




Engineering and Design Industry Sector

Career Pathways

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



Engineering and Design Industry Sector

The Engineering and Design sector is designed to provide a foundation in engineering and design for students in California. 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. The following pathways emphasize real-world, occupationally relevant experiences of significant scope and depth: Architectural and Structural Engineering; Computer Hardware, Electrical, and Networking Engineering; Engineering Design; Engineering Technology; and Environmental and Natural Science Engineering. 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; internship, community classroom, and cooperative career technical education; work experience education; and leadership and interpersonal skills development.

FOUNDATION STANDARDS

1.0 Academics

Students understand the academic content required for entry into postsecondary education and employment in the Engineering and Design sector.

(The standards listed below retain in parentheses the numbering as specified in the mathematics, science, history–social science, and visual and performing arts content standards adopted by the State Board of Education.)

1.1 Mathematics

Specific applications of Number Sense standards (grade seven):

- (1.1) Read, write, and compare rational numbers in scientific notation (positive and negative powers of 10) with approximate numbers using scientific notation.

- (1.2) Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers.
- (1.3) Convert fractions to decimals and percents and use these representations in estimations, computations, and applications.
- (1.4) Differentiate between rational and irrational numbers.
- (1.5) Know that every rational number is either a terminating or a repeating decimal and be able to convert terminating decimals into reduced fractions.
- (1.6) Calculate the percentage of increases and decreases of a quantity.
- (1.7) Solve problems that involve discounts, markups, commissions, and profit and compute simple and compound interest.

Specific applications of Mathematical Reasoning standards (grade seven):

- (2.1) Use estimation to verify the reasonableness of calculated results.
- (2.2) Apply strategies and results from simpler problems to more complex problems.
- (2.3) Estimate unknown quantities graphically and solve for them by using logical reasoning and arithmetic and algebraic techniques.
- (2.4) Make and test conjectures by using both inductive and deductive reasoning.
- (2.5) Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.
- (2.6) Express the solution clearly and logically by using the appropriate mathematical notation and terms and clear language; support solutions with evidence in both verbal and symbolic work.
- (2.7) Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.
- (2.8) Make precise calculations and check the validity of the results from the context of the problem.
- (3.1) Evaluate the reasonableness of the solution in the context of the original situation.
- (3.2) Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.
- (3.3) Develop generalizations of the results obtained and the strategies used and apply them to new problem situations.

Specific applications of Algebra I standards (grades eight through twelve):

- (1.1) Students use properties of numbers to demonstrate whether assertions are true or false.
- (2.0) Students understand and use such operations as taking the opposite, finding the reciprocal, taking a root, and raising to a fractional power. They understand and use the rules of exponents.
- (3.0) Students solve equations and inequalities involving absolute values.
- (5.0) Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.

(12.0) Students simplify fractions with polynomials in the numerator and denominator by factoring both and reducing them to the lowest terms.

(15.0) Students apply algebraic techniques to solve rate problems, work problems, and percent mixture problems.

Specific applications of Geometry standards (grades eight through twelve):

(15.0) Students use the Pythagorean theorem to determine distance and find missing lengths of sides of right triangles.

(19.0) Students use trigonometric functions to solve for an unknown length of a side of a right triangle, given an angle and a length of a side.

Specific applications of Algebra II standards (grades eight through twelve):

(3.0) Students are adept at operations on polynomials, including long division.

(6.0) Students add, subtract, multiply, and divide complex numbers.

1.2 Science

Specific applications of Physics standards (grades nine through twelve):

(3.a) Students know heat flow and work are two forms of energy transfer between systems.

(3.b) Students know that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy.

(3.c) Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as *thermal energy*. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.

(3.g) Students know how to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.

Specific applications of Investigation and Experimentation standards (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.

(1.d) Formulate explanations by using logic and evidence.

(1.1) Analyze situations and solve problems that require combining and applying concepts from more than one area of science.

1.3 History–Social Science

Specific applications of World History, Culture, and Geography: The Modern World standards (grade ten):

(10.3) Students analyze the effects of the Industrial Revolution in England, France, Germany, Japan, and the United States.

- (10.3.5) Understand the connections among natural resources, entrepreneurship, labor, and capital in an industrial economy.

Specific applications of United States History and Geography: Continuity and Change in the Twentieth Century standards (grade eleven):

- (11.5) Students analyze the major political, social, economic, technological, and cultural developments of the 1920s.
- (11.5.4) Analyze the passage of the Nineteenth Amendment and the changing role of women in society.
- (11.5.7) Discuss the rise of mass production techniques, the growth of cities, the impact of new technologies (e.g., the automobile, electricity), and the resulting prosperity and effect on the American landscape.
- (11.7) Students analyze America's participation in World War II.
- (11.7.6) Describe major developments in aviation, weaponry, communication, and medicine and the war's impact on the location of American industry and use of resources.
- (11.8) Students analyze the economic boom and social transformation of post-World War II America.
- (11.8.7) Describe the effects on society and the economy of technological developments since 1945, including the computer revolution, changes in communication, advances in medicine, and improvements in agricultural technology.

Specific applications of Principles of Economics standards (grade twelve):

- (12.1) Students understand common economic terms and concepts and economic reasoning.
- (12.1.1) Examine the causal relationship between scarcity and the need for choices.
- (12.1.2) Explain opportunity cost and marginal benefit and marginal cost.
- (12.1.3) Identify the difference between monetary and nonmonetary incentives and how changes in incentives cause changes in behavior.
- (12.1.4) Evaluate the role of private property as an incentive in conserving and improving scarce resources, including renewable and nonrenewable natural resources.
- (12.1.5) Analyze the role of a market economy in establishing and preserving political and personal liberty (e.g., through the works of Adam Smith).
- (12.2) Students analyze the elements of America's market economy in a global setting.
- (12.2.1) Understand the relationship of the concept of incentives to the law of supply and the relationship of the concept of incentives and substitutes to the law of demand.
- (12.2.2) Discuss the effects of changes in supply and/or demand on the relative scarcity, price, and quantity of particular products.
- (12.2.3) Explain the roles of property rights, competition, and profit in a market economy.
- (12.2.4) Explain how prices reflect the relative scarcity of goods and services and perform the allocative function in a market economy.
- (12.2.5) Understand the process by which competition among buyers and sellers determines a market price.

