

FOLSOM CORDOVA UNIFIED SCHOOL DISTRICT



Advanced Engineering Technology

Board Approval Date: January 18, 2024	Course Length: 2 Semesters
Grading: A-F	Credits: 5 Credits per Semester
Proposed Grade Level(s): 10, 11, 12	Subject Area: Elective Elective Area (if applicable): Career Technical Education
Prerequisite(s): Engineering Design	Corequisite(s): N/A
CTE Sector/Pathway: Engineering and Architecture / Engineering Technology	
Intent to Pursue 'A-G' College Prep Status: Yes	
A-G Course Identifier: (g) College-preparatory elective	
Graduation Requirement: No	
Course Intent: District Course Program (if applicable): CTE	
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COURSE DESCRIPTION:

Advanced Engineering Technology is a capstone level course in which students build upon the problem-solving skills and three-dimensional solid models taught in the Engineering Technology course. This course is one year in length and primarily offered to 10th to 12th grade students. Students will develop an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. The course will develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions using appropriate learning strategies.

DETAILED UNITS OF INSTRUCTION:

Unit Number/Title	Unit Essential Questions	Examples of Formative Assessments	Examples of Summative Assessment
1. Product Design & Development	Why is it important to begin considering career paths during high school? What career opportunities are available to match your specific interests? What are the diverse career opportunities in Engineering? What are mechanical systems? What are compound and complex machines? How are they alike and how do they differ? What are some current applications of simple machines, gears, pulleys, and sprockets? What are some strategies that can be used to make everyday mechanisms more efficient? What are the trade-offs of mechanical advantage related to design? How do you redirect energy using mechanisms? Why must efficiency be calculated and understood during the design process? Why is technical	*Explain how engineers and engineering technologists apply math, science, and discipline-specific skills to solve problems *Share how the field of Engineering offers creative job opportunities for individuals with a wide variety of backgrounds and goal *Explain how mechanical systems often require a combination of mechanisms to complete a given task *Demonstrate in a team the importance of technical communication can be accomplished in oral, written, and visual forms and must be organized in a clear and concise manner *Brainstorm ideas for accomplishing the assigned task, and record at least three ideas in your engineering notebook *Using isometric grid paper or 3D modeling software, sketch and annotate a preliminary design solution including individual	*Present a Career Exploration project on the varied engineering and engineering technology careers. *Research, design, build a series of individual machines, determine the actual mechanical advantage, ideal mechanical advantage, and the efficiency. Include a compound and complex machine. The compound machine must have a mechanical advantage greater than 1. *Final Design Project: Include a minimum of four mechanisms including any of the simple machines: a gear system; a pulley and belt system; and / or a sprocket and chain system. Document and illustrate the mechanical advantage and drive ratios of the individual mechanisms utilized within your final compound machine

	communication important?	mechanism mechanical advantage and drive ratios *Create an example of a compound and complex machine using various fischertechnik® components, including gears (sprockets), chains, belts, pulleys, axles, and support pieces *Build, test, and modify your compound machine design. -Demonstrate how mechanisms are used to redirect energy within a system by manipulating force, speed, and distance *Calculate mechanical advantage ratios mathematically evaluate input work versus output work of mechanisms *Participate in a pre-project planning meeting to discuss procedure to determine the instructor-assigned task in detail, including all required operations and time constraints *Investigate available equipment components and possible configurations	solution.
2. Energy Sources	How do you Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible? What is Ohm's law and how is it used to solve current, voltage and resistance? How are energy sources converted from one source to another to meet the needs of a given system? What energy source processes include harnessing, storing,	*Calculations to solve for current given voltage and resistance ($I=V/R$) and the voltage drop over R_4 *Project to find the total resistance and solve how four identical 50-Ω resistors are connected in a series with a 9-V battery. Find the total resistance *Summarize and reflect upon information collected during a visit to a local utility company *Display an understanding of work, energy, and power is required to determine system	*Create and deliver a presentation to explain a specific energy source. *Successfully identify and categorize energy sources as nonrenewable, renewable, or inexhaustible. *Create and deliver a presentation to explain a specific energy source. *Presentation and explanation on the relationship between the voltage output at the interface and the voltage

