Career and Technical Education, Texas Essential Knowledge and Skills
Engineering Career Cluster
Mechanical and Aerospace Engineering 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 Mechanical and Aerospace Engineering 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, MECHANICAL AND AEROSPACE ENGINEERING CTE TEKS TABLE OF CONTENTS

§127.411. Mechanical Design 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 1 and at least one credit in a course from the engineering career cluster. Recommended corequisite: Geometry. 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 Mechanical Design I demonstrate knowledge and skills associated with design and manufacture of mechanical systems. Fundamental mechanisms are introduced such as gears, belts, threaded elements, and four-bar mechanisms. Basic manufacturing processes such as stamping, injection molding, casting, machining, and assembly are explored through reverse engineering. The mechanisms encountered through reverse engineering enable the exploration of product functionality. Students compare engineering choices made for components, materials, and manufacturing processes. Emphasis is placed on team collaboration and professional documentation.

(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) Collaboration. The student develops teamwork skills. The student is expected to:

(A) discuss principles of critique such as describing, analyzing, interpreting and evaluating;

Comment [1](B) identify and demonstrate teamwork skills such as sensemaking where a team member recognizes another team member who requires additional clarity and then addresses the team member by providing clarity; ~~demonstrate sensemaking skills such as recognizing team members who require additional clarity and addressing team members to provide clarity;~~

(C) identify methods for structuring projects such as Gantt charts, Work Breakdown Structure, Agile, Critical Path Method; and

(D) discuss the importance of contributing to positive and productive group dynamics to enhance teamwork.

(5) Documentation. The student documents information gathered and interpretation developed throughout engineering processes. The student is expected to:

[1] Addresses the comment on "sensemaking" being vague for the teachers.

(A) create documents such as executive summaries, reverse engineering forms, test reports, failure documents, system black box models, engineering notebooks, and drawing packages aligned with professional industry standards;

Comment [2](B) select the document format to communicate essential information for identified stakeholders; ~~identify the audience and their needs for technical documents;~~ and

(C) explain and justify the structure and sequence of how information is presented in engineering documents.

(6) Mechanisms. The student investigates and understands mechanisms that convert motion such as gears, belts, threaded elements, linkages, or linear actuators. The student is expected to:

(A) create virtual models of physical mechanisms using appropriate tools;

(B) predict how different inputs affect the motion of a mechanism such as gears and linkages and compare the predictions with physical models;

Comment [3](C) classify ~~types of~~ mechanisms into different types such as gears, belts, threaded elements, linkages, or linear actuators; and

(D) explain how changes in the dimensions of a mechanism influence the relationship between input to output.

(7) Reverse engineering. The student systematically disassembles and analyzes a system to identify the concepts involved in function and manufacture. The student is expected to:

(A) use appropriate simple tools and methods to disassemble consumer products such as can openers, mixers, or drills;

(B) document the reverse engineering process using appropriate documentation tools and methods;

(C) identify mechanisms of a product such as drive systems and gears and how their function contributes to the overall function of the product;

(D) identify elements of a product such as housings, covers, controls and how their attributes contribute to the product;

(E) use appropriate measurement tools and methods to capture and document information about the sub-assemblies and components in a product;

(F) identify and evaluate the choice of particular materials in the elements of a product;

Comment [4](G) identify and evaluate the choice of the ~~manufacturing~~ process used to manufacture ~~of~~ the element of a product; and

Comment [5](H) identify and evaluate the choice of the process to assemble ~~assembly process of~~ a product.

(8) Manufacturing. The student identifies different manufacturing processes such as stamping, injection molding, casting, sintering, and machining and assembly. The student is expected to:

Comment [6](A) explain and compare common manufacturing processes such as stamping, casting, injection molding, and machining;

[2] Clarified the measurability of the SE
[3] Added clarity (reworded)
[4] Edited for clarity
[5] Edited for clarity
[6] Edited "common" for breakout clarity

Comment [7](B) identify and describe stamping manufacturing process ~~explain the~~ elements such as press, tool, and blank, and ~~related~~ process steps such as shearing, bending, and perforating, ~~used in the stamping manufacturing process~~;

(C) identify and describe injection molding ~~explain the~~ elements such as hopper, heater, platen, and mold, and ~~related~~ process steps such as heating, injecting~~, used in the injection molding manufacturing process~~;

(D) identify and describe casting ~~explain the~~ elements such as mold, furnace, parting plane, sprue, and gate and ~~related~~ process steps such as heating, pouring, cooling, and removal ~~in casting manufacturing processes such as sand casting, investment casting, or die casting~~;

(E) identify and describe sintering ~~explain the~~ elements such as mold, furnace, binder, and powder, and ~~related~~ process steps such as heating, pressing, cooling, and post-processing~~, used in the sintering manufacturing process~~;