- (12.2.6) Describe the effect of price controls on buyers and sellers.
- (12.2.7) Analyze how domestic and international competition in a market economy affects goods and services produced and the quality, quantity, and price of those products.
- (12.2.8) Explain the role of profit as the incentive to entrepreneurs in a market economy.
- (12.2.9) Describe the functions of the financial markets.
- (12.2.10) Discuss the economic principles that guide the location of agricultural production and industry and the spatial distribution of transportation and retail facilities.
- (12.3) Students analyze the influence of the federal government on the American economy.
 - (12.3.1) Understand how the role of government in a market economy often includes providing for national defense, addressing environmental concerns, defining and enforcing property rights, attempting to make markets more competitive, and protecting consumers' rights.
 - (12.3.2) Identify the factors that may cause the costs of government actions to outweigh the benefits.
 - (12.3.3) Describe the aims of government fiscal policies (taxation, borrowing, spending) and their influence on production, employment, and price levels.
 - (12.3.4) Understand the aims and tools of monetary policy and their influence on economic activity (e.g., the Federal Reserve).
- (12.4) Students analyze the elements of the U.S. labor market in a global setting.
 - (12.4.1) Understand the operations of the labor market, including the circumstances surrounding the establishment of principal American labor unions, procedures that unions use to gain benefits for their members, the effects of unionization, the minimum wage, and unemployment insurance.
 - (12.4.2) Describe the current economy and labor market, including the types of goods and services produced, the types of skills workers need, the effects of rapid technological change, and the impact of international competition.
 - (12.4.3) Discuss wage differences among jobs and professions, using the laws of demand and supply and the concept of productivity.
 - (12.4.4) Explain the effects of international mobility of capital and labor on the U.S. economy.
- (12.6) Students analyze issues of international trade and explain how the U.S. economy affects, and is affected by, economic forces beyond the United States's borders.
 - (12.6.1) Identify the gains in consumption and production efficiency from trade, with emphasis on the main products and changing geographic patterns of twentieth-century trade among countries in the Western Hemisphere.
 - (12.6.2) Compare the reasons for and the effects of trade restrictions during the Great Depression compared with present-day arguments among labor, business, and political leaders over the effects of free trade on the economic and social interests of various groups of Americans.

- (12.6.3) Understand the changing role of international political borders and territorial sovereignty in a global economy.
- (12.6.4) Explain foreign exchange, the manner in which exchange rates are determined, and the effects of the dollar's gaining (or losing) value relative to other currencies.

1.4 *Visual and Performing Arts*

Specific applications of Visual Arts standards at the advanced level (grades nine through twelve):

- (1.1) Analyze and discuss complex ideas, such as distortion, color theory, arbitrary color, scale, expressive content, and real versus virtual in works of art.
- (1.3) Analyze their works of art as to personal direction and style.
- (1.7) Select three works of art from their art portfolio and discuss the intent of the work and the use of the media.
- (2.3) Assemble and display objects or works of art as a part of a public exhibition.
- (2.4) Demonstrate in their own works of art a personal style and an advanced proficiency in communicating an idea, theme, or emotion.
- (2.5) Use innovative visual metaphors in creating works of art.
- (2.6) Present a universal concept in a multimedia work of art that demonstrates knowledge of technology skills.
- (3.1) Identify contemporary styles and discuss the diverse social, economic, and political developments reflected in the works of art examined.
- (3.2) Identify contemporary artists worldwide who have achieved regional, national, or international recognition and discuss ways in which their work reflects, plays a role in, and influences present-day culture.
- (3.3) Investigate and discuss universal concepts expressed in works of art from diverse cultures.
- (4.3) Analyze and articulate how society influences the interpretation and message of a work of art.
- (4.6) Develop written criteria for the selection of a body of work from their portfolios that represents significant achievements.
- (5.1) Speculate on how advances in technology might change the definition and function of the visual arts.
- (5.3) Prepare portfolios of their original works of art for a variety of purposes (e.g., review for postsecondary application, exhibition, job application, and personal collection).

2.0 Communications

Students understand the principles of effective oral, written, and multimedia communication in a variety of formats and contexts.

(The standards listed below retain in parentheses the numbering as specified in the English–language arts content standards adopted by the State Board of Education.)

2.1 Reading

Specific applications of Reading Comprehension standards (grades nine and ten):

- (2.1) Analyze the structure and format of functional workplace documents, including the graphics and headers, and explain how authors use the features to achieve their purposes.
- (2.2) Prepare a bibliography of reference materials for a report using a variety of consumer, workplace, and public documents.
- (2.6) Demonstrate use of sophisticated learning tools by following technical directions (e.g., those found with graphic calculators and specialized software programs and in access guides to World Wide Web sites on the Internet).

Specific applications of Reading Comprehension standards (grades eleven and twelve):

- (2.3) Verify and clarify facts presented in other types of expository texts by using a variety of consumer, workplace, and public documents.
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2.2 Writing

Specific applications of Writing Strategies standards (grade eight):

- (1.4) Plan and conduct multiple-step information searches by using computer networks and modems.
- (1.5) Achieve an effective balance between researched information and original ideas.
- (1.6) Revise writing for word choice; appropriate organization; consistent point of view; and transitions between paragraphs, passages, and ideas.

