Texas CTE

Aerospace Design I

Knowledge and skills. AERODES1

1 **The student discusses ethics pertaining to engineering. The student is expected to identify and discuss the importance of professionalism, standards of conduct, and ethics as defined by the Texas Engineering Practice Act and rules concerning the practice of engineering and surveying.** AERODES1.1

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:** AERODES1.2

- A explain the importance of defining an engineering problem as an initial step in the engineering design process; AERODES1.2A
- B describe the research stage of the engineering design process; AERODES1.2B
- C define ideation and conceptualization and discuss the role these processes play in innovation and problem solving; AERODES1.2C
- D explain the processes of selecting an idea or concept for detailed prototype design, development, and testing; AERODES1.2D
- E describe the purpose of non-technical drawings, technical drawings, models, and prototypes in designing a solution to an engineering problem; AERODES1.2E
- F describe the process of relevant experimental design, conducting tests, collecting data, and analyzing data to evaluate potential solutions; AERODES1.2F
- G explain how the engineering design process is iterative and the role reflection plays in developing an optimized engineering solution; and AERODES1.2G
- H describe the purpose of effective communication of the engineering solution as obtained through the engineering design process to various audiences. AERODES1.2H

3 **The student explores and develops skills to solve problems, make decisions, and manage a project. The student is expected to:** AERODES1.3

- A discuss strategies for managing time, setting deadlines, and prioritizing to accomplish goals; AERODES1.3A
- B identify constraints and describe the importance of planning around constraints, including budgets, resources, and materials; AERODES1.3B
- C define milestones and deliverables and explain the advantages of dividing a large project into smaller milestones and deliverables; AERODES1.3C
- 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 AERODES1.3D

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E identify strategies to solve problems and describe how problem solving is utilized to accomplish personal and team objectives. AERODES1.3E

4 **(4) Collaboration. The student engages in multiple team projects and activities. The student is expected to:** AERODES1.4

A discuss principles of critique such as describing, analyzing, interpreting, and evaluating; AERODES1.4A

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; AERODES1.4B

C identify methods for structuring projects such as Gantt charts, work breakdown structure, Agile, and critical path method; and AERODES1.4C

D discuss the importance of contributing to positive and productive group dynamics to enhance teamwork. AERODES1.4D

5 **Documentation. The student documents information and interpretation developed throughout engineering processes. The student is expected to:** AERODES1.5

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; AERODES1.5A

B select the document format to communicate essential information for identified stakeholders; and AERODES1.5B

C explain and justify the structure and sequence of how the information is presented in the engineering documents. AERODES1.5C

6 **History of flight. The student understands the history and evolution of human flight, including flight within and outside the Earth's atmosphere. The student is expected to:** AERODES1.6

A identify and discuss successes and failures in human efforts to fly prior to powered flight; AERODES1.6A

B research and discuss innovations in aircraft prior to the jet age and explain how world events impacted these innovations; AERODES1.6B

C research and discuss innovations in aircraft after the beginning of the jet age and explain how world events impacted these innovations; AERODES1.6C

D research and discuss innovations in rockets prior to human spaceflight and explain how world events impacted these innovations; AERODES1.6D

E research and discuss innovations in rockets after the first human spaceflight and explain how world events impacted these innovations; and AERODES1.6E

F discuss the history of regulation of aircraft and the role of the Federal Aviation Administration (FAA). AERODES1.6F

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ntroduction to aircraft. The student explains the FAA categories for aircraft and categorizes 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: AERODES1.7

A identify and describe classes of aircraft such as single-engine land (SEL), gyroplane, powered-lift, and glider using the FAA categories; AERODES1.7A

B categorize aircraft by attributes such as piston engine, turboprop, powered or unpowered, and drones or piloted; AERODES1.7B

C compare aircraft categories and use cases for each category; and AERODES1.7C

D research and discuss emerging trends in aircraft such as airships, rotary powered aircraft, and alternative energy powered aircraft. AERODES1.7D

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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 of the aircraft. The student is expected to:** AERODES1.8

A explain the relationships between atmospheric temperature, pressure, density, and altitude; AERODES1.8A

B identify and describe the motion about the three axes of an aircraft, including yaw, pitch, and roll; AERODES1.8B

C identify and describe ways to control motion about the three axes; AERODES1.8C

D identify and explain the four forces acting on aerospace vehicles in flight, including lift, drag, thrust, and weight; AERODES1.8D

E explain the relationship between weight, mass, gravity, and acceleration and identify their corresponding units such as pounds-force, pound-mass, kilogram, and Newton; AERODES1.8E

F discuss the difference between g-force and weight; AERODES1.8F

G draw the forces of flight for a straight and level flight and a level banked turn; AERODES1.8G

H identify different ways to control the forces that change the pitch, roll, and yaw of an aircraft; AERODES1.8H

I identify and explain the major fixed and movable components of various aircraft to enable stability and control within the atmosphere; and AERODES1.8I

J define and discuss aerodynamics as a subset of aerospace. AERODES1.8J

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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:** AERODES1.9

A explain how an airfoil generates lift; AERODES1.9A

B explain how the angle of attack (AoA) influences lift; AERODES1.9B

C explain how to interpret a "Lift Coefficient (CL) versus AoA" chart; AERODES1.9C

D define and discuss stall for an airfoil; AERODES1.9D

Skip to main content

E explain the types of drag, including profile/form, skin friction, interference, trim, and induced; AERODES1.9E