Comment [8](F) identify and describe material removal ~~explain the~~ elements such as workpiece, tool, jigs and fixtures, and the machine used such as mill, lathe, or drill, and ~~related~~ process steps such as holding, locating, and cutting ~~used in material removal processes such as milling, turning, drilling, and grinding~~;

(G) identify and describe assembly process ~~explain the~~ elements such as jigs and fixtures, tolerances, fasteners, and tools and related process steps such as locating, holding, joining, and automating ~~used in the assembly process~~; and

Comment [9](H) identify and explain which material types are appropriate for manufacturing processes such as stamping, injection molding, casting, sintering, material removal, and assembly.

(9) Assembly. The student explores the assembly process. The student is expected to:

Comment [10](A) explain the purposes of joining methods such as welding, adhesive bonding, fastening, riveting, and snap fitting;

Comment [11](B) evaluate the choice of joining methods found in a consumer product and generate requirements based on the evaluation ~~to justify the selected methods~~; and

(C) compare different assembly strategies such as assembly line, automation versus manual, or batch versus pull.

(10) Design. The student applies appropriate professional design tools. The student is expected to:

(A) define industry relevant terminology, including Failure Modes Effects Analysis (FMEA), Design for Manufacturing (DFM), Design for Assembly (DFA), Lean Manufacturing, Design of Experiments (DOE), benchmarking, reverse engineering, and Life Cycle Analysis (LCA);

(B) use design tools such as Failure Modes Effect Analysis (FMEA), Quality Functional Deployment (QFD), root cause analysis, five whys, or decision matrices to extract information about a reverse engineered product;

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[7] For all of the manufacturing SEs, we switched “explain” with “describe” and moved the manufacturing process to the start of the SE so that the two lists (elements and process steps) flowed more readily…
[8] “jigs and fixtures” is a single item in the list; reworked the SE to move the manufacturing process to the start of the SE with a focus on elements and process steps.
[9] Added “identify” to address the comment.
[10] Added explanation of “explain”
[11] Changed wording for clarity

Comment [12](C) develop an ~~generate~~ engineering requirements list to justify the selection of materials, processes, parts, and features from a reverse engineered product;

Comment [13](D) identify opportunities for manufacturing and assembly improvement from a ~~in~~ reverse engineered consumer product ~~products~~; and

(E) design and conduct tests to collect information needed to understand the engineers' design decisions, including material, manufacturing process, and mechanism choices, during a reverse engineering project.

Comment [14] (11) Key concepts. The student understands key concepts of mechanical engineering. The student is expected to:

(A) define heat transfer concepts such as conduction, convection, or radiation;

(B) define thermodynamic concepts such as systems boundary, conservation, or entropy;

(C) define mechanics of materials concepts such as strain, stress, elasticity, brittleness, or fatigue;

(D) define dynamics concepts such as vibrations, dampening, or spring coefficients;

(E) define material concepts such as strength, hardness, metallics, polymers, or ceramics;

(F) define fluids concepts such as mass flow rate, viscosity, compressibility, turbulence, or boundary layer;

(G) define statics concepts such as free body diagrams, force, torque, moment, or equilibrium;

(H) define controls concepts such as open loop, closed loop, or systems modeling; and

(I) define engineering computational tools such as computer aided design (CAD), finite element analysis (FEA), or computational fluid dynamics (CFD).

[12] Switched verb from generate to develop and added "list" to clarify the requirements…
[13] Cleaned up the preposition
[14] Added "key mechanical engineering concepts" to provide additional vocabulary

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

§127.412. Mechanical Design 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. Prerequisite: Mechanical Design I. 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) Students enrolled in Mechanical Design II demonstrate knowledge and skills associated with the design development and validation of a prototype solution to meet a given set of requirements. Students identify project stakeholders; manage projects; evolve requirements; model system solutions; develop, test, and refine prototypes; and validate project solutions. Emphasis is placed on budget management, professional documentation, conducting project status updates, critiquing design reviews, and team collaboration.

(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) Collaboration. The student develops teamwork skills. The student is expected to:

Comment [1](A) explain and apply sensemaking skills such as recognizing team members who require additional clarity and addressing team members to provide clarity;

Comment [2](B) apply methods ~~for structuring projects~~ such as Gantt charts, Work Breakdown Structure, Agile, Critical Path Method, to structure a project;

Comment [3](C) apply principles of critique within the team such as describing, analyzing, interpreting and evaluating;

Comment [4](D) develop and present ~~execute~~ action plans to positively support the team's work relationships;

[1] Added "explain" the skill to help with measurement
[2] Adjusted the wording to make it clear
[3] Added clarity "within the team"
[4] Clarified "actions" as "action plans"

(E) explain and model how to provide an effective critique of team members on topics such as team performance, test performance, project development, or presentation;

(F) explain and model how to provide an effective critique of other teams on topics such as presentation, problem definition, schedule, and solution justification;

(G) analyze and evaluate critique received from team members and other teams; and

(H) develop a design review presentation to provide status and solicit feedback on the design problem and solution.

