Colorado CTE Course – Scope and Sequence

Course Name	Engineering 3		**Course Details** **Course = 0.50 Carnegie Unit Credit**	**1.0**	
Course Description	This course builds upon the basic engineering concepts and foundations from level 2 and is comparable to a HS Level 1 course. *Upon completion of this course, students are able to identify and explain the steps in the engineering design process. They can evaluate an existing engineering design, use fundamental sketching and engineering drawing techniques, complete simple design projects using the engineering design process, and effectively communicate design solutions to others.*				
Note:	This is a suggested scope and sequence for the course content. The content will work with any textbook or instructional resource. If locally adapted, make sure all essential knowledge and skills are covered.				
SCED Identification #		Schedule calculation based on 60 calendar days of a 90-day semester. Scope and sequence allows for additional time for guest speakers, student presentations, field trips, remediation, or other content topics.			
All courses taught in an approved CTE program must include Essential Skills embedded into the course content. The Essential Skills Framework for this course can be found at **https://www.cde.state.co.us/standardsandinstruction/essentialskills**					
Instructional Unit Topic	Suggested Length of Instruction	CTE or Academic Standard Alignment	Competency / Performance Indicator	Outcome / Measurement	CTSO Integration
Unit 1 **Engineering Design & Scientific Method**	1-2 weeks	Use various input technologies to enter and manipulate information appropriately. Improve a system design to meet a specified need, including properties of materials selected. Demonstrate critical thinking, identify the system constraints, and make fact-based decisions	Identify the differences of the disciplines of Science, Technology, Engineering, and Mathematics and how they are integrated to solve problems Compare and contrast the engineering design process to the scientific method Identify the Engineering Design Process used within your school, which typically includes steps similar to: i. Identify the problem ii. Plan/Ideate iii. Prototype and Test iv. Final Product v. Communicate results	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-3 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-2	**Challenging Technology Issues** Following the onsite random selection of a technology topic from a group of pre-conference posted topics, participants work to prepare for and deliver a debate-style presentation, in which they explain opposing views of the selected topic.

Unit 2 **CAD & Spatial Reasoning**	2-4 weeks	Read and understand technical drawings. Demonstrate understanding of annotation styles and setup by defining units, dimension styles, and leader lines Use various input technologies to enter and manipulate information appropriately. Identify and describe the steps needed to produce a prototype Identify and use appropriate tools, equipment, machines, and materials to produce the prototype Use rational thinking to develop or improve a system	Develop/Review Technical Skills: ● Technical Sketching/Drawing ● Computer Modeling (CAD) Statistical Analysis Practical Physics Principles Simple machines Gear ratios Forces Produce industry relevant documents & presentations, which may include a. Plans b. Design Briefs c. Engineering notebook d. Portfolio e. Create and deliver a presentation to an appropriate audience (e.g. instructor, class, CTSO event, etc.) Create Technical Sketches/Drawings/Designs	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem MS-ETS1-2 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-3 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. MS-ETS1-4	**CAD Foundations** Participants have the opportunity to demonstrate their understanding of CAD fundamentals as they create a two-dimensional (2D) graphic representation of an engineering part or object. **System Control Technology** In response to a challenge presented onsite at the conference, participants analyze a problem (typically one in an industrial setting), build and program a computer-controlled mechanical model to solve the problem, explain the program and the features of the mechanical model solution, and provide instructions for evaluators to operate the device.
Unit 3 **BioEngineering & Ergonomics**	2-4 weeks	Asking Questions and Defining Problems Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. Developing and Using Models **Evaluate limitations** of a model for a proposed object or tool. Constructing Explanations	Perform safe practices within the classroom a. Accurately read and interpret safety rules adopted by the school/district as they relate to the spaces and equipment used in this b. Identify and explain the intended use of safety equipment available in the classroom. c. Demonstrate how to properly inspect and use safe operating	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions MS-ETS1-1 Evaluate competing design solutions using a systematic process to determine how well they meet the	**Mechanical Engineering** Participants design, document, and build a mechanical device (mousetrap car) that incorporates the elements of the annual theme/problem – and then race the

