Title: Introduction to Engineering Design (PLTW)

Job Titles: Architectural and Civil Drafters 17-3011  
Civil Engineering Technicians 17-3022  
Engineering Technicians 17-3029  
Industrial Engineering Technician Mechanical Drafters  
Mechanical Engineering Technicians

Course Description:  
Introduction to Engineering Design™ (IED) is a high school level course that is appropriate for 9th or 10th grade students who are interested in design and engineering. The major focus of the IED course is to expose students to design process, research and analysis, teamwork, communication methods, global and human impacts, engineering standards, and technical documentation. IED gives students the opportunity to develop skills and understanding of course concepts through activity-, project-, and problem-based (APPB) learning. Used in combination with a teaming approach, APPB-learning challenges students to continually hone their interpersonal skills, creative abilities and understanding of the design process. It also allows students to develop strategies to enable and direct their own learning, which is the ultimate goal of education.

The course assumes no previous knowledge, but students should be concurrently enrolled in college preparatory mathematics and science. Students will employ engineering and scientific concepts in the solution of engineering design problems. In addition, students use a state-of-the-art 3D solid modeling design software package to help them design solutions to solve proposed problems. Students will develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges that increase in difficulty throughout the course. Students will also learn how to document their work, and communicate their solutions to their peers and members of the professional community. Introduction to Engineering Design™ is one of three foundation courses in the Project Lead The Way® high school pre-engineering program. The course applies and concurrently develops secondary level knowledge and skills in mathematics.

This course aligns with and incorporates the California Career Technical Education Model Curriculum Standards, Common Core Content Standards as reflected in the Academic Alignment Matrix, Standards for Career Ready Practice, Anchor Standards, and Pathway Standards.

<table>
<thead>
<tr>
<th>Module</th>
<th>Module Title</th>
<th>Classroom Hours</th>
<th>OJT (CC) Hours</th>
<th>OJT (CVE) Hours</th>
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<tbody>
<tr>
<td>I</td>
<td>Career Ready Practice</td>
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<tr>
<td>II</td>
<td>Design Process</td>
<td>49</td>
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<td>III</td>
<td>Design Exercises</td>
<td>50</td>
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<td>VI</td>
<td>Reverse Engineering</td>
<td>43</td>
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<td>V</td>
<td>Open-Ended Design Problems</td>
<td>33</td>
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<td></td>
<td><strong>Total Hours:</strong> 187</td>
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Revised 2014-2015
Los Angeles County Career Technical Education  
COURSE OUTLINE  
Introduction to Engineering Design (PLTW)

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Introduction to Engineering Design (PLTW)</th>
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<tbody>
<tr>
<td>CBEDS Code</td>
<td>5782</td>
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<tr>
<td>State Course ID</td>
<td>6938</td>
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<td>ROCP #</td>
<td>17-303</td>
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<tr>
<td>Approval Date</td>
<td>August 17, 2011</td>
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<tr>
<td>Revision Date</td>
<td>April, 2015</td>
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</table>
| O*Net Codes and Job Titles | Architectural and Civil Drafters 17-3011  
Civil Engineering Technicians 17-3022  
Engineering Technicians 17-3029  
Industrial Engineering Technician  
Mechanical Drafters  
Mechanical Engineering Technicians |
| CTE Industry Sector | Engineering and Architecture            |
| Career Pathway(s) | Engineering Design (C)  
Engineering Technology (B) |
| UC Credit      | No                                       |
| Industry Certification | No                                |
| Student Prerequisites | None                               |
| Total Course Hours | 187                                  |

**Course Description**

Introduction to Engineering Design™ (IED) is a high school level course that is appropriate for 9th or 10th grade students who are interested in design and engineering. The major focus of the IED course is to expose students to design process, research and analysis, teamwork, communication methods, global and human impacts, engineering standards, and technical documentation. IED gives students the opportunity to develop skills and understanding of course concepts through activity-, project-, and problem-based (APPB) learning. Used in combination with a team approach, APPB-learning challenges students to continually hone their interpersonal skills, creative abilities and understanding of the design process. It also allows students to develop strategies to enable and direct their own learning, which is the ultimate goal of education.