(5) Documentation. The student documents information gathered and interpretations developed throughout the applied engineering process. The student is expected to:

(A) generate documents such as executive summaries, reverse engineering forms, test reports, failure documents, system black box models, engineering notebooks, and drawing packages by applying professional standards and templates;

(B) select the appropriate document format for the information being communicated based on the audience;

(C) explain and justify the structure and sequence of how the information is presented in the engineering documents;

(D) create assembly and user manuals for peer review; and

(E) generate a final design report that focuses on the project scope and solution with appendices to capture all relevant design information such as the design process used, requirements compliance matrix, concept reports, and test reports.

(6) Project management. The student reviews and applies basic project management strategies following a proposal-justification-approval process for each significant model considered. The student is expected to:

(A) generate a project management plan that includes time and deliverable estimates;

Comment [5](B) review and update periodically the project management plan ~~and~~ based on appropriate industry standard practices ~~tools~~ such as stage-gate and agile; team structure and formation; and project modeling such as flow charts, Gantt charts, Program Evaluation Review Technique (PERT), critical path method, and work breakdown structures;

(C) create model or test proposals for review; and

(D) compare project management approaches such as stage-gate and agile.

(7) Stakeholder. The student understands how to engage stakeholders, including end user, consumer, fabricator, maintenance, the design team, and other engineers. The student is expected to:

(A) describe how an engineer's professional responsibility applies to stakeholders;

(B) develop a journey map or equivalent tool to model how the stakeholder interacts with the product; and

(C) explain the importance of maintaining engagement with the stakeholder throughout the project.

Comment [6](8) Design Requirements. The student understands the importance of the role of requirements in the ~~to~~ mechanical engineering design process. The student is expected to:

(A) identify and elicit stakeholder requirements;

[5] Cleaned up the text

[6] Added clarity (modifiers); significant rework of all the SE's based on the comments

(B) ~~(C)~~ *generate, refine,* and document product and project *requirements throughout the project;*

(C) ~~(B)~~ document ~~create~~ requirements in correct format with appropriate standards such as NASA, Mil-Standard, and INCOSE;

~~(B)~~ ~~*generate and refine requirements throughout the project;*~~

~~(C) relate requirements to stakeholders;~~

(D) verify that each requirement can be associated to at least one stakeholder;

(E) verify that each stakeholder can be associated to at least one requirement;

(F) ~~(D)~~ discuss the importance of the relation between requirements and respective stakeholders; ~~and~~

(G) explain how the key mechanical engineering concepts relate to the requirements, such as heat transfer, statics, dynamics, or materials; and

(H) ~~(G)~~ explain how requirements drive the project.

(9) System modeling. The student generates multiple abstract models of mechanical systems using representations such as schematic diagramming and function structure modeling. The student is expected to:

(A) create models of various mechanical system concepts;

(B) compare different models against the appropriate requirements;

(C) extract new system requirements from the models;

(D) create models to communicate engineering design solutions to stakeholders for a project;

(E) discuss conservation principles of energy, matter, and motion; and

(F) apply conservation principles throughout the system model.

(10) Design space modeling. The student models conceptual design spaces through the use of morphological matrices. The student is expected to:

(A) select the key requirements for the problem;

(B) generate multiple means to address each key requirement to populate a morphological matrix;

(C) generate multiple integrated solutions by selecting means from each requirement for further modeling and refinement; and

(D) calculate the total number of possible solutions captured in the generated morphological matrix.

(11) Concept generation. The student generates systematic multiple concepts using appropriate ideation tools. The student is expected to:

(A) explain the rules of ideation tools such as brainstorming, 6-3-5, Gallery Method, C-Sketch, and concept mapping;

(B) apply ideation tools to generate multiple concepts for a problem; and

(C) compare the ideation tools based on the rules, number of people, representation, and purpose.

(12) Concept pruning. The student prunes sets of concepts using design tools such as decision matrices, pair-wise comparison, and pro-con lists. The student is expected to:

Comment [7](A) use and explain absolute or relative decision matrices to prune a set of concepts;

(B) use and explain pair-wise comparisons to prune a set of concepts;

(C) use and explain pro-con lists to prune a set of concepts;

(D) explain why it is important to use multiple pruning tools in design; and

(E) explain why the pruning tools are not for selecting concepts.