Specific applications of Writing Strategies and Applications standards (grades nine and ten):

- (1.3) Use clear research questions and suitable research methods (e.g., library, electronic media, personal interview) to elicit and present evidence from primary and secondary sources.
- (1.4) Develop the main ideas within the body of the composition through supporting evidence (e.g., scenarios, commonly held beliefs, hypotheses, definitions).
- (1.5) Synthesize information from multiple sources and identify complexities and discrepancies in the information and the different perspectives found in each medium (e.g., almanacs, microfiche, news sources, in-depth field studies, speeches, journals, technical documents).
- (1.7) Use appropriate conventions for documentation in the text, notes, and bibliographies by adhering to those in style manuals (e.g., *Modern Language Association Handbook*, *The Chicago Manual of Style*).

- (1.8) Design and publish documents by using advanced publishing software and graphic programs.
- (2.6) Write technical documents (e.g., a manual on rules of behavior for conflict resolution, procedures for conducting a meeting, minutes of a meeting):
 - a. Report information and convey ideas logically and correctly.
 - b. Offer detailed and accurate specifications.
 - c. Include scenarios, definitions, and examples to aid comprehension (e.g., troubleshooting guide).
 - d. Anticipate readers' problems, mistakes, and misunderstandings.

Specific applications of Writing Strategies and Applications standards (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).
- (1.8) Integrate databases, graphics, and spreadsheets into word-processed documents.
- (2.5) Write job applications and résumés:
 - a. Provide clear and purposeful information and address the intended audience appropriately.
 - b. Use varied levels, patterns, and types of language to achieve intended effects and aid comprehension.
 - c. Modify the tone to fit the purpose and audience.
 - d. Follow the conventional style for that type of document (e.g., résumé, memorandum) and use page formats, fonts, and spacing that contribute to the readability and impact of the document.
- (2.6) Deliver multimedia presentations:
 - a. Combine text, images, and sound and draw information from many sources (e.g., television broadcasts, videos, films, newspapers, magazines, CD-ROMs, the Internet, electronic media-generated images).
 - b. Select an appropriate medium for each element of the presentation.
 - c. Use the selected media skillfully, editing appropriately and monitoring for quality.
 - d. Test the audience's response and revise the presentation accordingly.

2.3 *Written and Oral English Language Conventions*

Specific applications of English Language Conventions standards (grades eleven and twelve):

- (1.1) Demonstrate control of grammar, diction, and paragraph and sentence structure and an understanding of English usage.
- (1.2) Produce legible work that shows accurate spelling and correct punctuation and capitalization.
- (1.3) Reflect appropriate manuscript requirements in writing.

2.4 *Listening and Speaking*

Specific applications of Listening and Speaking Strategies and Applications standards (grade eight):

- (1.1) Analyze oral interpretations of literature, including language choice and delivery, and the effect of the interpretations on the listener.
- (1.2) Paraphrase a speaker's purpose and point of view and ask relevant questions concerning the speaker's content, delivery, and purpose.
- (1.3) Organize information to achieve particular purposes by matching the message, vocabulary, voice modulation, expression, and tone to the audience and purpose.
- (1.4) Prepare a speech outline based upon a chosen pattern of organization, which generally includes an introduction; transitions, previews, and summaries; a logically developed body; and an effective conclusion.
- (1.5) Use precise language, action verbs, sensory details, appropriate and colorful modifiers, and the active rather than the passive voice in ways that enliven oral presentations.
- (1.6) Use appropriate grammar, word choice, enunciation, and pace during formal presentations.
- (1.7) Use audience feedback (e.g., verbal and nonverbal cues):
 - a. Reconsider and modify the organizational structure or plan.
 - b. Rearrange words and sentences to clarify the meaning.
- (1.8) Evaluate the credibility of a speaker (e.g., hidden agendas, slanted or biased material).
- (1.9) Interpret and evaluate the various ways in which visual image makers (e.g., graphic artists, illustrators, news photographers) communicate information and affect impressions and opinions.
- (2.1) Deliver narrative presentations (e.g., biographical, autobiographical):
 - a. Relate a clear, coherent incident, event, or situation by using well-chosen details.
 - b. Reveal the significance of, and the subject's attitude about, the incident, event, or situation.
 - c. Employ narrative and descriptive strategies (e.g., relevant dialogue, specific action, physical description, background description, comparison or contrast of characters).
- (2.2) Deliver oral responses to literature:
 - a. Interpret a reading and provide insight.
 - b. Connect the students' own responses to the writer's techniques and to specific textual references.
 - c. Draw supported inferences about the effects of a literary work on its audience.
 - d. Support judgments through references to the text, other works, other authors, or personal knowledge.

- (2.3) Deliver research presentations:
 - a. Define a thesis.
 - b. Record important ideas, concepts, and direct quotations from significant information sources and paraphrase and summarize all relevant perspectives on the topic, as appropriate.
 - c. Use a variety of primary and secondary sources and distinguish the nature and value of each.
 - d. Organize and record information on charts, maps, and graphs.
- (2.4) Deliver persuasive presentations:
 - a. Include a well-defined thesis (i.e., one that makes a clear and knowledgeable judgment).
 - b. Differentiate fact from opinion and support arguments with detailed evidence, examples, and reasoning.
 - c. Anticipate and answer listener concerns and counterarguments effectively through the inclusion and arrangement of details, reasons, examples, and other elements.
 - d. Maintain a reasonable tone.
- (2.5) Recite poems (of four to six stanzas), sections of speeches, or dramatic soliloquies, using voice modulation, tone, and gestures expressively to enhance the meaning.

Specific applications of Listening and Speaking Strategies and Applications standards (grades nine and ten):

- (1.7) Use props, visual aids, graphs, and electronic media to enhance the appeal and accuracy of presentations.
- (1.8) Produce concise notes for extemporaneous delivery.
- (1.12) Evaluate the clarity, quality, effectiveness, and general coherence of a speaker's important points, arguments, evidence, organization of ideas, delivery, diction, and syntax.
- (2.2) Deliver expository presentations:
 - a. Marshal evidence in support of a thesis and related claims, including information on all relevant perspectives.
 - b. Convey information and ideas from primary and secondary sources accurately and coherently.
 - c. Make distinctions between the relative value and significance of specific data, facts, and ideas.
 - d. Include visual aids by employing appropriate technology to organize and display information on charts, maps, and graphs.
 - e. Anticipate and address the listener's potential misunderstandings, biases, and expectations.
 - f. Use technical terms and notations accurately.