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This course aligns with and incorporates the California Career Technical Education Model Curriculum Standards, Common Core Content Standards as reflected in the Academic Alignment Matrix, Standards for Career Ready Practice, Anchor Standards, and Pathway Standards.
Classroom Physical Environment
The classroom portion of this course should be conducted in a classroom or a site conducive to create/maintain an appropriate learning environment. The classroom setting requires both a fully equipped workshop with equipment, tools, and supplies in sufficient quantity to train the number of students assigned to each instructor. It requires space conducive for a group theory lesson including flat student desks or worktables, chalkboard or whiteboard, locked file cabinet, teacher’s chair and desk, computer tables to accommodate at least four computers, and Internet access. A printer, projector, document cameras, DVD player, and screen are also needed. This facility must be equipped with adequate lighting and many electrical outlets (at least one outlet per every two students plus four additional).

- NOTE: This class should be conducted in a site that simulates an industry-standard workplace in this field.

Equipment and Supplies

Computer Software:
- Autodesk
- PLTW Virtual Academy

Computer Hardware and Supplies:
- Desktop and/or Laptop Computers must be at least: Desktop Computer Intel® Core 2 Duo or i5, 8 GB RAM, 500 GB Hard Drive, 1 GB dedicated RAM or greater, DirectX (Direct3D/OpenGL) capable graphics card supporting 1280 x 1024 screen resolution, DVD-ROM Drive, Windows 7 or Windows 8.1, 64 bit operating system or Apple device with OSX 10.8, Bootcamp required with one of the above Windows operating systems, and must have network connectivity (wireless and/or wired).
- Printer and Toner Cartridge
- Scanner
- LCD Projector
- Digital Camera and Memory Cards
- Jump Drives
- Toner Cartridge
- 20 lb. Plotter Bound Non-Glossy 11" x 17" Paper
- 8 1/2 x 11 20 lb. Paper

Engineering Specialty:
- Assorted Automoblox model cars
- 3/4" Square Wooden Craft Blocks
- 20cc Syringe only Luer-Lok
- 1/8" ID Flexible Tubing

California Career Technical Education Model Curriculum Standards, Grades 7-12
Industry Sector Anchor Standards (AS): Engineering and Architecture
Pathway Standards (PS): Engineering Technology (B) and Engineering Design (C)
Standards for Career Ready Practice (CRP):
Common Core State Standards (CCSS): Language Arts (ELA); Mathematics (M)
• 1/8" Connectors and splitter for tubing. T style and three way style Set of 5 Connectors for Two Users
• Flight of the Gossamer Condor DVD. Include public performance license.
• The Films of Charles and Ray Eames - Volume 4 DVD. Includes public performance license.
• Nightline: The Deep Dive DVD
• Rosin Core Solder (1/16" Diameter, 1lb spool)
• 30-60-90 Triangle, X 10", clear plastic.
• 45-45-90 Triangle, X 10", clear plastic.
• Circle Template, 42 circles ranging from 1/16” through 2 ¼” Alvin # 88T.
• Ellipse Template, 35 ellipses ranging from 1/16” through 2 ¼” Alvin #97T.
• Digital Multimeter, voltage range: 200mV – 1,00V DC (+) (-) 8%&200mV – 450V (+) (-) 2.0%, current range: 200 uA-19A dc (+) (-) 1.5%, resistance 200 – 20m (+) (-) 2% capacitance with Leads.
• Weller SP-23 Soldering Iron 25 Watt
• Soldering Iron Holder
• Safety Glasses with Side Shields & Adjustable Temple #11782 Phoenix Edge-Black TM-53
• Alvin 6” Professional Semicircular Protractor
• CS-20000 Compact Digital Scale, 2000g. Capacity -1gram readability g, lb, oz, modes.
• 6" Steel Dial Calipers, graduated in .001, White faced Dial
• Cutting Mats, Self-Healing, 12" X 18" Kelvin #470079
• Alvin Flexible Stainless Steel Ruler- Graduated to 32nds and 16ths and metric. Non-skied cork backing