(13) Prototyping and testing. The student fabricates multiple physical prototypes ranging from parts to sub-systems to final integrated prototypes to gather information needed to support mechanical engineering design decision making. The student is expected to:

(A) develop prototyping proposals that include cost, time, and effort estimates; desired information; and testing plans;

(B) use appropriate tools and materials to fabricate prototypes;

(C) evaluate and execute testing plans for each prototype to gather information or check requirement satisfaction;

(D) extract and document new requirements from prototyping and testing; and

(E) justify the purpose for each physical or virtual model constructed against the cost of making the model.

(14) Embodiment and refinement. The student refines design solutions by selecting and sizing components appropriately. Students justify material choices based on the requirements defined. The student is expected to:

(A) construct geometric models and drawings to represent designed system;

(B) justify and use appropriate analytical and simulation tools to correlate the changes in parameters of the models with changes in the performance of the modeled system;

(C) justify design decisions using the requirements such as functional, cost, performance or time;

(D) use appropriate tools and materials to fabricate a final prototype;

(E) develop final product documents such as Bill of Materials, assembly models, user manual, and assembly instructions; and

(F) explain the evolution of requirements between earlier and final prototypes.

(15) Solution validation. The student tests and verifies requirements throughout the project. The student understands the importance of discovering new requirements through testing and simulation. The student is expected to:

(A) analyze information gained from testing and simulation to document new or refined requirements;

(B) document simulations or tests using an appropriate report template;

(C) design and execute simulations or tests to validate functional requirements are met;

(D) explain why engineering design processes are iterative; and

(E) discuss how continuous improvement and design iteration are related.

(16) Budget. The student plans, monitors, and updates project budgets throughout the design project. The student is expected to:

[7] Clarifying “a set of “ concepts

(A) create budgets for initial project costs such as raw materials, purchased parts, salvaged parts, hardware, taxes, shipping, and handling categories;

(B) create a Bill of Materials cost report for the final build;

(C) compare and explain any differences between the final product build cost and the project budget;

(D) monitor and update the project budget throughout the duration of the project;

(E) prepare budget status reports that include explanations of spenddown rates and changes to the budget; and

(F) explain the importance of budget tracking in design projects.

(17) Continuous learning. The student relates key mechanical engineering concepts in education and practice. The student is expected to:

(A) explain how key mechanical engineering concepts are addressed in college engineering plans of study;

(B) explain how to interpret an engineering job description; and

(C) identify which key mechanical engineering concepts are relevant and the minimum educational expectations for mechanical engineering positions.

§127.413. Aerospace Design 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.

Comment [1](b) General requirements. This course is recommended for students in Grades 10-12. Prerequisite: Algebra 1 and at least one credit in a course from the engineering career cluster. Recommended corequisite: Geometry. 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 [2](3) Students enrolled in Aerospace Design I, demonstrate knowledge and skills associated with the design evolution and emerging trends of aircraft and aerospace systems. Fundamental concepts such as forces of flight, structures, aerodynamics, propulsion, stability and control, and orbital mechanics are introduced as related to design decisions for atmospheric and space flight. These concepts are related to mission requirements and solution approaches.

(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;

[1] Added the CTE prerequisite
[2] Added "aerospace" to systems in the introduction to be a little broader

(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) Collaboration. The student engages in multiple team projects and activities. The student is expected to:

Comment [3](A) discuss principles of critique such as describing, analyzing, interpreting and evaluating;

(B) identify and demonstrate teamwork skills such as sensemaking where a team member recognizes another team member who requires additional clarity and then addresses the team member by providing clarity;

(C) identify methods for structuring projects such as Gantt charts, Work Breakdown Structure, Agile, Critical Path Method; and

(D) discuss the importance of contributing to positive and productive group dynamics to enhance teamwork.

~~(A) demonstrate how to provide and receive critical feedback;~~

[3] Addressed comment about observability of the SE

~~(B) develop sensemaking skills, learning to recognize when team members require additional clarity;~~

~~(C) demonstrate how to structure a project;~~

~~(D) synthesize appropriate team responses for different challenges; and~~

~~(E) support the team's positive social climate.~~

(5) Documentation. The student documents information and interpretation developed throughout engineering processes. The student is expected to:

Comment [4](A) use professional standards and templates to generate documents such as executive summaries, test reports, failure documents, system black box models, engineering notebooks, and drawing packages;

Comment [5](B) select the document format to communicate essential information for identified stakeholders ~~identify the stakeholder a and appropriately select the document format for the information being communicated~~; and

(C) explain and justify the structure and sequence of how the information is presented in the engineering documents.