- (2.5) Deliver persuasive arguments (including evaluation and analysis of problems and solutions and causes and effects):
 - a. Structure ideas and arguments in a coherent, logical fashion.
 - b. Use rhetorical devices to support assertions (e.g., by appeal to logic through reasoning; by appeal to emotion or ethical belief; by use of personal anecdote, case study, or analogy).
 - c. Clarify and defend positions with precise and relevant evidence, including facts, expert opinions, quotations, expressions of commonly accepted beliefs, and logical reasoning.
 - d. Anticipate and address the listener's concerns and counterarguments.

Specific applications of Listening and Speaking Strategies and Applications standards (grades eleven and twelve):

- (1.3) Interpret and evaluate the various ways in which events are presented and information is communicated by visual image makers (e.g., graphic artists, documentary filmmakers, illustrators, news photographers).
- (1.8) Use effective and interesting language, including:
 - a. Informal expressions for effect
 - b. Standard American English for clarity
 - c. Technical language for specificity
- (1.10) Evaluate when to use different kinds of effects (e.g., visual, music, sound, graphics) to create effective productions.
- (2.2) Deliver oral reports on historical investigations:
 - a. Use exposition, narration, description, persuasion, or some combination of those to support the thesis.
 - b. Analyze several historical records of a single event, examining critical relationships between elements of the research topic.
 - c. Explain the perceived reason or reasons for the similarities and differences by using information derived from primary and secondary sources to support or enhance the presentation.
 - d. Include information on all relevant perspectives and consider the validity and reliability of sources.
- (2.4) Deliver multimedia presentations:
 - a. Combine text, images, and sound by incorporating information from a wide range of media, including films, newspapers, magazines, CD-ROMs, online information, television, videos, and electronic media-generated images.
 - b. Select an appropriate medium for each element of the presentation.
 - c. Use the selected media skillfully, editing appropriately and monitoring for quality.
 - d. Test the audience's response and revise the presentation accordingly.

2.5 *Multimedia*

Understand the importance of technical and computer-aided design and drawing technologies essential to the language of the engineering and design industry, including reading, writing, interpreting, and creating drawings, sketches, and schematics using engineering and design industry conventions and standards; interpreting and understanding detailed information provided from available technical documents, both print and electronic, and from experienced people; and using computers, calculators, multimedia equipment, and other devices in a variety of applications.

3.0 Career Planning and Management

Students understand how to make effective decisions, use career information, and manage personal career plans:

- 3.1 Know the personal qualifications, interests, aptitudes, knowledge, and skills necessary to succeed in a career.
- 3.2 Understand the scope of career opportunities and know the requirements for education, training, and licensure.
- 3.3 Develop a career plan that is designed to reflect career interests, pathways, and postsecondary options.
- 3.4 Understand the role and function of professional organizations, industry associations, and organized labor in a productive society.
- 3.5 Understand the past, present, and future trends that affect careers, such as technological developments and societal trends, and the resulting need for lifelong learning.
- 3.6 Know important strategies for self-promotion in the hiring process, such as job applications, résumé writing, interviewing skills, and preparation of a portfolio.
- 3.7 Understand the nature of entrepreneurial activities.

4.0 Technology

Students know how to use contemporary and emerging technological resources in diverse and changing personal, community, and workplace environments:

- 4.1 Understand past, present, and future technological advances as they relate to a chosen pathway.
- 4.2 Understand the use of technological resources to gain access to, manipulate, and produce information, products, and services.
- 4.3 Understand the influence of current and emerging technology on selected segments of the economy.

5.0 Problem Solving and Critical Thinking

Students understand how to create alternative solutions by using critical and creative thinking skills, such as logical reasoning, analytical thinking, and problem-solving techniques:

- 5.1 Apply appropriate problem-solving strategies and critical thinking skills to work-related issues and tasks.
- 5.2 Understand the systematic problem-solving models that incorporate input, process, outcome, and feedback components.
- 5.3 Use critical thinking skills to make informed decisions and solve problems.

6.0 Health and Safety

Students understand health and safety policies, procedures, regulations, and practices, including the use of equipment and handling of hazardous materials:

- 6.1 Know the policies, procedures, and regulations regarding health and safety in the workplace, including employers' and employees' responsibilities.
- 6.2 Understand the critical elements of health and safety practices related to storing, cleaning, and maintaining tools, equipment, and supplies.

7.0 Responsibility and Flexibility

Students know the behaviors associated with the demonstration of responsibility and flexibility in personal, workplace, and community settings:

- 7.1 Understand the qualities and behaviors that constitute a positive and professional work demeanor.
- 7.2 Understand the importance of accountability and responsibility in fulfilling personal, community, and workplace roles.
- 7.3 Understand the need to adapt to varied roles and responsibilities.
- 7.4 Understand that individual actions can affect the larger community.

8.0 Ethics and Legal Responsibilities

Students understand professional, ethical, and legal behavior consistent with applicable laws, regulations, and organizational norms:

- 8.1 Know the major local, district, state, and federal regulatory agencies and entities that affect the industry and how they enforce laws and regulations.
- 8.2 Understand the concept and application of ethical and legal behavior consistent with workplace standards.
- 8.3 Understand the role of personal integrity and ethical behavior in the workplace.

9.0 Leadership and Teamwork

Students understand effective leadership styles, key concepts of group dynamics, team and individual decision making, the benefits of workforce diversity, and conflict resolution:

- 9.1 Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace settings.
- 9.2 Understand the ways in which preprofessional associations, such as SkillsUSA, and competitive career development activities enhance academic skills, promote career choices, and contribute to employability.
- 9.3 Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals.
- 9.4 Know multiple approaches to conflict resolution and their appropriateness for a variety of situations in the workplace.
- 9.5 Understand how to interact with others in ways that demonstrate respect for individual and cultural differences and for the attitudes and feelings of others.
- 9.6 Understand how to organize, conduct, lead, and participate in student-centered activities and events through student-based organizations.