Engineering Lab Hardware and Supplies:
• 1/4" diameter x 36" long Birch Hardwood Dowels
• Utility/X-Acto Knife with replacement blades
• Quick Dry Tacky Glue, 4oz. Kelvin #930048
• Staples 3/8" Long for Arrow #T50
• Storage Organizer for fischertechnik® parts, e.g. tackle box (13 1/8 x 17 x 3 7/16)
• Steel Tape measure, Blade Size 1" X 25" wide Blade, Power Return and Thumb Lock, Stanley
• Compass, Pencil, Adjustable to 8" diameter, General #842
• Wrench Adjustable 8" Long Max Opening 1 1/8" Crescent #AT18
• 9 Piece Combination Wrench Set, 1/4, 5/16, 3/8, 7/16, 1/2, 9/16, 5/8, 11/16, 3/4
• Hex Key Wrench Set, .05" -3/16" Fold Uni-Key Set, Eklind #91S
• Square, Combination, 12" Grooved Blade, Stanley #46-123
- 4.5-Inch Needle Nose Pliers (Crescent or Channel Lock) CL#43
- Long Nose Pliers, 6 1/ 2" Long, Cushion Grip, Great Neck
- Lineman Pliers, 8" Cushion Grip Great Neck #E8C
- 4.5-Inch Diagonal Cutter (Crescent or Channel Lock) CL #41
- Locking Pliers, 7" long 1" Throat Depth, Vice - Grip #RR
- Xcelite 103-S Wire Stripper
- Screwdriver, Jeweler’s Set of 6, Nickel Plated, General #SPC600
- Screwdriver Set, 7 Piece, Flat Blade Stanley #66-157
- Screwdriver Set, 5 Piece, Phillips Stanley #66-156
- Socket Set, 3/8" drive, 18 Pieces, Paxton Patterson #18-3644
- Saw, Back Blade 14", 12 pts. Per inch, Stanley #10-4498
- Saw, Hack Frame, For 10" or 12" Blades, Nicholson #80951
- Hammer, Ball Peen, 8oz.
- Hammer, Curved, Claw, 16 oz. Stanley #51-110
- HSS Drills, 1/16" - 1/2" by 64ths, With Case, Paxton Patterson #14-3002
- Spade Bit, 6 Bit Set, 3/8", 1/2", 5/8", 3/4", 7/8", 1", Paxton Patterson
- Cordless Drill, 14 Volt or Higher, 3/8" Keyless Chuck, Variable Speed Reversing, Dual Speed Ranges: 0-300 & 0-1100 rpm, 16 Position Chuck, Recharging Unit & two batteries
- Knife, Putty Stiff Blade, 1 1/4" Wide Blade, Hyde #02050
- Aviation Snip, Combination - M-3, Wiss #M-3R
- Files, Metal, 6 Piece Assortment Paxton Patterson #10-2830
- "Surform" File Flat, Regular Cut, Stanley #21-293
- Level, Torpedo, magnetic, 9" Paxton Patterson #10-6676
- Level, 24" Long, Aluminum, Paxton Patterson #12-2714
- Lo-Temp Full Size 110 Volt Glue Gun with 12" Glue Sticks
- Lo-Temp Glue Sticks, 1/2" x 4" Long
- Staple Gun, Arrow #T50
- Quick Grip Bar Clamp, 6" Jaw, Quick Grip #506
- Quick Grip Bar Clamp, 12" Jaw, Quick Grip #512
- Quick Grip Bar Clamp, 24" Jaw, Quick Grip # 524
- Spring Clamps, 4" Long, 1" Opening
- Spring Clamps, 9" Long, 3" Opening
- Drill Press Vise, 4" Capacity, Delta #20-621
• Storage Cabinet, Steel, 36"W x 18"D x 72"H with 5 Steel Shelves and locking handle
• Machinist Vise, 4" Jaw Width X 6 1/2" Jaw Opening, Fixed Base
• Woodworker's vise, 3 1/2" X 7 1/8" Jaw to accept Wooden Jaw Covers, With Steel Dog Front
• Miter Box, Hard Maple or Plastic 4" High Sides, Inside Dimensions 16" X 4" X 4"
• Power Miter Box, 10", 5 1/2" Cross Cut at 90°, Electric Blade Brake, Retractable Blade Guard, Dust Bag, 15A 115V Motor
• Band saw, Bench top, 9" Throat, 115V, 1/5HP, Tilting
• Scroll Saw, Bench Top Model
• Drill Press, 12", Bench Top Model
• Hot Wire Foam Cutter, Free Hand, 11 3/4" X 16" 24 gauge wire, Kelvin #740110
• Assorted Sandpaper