	transporting, and converting? What determines the atomic structure of a material and whether it is a conductor, an insulator, or a semiconductor? How do you calculate the voltage drop over R4? What is the power used if 4,000 joules of energy are consumed over a period of 50 seconds? What is one strategy for making the system even more efficient? What are two or more reasons why automotive engineers are concerned with eliminating inefficiency from vehicles?	efficiency *Define the possible types of power conversion *Calculate work and power *Demonstrate the correct use of a digital multimeter *Calculate power in a system that converts energy from electrical to mechanical *Determine efficiency of a system that converts an electrical input to a mechanical output *Calculate circuit resistance, current, and voltage using Ohm's law *Understand the advantages and disadvantages of parallel and series circuit design in an application *List and describe three factors that reduced efficiency in the winch system *Explain the difference between a series and a parallel circuit	across the series and parallel circuit that your team constructed and how your data supports this explanation. *Project: Present a parallel circuit and the relationship between the current output at the interface and current in each branch. Explain how your data supports the relationship observed.
3. Energy Applications	What is one thing that surprised you about the energy source that you researched and presented? How would you describe one thing that surprised you about an energy source that another team presented? How would you describe and defend what you believe to be the most important technological need regarding energy? How do hydrogen fuel cells create electricity and heat through an electrochemical process that converts hydrogen and oxygen into water? How do solar cells convert light energy into electricity by using photons to create	*Quiz on energy management, efficient and accessible uses of energy and multiple energy sources that can be combined to convert energy into useful forms. *Design, construct, and test recyclable insulation materials. *Complete calculations for conduction, R-values, and radiation. *Projects on thermodynamics, thermo energy, material conductivity, resistance and energy transfer	*Test and apply the relationship between voltage, current, and resistance relating to a photovoltaic cell and a hydrogen fuel cell. *Experiments with a solar hydrogen system to produce mechanical power. *Test and apply the relationship between R-values and recyclable insulation.

	electron flow? What is thermodynamics?		
4. Design Problem: Energy and Power	How do engineers use the design process to create solutions to existing problems? How do communication skills impact individual efforts and teamwork to achieve the desired goal? What is a design brief and how are they used to identify the problem specifications and to establish project constraints?	*Brainstorm and sketch possible solutions to an existing design problem *Selection of an approach that meets or satisfies the constraints provided in a design brief *Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions	*Create a decision-making matrix for a design problem. *Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix. *Present a workable solution.
5. Statics	What are the laws of motion? How would you describe the interaction of forces acting on a body? What are clockwise forces and why are they considered negative when they summed with counterclockwise forces? What structural member properties are important to consider for structure design? What is static equilibrium and how does it occur when the sum of all forces acting on a body are equal to zero? What are translational and rotational equilibrium equations? How do external forces cause an object to rotate?	*Calculate the moment force if you were to hold a 15 lb. bowling ball with your forearm perpendicular to your body and describe the pinned connection *Explain clockwise forces and if they are really negative forces *Describe structural member properties including centroid location, moment of inertia, and modulus of elasticity and why they are important considerations for structure design *Differentiate between scalar and vector quantities *Identify magnitude, direction, and sense of a vector and calculate the X and Y components given a vector *Display how a breakdown of vector components and the applied forces are vector quantities with a defined magnitude, direction, and sense *Demonstrate how in a statically determinate truss, translational and rotational	*Create free body diagrams of objects, identifying all forces acting on the object. *Mathematically locate the centroid of structural members. *Exams: Calculate moment of inertia of structural members. Calculate moment forces given a specified axis. Calculate unknown forces using equations of equilibrium to calculate unknown forces. *Use the method of joint strategy to determine forces in the members of a statically determinate truss.

