(K) compare skills and characteristics of managers and leaders in the workplace.

(2) The student understands how to implement an engineering design process to develop a product or solution. The student is expected to:

(A) describe and implement the stages of an engineering design process to construct a model;

(B) explain how factors, including complexity, scope, resources, ethics, regulations, manufacturability, and technology, impact stages of the engineering design process;

(C) explain how stakeholders impact an engineering design process; and

(D) analyze how failure is often an essential component of the engineering design process.

(3) The student explores the methods and aspects of project management in relation to projects. The student is expected to:

(A) research and explain the process and phases of project management, including initiating and planning; executing; and closing;

(B) explain the roles and responsibilities of team members, including project managers and leads;

(C) research and evaluate methods and tools available for managing a project;

(D) discuss the importance of developing and implementing a system for the organization of project documentation such as file naming conventions, document release control, and version control;

(E) describe how project requirements, constraints, and deliverables impact the project schedule and influence and are influenced by an engineering design;

(F) explain how a project budget is developed and maintained, including materials, equipment, and labor; and

(G) describe the importance of management of change (MOC) and how it applies to project planning.

(4) Computational thinking--foundations. The student explores the core concepts of computational thinking related to engineering solutions, a set of problem-solving processes that involve decomposition, pattern recognition, abstraction, and algorithms. The student is expected to:

(A) decompose real-world engineering problems into structured parts by using visual representation;

(B) analyze and use industry specific symbols, patterns and sequences found in visual representations such as flow-charts, pseudocode, concept maps, or other representations of data;

(C) define and practice abstraction in the context of writing a program to solve an engineering problem;

(D) design a plan ~~collaboratively~~ using visual representation to document a problem, possible solutions, and an expected timeline for the development of a coded engineering solution;

(E) analyze different techniques used in debugging and apply them to an algorithm;

(F) analyze the benefits of using iteration such as ~~(~~code and sequence repetition~~)~~ in algorithms, including loops and functions;

(G) define and analyze Boolean expressions;

(H) define and analyze conditional statements;

(I) write code that uses conditional statements such as (if), (then), (while), and (else);

(J) compare the differences between scripting and programming languages~~,~~ such as ~~for example~~ interpretation versus compiling; and

(K) identify ~~define~~ and demonstrate when to use a compiler and editor for programming design.

(5) Computational thinking--applications. The student applies the fundamentals of programming within the context of engineering. The student is expected to:

(A) analyze how programming parallels ~~the~~ iterative design within the engineering design process such as problem solving and critical thinking illustrated in an engineering notebook;

(B) modify ~~and implement~~ previously written code and implement the modified code to develop improved programs;

(C) solve an engineering problem by creating block-based or ~~and~~ text-based programs that include sequences, functions, loops, conditionals, and events;

(D) identify ~~define~~ and label variables that relate to a ~~their~~ programming ~~programming~~ or algorithm;

(E) manipulate and rename variables and describe different data types;

(F) write comments while coding programs for ~~within the context of~~ engineering solutions to enhance readability and functionality~~,~~ such as ~~including~~ descriptive identifiers, internal comments, white space, spacing, punctuation, indentation and standardized programming style;

(G) write code that uses comparison operators such as greater than, less than, equal to, and modulus to perform mathematical computations;

(H) write code that uses strings to sort different ~~*types*~~ ~~of~~ data *types* such as Boolean operators, floats, and integers; and

(I) perform user testing on code to assess and improve a ~~their~~ program.

(6) The student understands physical computing systems to integrate input and output functions in engineering concepts. The student is expected to:

(A) write programming to process data and control physical devices for efficient and optimized solutions;

(B) apply coding to demonstrate the correct operation of the output device such as motors, video displays, speakers, rapid prototype machines, and lights;

(C) apply coding to demonstrate the correct operation of the input device such as buttons, sensors, and switches;

(D) apply critical problem-solving skills to troubleshoot any errors and miscommunication such as wiring, code and physical hardware;

(E) apply ~~demonstrate~~ basic circuit theory as it pertains to ground and power systems for diagramming input and output devices and use tools such as a multimeters, microcontrollers, sensors, and LEDs; and

(F) apply ~~demonstrate~~ script writing and its importance automating input and output devices to develop engineering solutions such as automatic data collecting, data analysis, programmable logic controllers, power system programming, robotics, and scripting for commercial engineering related software.