10.0 Technical Knowledge and Skills

Students understand the essential knowledge and skills common to all pathways in the Engineering and Design sector:

- 10.1 Use and maintain industrial and technological products and systems.
- 10.2 Understand the importance of technical and computer-aided technologies essential to the language of the engineering and design industry.
- 10.3 Understand how to use, adjust, maintain, and troubleshoot the equipment and tools of the engineering and design industry in a safe, effective, and efficient manner.
- 10.4 Acquire, store, allocate, and use materials and space efficiently.
- 10.5 Understand the role of the engineering and design industry in the California economy.
- 10.6 Understand and apply the appropriate use of quality control systems and procedures.
- 10.7 Understand the need and process to obtain and maintain industry-standard, technical certifications and affiliations with professional organizations, including the American Society for Engineering Education, the Accreditation Board for Engineering and Technology, and the American Society of Civil Engineers.
- 10.8 Understand the need to obtain and maintain industry-standard, technical certifications significant to a particular industry.

11.0 Demonstration and Application

Students demonstrate and apply the concepts contained in the foundation and pathway standards.

PATHWAY STANDARDS

A. Architectural and Structural Engineering Pathway

The Architectural and Structural Engineering Pathway provides learning opportunities for students interested in preparing for careers in such areas as architecture, industrial design, and civil engineering.

A1.0 Students understand the ways in which architecture is shaped by history and know significant events in the history of structural engineering:

- A1.1 Know significant historical architectural and structural projects and their effects on society.
 - A1.2 Understand the development of architectural and structural systems in relation to aesthetics, efficiency, and safety.
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A2.0 Students understand the theoretical, practical, and contextual issues that influence design:

- A2.1 Understand the ways in which sociocultural conditions and issues influence architectural design.
 - A2.2 Understand the theoretical and practical effects of human and physical factors and cost analysis on the development of architectural designs.
 - A2.3 Use the necessary equipment for producing an architectural design and the appropriate methods and techniques for employing the equipment.
 - A2.4 Use freehand graphic communication skills to represent conceptual ideas, analysis, and design concepts.
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A3.0 Students understand the relationship between architecture and the external environment:

- A3.1 Understand the influence of community context and zoning requirements on architectural design.
 - A3.2 Develop a site analysis that considers passive energy techniques, sustainability issues, and landscaping.
 - A3.3 Develop a preliminary proposal for a simulated architectural design.
 - A3.4 Develop a complete set of architectural plans and drawings.
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A4.0 Students understand the mechanics and properties of structural materials:

- A4.1 Understand the integration of architectural factors, such as soil mechanics, foundation design, engineering materials, and structure design.
- A4.2 Understand various forces that bear on and within structures, including axial force, shear, torsion, and moment.
- A4.3 Know the various components of structures, including lighting; heating, ventilating, and air-conditioning (HVAC); mechanical; electrical; plumbing; communication; security; and vertical transportation systems.

- A4.4 Develop a stress analysis chart of a typical structural component.
- A4.5 Evaluate available building materials (e.g., steel and wood) by considering their properties and their effect on building form.
- A4.6 Develop a preliminary building plan by using the appropriate materials.

A5.0 Students understand methods used to analyze simple structures:

- A5.1 Understand load transfer mechanisms.
- A5.2 Understand stress-strain relationships of building structures.
- A5.3 Understand structural design considerations, including load-bearing relationships of shear walls, columns, and beams.
- A5.4 Design a simple structure by using structural analysis principles.

A6.0 Students understand the use of computer-aided drafting and design (CADD) in developing architectural designs:

- A6.1 Know various CADD programs that are commonly used in architectural design.
- A6.2 Use CADD software to develop a preliminary architectural proposal.

A7.0 Students understand how to systematically complete an architectural project:

- A7.1 Develop, read, and understand architectural and construction plans, drawings, diagrams, and specifications.
- A7.2 Estimate the materials needed for a project by reading an architectural drawing.
- A7.3 Plan the sequence of events leading to an architectural project.
- A7.4 Develop a process to record the progress of a project.

A8.0 Students understand the methods of creating both written and digital portfolios:

- A8.1 Develop a binder of representative student work for presentation.
- A8.2 Produce a compact disc, Web site, or other digital-media portfolio.
- A8.3 Give an effective oral presentation of a portfolio.

A9.0 Students understand the effective use of architectural and structural equipment:

- A9.1 Use the appropriate methods and techniques for employing all architectural and structural equipment.
- A9.2 Apply conventional architectural and structural processes and procedures accurately, appropriately, and safely.
- A9.3 Apply the concepts of architectural and structural engineering to the tools, equipment, projects, and procedures of the Architectural and Structural Engineering Pathway.

B. Computer Hardware, Electrical, and Networking Engineering Pathway

The Computer Hardware, Electrical, and Networking Engineering Pathway provides learning opportunities for students interested in preparing for careers in the assembly, manufacturing, programming, design, production, and maintenance of information technology, computer, telecommunications, and networking systems.