		equilibrium equations can be used to calculate external and internal forces *Show how forces acting at a distance from an axis or point attempt to cause an object to rotate	
6. Design Problem: Materials and Structures	How is the design process used to create solutions to existing problems? What is a design brief and how are they used? Why is communication important in working with a team in order to achieve the desired goal? What is the significance of including roller connections rather than pinned connections? How does the triangle shape make a truss rigid?	*Solve a design problem by yourself or as part of a team *Create a design brief to identify the problem specifications and establish project constraints *Communication exercises for effective teamwork requires constant communication *Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions	*Brainstorm and sketch possible solutions to an existing design problem. *Create a decision making matrix for the design problem. *Select an approach that meets or satisfies the constraints given in a design brief. *Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon your team's decision matrix. *Present a workable design solution.
7. Machine Control	What was the most challenging aspect of this design problem? What are control systems and how do they impact a design? What are some creative changes that you would make to the design solution if you could start over? What are closed and open loop systems and how do they differ? What are the characteristics of digital and analog devices?	*Flowcharts provide a step by step schematic representation of an algorithm or process *Design control systems to provide consistent process control and reliability *Define the control system protocols and the established set of commands or functions typically created in a computer programming language *Demonstrate how closed loop systems use digital and analog sensor feedback to make operational and process decisions. And how open loop systems use programming constants such as time to make operational and process decisions	*Create detailed flow charts utilizing a computer software application. *Create control system operating programs utilizing computer software. *Create system control programs that utilize flowchart logic. *Judge between open and closed loop systems in order to choose the most appropriate system for a given technological problem. *Design and create a control system based on given needs and constraints.

		*Explain the appropriate inputs and output devices based on the need of a technological system *Differentiate between the characteristics of digital and analog devices	
8. Design Problem: Control Systems	How do engineers use the design process to create solutions? What is a design brief and how are they used in the field of Engineering?	*Team project to explain how design problems can be solved by individuals or as a collaboration with others in a team *Explain how engineers use the design process to create solutions to existing problems *Demonstrate how design briefs are used to identify the problem specifications and to establish project constraints *Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions *Select an approach that meets or satisfies the constraints provided in a design brief	*Brainstorm and sketch possible solutions to an existing design problem. *Create a decision-making matrix for a design problem. *Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix. *Present a workable solution to the design problem.
9. Statistics	Why are statistics important in the field of Engineering? How do engineers use statistics in making decisions? What calculations are used in Engineering? What is the Bernoulli process and how is it applied? What is Bayes' theorem?	*Demonstrate how engineers use statistics to make informed decisions based upon established principles *Create visual representations of data analyses allowing for easy distribution and understanding of data *Explain how statistics is based upon both theoretical and experimental data analysis *Demonstrate and apply AND, OR, and NOT logic to probability *Calculate the central tendency of a data array, including mean, median, and mode	*Calculate the theoretical probability that an event will occur. *Calculate the experimental frequency distribution of an event occurring. *Apply the Bernoulli process to events that only have two distinct possible outcomes. *Apply Bayes' theorem to calculate the probability of multiple events occurring. *Create a histogram to illustrate frequency distribution.