**General Supplies:**
• X-Acto Display Board Plus, 36" x 48" White
• Royal Brites Poster Boards, 22" x 28" White pack of 10
• Isometric Graph Paper, 8 1/2' X 11", 1/4" square grid superimposed over isometric grid Alvin #1242
• Ampad Quadrille Lined Graph Paper, 11" x 17". 50 sheets/ pad
• 1" Wide Masking Tape 50ft.
• Duct Tape, Gray 50ft.
• Composition Notebook, Quadrille Ruled, 9-34" x 7-1/2"
• PTE Engineering Notebook, cost for a package of 25 is $56.25. ISBN#: 978-0-578-05027-0
  NOTE: Purchase either 1680 or 1690, not both.
• Three Hole Punch
• Plastic Ruler
• Assorted Permanent Markers
• Paper Cutter
• Scissors
• Tape, Plastic Electrical, Black, 3/4" X 30'

**Operational Methodologies**
• **Classroom (C):** Instruction provided by a qualified teacher, utilizing a lesson plan, to a group of students in a classroom.
• **Community Classroom (CC):** An instructional method which utilizes unpaid, on-the-job training experiences at business, industry, and public agency sites.
• **Cooperative Vocational Education (CVE):** An instructional method which correlates concurrent, formal vocational classroom instruction with regularly scheduled, paid on-the-job training experience.
• **Related Instruction (RI):** Classroom instruction and unpaid/paid on-the-job training experiences are being conducted together within the same time frame (quarter, semester, etc.).

• **On-the-Job Training (OJT):** Refers to “hands-on” job skill training in either the community classroom (unpaid) or in correlation with cooperative vocational education (paid).

**Training OJT Environment**
Title 5 Education Code No. 10085

The following criteria shall be used to select and approve a community classroom training station:

(a) The management of the community classroom training station shall:

1. Have a clear understanding of the community classroom methodology and a willingness to participate in the training experience.
2. Cooperate with the career technical education director, or his/her designee, in preparing a written joint venture agreement.
3. Participate with the community classroom teacher in preparing an individualized training plan.
4. Provide and assist students with unpaid on-the-job training experiences as described in the individualized training plan.
5. Consult with the community classroom teacher regarding the student’s progress during the unpaid on-the-job training experiences.
6. Assist in maintaining accurate records of the pupils training hours.

(b) The training station shall offer training opportunities in the specific occupation for which the course is approved. Training opportunities at the station shall expand competencies developed in the classroom instruction portion of the student’s training.

(c) The training station shall have adequate equipment, materials, and other resources to provide an appropriate learning opportunity.

(d) Training station conditions shall prevail which will not endanger the health, safety, welfare, or morals of the pupil.

(e) The training station shall be concurrently engaged in a business operation, which requires employment in the occupation for which training is provided.

**Ed. Code Title 5 10107**

(a) The employer at the cooperative career technical training station shall:

1. Have a clear understanding of program objectives and a willingness to participate in the program.
2. Provide adequate supervision to ensure a planned program of the students’ paid on-the-job training in order that the student may receive maximum education benefit.
3. Consult with the cooperative career technical education teacher regarding the paid on-the-job progress of the student.
4. Cooperate with the career technical education direction or his or her designee in preparing a written training agreement.
5. Participate with the cooperative career technical education teacher and the student in preparing an individualized training plan.
(6) Provide a minimum of 8 hours of paid employment per week to assist students to acquire those competencies necessary for employment and advancement in the occupational area for which training offered.

(7) Assist in maintaining accurate records of the students’ training hours.

(8) Provide Workers’ Compensation Insurance for students employed through the Cooperative Career Technical Education Program.

(b) The training station shall offer training opportunities in the specific occupation for which the course is approved. Training opportunities at the paid station shall be in the occupation for which related instruction is provided.

(c) Training station working conditions shall not endanger the health, safety, welfare or morals of the students.

(d) The training station shall have adequate equipment, materials and other resources to provide an appropriate learning opportunity.