(6) History of flight. The student understands the history and evolution of human flight to include within and outside the earth's atmosphere. The student is expected to:

Comment [6](A) identify and discuss successes and failures in human efforts to fly prior to powered flight;

Comment [7](B) research and discuss innovations in aircraft prior to the jet age and explain how world events impacted these innovations;

(C) research and discuss innovations in aircraft after the beginning of the jet age and explain how world events impacted these innovations;

(D) research and discuss innovations in rockets prior to human spaceflight and explain how world events impacted these innovations; ~~and~~

(E) research and discuss innovations in rockets after the first human spaceflight and explain how world events impacted these innovations; and~~.~~

Comment [8](F) discuss the history of regulation of aircraft and the role of the Federal Aviation Administration (FAA).

(7) Introduction to aircraft. The student explains the Federal Aviation Agency categories for aircraft and categorize the different types of aircraft such as airplanes, rotorcraft, Lighter-than-air or aerostats, glider, powered-lift, powered parachutes, Weight-shift aircraft, Ground-effect Vehicles (GEV), Air-cushion vehicles (ACV), and Rockets. The student is expected to:

(A) identify and describe classes of aircraft such as Single-Engine Land (SEL), Gyroplane, Powered-lift, and Glider using the Federal Aviation Agency (FAA) categories;

(B) categorize aircraft by attributes such as piston engine, turboprop, powered or unpowered, drones or piloted;

Comment [9](C) compare ~~and contrast~~ aircraft categories and use cases for each category; and

[4] Use the templates to do what – create documents.
[5] Clarified the measurability of the SE
[6] Added "identify" to help with the measurability
[7] Added research as a predecessor to discuss
[8] In response to comments about more FAA exposure
[9] Removed "contrast"

(D) research and discuss emerging trends in aircraft such as airships, rotary powered aircraft, and alternative energy powered aircraft.

(8) Atmospheric flight. The student identifies and relates the three axes of an aircraft, the four forces of flight, and the components used for stability and control the aircraft. The student is expected to:

(A) explain ~~research and discuss~~ the relationships between atmospheric temperature, pressure, ~~and~~ density, and ~~with~~ altitude;

(B) identify and describe the motion about the three axes of an aircraft, including yaw, pitch, and roll;

(C) identify and describe ways to control motion about the three axes;

(D) identify and explain the four forces acting on aerospace vehicles in flight, including lift, drag, thrust, and weight;

(E) explain the relationship between weight, mass, gravity, and acceleration and identify their corresponding units such as pounds-force, pound-mass, kilogram, and Newton;

(F) discuss the difference between g-force and weight;

(G) draw the forces of flight for a straight and level flight and a level banked turn;

(H) identify different ways to control the forces that change the pitch, roll and yaw of an aircraft;

(I) identify and explain the major fixed and movable components of various aircraft to enable stability and control within the atmosphere; and

Comment [10](J) define and discuss aerodynamics as a subset of aerospace.

(9) Lift and drag. The student explains how lift and drag are generated by an aircraft and how they change during flight. The student is expected to:

(A) explain how an airfoil generates lift;

(B) explain how the angle of attack (AoA) influences lift;

(C) explain how to interpret a "Lift Coefficient (CL) versus Angle of Attack (AoA)" chart;

(D) define and discuss stall for an airfoil;

(E) explain the types of drag, including profile/form, skin friction, interference, trim, and induced;

(F) explain how the angle of attack (AoA) influences drag;

(G) explain how to interpret a "Drag Coefficient (CD) versus Angle of Attack (AoA)" chart;

(H) explain how changes in drag during flight impact performance such as range, altitude, and power requirements;

(I) define and discuss Lift-to-Drag (L/D) ratio;

(J) explain how to interpret a Lift-to-Drag (L/D) chart;

(K) identify the maximum Lift-to-Drag (L/D) ratio from a chart to determine the optimal glide speed for maximum range;

(L) research and discuss other systems that use airfoils such as windmills, fans, and propelling aircraft; and

Comment [11](M) explain ~~discuss~~ how a plane can fly without engine power and in some cases can gain altitude to stay aloft for extended time and distance.

[10] Clarified aerodynamics as a subset of aerospace engineering…
[11] Refined "discuss" to "explain"

(10) Weight and balance. The student recognizes components have mass, weight, and location resulting in moments that are balanced by control surfaces. The student is expected to:

(A) identify and calculate moments created by the forces of flight;

(B) define and discuss Center of Gravity (CG);

(C) define and discuss Center of Pressure (CP);

Comment [12](D) explain ~~research and discuss~~ how the locations of the Center of Pressure (CP) and Center of Gravity (CG) influence the stability of an aircraft; and

(E) create a model of an aircraft with variable configurations for Center of Gravity (CG) and Center of Pressure (CP) to determine stability of an aircraft.