		*Calculate data variation, including range, standard deviation, and variance	
10. Kinematics	What was the most challenging aspect of this design problem? What are some creative changes that you would make to the design solution if you could start over? How do engineers differentiate and calculate distance, displacement, speed, velocity, and acceleration? What is freefall and how does it occur? What is projectile motion?	*Project: Suppose that the client wants your ballistic launcher to be guaranteed to hit a target at least once, given three tries. Would a 34% success rate per launch be good enough? Explain why or why not. If a launcher hits the target 34% of the time, what is the probability that it will miss three out of three tries? *Enrichment: If the client defines a “success” as hitting the target at least once, given three shots, what success rate per launch is necessary to succeed 99 times in 100 groups of three shots? Explain your reasoning. Explain when working with bodies in motion, why engineers must be able to differentiate and calculate distance, displacement, speed, velocity, and acceleration. Demonstrate how when air resistance is not taken into account, released objects will experience acceleration due to gravity, also known as freefall. Explain how projectile motion can be predicted and controlled using kinematics equations. Explain how when a projectile is launched, velocity in the x direction remains constant; whereas, with time, the velocity in the Y direction in magnitude and direction changes due to gravity.	*Calculate distance, displacement, speed, velocity, and acceleration from data. *Design, build, and test a vehicle that stores and releases potential energy for propulsion. *Calculate acceleration due to gravity given data from a free fall device. *Calculate the X and Y components of a projectile motion. *Determine the angle needed to launch a projectile at a specific range given the projectile’s initial velocity.

ESSENTIAL STANDARDS:

Engineering Technology Pathway Standards:

B1.0 Communicate and interpret information clearly in industry-standard visual and written formats.

B1.1 Explain the classification and use of various components, symbols, abbreviations, and media common to technical drawings.

B1.2 Describe the current industry standards for illustration and layout.

B1.3 Draw flat layouts of a variety of objects by using the correct drafting tools, techniques, and media.

B1.4 Organize and complete an assembly drawing using information collected from detailed drawings.

B1.5 Create reports and data sheets for writing specifications.

B2.0 Demonstrate the sketching process used in concept development.

B2.1 Understand the process of producing proportional two- and three-dimensional sketches and designs.

B2.2 Apply sketching techniques to a variety of architectural and engineering models.

B2.3 Present conceptual ideas, analysis, and design concepts using freehand graphic communication techniques.

B3.0 Identify the fundamentals of the theory, measurement, control, and applications of electrical energy, including alternating and direct currents.

B3.1 Understand the characteristics of alternating current (AC) and how it is generated; the characteristics of the sine wave; and of AC, tuned, and resonant circuits; and the nature of the frequency spectrum.

B3.2 Analyze relationships between voltage, current, resistance, and power related to direct current (DC) circuits.

B3.3 Calculate, construct, measure, and interpret both AC and DC circuits.

B3.4 Understand how electrical control and protection devices are used in electrical systems.

B3.5 Calculate loads, currents, and circuit-operating parameters.

B3.6 Classify and use various electrical components, symbols, abbreviations, media, and standards of electrical drawings.

B3.7 Analyze, repair, or measure electrical and electronic systems, circuits, or components using appropriate electronic instruments.

B3.8 Predict the effects of circuit conditions on the basis of measurements and calculations of voltage, current, resistance, and power.

B4.0 Understand the concepts of physics that are fundamental to engineering technology.

B4.1 Describe Newton's laws and how they affect and define the movement of objects.

B4.2 Explain how the laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.

B4.3 Compare the effects and applications of heat transfer and thermal dynamic processes.

B4.4 Explore the fundamentals and properties of waveforms and how waveforms may be used to carry energy.

B4.5 Analyze how electric and magnetic phenomena are related and know common practical applications.

B5.0 Understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems.

B5.1 Differentiate between scalars and vectors.

B5.2 Solve problems by using the concept of vectoring to predict resultants.

B5.3 Compare and explore the six simple machines and their applications.

B5.4 Evaluate how energy is transferred and predict the effects of resistance in mechanical, electrical, fluid, and thermal systems.

B5.5 Formulate and solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems.

B6.0 Employ the design process to solve analysis and design problems.

B6.1 Understand the steps in the design process.

B6.2 Determine what information and principles are relevant to a problem and its analysis.