B1.0 Students know how to communicate and interpret information clearly in industry-standard visual and written formats:

- B1.1 Understand the classification and use of various electronic components, symbols, abbreviations, and media common to electronic drawings.
 - B1.2 Plan, prepare, and interpret mechanical, civil, chemical, and electrical sketches and drawings.
 - B1.3 Know the current industry standards for illustration and layout.
 - B1.4 Understand, organize, and complete network diagrams by using information collected from detailed drawings.
 - B1.5 Draw flat layouts of a variety of objects by using the correct drafting tools, techniques, and media.
 - B1.6 Prepare reports and data sheets for writing specifications.
-

B2.0 Students understand the telecommunications systems, such as electromagnetic, fiber optic, and digital, that apply to the transmission of data:

- B2.1 Understand how to confirm operating parameters, apply test procedures, make necessary adjustments, and assemble the components of a telecommunications system or subsystem.
 - B2.2 Understand how to plan, install, and maintain copper and fiber optic cabling for telecommunications systems.
 - B2.3 Test and maintain wireless communications components and systems.
 - B2.4 Understand how to safely operate various data networking and telecommunications systems.
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B3.0 Students know the fundamentals of the theory, measurement, control, and applications of electrical energy, including alternating and direct currents:

- B3.1 Analyze relationships between voltage, current, resistance, and power related to direct current (DC) circuits.
- B3.2 Understand the characteristics of alternating current (AC) and how AC is generated; the characteristics of the sine wave; the basic characteristics of AC circuits, tuned circuits, and resonant circuits; and the nature of the frequency spectrum.
- B3.3 Calculate, construct, measure, and interpret both AC and DC circuits.
- B3.4 Understand the fabrication processes and how they are applied in the electronics industry.

- B3.5 Use appropriate electronic instruments to analyze, repair, or measure electrical and electronic systems, circuits, or components.
- B3.6 Analyze and predict the effects of circuit conditions on the basis of measurements and calculations of voltage, current, resistance, and power.

B4.0 Students understand computer systems and solve computer-related problems from an engineering perspective:

- B4.1 Understand how to design and assemble systems that use computer programs to interact with hardware.
- B4.2 Install and configure essential computer hardware and software components.
- B4.3 Understand the ethical issues in computer engineering.
- B4.4 Know the function and interaction of basic computer components and peripherals.
- B4.5 Understand the relationship among computer hardware, networks, and operating systems.
- B4.6 Understand the process of assembling, testing, and troubleshooting computer equipment and systems.
- B4.7 Use utility software and test equipment efficiently to diagnose and correct problems.

B5.0 Students understand the design process and how to solve analysis and design problems:

- B5.1 Understand the steps in the design process.
- B5.2 Determine what information and principles are relevant to a problem and its analysis.
- B5.3 Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution.
- B5.4 Translate word problems into mathematical statements when appropriate.
- B5.5 Understand the process of incorporating multiple details into a single solution.
- B5.6 Build a prototype from plans and test it.
- B5.7 Evaluate and redesign a prototype on the basis of collected test data.

B6.0 Students understand the principles of data systems networking (e.g., design, configuration, topology, and implementation):

- B6.1 Understand the terminology used in the design, assembly, configuration, and implementation of data systems networks.
- B6.2 Know the fundamental elements of the major networking models established by the industry standards of recognized organizations (e.g., the Open System Interconnect [OSI] or transmission-control/Internet protocol [TCP/IP] models).
- B6.3 Know how data are carried through the most common network media.
- B6.4 Understand the composition and function of the various networks, including local area networks (LANs), medium area networks (MANs), and wide area networks (WANs).

- B6.5 Use the major routing and addressing protocols used in networking.
- B6.6 Understand the characteristics, advantages, and disadvantages of the various networking presentation functions (e.g., data formatting, data encryption, and data compression).
- B6.7 Know the characteristics of networking hardware and applications and the methods to implement them.
- B6.8 Design and document data systems networks.

B7.0 Students understand how to define a network security plan:

- B7.1 Know the common potential threats to networks and ways to neutralize them.
- B7.2 Know the main functions of and installation protocols for firewalls, virus detection software, and other security measures.
- B7.3 Upgrade and patch operating systems as necessary.
- B7.4 Define and configure firewalls.
- B7.5 Detect and remove virus and worm threats.
- B7.6 Use a management plan to develop an acceptable-use policy.

B8.0 Students understand fundamental automation modules and know how to set up simple systems to complete preprogrammed tasks:

- B8.1 Use appropriate tools and technology to install equipment, assemble hardware, perform tests, collect data, analyze relationships, and display data in a simulated or modeled automated system.
- B8.2 Understand the use of sensors for data collection and process correction in an automated system.
- B8.3 Understand how to program a computing device to control an automated system or process.

B9.0 Students understand the effective use of computer and networking equipment:

- B9.1 Use methods and techniques for employing all computer and networking equipment appropriately.
- B9.2 Apply conventional computer and networking processes and procedures accurately, appropriately, and safely.
- B9.3 Apply the concepts of computer and networking equipment to the tools, equipment, projects, and procedures of the Computer Hardware, Electrical, and Networking Engineering Pathway.

C. Engineering Design Pathway

The Engineering Design Pathway provides learning opportunities for students interested in preparing for careers in the design and production of visual communications. The students plan, prepare, and interpret drawings and models through traditional drafting or computer-aided drafting and design (CADD) techniques.

C1.0 Students recognize historical and current events related to engineering design and their effects on society:

- C1.1 Know historical and current events that have relevance to engineering design.
 - C1.2 Understand the development of graphic language in relation to engineering design.
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C2.0 Students understand the effective use of engineering design equipment:

- C2.1 Use the appropriate methods and techniques for employing all engineering design equipment.
 - C2.2 Apply conventional engineering design processes and procedures accurately, appropriately, and safely.
 - C2.3 Apply the concepts of engineering design to the tools, equipment, projects, and procedures of the Engineering Design Pathway.
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C3.0 Students understand measurement systems as they apply to engineering design:

- C3.1 Know how the various measurement systems are used in engineering drawings.
 - C3.2 Understand the degree of accuracy necessary for engineering design.
-

C4.0 Students use proper projection techniques to develop orthographic drawings:

- C4.1 Understand the commands and concepts necessary for producing drawings through traditional or computer-aided means.
 - C4.2 Understand the orthographic projection process for developing multiview drawings.
 - C4.3 Understand the various techniques for viewing objects.
 - C4.4 Use the concepts of geometric construction in the development of design drawings.
 - C4.5 Apply pictorial drawings derived from orthographic multiview drawings and sketches and from a solid modeler.
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C5.0 Students know various object-editing techniques and CADD programs:

- C5.1 Understand the commands and concepts necessary for editing engineering drawings.
- C5.2 Know the various object-altering techniques.
- C5.3 Know the CADD components and the operational functions of CADD systems.

