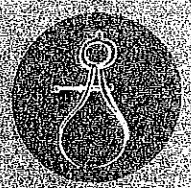

Engineering and Design Industry Sector

The Engineering and Design industry sector provides a strong foundation in engineering and design for students in California. The students are engaged in an instructional program that integrates academic and technical preparation and focuses on career awareness, career exploration, and career preparation in five pathways. To prepare students for the vast scope of job opportunities in this field, middle schools, high schools, regional occupational centers and programs, apprenticeship programs, community colleges, and four-year colleges and universities provide education and training in engineering-related occupations. The demand for engineers in a variety of specializations throughout the state and the nation will remain high.[1]

The five pathways in this sector emphasize real-world, occupationally relevant experiences of significant scope and depth. To prepare students for continued training, advanced educational opportunities, and direct entry to a career, the engineering and design programs offer the following components: classroom, laboratory, and hands-on contextual learning; project- and work-based instruction; internships, community classroom, and cooperative career technical education; work experience education; and leadership and interpersonal skills development.

Engineering and Design Industry Sector Pathways:

- Architectural and Structural Engineering
- Computer Hardware, Electrical, and Networking Engineering
- Engineering Design
- Engineering Technology
- Environmental and Natural Science Engineering

Engineering Technology

Sample sequence of courses in the Engineering Technology pathway:

STEM courses	Related courses
Introductory • Technology Core • Introduction to Electricity/ Electronics • Metal Technology • Introduction to Computers • Introduction to Drafting/CADD • Exploring Technology • Introduction to Engineering Technology	• Physics • Chemistry • English Composition • Trigonometry • Orientation to Apprenticeship
Concentration • Electro-Mechanical Systems • Digital Logic Design • Mechatronics/Robotics	
Capstone • Telecommunications • Electrical/Electronic Technology • Industrial Engineering Technology	

Sample of appropriate foundation and pathway standards for the Introduction to Engineering Technology course in the Engineering Technology pathway:

Foundation standards	Academics 1.1 Algebra I (grades eight through twelve) 5.0: Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.
	Academics 1.2 Investigation and Experimentation (grades nine through twelve) 1.a: Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
	Communications 2.2 Writing Strategies and Applications (grades eleven and twelve) 1.6: Develop presentations by using clear research questions and creative and critical research strategies (e.g., field studies, oral histories, interviews, experiments, electronic sources).
	Career Planning and Management 3.3: Develop a career plan that is designed to reflect career interests, pathways, and postsecondary options.
	Technology 4.1: Understand past, present, and future technological advances as they relate to a chosen pathway.
	Leadership and Teamwork 9.3: Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals.
	Demonstration and Application 11.0: Students demonstrate and apply the concepts contained in the foundation and pathway standards.

Pathway standards	ED D4.0: Students understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems.
	ED D5.0: Students understand the design process and how to solve analyze and design problems.
	ED D6.0: Students understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality assurance.

Sample analysis ("unpacking") of a standard for the Introduction to Engineering Technology course in the Engineering Technology pathway:

Standard	Engineering and Design D4.0: Students understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems.	
Standard subcomponent	Engineering and Design D4.4: Know how energy is transferred; know the effects of resistance in mechanical, electrical, fluid, and thermal systems.	
Course level	☒ Introductory ❑ Concentration ❑ Capstone	
What do students need to know? At what level?	*Concepts* 1. Mechanical energy transfer and resistance 2. Thermal energy transfer and resistance 3. Electrical energy transfer and resistance 4. Fluid energy transfer and resistance 5. Energy transfer and resistance in everyday life	*Benchmarks* 1. Explain and give three examples of mechanical energy transfer and resistance. 2. Explain and give three examples of thermal energy transfer and resistance. 3. Explain and give three examples of electrical energy transfer and resistance. 4. Explain and give three examples of fluid energy transfer and resistance. 5. Explain five ways in which energy transfer and resistance are utilized in machines and systems that affect our everyday lives.
What should students be able to do? At what level?	*Skills* 1. How to measure energy movement in the four energy systems 2. How to choose effective conductors and resistors for each energy system	*Benchmarks* 1. Use system-specific instrumentation to measure energy movement with at least 70 percent accuracy. 2. Determine efficiency of conductors and resistors for each energy system to at least 70 percent accuracy.
Topics and contexts **What must be taught?**	1. Physics of energy transfer for each of the energy systems 2. Measurement of energy movement 3. Choices of effective conductors and resistors	

Sample Performance Task

Standards: This sample performance task targets the following Engineering and Design industry sector foundation and Engineering Technology pathway standards:

Standard number	Standards
Foundation: Academics 1.1 Algebra I (grades eight through twelve) 5.0	Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.
Foundation: Academics 1.2 Investigation and Experimentation (grades nine through twelve) 1.a	Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
Foundation: Leadership and Teamwork 9.3	Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals.
Foundation: Demonstration and Application 11.0	Students demonstrate and apply the concepts contained in the foundation and pathway standards.
Pathway: ED 4.4	Know how energy is transferred; know the effects of resistance in mechanical, electrical, fluid, and thermal systems.

