Learning that works for Colorado CTE™

Colorado CTE Course – Scope and Sequence

Course Name	**Engineering 2**		**Course Details** **Course = 0.50 Carnegie Unit Credit**	**1.0**	
Course Description	This course builds upon the basic engineering concepts and foundations from level 1. *It provides an overview of skills necessary to be successful in all fields of engineering including spatial reasoning & design drafting, materials analysis, basic physics/dynamics, and basic manufacturing and production.*				
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 Principles Review	1-2 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	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 (TSA competition)** 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 (TSA Competition)** 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 2 Electricity/Electronics	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. 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. 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 problem s Constructing Explanations and Designing Solutions Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system	**Applied Electronics - Electrical Design (Biotech/payloads)** Basic Direct Current (DC) Electricity Principles Schematics, resistance, components, Ohm's Law, AC vs DC and applications Soldering Electronic components: LED< Resistors Circuits Hardware/software Sensors Programming of electrical components (microcontrollers) **Project Ideas:** Motorboats Soldering Alarm Clocks E-Textiles	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 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	**Electrical Applications (TSA competition)** Participants take a written test on basic electrical and electronic theory. Semifinalists assemble a specific circuit from a schematic diagram using their own kit, make required electrical measurements, and explain their solution during an interview.

		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. 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 3 Automation/ Microcontrollers	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. Using Mathematics and Computational Thinking Decide when to use qualitative vs. quantitative data. Create algorithms (a series of ordered steps) to solve a problem. Apply mathematical concepts and/or processes (such as ratio, rate, percent, basic operations, and simple algebra) to scientific and engineering questions and problems.	**Automation in Engineering - control tech** Hardware v software and software/hardware connection How computers 'work' binary & processing Intro to Block programming ● Variables ● if/else ● Looping ● Debugging ● input/output ● Custom functions ● If statements Text based programming ● Syntax ● if/else ● Looping ● Debugging ● Variables ● Custom functions graphing & XY coordinates **Project Ideas:** Biomedical Innovations (wearables or prosthetics) Rocket Payloads	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	**System Control Technology (TSA competition)** Participants use a team approach to develop a computer-controlled model solution to a given problem, typically one based on an industrial setting. Teams analyze the problem, build a computer-controlled mechanical model, program the model, explain the program and mechanical features of the model-solution, and leave instructions for judges to operate

		Use mathematical representations to describe and/or support design solutions [Constructing Explanations and Designing Solutions](#) Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing. 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](#) Evaluate competing design solutions 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.	UAV applications		the device. **Microcontroller Design (TSA competition)** Participants develop a working digital device (product) with real-world applications. Through a product demonstration and documentation, the team demonstrates knowledge of microcontroller programming, simple circuitry, and product design and marketing. The project should have educational and social value, and conform to the theme for the year. Semifinalists demonstrate and promote their work in a presentation. **https://www.amazonfutureengineer.com/YourVoiceIsPower**
Unit 4 Mechanical Engineering	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,	Basic Energy Transfers/Transformations • Chemical, atomic, gravitational, elastic, thermal, electrical, radiant, motion, sound Simple Machines • Incline plane, screw, wedge, lever, wheel/ axle, pulley Compound machines Developing with a purpose Biomechanical engineering Sustainable Design Motor v turbine Energy: solar car/ gear ratios/	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	**NREL Junior Solar Sprint (JSS) (TSA competition)** Participants apply STEM concepts, creativity, teamwork, and problem-solving skills as they design, construct, and race a solar-powered model car. Learn more

		or system under a range of conditions. Developing and Using Models Evaluate limitations of a model for a proposed object or tool. Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. Analyzing and Interpreting Data Analyze data to define an optimal operational range for a proposed 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 scientific conclusions and design solutions. Constructing Explanations and Designing Solutions Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system	Wind turbines Reverse engineering **Project Ideas:** Solar Cars Wind Turbines Rube Goldberg Machines Prosthetics	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	about JSS, then register on Cvent to begin your JSS journey. **Mechanical Engineering (TSA competition)** Participants design and build a mechanical device to solve the problem statement for the identified theme. Teams identify and research an engineering process and construct a mechanical system. Semifinalists participate in a presentation/interview.

		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 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.