**Instructional Methodologies, Strategies and Techniques**

A variety of instructional methodologies, strategies, and techniques are used to instruct the students. These include, but are not limited to the following:

- Lecture and Discussion
- Teacher modeling
- Demonstration
- Laboratory Activities which Emphasize Open-ended Hands-on Exploration and Investigation
- Team and Subspecialty Teamwork
- Exposure to Current Trends and Information in Robotics/Electronics through Reading Assignments in Current Periodicals and Journals
- Written Assignments Correlating with Concepts Presented in Lecture
- Independent and Group Research Projects
- Independent and Group Engineering Projects
- Internet Research
- Personal Journals
- Enrichment Videos and Slide Presentations
- Collaboration with Community, Corporate and JPL/Cal Tech Mentors
- Possible Field Trips to Cal Tech, JPL, and a Manufacturing and/or Electronics Company
- Multimedia presentations
- Guest speakers
- DVDs
- Student presentations (oral, written, technological)
- Utilization of computers/technology
Assessment of Student Performance
Assessment of student performance may include but is not limited to:
- Extensive Reading Assignments, Substantial Written Assignments, Internet Research
- Individual and Group Research Projects
- Problem-solving Activities
- Written Tests and Quizzes
- Participation in Engineering design sessions
- Engineering Design and Building Projects
- Accomplishment of Specific Goals in Subspecialty Teams
- Student demonstrations
- Individual and group presentations
- Supervisor/teacher observations
- Peer evaluations
- Self-reflections
- Critiques
- Rubrics
- Oral assessment
- Reports and research papers
- Performance tasks

Students will be assessed in multiple ways to ensure that a variety of learning styles are addressed.

Safety
- All students will successfully complete a safety exam with results kept on file.
- Specialized safety needs related to tools and supplies used.

Recommended Supplemental Instructional Textbooks
- Robotics Technology by James W. Masterson – Introduction to Robotics
- Robotics Technology: Laboratory Manual by James W. Masterson – Introduction to Robotics
Magazines & Scientific Journals
- Popular Electronics
- Microcomputer Journal
- Nuts & Volts
- Scientific American
- Electronic Design
- Robotics Research

Reference Books
- Robotics! Student Workbook (Parallax)
- The Basic Stamp User's Manual (Parallax) – Introduction to Robotics
- Advanced Robotics Student Workbook (Parallax) – Advanced Robotics
- Javalin User’s Manual (Parallax) – Advanced Robotics
- The Basic Stamp User’s Manual (Parallax)
- Engineer’s Notebooks
- Engineering “Cookbooks”
- The Robot Builder’s Bonanza
- The How and Why of Mechanical Movement
- Sensors for Mobile Robots
- Navigating Mobile Robots
- Handbook of Physics
- Practical Robotics: Principles and Applications by Bill Davies
- Robot Technology Fundamentals by James G. Keramas

Special Instructor(s) Prerequisites
- Valid California Designated Subjects credential authorizing CTE teaching in the industry sector identified.
- Knowledge of current industry trends and practices, including appropriate technology.
- Willingness to establish local community work sites and ability to access resources.
- Willingness to participate in advisory and committee meetings, including recruiting and collaborating with business partners.
<table>
<thead>
<tr>
<th>INSTRUCTIONAL CONTENT</th>
<th>STUDENT OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. CAREER READY PRACTICE</td>
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</table>
| A. Orientation/ Introduction to CTE | • Relate philosophy, purpose and goals of CTE.  
• Explain the importance of meeting the demands of the 21st century workplace.  
• Explain the “Drivers of Change” and how it relates to college and career. |
| B. Occupational Safety | • Discuss health and safety policies, procedures, regulations, practices and exhibit the proper use of equipment and handling of hazardous materials.  *AS 6.0*  
• Explain the reasoning of basic safety rules in the classroom and workplace. Demonstrate an understanding of safety rules and practices by passing an assessment, with 90% accuracy. |
| C. Technical Skills and Academic Knowledge | • Apply appropriate technical skills and academic knowledge.  *CRP 1*  
• Analyze and apply appropriate academic standards required for successful industry sector pathway completion leading to postsecondary education and employment. Refer to the industry sector alignment matrix for identification of standards.  *AS 1.0* |
| D. Communication Skills | • Communicate clearly, effectively, and with reason.  *CRP 2*  
• Explain how a positive attitude can help in becoming an effective communicator.  
• Practice good communication to help build positive relationships in the classroom and at the workplace.  
• Compare and contrast written and oral communications.  
• Describe the importance of email etiquette as it relates to effective |
<table>
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<th>C</th>
<th>CC</th>
<th>CVE</th>
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<td>I. CAREER READY PRACTICE (Continued)</td>
<td>communication.</td>
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<td>• Assess how nonverbal communication affects messages.</td>
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<td>• Explain the impact of personal and professional social media in communication.</td>
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<td>• Describe issues related to communicating in a global society.</td>
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<td>• Explain the appropriate etiquette for answering telephone calls and leaving voicemail messages; receiving and making requests; giving directions and persuading others.</td>
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<td>• Identify the steps to plan a successful oral presentation.</td>
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<td>• Develop an education and career plan aligned with personal goals.</td>
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<td>CRP 3</td>
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<td>Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. AS 3.0</td>
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<td>• Apply the decision-making process to develop a college and career plan. AS 5.0</td>
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<td>• Identify employability skills required for participation in the world of work.</td>
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<td>• Assess interests, skills and aptitudes and match these to career options.</td>
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<td>• Identify further education and/or training needed for career choices.</td>
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<td>• Develop a resume, cover letter and other resources for the job search process.</td>
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<td>• Complete a job application.</td>
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<td>• Identify what employers are looking for when hiring employees.</td>
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<td>• Apply effective interviewing skills and write a thank-you note.</td>
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<td>• Create a career portfolio that links to future college and career options.</td>
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</table>
| F. Technology | • Apply technology to enhance productivity. *CRP 4*
| | • Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments and information. *AS 4.0; AS 10.0*
| | • Explain the role technology plays in the workplace.
| | • Describe the laws and licenses that govern the use of technology at school and in the workplace.
| | • Compare different types of media (word processing, digital media software, and video, audio) in relation to effectively communicating messages.