(11) Mission requirements. The student understands how mission requirements influence the type and form of aircraft. The student is expected to:

(A) analyze a mission to generate a list of atmospheric mission requirements such as payload, range, cruise, take-off length, landing length, climb gradient, altitude, land or sea;

(B) analyze a mission to generate a list of space mission requirements such as payload, altitude, vibration sensitivity, launch conditions, environmental conditions, recovery;

(C) explain how the mission requirements are interrelated;

(D) discuss how the mission requirements relate to the aircraft and spacecraft categories;

(E) discuss how mission requirements relate to the overall aircraft design; and

(F) interpret a mission profile and explain how it impacts mission requirements.

(12) Propulsion. The student explains and evaluates different types of propulsion systems such as piston engine, turboprop, jet, and rocket. The student is expected to:

(A) identify and explain how a piston powered aircraft delivers thrust, with respect to design requirements ~~considerations~~ such as cost, operation cost, reliability, power, altitude limits, and speed limitations;

(B) identify and explain how a turboprop powered aircraft delivers thrust, with respect to design requirements ~~considerations~~ such as cost, operation cost, reliability, power, altitude limits, and speed limitations;

(C) identify and explain how a jet powered aircraft delivers thrust, with respect to design requirements ~~considerations~~ such as cost, operation cost, reliability, power, altitude limits, and speed limitations;

(D) explore and explain how a rocket engine is different from a jet engine;

Comment [13](E) research and discuss the applications for solid-fuel rockets; and

Comment [14](F) research and discuss the applications for liquid-fuel rockets.

(13) Material selection. The student explains why a particular material is used in an aircraft application taking into account cost, density, strength, and mission requirements. The student is expected to:

(A) research and discuss material classes used in aerospace design such as woods, composites, metals, and plastics;

Comment [15](B) explain why specific materials might have been chosen for components on different aircraft ~~discuss appropriate materials for various aircraft components~~;

[12] Rewrote as "explain"
[13] Added "research"
[14] Added "research"
[15] Rewrote to focus on the purpose of the discussion

Comment [16](C) discuss methods for manufacturing various aircraft components such as landing gears, wings, fuselage, or canopies;

(D) explain the impact of material and manufacturing costs on design decisions; and

(E) explain how material requirements relate to mission requirements.

(14) Aerospace structures. The student explains and compares and contrasts types of structures such as truss, semi-monocoque, monocoque. The student is expected to:

(A) identify and discuss truss, semi-monocoque, and monocoque structures;

(B) explain why different structure types are used in various aircraft categories;

(C) discuss how mission requirements impact the selection of the structural types for an aircraft;

(D) identify structural components in the fuselage such as stringers, bulkheads, and skin;

(E) identify structural components in the wings and empennage such as ribs, spars, stringers, and skin; and

Comment [17](F) compare structures used in atmospheric flight and to space flight.

(15) Space flight and orbital mechanics. The student knows properties of orbital mechanics as they relate to space flight and the impact of the space environment on design. The student is expected to:

(A) identify and describe orbits based on the six Keplerian Elements;

(B) explain how changes in Keplerian Elements change the orbit;

(C) explain how mission requirements determine specific orbit types;

(D) describe the unique environmental conditions of operating in space for human or autonomous missions;

Comment [18](E) research and discuss methods to reach and recover a spacecraft from space; and

(F) research and discuss emerging trends in space flight.

(16) Alternate applications for aerospace design. The student identifies and discusses alternate applications for aerospace design techniques, including automotive, naval, commercial and home products. The student is expected to:

(A) research and discuss how aerospace engineers contribute to automotive and naval applications to improve performance;

(B) research and identify commercial applications for aerospace design such as heating and cooling systems, building design, and wind turbines; and

(C) identify and discuss items at home that are impacted by aerodynamics such as fans, convection ovens, and heating and cooling systems.

(17) Aircraft systems. The student explores and discusses other aircraft systems such as navigation, communication, entertainment, flight control, actuation, energy storage and management, and propulsion. The student is expected to:

(A) explain basic functionality for aircraft systems such as navigation, communication, entertainment, flight control, propulsion; and

(B) research and discuss different implementations for aircraft systems such as navigation, communication, entertainment, flight control, propulsion.

[16] Added clarifying examples
[17] Comparison (to vs. and)
[18] Added "discuss" as a result of the research…

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

§127.414. Aerospace Design II (Two 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 11-12. Prerequisite: Geometry and Aerospace Design I. 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) Students enrolled in Aerospace Design II demonstrate knowledge and skills associated with the design and prototyping of aerospace systems. Through aerospace projects, students apply fundamental concepts such as managing an engineering project to meet mission requirements, prototyping, testing, and validating requirements. Students explore choices made for propulsion, material, and structural design as well as various ways aircraft can navigate. Emphasis is placed on team collaboration and professional documentation.