(7) The student understands the roles of sensors and programming sensors in engineering. The student is expected to:

(A) ~~identify and~~ describe how sensors were used in past and used currently in real-world engineered products, including ~~new and~~ innovative applications ~~methods~~ for sensors;

(B) identify ~~and describe~~ the proper input sensors to measure light, distance, sound, and color such as photoresistors, thermistors, sonar, switches, and buttons;

(C) identify ~~and analyze~~ the specifications of sensors and other input devices used in engineering problems, including units of measurement, upper limits, lower limits, and errors;

(D) differentiate the proper sensor and defend their choice in developing a solution to an engineering problem;

(E) write code that will control ~~the~~ sensors and accurately collect relevant information pertaining to the function of sensors ~~the sensor~~;

(F) debug, asses, and test code to evaluate and improve sensor performance; and

(G) document the steps of sensor integration in an engineering notebook using ~~such as~~ flowcharts or ~~and~~ technical drawings.

(8) The student understands how automation plays a role in engineering and manufacturing. The student is excepted to:

(A) research and explain ~~define~~ how automated machines are used in engineering and manufacturing;

(B) research and explain ~~define and present on the~~ different job roles and required level of education in the field of automation;

(C) compare the roles of engineers, technicians, and technologists in automation;

(D) describe the role of safety and ethics related to the use of ~~among~~ automation within engineering; and

(E) convert a manual mechanical system to an automated system using code and hardware.

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

~~(A) master relevant safety tests;~~

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

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

(C) ~~(D)~~ dispose of hazardous materials and wastes appropriately;

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

(D) ~~(F)~~ describe the implications of negligent or improper maintenance of tools in engineering solutions;

(E) ~~(G)~~ demonstrate the use of precision measuring instruments ~~instrument~~;

(F) ~~(H)~~ analyze a circuit design and identify specific areas where quality, reliability, and safety features can be implemented; and ~~identify areas where quality, reliability, and safety pertain in to can be designed into a circuit design;~~

(G) ~~(I)~~ identify governmental and organizational regulations for health and safety in the workplace related to electronics. ~~; and~~

~~(J) identify areas where quality, reliability, and safety can be designed into a product.~~

This document reflects the CTE TEKS work group final recommendations as of January 2025.

§127.452. Practicum in Engineering (Two Credits), Adopted 2025.

(a) Implementation. The provisions of this section shall be implemented by school districts beginning with the 2025-2026 school year.

(b) General requirements. This course is recommended for students in Grade 12. Prerequisite: Recommended prerequisite:

(c) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and emerging professions.

(2) The Engineering Career Cluster focuses on planning, designing, testing, building, and maintaining of machines, structures, materials, systems, and processes using empirical evidence and science, technology, and math principles. This career cluster includes occupations ranging from mechanical engineer and drafter to electrical engineer and to mapping technician.

Comment [1](3) ~~Students enrolled in~~ Practicum in Engineering is designed to give students supervised practical application of knowledge and skills. Practicum experiences can occur in a variety of locations appropriate to the nature and level of experiences such as employment, independent study, internships, assistantships, mentorships, or laboratories. To prepare for careers in engineering, students must attain academic knowledge and skills, acquire technical knowledge and skills related to the workplace, and develop knowledge and skills regarding career opportunities, entry requirements, and industry expectations. To prepare for success, students need opportunities to learn, reinforce, apply, and transfer their knowledge and skills and technologies in a variety of settings.

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

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(d) Knowledge and skills.

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

(A) demonstrate dressing appropriately, speaking politely, and conducting oneself in a manner appropriate for the profession and work site;

(B) analyze how teams can produce better outcomes through cooperation, contribution, and collaboration from members of the team;

(C) present written and oral technical communication in a clear, concise, and effective manner for a variety of purposes and audiences, including explaining and justifying decisions in the design process;

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

(E) describe the importance of and demonstrate punctuality, dependability, reliability, and responsibility in reporting for duty and performing assigned tasks as directed;

(F) explain how engineering ethics as defined by professional organizations such as the National Society of Professional Engineers applies to engineering practice;

(G) Demonstrate respect for diversity in the workplace;

[1] An introduction paragraph that provides a course description was added to the course.

(H) identify consequences relating to discrimination, harassment, and inequality;

(I) analyze elements of professional codes of conduct or creeds in engineering such as the National Society of Professional Engineers Code of Ethics for Engineers and how they apply to the knowledge and skills of the course and the engineering profession;

(J) identify the components of a safety plan and why it is critical for employees and employers to maintain a safe work environment; and

(K) compare skills and characteristics of managers and leaders in the workplace.