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<th>G. Critical Thinking and Problems Solving Skills</th>
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| | • Utilize critical thinking to make sense of problems and persevere in solving them. *CRP 5*
| | • Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem, narrow or broaden the inquiry when appropriate, and synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. *AS 5.0*
| | • Identify everyday strategies to build the capacity for critical thinking and school and the workplace.
| | • Explain the problem-solving process, including identifying the root cause of a problem, generating and considering possible solutions, choosing the best solution, and evaluating outcomes.

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<th>H. Personal Health and Financial Literacy</th>
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| | • Practice personal health and understand financial literacy. *CRP 6*
| | • Identify factors related to a person’s well-being.
| | • Analyze the relationship between personal health and workplace.
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| **I. CAREER READY PRACTICE** *(Continued)* | performance.  
- Explain the relationship between stress and aggressive behavior.  
- Identify ways to lower the level of stress.  
- Use critical thinking and communication skills to manage conflict.  
- Develop potential living expenses and a budget based on income and needs.  
- Understand the responsible use of financial institutions and services (e.g. checking, savings, ATM, credit cards, investments, retirement, etc.).  
- Recognize that financial literacy and responsibility leads to a secure future and career success. |
| **I. Responsible Citizenship** |  
- Act as a responsible citizen in the workplace and the community.  
- Explain what the school, workplace and community expects of a student as a member of society.  
- Identify personality and behavior characteristics that have a positive or negative impact at school, in the workplace, and in the community.  
- Analyze the impact of an individual’s decision on others and on the environment, and recognize both short and long term consequences of actions.  
- Identify areas in which sensitivity is required in a diverse workplace. |
| **J. Integrity, Ethical Leadership, and Effective Management** |  
- Model integrity, ethical leadership, and effective management.  
- Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the work.  
- Define integrity and how it relates to the classroom and workplace. |

California Career Technical Education Model Curriculum Standards, Grades 7-12  
Industry Sector Anchor Standards (AS): Engineering and Architecture  
Pathway Standards (PS): Engineering Technology (B) and Engineering Design (C)  
Standards for Career Ready Practice (CRP):  
Common Core State Standards (CCSS): Language Arts (ELA); Mathematics (M)
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| **K. Human Relations in the Workplace** | - Identify characteristics of ethical behavior and leadership.  
- Compare and contrast the three basic management styles: authoritarian, democratic, and laissez faire.  
- Work productively in teams while integrating cultural and global competence. *CRP 9*  
- Define human relations.  
- Explain the need for effective human relations skills at school and in the workplace.  
- Contrast the characteristics and consequences of positive and negative attitudes.  
- Recognize the contributions of diversity in society and in the workplace.  
- Assess the value of teamwork in the classroom and workplace.  
- Identify strategies that can be used to promote good working relationships within the classroom and in the workplace.  
- Explain the importance of networking.  
- Identify verbal, non-verbal, and physical types of harassment as defined by the state/federal law and determine appropriate behavior in the workplace. |
| **L. Creativity and Innovation** | - Demonstrate creativity and innovation. *CRP 10*  
- Identify how new ideas, thinking, tasks, solutions, and methods can be fostered in the workplace. *AS 5.0*  
- Explain the appropriate and constructive expression of creativity and innovation at school and in a workplace situation. |
| **M. Research Strategies** | - Employ valid and reliable research strategies. *CRP 11*  
- Define plagiarism.  
- Identify strategies for conducting basic research.  
- Explain resources for gathering information on a topic. |
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<tr>
<td>J. CAREER READY PRACTICE</td>
<td>Explain how to confirm the validity of sources.</td>
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</table>
| N. Decision-Making            | • Understand the environmental, social, and economic impacts of decisions. *CRP 12*
• Work with peers to promote civil, democratic discussions and decision making; set clear goals and deadlines; and establish individual roles as needed. *AS 9.0*
• Explain the decision-making process                                                                                                                                                                                                                                                                 |

