Tennessee CTE

Engineering Design I

Safety	1 Accurately read and interpret safety rules, including but not limited to rules published by the National Science Teachers Association (NSTA), rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply. 1
	2 Identify and explain the intended use of safety equipment available in the classroom. For example, demonstrate how to properly inspect, use, and maintain safe operating procedures with tools and equipment. Incorporate safety procedures and complete safety test with 100 percent accuracy. 2
Career Exploration	3 In teams, use an online editing tool to develop an informational paper or infographic illustrating various engineering disciplines (e.g., civil, mechanical, electrical, chemical, biomedical, computer, agricultural, industrial, and aerospace). The descriptions should contain definitions, job roles, professional societies, and applicable licenses and/or certifications associated with each discipline. Use a variety of sources to gather data, cite each source, and briefly describe why the chosen source is reliable. 3
	4 Research the postsecondary institutions (colleges of applied technology, community colleges, and four-year universities) in Tennessee and other states that offer engineering or engineering technology programs. Write an informative paper or develop an infographic identifying admissions criteria, the postsecondary programs of study, and the secondary courses that will prepare individuals to be successful in a postsecondary engineering or engineering technology program. 4

Engineering Design Process

5 **Compare and contrast the following engineering design process with the following eight common practices of science and engineering (Achieve, 2013). Based on observations, write a brief paper explaining how the engineering design process and the practices overlap. Present findings to the class and refine the paper based on feedback.** 5

1 Engineering Design Process 5.1

a Identify the problem 5.1.A

b Identify criteria and specify constraints 5.1.B

c Brainstorm possible solutions 5.1.C

d Research and generate ideas 5.1.D

e Explore alternative solutions 5.1.E

f Select an approach 5.1.F

g Write a design proposal 5.1.G

h Develop a model or prototype 5.1.H

i Test and evaluate 5.1.I

j Refine and improve 5.1.J

k Create or make a product 5.1.K

l Communicate results 5.1.L

2 Science and Engineering Practices 5.2

a Asking questions (for science) and defining problems (for engineering) 5.2.A

b Developing and using models 5.2.B

c Planning and carrying out investigations 5.2.C

d Analyzing and interpreting data 5.2.D

e Using mathematics and computational thinking 5.2.E

f Constructing explanations (for science) and designing solutions (for engineering) 5.2.F

g Engaging in argument from evidence 5.2.G

h Obtaining, evaluating, and communicating information 5.2.H

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6 **Apply a problem-solving format for assigned engineering problems. The format should include the problem statement with illustration (e.g., free body diagram), what is given, what the student is asked to find, a list of assumptions, a list of equations to be used to solve the problem, and the step-by-step solution.** 6

Engineering Drawing**	**7** **Define the differences in technique among freehand sketching, manual drafting, and computer-aided drafting (CAD), and describe the skills required for each. Create a twodimensional orthographic (multiview) drawing incorporating labels, notes, and dimensions, using sketching/geometric construction techniques. Apply basic dimensioning rules and properly use different types of lines (e.g., object, hidden, center). The orthographic projections should include principle views of a simple object from top, front, and right sides.** 7
	8 **Building on the knowledge of a two-dimensional drawing, create complex isometric (3-D pictorial) drawings, properly using lines (e.g., object, hidden, center), labels, and dimensioning techniques.** 8
	9 **Use CAD software to create simple two-dimensional and three-dimensional drawings, accurately incorporating labels, notes, dimensioning, and line types to design drawings. Perform basic operations such as creating, saving files, opening files, storing files, and printing.** 9
Work, Force, Power & Machines	**10** **Drawing on relevant technical documents, define and identify at least one application for each of the six simple machines listed below. Describe each with sketches and proper notation in an engineering notebook.** 10 a Inclined plane 10.A b Wedge 10.B c Lever 10.C d Wheel and axle 10.D e Pulley 10.E f Screw 10.F
	11 **In teams, document the process of completing a simple project, such as building or using one or more simple machines. Participate in and describe each engineering design process step in an engineering notebook. Create a physical prototype or model based on the constraints specified in the project and the data gathered in the process of development.** 11
	12 **Calculate force, work, and power, and apply these formulae to solve engineering problems as outlined by the instructor. Articulate specific scenarios in which an engineer must calculate force, work, and power.** 12
	13 **Calculate the ideal mechanical advantage and actual mechanical advantage, and explain to classmates what this concept means in the context of engineering. Given a specified engineering problem, calculate the efficiency of a machine when the ideal mechanical advantage and actual mechanical advantage are known.** 13