(2) The student understands how a professional engineer serves the local and global community. The student is expected to:

(A) research and identify student and professional engineering organizations and the benefits of membership such as networking platforms, training and educational opportunities, and participating in community initiatives;

(B) explain an engineer's role and how various engineering roles serve the organization, community, and society; and

(C) evaluate how the work of student or professional engineering organizations impact the local or global community such as recommended practices and issuing standards.

(3) The student uses critical thinking and problem solving in the work-based learning experience. The student is expected to:

(A) conduct technical research to gather information, identify gaps, and make decisions in the work-based learning experience;

(B) develop creative and innovative solutions to problems in the work-based learning experience;

(C) analyze and compare alternative designs for an effective solution to a problem in the work-based learning experience; and

(D) evaluate and present solutions to problems in the work-based learning experience.

(4) The student understands and demonstrates how effective leadership and teamwork skills enable the accomplishment of goals and objectives. The student is expected to:

(A) analyze leadership characteristics such as trustworthiness, positive attitude, integrity, and work ethic;

(B) explain and demonstrate effective characteristics of teamwork;

(C) explain and demonstrate responsibility for shared group and individual work tasks in the work-based learning experience;

(D) describe and analyze how to use effective working relationships such as meeting deadlines, showing respect for all individuals, and clear and timely communication, to accomplish objectives; and

(E) research and identify opportunities to participate in extracurricular engineering activities.

(5) The student demonstrates oral and written communication skills in delivering and receiving information and ideas. The student is expected to:

(A) apply appropriate content knowledge, technical concepts, and vocabulary to analyze information and follow directions;

(B) use professional communication skills such as using technical terminology, email etiquette, and following the organization or team communication plan and hierarchy when delivering and receiving information in the work-based learning experience;

(C) identify and analyze information contained in informational texts, internet sites, or technical materials in the work-based learning experience;

(D) describe and analyze verbal and nonverbal cues and behaviors such as body language, tone, and interrupting to enhance communication in the work-based learning experience; and

(E) apply active listening skills to receive and clarify information in the work-based learning experience.

(6) The student reflects on the work-based learning experience to prepare for postsecondary and employment success. The student is expected to:

(A) assess and evaluate personal strengths and weaknesses in knowledge and skill proficiency and contributions to a project related to the work-based learning experience;

(B) develop and maintain 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 and active participation in career and technical student organizations and professional organizations;

(v) abstract of key points of the practicum;

(vi) resume;

(vii) samples of work; and

(viii) evaluation from the practicum supervisor; and

(C) present the professional portfolio to interested stakeholders.

(7) The student develops a presentation describing the culmination of skills and knowledge gained from the work-based learning experience. The student is expected to:

(A) develop a professional presentation to display and communicate the work-based learning experience, including goals and objectives, levels of achievement, skills and knowledge gained, areas for improvement and personal growth, challenges encountered throughout the experience, and a plan for future goals;

(B) identify an appropriate audience and coordinate the presentation of findings related to the work-based learning experience;

(C) present findings in a professional manner using concise language, engaging content, relevant media, and clear speech; and

(D) analyze feedback received from a presentation.

Comment [2] ~~(8) The student compares engineering work-based learning project budget documents and processes to project budget documents and processes learned in engineering courses. The student is expected to review and interpret a budget for a project from the work-based learning experience.~~

[2] Eliminating this KS as high school students will most likely not have access to budget documents for either projects or processes in a workplace.

This document reflects the CTE TEKS work group final recommendations as of January 2025.

§127.453. Extended Practicum in Engineering (One Credit), Adopted 2025.

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

(b) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.

(2) The Engineering Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services, including laboratory and testing services, and research and development services.

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

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

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and skills.

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

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

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

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

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

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

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

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

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

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

(D) analyze, interpret, and effectively communicate information, data, and observations; and

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

(3) The student implements advanced problem-solving methods. The student is expected to:

(A) employ critical-thinking skills with increased fluency both independently and in groups to solve problems and make decisions;

(B) analyze elements of problems to develop creative and innovative solutions;

(C) apply decision-making techniques with increased fluency to the selection of technological solutions; and

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

(4) The student understands and applies proper safety and security techniques in the workplace. The student is expected to understand and consistently follow workplace safety rules and regulations.

(5) The student understands the professional, ethical, and legal responsibilities in engineering-related fields. The student is expected to:

(A) demonstrate a positive, productive work ethic by performing assigned tasks as directed;

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

(C) comply with all applicable rules, laws, and regulations in a consistent manner.

(6) The student participates in a supervised engineering experience. The student is expected to:

(A) conduct, document, and evaluate learning activities in a supervised engineering experience;

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

(C) evaluate strengths and weaknesses in technical skill proficiency; and

(D) collect representative work samples.