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### II. DESIGN PROCESS

#### A. Design Process

1. Sketches
2. Drawings
3. Statistical Analysis
4. Computer Aided Design

- Communicate and interpret information clearly in industry-standard visual and written formats. *PS B1.0*
  - Apply engineering notebook standards and protocols when documenting their work during the school year.
- Identify the characteristics of successful teams, including leadership, cooperation, collaboration, and effective decision-making skills, as applied in groups, teams, and career technical student organization activities. *AS 9.2*
  - Identify and apply group brainstorming techniques and the rules associated with brainstorming.
- Research past, present, and projected technological advances as they impact a particular pathway. *AS 4.5*
- Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources. *AS 4.3*
  - Use online and published works to research aspects of design problems.
- Communicate information and ideas effectively to multiple audiences using a variety of media and formats. *AS 2.5*
  - Research a product’s history, develop a PowerPoint presentation, list chronologically the major innovations to a product, and present findings to a group.
- Understand the steps in the design process. *PS B6.1*
  - Identify the design process steps used in given scenarios and be able to list the steps, if any are missing.

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<td>II. DESIGN PROCESS</td>
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<td>A. Design Process</td>
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<td>1. Sketches</td>
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<td>3. Statistical Analysis</td>
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<td>4. Computer Aided Design</td>
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<tr>
<td><strong>II. DESIGN PROCESS</strong> (Continued)</td>
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<tr>
<td><strong>B. Technical Sketching and Drawing</strong></td>
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</table>
| 1. Sketches | - Understand the sketching process used in concept development.  
  - *PS C3.0*  
  - Explain the concepts of technical sketching and drawing.  
  - *AS 4.5*  
  - Research past, present, and projected technological advances as they impact a particular pathway.  
  - *AS 4.5*  
  - Research and design a CD cover or book jacket on the origins of the measurement systems.  
  - Understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality. |
| 2. Pictorials | |
| 3. Designers | |
| 4. Multiview Projection | |
| **C. Measurement and Statistics** |                     |
| 1. Measurement Systems | |
| 2. Drawings | |
| 3. Manufactured Parts | |
| 4. Variation | |

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</table>
| II. DESIGN PROCESS (Continued) | assurance. *PS B7.0*  
  o Apply linear dimensions to a multiview drawing.  
  o Create a histogram of recorded measurements showing data elements or class intervals, and frequency.  
  • Estimate and measure the size of objects in both Standard International and United States units. *PS B7.4*  
  o Measure and record linear distances using a scale to a precision of 1/16 inch and 1 mm.  
  o Measure and record linear distances using a dial caliper to a precision of 0.001 inch.  
  o Add and subtract U.S. standard and metric linear measurements.  
  o Convert linear distance measurements from inches to millimeters and vice versa.  
  o Calculate the mean, mode, median, and range of a data set.  

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<tr>
<th>D. Puzzle Cube</th>
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<tr>
<td>1. Three-dimensional Forms Models.</td>
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</table>
  2. Geometric and Numeric Constraints |  
  3. CAD |  
  5. Packaging |  
  • Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution. *PS B6.3*  
  o Brainstorm and sketch possible solutions to an existing design problem.  
  • Demonstrate the process of developing multiple details, within design constraints, into a single solution. *PS B 6.5*  
  o Select an approach that meets or satisfies the constraints given in a design brief.  
  • Plan, prepare, and interpret drawings and models through traditional drafting or computer-aided design (CAD) techniques. *PS C10.4*  
  o Create simple extruded solid Computer Aided Design (CAD) models from dimensioned sketches.  
  o Generate dimensioned multiview drawings from simple CAD models.  