(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) Collaboration. The student engages in multiple team projects and activities. The student is expected to:

Comment [1](A) explain and apply sensemaking skills such as recognizing team members who require additional clarity and addressing team members to provide clarity;

(B) apply methods such as Gantt charts, Work Breakdown Structure, Agile, Critical Path Method, to structure a project;

(C) apply principles of critique within the team such as describing, analyzing, interpreting and evaluating;

(D) develop and present action plans to positively support the team's work relationships;

(E) explain and model how to provide an effective critique of team members on topics such as team performance, test performance, project development, or presentation;

[1] Brought the collaboration section back from Mechanical Design II

(F) explain and model how to provide an effective critique of other teams on topics such as presentation, problem definition, schedule, and solution justification;

(G) analyze and evaluate critique received from team members and other teams; and

(H) develop a design review presentation to provide status and solicit feedback on the design problem and solution.

~~(A) demonstrate how to provide and receive critical feedback;~~

~~(B) develop sensemaking skills, learning to recognize when team members require additional clarity;~~

~~(C) demonstrate how to structure a project;~~

~~(D) synthesize appropriate team responses for different challenges; and~~

~~(E) support the team's positive social climate.~~

(5) Documentation. The student documents information and interpretation developed throughout engineering processes. The student is expected to:

Comment [2](A) generate documents such as executive summaries, reverse engineering forms, test reports, failure documents, system black box models, engineering notebooks, and drawing packages by applying professional standards and templates;

(B) select the appropriate document format for the information being communicated based on the audience;

(C) explain and justify the structure and sequence of how the information is presented in the engineering documents;

(D) create assembly and user manuals for peer review; and

(E) generate a final design report that focuses on the project scope and solution with appendices to capture all relevant design information such as the design process used, requirements compliance matrix, concept reports, and test reports.

~~(A) use professional standards and templates, including executive summaries, reverse engineering forms, test reports, failure documents, system black box models, engineering notebooks, and drawing packages;~~

~~(B) identify the stakeholder and appropriately select the document format for the information being communicated; and~~

~~(C) explain and justify the structure and sequence of how the information is presented in the engineering documents.~~

(6) Designing to mission requirements. The student generates conceptual aircraft solutions to meet a set of given requirements. The student is expected to:

(A) analyze given mission requirements such as altitude, speed, and payload to derive sub requirements;

Comment [3](B) generate and document additional ~~aircraft~~ sub-requirements for the mission considering various factors such as maintainability, producibility, operational cost, and safety;

Comment [4](C) generate and document conceptual aircraft solutions to address mission and sub-requirements;

[2] Brought the documentation SE from MD 2 (for consistency across the two streams)
[3] Added "document" to clarify that the students need to capture these requirements
[4] Added "document" to clarify that the solutions need to be documented and added clarity on the requirements

Comment [5](D) classify the generated conceptual aircraft solutions into appropriate ~~aircraft~~ categories such as Single-Engine Land (SEL), Gyroplane, Powered-lift, and Glider using the Federal Aviation Agency (FAA) classification system;

Comment [6](E) select, justify, and document a conceptual solution that addresses the ~~overall~~ mission and sub- requirements; and

Comment [7](F) create a model such as a graph or matrix that displays the relationships between the documented ~~aircraft~~ requirements.

(7) Managing aerospace engineering projects. The student applies project management techniques to aerospace projects. The student is expected to:

(A) generate a project plan that includes time, deliverable, and cost estimates;

(B) review and update periodically a ~~the~~ project plan according to a stage gate process;

(C) document and execute test plans to evaluate prototypes against requirements;

Comment [8](D) ~~present progress and~~ justify and present design choices through periodic design reviews; and

(E) generate a final design report with an executive summary, a body with problem and solution descriptions, and appendices with additional relevant information such as the design process used, requirements compliance matrix, concept reports, and test reports.

(8) Prototyping aerospace vehicles. The student creates a prototype to address a set of mission requirements. The student is expected to:

Comment [9](A) ~~evaluate the presented requirements and~~ generate a list of design parameters based on the mission and sub- requirements;

(B) generate and document design concepts to address design parameters;

(C) use appropriate tools such as decision matrices, pro-con lists, and pair-wise comparison to evaluate, downselect, and justify design concepts to prototype;

(D) create and document prototypes to test, validate, and modify design concepts;

Comment [10](E) use appropriate tools such as decision matrices, pro-con lists, and pair-wise comparison to evaluate, downselect, and justify a prototype ~~prototypes~~ to develop as the solution;

Comment [11](F) evaluate a prototype to identify areas of improvement for iteration ~~of previously selected solution to revise, document, and prototype a new solution~~;

(G) test, evaluate, and document performance of the revised prototype in meeting project requirements; and

(H) compose and present a project debrief, including lessons learned.