		and Designing Solutions Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that **meets specific design criteria and constraints.** Engaging in Argument from Evidence Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system, **based on empirical evidence** concerning whether or not the technology **meets relevant criteria and constraints**. Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	procedures with tools and equipment d. Incorporate safety procedure Evaluate how the engineering design process was used to create/update a current product Apply the engineering design process to solve an identified problem Produce industry relevant documents & presentations, which may include a. Plans b. Design Briefs c. Engineering notebook d. Portfolio e. Create and deliver a presentation to an appropriate audience (e.g. instructor, class, CTSO event, etc.)	criteria and constraints of the problem. MS-ETS1-2 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-3 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. MS-ETS1-4	car. Finalists are determined based on an evaluation of the documentation portfolio, the race exit interview, and the race placement. **Medical Technology** Participants conduct research on a contemporary medical technology issue related to the annual theme, document their research, create a display, and build a prototype. Semifinalists deliver a presentation about their entry and participate in an interview.
Unit 4 Aerodynamics & Flight	2-4 weeks	Asking Questions and Defining Problems **Define a design problem** that can be solved through the development of an object, tool, process or system and **includes multiple criteria and constraints**, including scientific knowledge that may limit possible solutions. Planning and Carrying Out Investigations Collect data about the performance of a proposed object, tool, process, or system **under a range of conditions**. Analyzing and Interpreting Data Analyze data to define an optimal operational range for a proposed	Apply the engineering design process to solve an identified problem Produce industry relevant documents & presentations, which may include a. Plans b. Design Briefs c. Engineering notebook d. Portfolio e. Create and deliver a presentation to an appropriate audience (e.g. instructor, class, CTSO event, etc.) Satellites Rocket design Principles of Flight	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. MS-ETS1-1 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem MS-ETS1-2 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-3	**Flight** Participants submit a documentation portfolio and fabricate a glider designed to stay in flight for the greatest elapsed time. Semifinalists use their technical drawing skills to construct a glider that is flown onsite.

		object, tool, process or system that best meets criteria for success. Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible. Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g. multiple trials). Using Mathematics and Computational Thinking Apply mathematical concepts and/or processes (such as ratio, rate, percent, basic operations, and simple algebra) to scientific and engineering questions and problems. Use mathematical representations to describe and/or support design solutions Constructing Explanations & **Designing Solutions** **Apply scientific ideas** or principles to design, construct, and/or test a design of an object, tool, process or system Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that **meets specific design criteria and constraints**. Optimize performance of a design by **prioritizing criteria, making tradeoffs, testing, revising, and re-Testing.** Engaging in Argument from Evidence Evaluate competing design solutions		Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. MS-ETS1-4	

		based on jointly developed and agreed-upon design criteria. Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. Obtaining, Evaluating, and Communicating Information Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.			
Unit 5 Career & Education Opportunities	2-4 weeks		Identify various careers within engineering fields and their respective career opportunities. a. Recognize the work typically performed, tools and technology used, and nature of work environment b. Identify potential certification opportunities c. Find membership organizations associated with the careers d. Understand the necessary education associated within the careers e. Research security clearance requirements associated within the careers		**Leadership Strategies** Participants prepare for and deliver a presentation about a specific challenge that officers of a TSA chapter might encounter. Semifinalists follow the same competition procedure but must respond to a different chapter challenge.
Unit 6 Cornerstone: Student Choice Project	3-4 weeks	Read and understand technical drawings. Demonstrate understanding of annotation styles and setup by defining units, dimension styles, and leader lines Identify and use appropriate tools, equipment, machines, and materials to produce the prototype Use rational thinking to develop or		Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	**Challenging Technology Issues** Following the onsite random selection of a technology topic from a group of pre-conference posted topics, participants work to prepare for and deliver a debate-style presentation,

		improve a system [Planning and Carrying Out Investigations](#) Collect data about the performance of a proposed object, tool, process, or system under a range of conditions. Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials). Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.			in which they explain opposing views of the selected topic. **Leadership Strategies** Participants prepare for and deliver a presentation about a specific challenge that officers of a TSA chapter might encounter. Semifinalists follow the same competition procedure but must respond to a different chapter challenge.