F explain how the AoA influences drag; AERODES1.9F

G explain how to interpret a "Drag Coefficient (CD) versus AoA" chart; AERODES1.9G

H explain how changes in drag during flight impact performance such as range, altitude, and power requirements; AERODES1.9H

I define and discuss Lift-to-Drag (L/D) ratio; AERODES1.9I

J explain how to interpret an L/D chart; AERODES1.9J

K identify the maximum L/D ratio from a chart to determine the optimal glide speed for maximum range; AERODES1.9K

L research and discuss other systems that use airfoils such as windmills, fans, and propelling aircraft; and AERODES1.9L

M explain how a plane can fly without engine power and in some cases can gain altitude to stay aloft for extended time and distance. AERODES1.9M

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10 Weight and balance. The student recognizes that components have mass, weight, and location resulting in moments that are balanced by control surfaces. The student is expected to: AERODES1.10

A identify and calculate moments created by the forces of flight; AERODES1.10A

B define and discuss center of gravity (CG); AERODES1.10B

C define and discuss center of pressure (CP); AERODES1.10C

D explain how the locations of the CP and CG influence the stability of an aircraft; and AERODES1.10D

E create a model of an aircraft with variable configurations for CG and CP to determine stability of an aircraft. AERODES1.10E

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11 Computerized design tools. The student understands that computerized technology is available for design and analysis. The student is expected to: AERODES1.11

A identify engineering computational tools such as computer-aided design (CAD), finite element analysis (FEA), or computational fluid dynamics (CFD); and AERODES1.11A

B explain the applications of engineering computational tools used in aerospace design. AERODES1.11B

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12 Mission requirements. The student understands how mission requirements influence the type and form of aircraft. The student is expected to: AERODES1.12

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, and land or sea; AERODES1.12A

B analyze a mission to generate a list of space mission requirements such as payload, altitude, vibration sensitivity, launch conditions, environmental conditions, and recovery; AERODES1.12B

C explain how the mission requirements are interrelated; AERODES1.12C

Skip to main content

D discuss how the mission requirements relate to the aircraft and spacecraft categories; AERODES1.12D

E discuss how mission requirements relate to the overall aircraft design; and AERODES1.12E

F interpret a mission profile and explain how it impacts mission requirements. AERODES1.12F

13 Propulsion. The student explains and evaluates different types of propulsion systems such as piston engine, turboprop, jet, and rocket. The student is expected to: AERODES1.13

A identify and explain how a piston powered aircraft delivers thrust with respect to altitude limits and speed limitations; AERODES1.13A

B identify and explain how a turboprop powered aircraft delivers thrust with respect to design requirements such as cost, operation cost, reliability, power, altitude limits, and speed limitations; AERODES1.13B

C identify and explain how a jet powered aircraft delivers thrust with respect to design requirements such as cost, operation cost, reliability, power, altitude limits, and speed limitations; AERODES1.13C

D explore and explain how a rocket engine is different from a jet engine; AERODES1.13D

E research and discuss the applications for solid-fuel rockets; and AERODES1.13E

F research and discuss the applications for liquid-fuel rockets. AERODES1.13F

14 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: AERODES1.14

A research and discuss material classes used in aerospace design such as woods, composites, metals, and plastics; AERODES1.14A

B explain why specific materials might have been chosen for components on different aircraft; AERODES1.14B

C discuss methods for manufacturing aircraft components such as landing gears, wings, fuselage, or canopies; AERODES1.14C

D explain the impact of material and manufacturing costs on design decisions; and AERODES1.14D

E explain how material requirements relate to mission requirements. AERODES1.14E

15 Aerospace structures. The student explains and compares and contrasts types of structures such as truss, semi-monocoque, monocoque. The student is expected to: AERODES1.15

A identify and discuss truss, semi-monocoque, and monocoque structures; AERODES1.15A

Skip to main content

B explain why different structure types are used in various aircraft categories; AERODES1.15B

C discuss how mission requirements impact the selection of the structural types for an aircraft; AERODES1.15C

D identify structural components in the fuselage such as stringers, bulkheads, and skin; AERODES1.15D

E identify structural components in the wings and empennage such as ribs, spars, stringers, and skin; and AERODES1.15E

F compare structures used in atmospheric flight and space flight. AERODES1.15F

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16 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: AERODES1.16

A identify and describe orbits based on the six Keplerian Elements; AERODES1.16A

B explain how changes in Keplerian Elements change the orbit; AERODES1.16B

C explain how mission requirements determine specific orbit types; AERODES1.16C

D describe the unique environmental conditions of operating in space for human or autonomous missions; AERODES1.16D

E research and discuss methods to reach and recover a spacecraft from space; and AERODES1.16E

F research and discuss emerging trends in space flight. AERODES1.16F

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17 Alternate applications for aerospace design. The student examines alternate applications for aerospace design in various industries, including the automotive, naval, and other commercial industries. The student is expected to: AERODES1.17

A research and discuss how aerospace engineers contribute to automotive and naval applications to improve performance; AERODES1.17A

B research and identify commercial applications for aerospace design such as heating and cooling systems, building design, and wind turbines; and AERODES1.17B

C identify and discuss items at home that are impacted by aerodynamics such as fans, convection ovens, and heating and cooling systems. AERODES1.17C

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18 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: AERODES1.18

A explain basic functionality for aircraft systems such as navigation, communication, entertainment, flight control, and propulsion; and AERODES1.18A

B research and discuss different implementations for aircraft systems such as navigation, communication, entertainment, flight control, and propulsion. AERODES1.18B