Assignment: This activity will help identify and measure the flow of energy for fluid systems. Work on a team consisting of three other students (ED D4.4; Leadership and Teamwork 9.3). The activities for each energy system are listed as follows. Be sure to keep clear, legible, and thorough laboratory notes for each activity, including all mathematical calculations (Academics 1.1 Algebra I [grades eight through twelve] 5.0; Academics 1.2 Investigation and Experimentation [grades nine through twelve] 1.a).

Using a small computer fan, a paper tube, and a turbine made from a fan blade and toy electric motor, your team will construct an apparatus that will cause a light-emitting diode connected across the motor to illuminate when air (a fluid) is pushed by the fan to spin the wind generator. This activity will demonstrate how energy can be transferred through the movement of a fluid (ED D4.4).

Your group will write a 500-word report describing the process for creating and testing the fluid energy demonstration project, your findings, and your assessment of the accuracy of those findings. Staple raw data from each of the preceding tasks to the back of your report (Academics 1.2 Investigation and Experimentation [grades nine through twelve] 1.a; Leadership and Teamwork 9.3).

Performance task rubric: Your grade will be based on the following rubric. Individual teachers should determine how to weight the standards and assign points for each level.

Standards	Advanced	Proficient	Basic	Unacceptable
ED.D4.4: Know how energy is transferred; know the effects of resistance in mechanical, electrical, fluid, and thermal systems.	All student observations are validated by correct interpretations of gathered data. Tests on energy transfer are completed with above 90 percent accuracy.	Most student observations are validated by correct interpretations of gathered data. Tests on energy transfer are completed with 80 percent accuracy.	Student observations and interpretations of gathered data are flawed. Tests on energy transfer are completed with 70 percent accuracy.	Student observations of gathered data are incomplete or incorrect. Tests on energy transfer are completed with below 70 percent accuracy.
Academics 1.1 Algebra I (grades eight through twelve) 5.0: Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.	All calculations in determining the transfer of energy are correct. Students derive and make correct use of formulae in every instance.	Most calculations in determining the transfer of energy are correct. Students derive and make correct use of formulae.	Some calculations for determining the transfer of energy have errors. Students have some errors in the use of formulae.	Many calculations in determining the transfer of energy have errors. Students have numerous errors in the use of formulae.
Academics 1.2 Investigation and Experimentation (grades nine through twelve) 1.a: Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.	Report accurately and thoroughly describes the process used and makes good use of recorded laboratory data to explain findings. Report provides in-depth assessment of the accuracy of the findings and extrapolates possible conclusions. Raw findings are included.	Report accurately describes the process used and makes good use of recorded laboratory data to explain findings. Report provides basic assessment of the accuracy of the findings. Raw findings are included.	Report describes the process used and makes some use of recorded laboratory data to explain findings. Report fails to assess accuracy of the findings or includes other omissions. Raw findings are included.	Report is incomplete, or raw findings are not included.

Standards	Advanced	Proficient	Basic	Unacceptable
Leadership and Teamwork 9.3: Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals.	The team is observed working cooperatively and effectively. All members participate and contribute. Effective use is made of the tools of TQM and QI. Project is completed before the deadline.	The team is observed working effectively. Most members participate and contribute. Effective use is made of the tools of TQM and QI. Project is completed no later than the deadline.	The team is observed working with a minimum of cooperation. Not all members participate and contribute. Minimal use is made of the tools of TQM and QI. Project is completed later than the deadline.	The team is observed not working cooperatively. Not all members participate and contribute. Ineffective or no use is made of the tools of TQM and QI. Project is completed late.

Note: Demonstration and Application 11.0 is included in all of the preceding items.

Sample of Pathway Occupations: This sample of pathway occupations is organized by level of education and training required for workforce entry. Asterisked occupations require certification or licensure.

Engineering Technology Pathway Occupations	
High school (diploma)	• Electronic Mechanic Helper • Telecommunications/Security Equipment Installer • Apprentice Technician • HVAC Installer
Postsecondary training (certification and/or AA degree)	• Electronic Mechanic/Technician • Telecommunications Technician • Industrial Electronics Technician • Facilities Technician • Journeyman Engineer
College or university (bachelor's degree or higher)	• Electrical Engineer* • Telecommunications Engineer • Facilities Maintenance Engineer • Industrial Engineer • Instructor*