- B6.3 Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution.
- B6.4 Translate word problems into mathematical statements when appropriate.
- B6.5 Demonstrate the process of developing multiple details, within design constraints, into a single solution.
- B6.6 Construct a prototype from plans and test it.
- B6.7 Evaluate and redesign a prototype on the basis of collected test data.
- B7.0 Understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality assurance.
- B7.1 Know the structure and processes of a quality assurance cycle.
- B7.2 Describe the major manufacturing processes.
- B7.3 Use tools, fasteners, and joining systems employed in selected engineering processes.
- B7.4 Estimate and measure the size of objects in both Standard International and United States units.
- B7.5 Apply appropriate geometric dimensioning and tolerancing (GD&T) practices.
- B7.6 Calibrate precision measurement tools and instruments to measure objects.
- B8.0 Understand fundamental control system design and develop systems that complete preprogrammed tasks.
- B8.1 Identify the elements and processes necessary to develop a controlled system that performs a task.
- B8.2 Demonstrate the use of sensors for data collection and process correction in controlled systems.
- B8.3 Perform tests, collect data, analyze relationships, and display data in a simulated or modeled system using appropriate tools and technology.
- B8.4 Program a computing device to control systems or process.
- B8.5 Use motors, solenoids, and similar devices as output mechanisms in controlled systems.
- B8.6 Assemble input, processing, and output devices to create controlled systems capable of accurately completing a preprogrammed task.
- B9.0 Understand the fundamentals of systems and market influences on products as they are developed and released to production.
- B9.1 Understand the process of product development.
- B9.2 Understand decision matrices and the use of graphic tools in illustrating the development of a product and the processes involved.
- B10.0 Design and construct a culminating project effectively using engineering technology.
- B10.1 Use methods and techniques for employing all engineering technology equipment appropriately.
- B10.2 Apply conventional engineering technology processes and procedures accurately, appropriately, and safely.
- B10.3 Apply the concepts of engineering technology to the tools, equipment, projects, and procedures of the Engineering Technology Pathway.
- B11.0 Understand the methods of creating both written and digital portfolios.
- B11.1 Develop a binder or digital portfolio representative of student work for presentation.
- B11.2 Give an effective oral presentation of a portfolio.

RELEVANT STANDARDS AND FRAMEWORKS, CONTENT/PROGRAM SPECIFIC STANDARDS:

Link to Common Core Standards (if applicable):

Educational standards describe what students should know and be able to do in each subject in each grade. In California, the State Board of Education decides on the standards for all students, from kindergarten through high school.

CCSS for ELA - Content Standards (CA Dept of Education),

<https://www.cde.ca.gov/be/st/ss/documents/ccssmathstandardaug2013.pdf>

Link to Framework (if applicable):

Curriculum frameworks provide guidance for implementing the content standards adopted by the State Board of Education (SBE). Frameworks are developed by the Instructional Quality Commission, formerly known as the Curriculum Development and Supplemental Materials Commission, which also reviews and recommends textbooks and other instructional materials to be adopted by the SBE.

Link to Subject Area Content Standards (if applicable):

Content standards were designed to encourage the highest achievement of every student, by defining the knowledge, concepts, and skills that students should acquire at each grade level.

Standards for Career Ready Practice Flyer - Standards and Framework (CA Dept of Education) CTE Model Curriculum Standards: Engineering and Arch - Standards and Framework (CA Dept of Education)

Link to Program Content Area Standards (if applicable):

Program Content Area Standards applies to programs such as International Baccalaureate, Advanced Placement, Career and Technical Education, etc.

CTE Model Curriculum Standards: Engineering and Arch - Standards and Framework (CA Dept of Education)

TEXTBOOKS AND RESOURCE MATERIALS:**Textbooks**

Board Approved	Pilot Completion Date (If applicable)	Textbook Title	Author(s)	Publisher	Edition	Date
		N/A				

Other Resource Materials

California Career Zone (online), California Career Resource Network (CDE), SkillsUSA Career Essentials Job Hunting Handbook, Dahlstrom & Company, Inc., instructor created materials, various online source materials

Supplemental Materials

Board approved supplemental materials (Including but not limited to: Film Clips, Digital Resources, Supplemental texts, DVDs, Programs (Pebble Creek, DBQ, etc.):

N/A