Mechanisms

14 **Explain the definition of a mechanism. Interpret technical information in design problems to identify types of mechanisms such as:** 14

- a Linkages 14.A
- b Cam and follower 14.B
- c Bearings 14.C
- d Gears 14.D
- e Sprockets and chain 14.E
- f Drives 14.F

15 **Create equations that describe relationships to solve engineering problems using formulae such as gear ratio, speed ratio, torque, and torque ratio. For example, understand that if a gear ratio is 2, the input gear must make two complete revolutions to every one revolution that the output gear makes.** 15

Energy

16 **Write an explanatory text defining energy, in particular its use in engineering, drawing on engineering texts and other technical documents. In addition, identify and explain the different forms of energy. The explanation should include the categorization of various forms of energy such as potential or kinetic.** 16

17 **Draw on engineering texts and other technical documents to synthesize and explain the concept of heat. Include definitions of the different temperature scales such as Fahrenheit, Celsius, and Kelvin. Furthermore, explain the three forms of heat transfer: conduction, convection, and radiation.** 17

18 **Understand and solve problems in specific engineering contexts involving conversion from one unit of energy such as British Thermal Units (Btu), Joule (J), and Calorie (cal) to another. Use this information to calculate the heat needed to change temperature.** 18

19 **Research print and electronic sources published by government, nonprofit, or engineering organizations to define different renewable energy sources such as biomass, hydroelectric power, geothermal, wind, and solar, as well as nonrenewable energy sources such as petroleum, natural gas, coal, and nuclear energy. In teams, create and deliver a presentation justifying the use of one energy source for their local community; the presentation must contain at least one summary table or graphic. In addition, the presentation should provide an analysis demonstrating the advantage of their selected source over others.** 19

Electrical Systems

20 **Write a technical report describing the subatomic particles (e.g., nucleus, proton, neutron, and electron) that make up an atom. Moreover, cite technical texts to explain how the particles relate to electricity, including characteristics that make materials either conductors or insulators, and explain the relationship between the flow of charge and electrical current at the subatomic and atomic level.** 20

21 **Write an explanatory paper defining, comparing, and contrasting voltage, current, and resistance, incorporating appropriate graphic illustrations (such as diagrams) to complement the narrative. Identify sources of voltage as well. For example, a battery is a source of voltage, and one end of the battery represents a positive charge, while the other end represents a negative charge.** 21

22 **Calculate voltage, current, and/or resistance in a DC circuit using Ohm's law (V = IR). Explain how Ohm's Law relates voltage, current, and resistance, citing technical examples for illustration. For example, if voltage remains constant and resistance decreases, the current will increase. Given a physical circuit, demonstrate how to measure each using a digital multimeter. Where unexpected behavior is observed, cite specific evidence to explain the observations. Prepare an informative report comparing calculated values with measured values and include an explanation of any sources of error.** 22

23 **Explain how series and parallel circuits function, including identification of their chief components, characteristics, and differences. Solve problems involving series and parallel circuits including calculating equivalent resistance and calculating voltage and/or current through elements within a circuit.** 23

Computer Software for Engineering Problem Solving

24 **Use computer tools, such as spreadsheet software (e.g., Microsoft Excel), analytical/scientific software (e.g., MATLAB), and/or programming software (e.g., Microsoft Visual Basic) to solve at least one problem from the content described in the standards above. Examples may include the use of spreadsheets to input data from experimental tests and create graphs for presentation, or the use of MATLAB to solve a system of equations.** 24

Team Project

25 **As a team, identify a problem in the school or community. Draft a problem statement to guide a project incorporating engineering concepts from at least three of the content sections (i.e., electrical systems, energy, mechanisms, etc.) outlined above. Follow the engineering design process to solve the problem. Each team will develop a paper following the format of a typical technical report (see components of the report below). Upon completion of the report, create and deliver a presentation for a CTSO event using appropriate citation conventions. Refine the report as would a team of engineers by incorporating feedback from the presentation.The written report should include, but is not limited to:** 25

a Background 25.A

b Problem definition 25.B

c Design constraints 25.C

d Methodology 25.D

e Data analysis (e.g., charts, graphs, calculations) 25.E

f Results/Problem solution (including engineering drawings) 25.F

g Conclusions and recommendations for future research. 25.G