- C5.4 Apply two-dimensional and three-dimensional CADD operations in creating working and pictorial drawings, notes, and notations.
- C5.5 Understand how to determine properties of drawing objects.

C6.0 Students understand and apply proper dimensioning to drawings:

- C6.1 Know a variety of drafting applications and understand the proper dimensioning styles for each.
- C6.2 Apply dimensioning to various objects and features.
- C6.3 Edit a dimension by using various editing methods.

C7.0 Students understand sectional view applications and functions:

- C7.1 Understand the function of sectional views.
- C7.2 Use a sectional view and appropriate cutting planes to clarify hidden features of an object.

C8.0 Students understand the tolerance relationships between mating parts:

- C8.1 Understand what constitutes mating parts in engineering design.
- C8.2 Use tolerancing in an engineering drawing.
- C8.3 Interpret geometric tolerancing symbols in a drawing.

C9.0 Students understand the methods of inserting text into a drawing:

- C9.1 Understand the processes of lettering and text editing.
- C9.2 Develop drawings using notes and specifications.
- C9.3 Understand the methods of title block creation.

C10.0 Students understand the sketching process used in concept development:

- C10.1 Understand the process of producing proportional two- and three-dimensional sketches and designs.
- C10.2 Use sketching techniques as they apply to a variety of architectural and engineering models.
- C10.3 Use freehand graphic communication skills to represent conceptual ideas, analysis, and design concepts.

C11.0 Students understand the methods of creating both written and digital portfolios:

- C11.1 Develop a binder of representative student work for presentation.
- C11.2 Produce a compact disc, Web site, or other digital-media portfolio.
- C11.3 Know how to give an effective oral presentation of a portfolio.

D. Engineering Technology Pathway

The Engineering Technology Pathway provides learning opportunities for students interested in preparing for careers in the design, production, and maintenance of mechanical, telecommunications, electrical, electronics, and electromechanical products and systems.

D1.0 Students know how to communicate and interpret information clearly in industry-standard visual and written formats:

- D1.1 Understand the classification and use of various electronic components, symbols, abbreviations, and media common to electronic drawings.
 - D1.2 Understand, organize, and complete an assembly drawing by using information collected from detailed drawings.
 - D1.3 Know the current industry standards for illustration and layout.
 - D1.4 Draw flat layouts of a variety of objects by using the correct drafting tools, techniques, and media.
 - D1.5 Prepare reports and data sheets for writing specifications.
-

D2.0 Students understand telecommunications systems, such as electromagnetic, fiber optic, and digital, that apply to the transmission of data:

- D2.1 Assemble the components of a telecommunications system or subsystem, including confirming operating parameters, applying test procedures, and making necessary adjustments.
 - D2.2 Plan, install, and maintain copper and fiber optic cabling for telecommunications systems.
 - D2.3 Test and maintain wireless communications components and systems.
 - D2.4 Understand how to safely operate various data networking and telecommunications systems.
-

D3.0 Students know the fundamentals of the theory, measurement, control, and applications of electrical energy, including alternating and direct currents:

- D3.1 Analyze relationships between voltage, current, resistance, and power related to direct current (DC) circuits.
- D3.2 Understand the characteristics of alternating current (AC) and how it is generated; the characteristics of the sine wave; the basic characteristics of AC circuits, tuned circuits, and resonant circuits; and the nature of the frequency spectrum.
- D3.3 Calculate, construct, measure, and interpret both AC and DC circuits.
- D3.4 Use appropriate electronic instruments to analyze, repair, or measure electrical and electronic systems, circuits, or components.
- D3.5 Analyze and predict the effects of circuit conditions on the basis of measurements and calculations of voltage, current, resistance, and power.
- D3.6 Classify and use various electrical components, symbols, abbreviations, media, and standards of electrical drawings.

- D3.7 Understand how electrical control and protection devices are used in electrical systems.
 - D3.8 Calculate loads, currents, and circuit-operating parameters.
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D4.0 Students understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems:

- D4.1 Understand scalars and vectors.
 - D4.2 Solve problems by using the concept of vectoring to predict the resultant forces.
 - D4.3 Know the six simple machines and their applications.
 - D4.4 Know how energy is transferred; know the effects of resistance in mechanical, electrical, fluid, and thermal systems.
 - D4.5 Solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems.
-

D5.0 Students understand the design process and how to solve analysis and design problems:

- D5.1 Understand the steps in the design process.
 - D5.2 Determine what information and principles are relevant to a problem and its analysis.
 - D5.3 Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution.
 - D5.4 Translate word problems into mathematical statements when appropriate.
 - D5.5 Understand the process of developing multiple details into a single solution.
 - D5.6 Build a prototype from plans and test it.
 - D5.7 Evaluate and redesign a prototype on the basis of collected test data.
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D6.0 Students understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality assurance:

- D6.1 Know the common structure and processes of a quality assurance cycle.
 - D6.2 Understand the major manufacturing processes.
 - D6.3 Use tools, fasteners, and joining systems employed in selected engineering processes.
 - D6.4 Estimate and measure the size of objects in both Standard International and United States units.
 - D6.5 Calibrate and measure objects by using precision measurement tools and instruments.
-

D7.0 Students understand the concepts of physics that are fundamental to engineering technology:

- D7.1 Understand Newton's laws and how they affect and define the movement of objects.
- D7.2 Understand how the laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.

- D7.3 Analyze the fundamentals and properties of waveforms and how waveforms may be used to carry energy.
- D7.4 Understand how electric and magnetic phenomena are related and know common practical applications.

