Texas CTE

Engineering Design and Problem Solving

Knowledge and skills. EDPS

1 **The student researches and describes ethics pertaining to engineering. The student is expected to explain how engineering ethics as defined by the Texas Board of Professional Engineers and Land Surveyors apply to engineering practice.** EDPS.1

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:** EDPS.2

- A ask questions and define problems based on observations or information from text, phenomena, models, or investigations; EDPS.2A
- B apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems; EDPS.2B
- C use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards; EDPS.2C
- D use appropriate tools such as dial caliper, micrometer, protractor, compass, scale rulers, multimeter, and circuit components; EDPS.2D
- E collect quantitative data using the International System of Units (SI) and United States customary units and qualitative data as evidence; EDPS.2E
- F organize quantitative and qualitative data using spreadsheets, engineering notebooks, graphs, and charts; EDPS.2F
- G develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and EDPS.2G
- H distinguish between scientific hypotheses, theories, and laws. EDPS.2H

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:** EDPS.3

- A identify advantages and limitations of models such as their size, scale, properties, and materials; EDPS.3A
- B analyze data by identifying significant statistical features, patterns, sources of error, and limitations; EDPS.3B

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C use mathematical calculations to assess quantitative relationships in data; and EDPS.3C

D evaluate experimental and engineering designs. EDPS.3D

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

A develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories; EDPS.4A

B communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and EDPS.4B

C engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence. EDPS.4C

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: EDPS.5

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; EDPS.5A

B relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of various scientists and engineers as related to the content; and EDPS.5B

C research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field. EDPS.5C

6 The student understands how to implement an engineering design process to develop a multi-system product or solution for a complex problem. The student is expected to: EDPS.6

A implement the stages of an engineering design process to construct a model of a multi-system product or solution; EDPS.6A

B explain how factors, including complexity, scope, resources, ethics, regulations, manufacturability, maintainability, and technology, affect stages of the engineering design process; EDPS.6B

C explain how interested parties affect an engineering design process; and EDPS.6C

D discuss how lessons learned from failure is often an essential component of the engineering design process. EDPS.6D

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: EDPS.7

A research and explain the process and phases of project management, including initiating, planning, executing, and closing; EDPS.7A

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B explain the roles and responsibilities of team members, including project managers and leads; EDPS.7B

C create a resource-loaded project schedule for an engineering project; EDPS.7C

D maintain a resource-loaded project schedule for the life of an engineering project; EDPS.7D

E develop and implement a system for the organization of project documentation such as file naming conventions, document release control, and version control; EDPS.7E

F describe how project requirements, constraints, and deliverables affect the project schedule and influence and are influenced by an engineering design; EDPS.7F

G create a budget that includes materials, equipment, and labor for an engineering project; EDPS.7G

H describe the importance of management of change (MOC) and how MOC applies throughout the life of an engineering project; EDPS.7H

I create and implement a project management plan for an engineering project; and EDPS.7I

J describe how techniques such as Monte Carlo simulation, risk matrices, and tornado diagrams are used to evaluate risk. EDPS.7J

8 **The student conducts research and analyzes data to create a problem statement in the engineering design process. The student is expected to:** EDPS.8

A create an organized engineering notebook to record research and findings for an engineering project; EDPS.8A

B select an open-ended real-world problem that can be solved using scientific and engineering practices and the engineering design process; EDPS.8B

C collect, organize, analyze, and summarize scientific and technical articles, data, and information to support the development of a problem statement; EDPS.8C

D define and use relevant scientific and engineering vocabulary as it relates to the problem statement; EDPS.8D

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 EDPS.8E

F create a problem statement that is concise, specific, and measurable. EDPS.8F

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:** EDPS.9

A identify or create alternative solutions to a problem using a variety of techniques such as sketching, brainstorming, reverse engineering, and researching engineered and natural solutions; EDPS.9A

B select a preferred solution to a problem by applying structured techniques such as a decision tree, design matrix, or cost-benefit analysis; EDPS.9B

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C evaluate whether the preferred solution meets the requirements of the problem statement in the context of an iterative design process; EDPS.9C

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 material selection; EDPS.9D

E explain how different engineering solutions can have significantly different effects on individuals, society, and the natural world; and EDPS.9E

F document concepts, solutions, findings, and structured decision-making techniques in the engineering notebook. EDPS.9F

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

A determine and explain the type of technical drawing that best represents the solution; EDPS.10A

B create a technical drawing(s) that includes dimensions, scale, views, annotations, tolerances, legends, symbols, and material specifications; EDPS.10B

C create a mathematical or physical model(s) to make predictions, identify limitations, and optimize design criteria; EDPS.10C

D create a prototype for testing; EDPS.10D

E evaluate the successes and failures of the prototype(s) in the context of an iterative design process; and EDPS.10E

F revise technical drawings, models, and prototype(s) as the solution evolves to better meet objectives. EDPS.10F

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: EDPS.11

A design and conduct experiments and tests to determine whether the prototype meets the requirements of the problem statement; EDPS.11A

B document and evaluate quantitative and qualitative data obtained through experiments and tests of the prototype in the engineering notebook; EDPS.11B

C create and analyze charts, data tables, or graphs to organize information collected during experiments on the prototype; EDPS.11C

D determine acceptable limits of error in data from experiments and tests of the prototype; EDPS.11D

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; EDPS.11E

F identify linear and nonlinear relationships in data and situations where regression is appropriate; EDPS.11F

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G identify sources of random error and systematic error and differentiate between both types of error from experiments and tests of the prototype; and EDPS.11G

H 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. EDPS.11H

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: EDPS.12

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; EDPS.12A

B solicit and evaluate feedback from the audience on the comprehensive report and presentation; EDPS.12B

C present learning experiences such as essential skills gained, areas of personal growth, and challenges and solutions encountered throughout the design process; and EDPS.12C

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. EDPS.12D