(9) Atmospheric flight. The student relates the three axes of an aircraft, the four forces of flight, and the components used for stability and control. The student is expected to:

[5] Added modifiers to the solutions.
[6] Added modifier to the requirements
[7] Added more guidance on what the relationship model might look like – a graph or a matrix
[8] Edited based on comments for clarity
[9] Edited based on comments
[10] Edited to ensure that a single prototype is selected as the solution to evolve.
[11] Removed the additional recommended steps

Comment [12](A) calculate and discuss the relationships between atmospheric temperature, pressure and density with altitude;

(A) (B) research and discuss ways to control motion about the three axes;

Comment [13](B) (C) explain and calculate and explain changes in motion due to the four forces acting on aircraft during flight;

(C) (D) explain why loads acting on aircraft change during different flight scenarios;

(D) (E) draw and calculate the forces of flight for a straight and level flight and a level banked turn; and

(E) (F) describe which aircraft components control and provide stability with respect to the six degrees of freedom.

(10) Lift and drag. The student explains how lift and drag are generated by an aircraft and how they change during flight. The student is expected to:

(A) explain the lift equation and illustrate the relationships between its variables;

(B) explain the drag equation and illustrate the relationships between its variables;

Comment [14](C) calculate the changes to lift and drag based on changes to atmospheric conditions, such as temperature, density, and pressure;

(D) (E) describe how aircraft control surfaces, including leading edge flaps, trailing edge flaps, ailerons, and spoilers influence lift;

(E) (F) describe how aircraft control surfaces, including leading edge flaps, trailing edge flaps, ailerons, and spoilers influence drag;

(F) (G) define and discuss how the stall angle and stall speed can be changed; and

Comment [15](G) (H) research and present contemporary developments reducing drag such as winglets, boundary layer control, and surface effects.

(11) Weight and balance. The student recognizes components have mass, weight, and location resulting in moments that are balanced by control surfaces. The student is expected to:

(A) calculate an the aircraft's estimated Center of Gravity throughout a mission profile considering factors such as fuel consumption, payload, and passengers;

(B) estimate the location of an the aircraft's Center of Pressure;

(C) calculate the static margin throughout a flight profile to verify positive stability margin;

(D) generate and document solutions to improve positive static stability in the event of a negative stability margin; and

(E) revise and document static margin calculations reflecting proposed solutions.

(12) Propulsion. The student evaluates various propulsion solutions to downselect the solutions to meet mission requirements. The student is expected to:

(A) evaluate and select a propulsion solution that meets requirements such as piston, jet, turboprop, and rocket;

(B) evaluate and select the number of engines to meet mission and sub- requirements; and

[12] Removed this and reworked a new SE in KS #10
[13] Changed the order of verbs.
[14] Added a new SE for looking at changes to lift and drag equations based on different conditions.
[15] Added "present" based on recommendations

(C) calculate propulsion weight of the selected solution to meet mission and sub-requirements.

(13) Material selection. The student evaluates various materials to meet mission and sub- requirements. The student is expected to:

Comment [16](A) analyze component material requirements ~~evaluate~~ ~~and~~ to select materials ~~a material~~ that meets mission and sub- requirements~~ for a component such as struts, wings, or fuselage~~; and

Comment [17](B) document the justification for the ~~of~~ materials selected to meet component requirements.

(14) Aerospace structures. The student evaluates and selects structure types to meet mission and sub-requirements. The student is expected to:

Comment [18](A) analyze structural requirements ~~evaluate~~ ~~and~~ to select ~~a~~ structure types ~~type~~ that meets mission and sub- requirements~~ for a component such as struts, wings, or fuselage~~; and

Comment [19](B) document the justification for the ~~of~~ structure types selected to meet structural requirements.

(15) Navigation. The student defines and explains types of navigation used for flight. The student is expected to:

Comment [20](A) explain Dead Reckoning ~~dead reckoning~~ navigation using ~~with~~ an aeronautical chart, compass, clock, and airspeed indicator;

(B) explain navigation using radio radials such as Automatic Direction Finder (ADF) and VHF Omnidirectional Range (VOR);

(C) explain navigation using an Inertial Navigation System (INS); and

(D) explain navigation using Global Positioning Systems (GPS).

[16] Edited the verb alignment for clarity based on comment
[17] Edited for clarity
[18] Edited the verb alignment for clarity based on comment
[19] Edited for clarity
[20] Edited based on comment