D8.0 Students understand computer systems and solve computer-related problems from an engineering perspective:

- D8.1 Understand how to design systems that use computer programs to interact with hardware.
- D8.2 Install and configure the main computer hardware and software components.
- D8.3 Understand the ethical issues in computer engineering.
- D8.4 Know the function and interaction of basic computer components and peripherals.
- D8.5 Understand the relationship among computer hardware, networks, and operating systems.
- D8.6 Understand the process of testing and troubleshooting computer equipment and systems.
- D8.7 Use utility software efficiently to diagnose and correct problems.

D9.0 Students understand fundamental automation modules and are able to develop systems that complete preprogrammed tasks:

- D9.1 Use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data in a simulated or modeled automated system.
- D9.2 Understand the use of sensors for data collection and process correction in an automated system.
- D9.3 Program a computing device to control an automated system or process.
- D9.4 Use motors, solenoids, and similar devices as output mechanisms in automated systems.
- D9.5 Assemble input, processing, and output devices to create an automated system capable of accurately completing a preprogrammed task.

D10.0 Students understand the fundamentals of systems and products as they are developed and released to production and marketing:

- D10.1 Understand the process of product development.
- D10.2 Understand charting and the use of graphic tools in illustrating the development of a product and the processes involved.

D11.0 Students understand the effective use of engineering technology equipment:

- D11.1 Use methods and techniques for employing all engineering technology equipment appropriately.
- D11.2 Apply conventional engineering technology processes and procedures accurately, appropriately, and safely.
- D11.3 Apply the concepts of engineering technology to the tools, equipment, projects, and procedures of the Engineering Technology Pathway.

E. Environmental and Natural Science Engineering Pathway

The Environmental and Natural Science Engineering Pathway provides students with the opportunity to prepare for careers in the environmental and natural sciences. They learn to design and develop processes, equipment, and systems that are used to create, monitor, prevent, or correct environmental events and conditions.

E1.0 Students know how to communicate and interpret information clearly in industry-standard visual and written formats:

- E1.1 Understand the classification and use of various electronic components, symbols, abbreviations, and media common to electronic drawings.
 - E1.2 Know the current industry standards for illustration and layout.
 - E1.3 Organize and complete site plans.
-

E2.0 Students study and understand the fundamentals of earth science as they relate to environmental engineering:

- E2.1 Classify the three major groups of rocks according to their origin on the basis of texture and mineral composition.
 - E2.2 Analyze the importance and use of soil, and evaluate how soil may be preserved and conserved.
 - E2.3 Know how to assess and evaluate geological hazards.
 - E2.4 Understand how to read, interpret, and evaluate topographical maps and images.
 - E2.5 Use global positioning systems equipment and related technology to locate and evaluate soil or geological conditions or features.
 - E2.6 Analyze soil erosion and identify the causes.
 - E2.7 Know the fundamental stages of geochemical cycles.
 - E2.8 Understand the effects of pollution on hydrological features.
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E3.0 Students understand the effects of the weather, the hydrosphere, and the atmosphere on the environment:

- E3.1 Understand the effects of weather fronts on regional air pollution.
- E3.2 Know the common causes of atmospheric contamination.
- E3.3 Analyze atmospheric pressure and weather systems.
- E3.4 Know the major systems used to monitor, analyze, and predict conditions of meteorological events.
- E3.5 Analyze the mechanisms for air mass movement.
- E3.6 Understand the relationship between the health of the marine environment and climate control.
- E3.7 Understand the effects of human activity on the atmospheric environment.

E4.0 *Students understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems:*

- E4.1 Understand scalars and vectors.
- E4.2 Solve problems by using the concept of vectoring to predict the resultant forces.
- E4.3 Know the six simple machines and their applications.
- E4.4 Know how energy is transferred and the effects of resistance in mechanical, electrical, fluid, and thermal systems.
- E4.5 Solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems.

E5.0 *Students understand the design process and how to solve analysis and design problems:*

- E5.1 Understand the steps in the design process.
- E5.2 Determine what information and principles are relevant to a problem and its analysis.
- E5.3 Choose between alternate solutions in solving a problem and be able to justify choices in determining a solution.
- E5.4 Translate word problems into mathematical statements when appropriate.
- E5.5 Understand the process of developing multiple details into a single solution.
- E5.6 Build a prototype from plans and test it.
- E5.7 Evaluate and redesign a prototype on the basis of collected test data.

E6.0 *Students understand the concepts of physics that are fundamental to engineering technology:*

- E6.1 Understand Newton's laws and how they affect and define the movement of objects.
- E6.2 Understand how the laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.
- E6.3 Analyze the fundamentals and properties of waveforms and how waveforms may be used to carry energy.
- E6.4 Understand how electric and magnetic phenomena are related and know common practical applications.

E7.0 *Students understand how computer hardware and software are combined to create systems and process information and data:*

- E7.1 Use computer programs to interact with sensors and monitor equipment.
- E7.2 Install and configure the main computer hardware and software components.
- E7.3 Understand ethical issues in computer engineering.
- E7.4 Know the function and interaction of basic computer components and peripherals.
- E7.5 Understand the relationship among computer hardware, networks, and operating systems.

- E7.6 Understand the process of testing and troubleshooting computer equipment and systems.
- E7.7 Use utility software efficiently to diagnose and correct problems.

E8.0 Students understand fundamental automation modules and know how to set up simple systems that will complete preprogrammed tasks:

- E8.1 Use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data in a simulated or modeled automated system.
- E8.2 Understand the use of sensors for data collection and process correction in an automated system.
- E8.3 Understand how to program a computing device to control an automated system or process.
- E8.4 Assemble input, processing, and output devices to create an automated system that is capable of accurately completing a preprogrammed task.

E9.0 Students understand the effective use of environmental and natural science equipment:

- E9.1 Use appropriate methods and techniques for employing environmental and natural science equipment.
- E9.2 Apply conventional environmental and natural science processes and procedures accurately, appropriately, and safely.
- E9.3 Apply the concepts of environmental and natural science to the tools, equipment, projects, and procedures of the Environmental and Natural Science Engineering Pathway.