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| **II. DESIGN PROCESS (Continued)**       | • Construct a prototype from plans and test it. *PS B6.6*  
  o Measure and Fabricate parts for a functional prototype from the CAD multiview drawings.  
  o Assemble the product using the CAD modeling software.  
  o Test and evaluate the prototype and record results.  
  o Apply geometric and numeric constraints to CAD sketches.  
  o Identify the purpose of packaging in the design of consumer products. |
|                                          |                                                                                                                                                                                                               |
### III. DESIGN EXERCISES

**A. Geometric Shapes and Solids**
1. Geometric Shapes and Dimensional Contours
2. Properties of Volume and Surface Area
3. CAD

- Use the concepts of geometric construction in the development of design drawings. *PS C5.4*
  - Identify common geometric shapes and forms by name.
  - Calculate the area of simple geometric shapes.
  - Calculate the surface area and volume of simple geometric forms.
  - Explain how a given object’s geometry is the result of sequential additive and subtractive processes.

- Understand and apply proper dimensioning standards to drawings. *PS C8.0*
  - Identify and explain the various geometric relationships that exist between the elements of two-dimensional shapes and three-dimensional forms.

- Understand measurement systems as they apply to engineering design. *PS C4.0*
  - Identify and define the axes, planes, and sign conventions associated with the Cartesian coordinate system.
  - Apply geometric and numeric constraints to CAD sketches.
  - Utilize sketch-based, work reference, and placed features to develop solid CAD models from dimensioned drawings.

**B. Dimensions and Tolerance**
1. Working Drawings
2. Object Require Specialized Dimensions
3. Variations Between Actual Manufactured Objects and Drawings

- Know a variety of drafting applications and understand the proper dimensioning standards for each. *PS C8.1*
  - Explain the differences between size and location dimensions.
  - Differentiate between datum dimensioning and chain dimensioning.
  - Explain the rules that are associated with the application of dimensions to multiview drawings. (PSC 6.0)

- Understand the concepts and procedures necessary for producing...
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<tr>
<td>III. DESIGN EXERCISES (Continued)</td>
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<tr>
<td>4. Specify Tolerances</td>
<td><strong>drawings. PS C5.1</strong></td>
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| 5. Tolerances for Mating Part Features | - Identify and dimension fillets, rounds, diameters, chamfers, holes, slots, and screw threads in orthographic projection drawings.  
- Differentiate between clearance and interference fits. |

**C. Advance Modeling Skills**

1. Solid Modeling Programs
2. CAD
3. Auxiliary Views
4. Sectional Views
5. Assembling of Objects
6. Mathematical Formulas
7. Title Blocks
8. Parts List

- Understand the applications and functions of auxiliary views. **PS C7.0**  
  - Sketch and model an auxiliary view of a given object to communicate the true size and shape of its inclined surface.  
- Understand the applications and functions of sectional views. **PS C6.0**  
  - Sketch a full and half section view of a given object to communicate its interior features.  
- Clarify hidden features of an object using a sectional view and appropriate cutting planes. **PS C6.2**  
  - Describe the purpose and demonstrate the application of section lines and cutting plane lines in a section view drawing.  
- Apply dimensions to various objects and features. **PS C8.2**  
  - Identify algebraic relationships between the dimensional values of a given object.  
- Organize and complete an assembly drawing using information collected from detailed drawings. **PS B1.4**  
  - Apply assembly constraints to individual CAD models to create mechanical systems.  
  - Perform part manipulation during the creation of an assembly model. 

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| III. DESIGN EXERCISES (Continued) | ○ Explain how assembly constraints are used to systematically remove the degrees of freedom for a set of components in a given assembly.  
○ Create an exploded model of a given assembly.  
○ Determine ratios and apply algebraic formulas to animate multiple parts within an assembly model.  
○ Create and describe the purpose of the following items: exploded isometric assembly view, balloons, and parts list. |
| D. Advanced Designs | • Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution. *PS B6.3*  
○ Brainstorm and sketch possible solutions to an existing design problem  
○ Create a decision making matrix  
• Demonstrate the process of developing multiple details, within design constraints, into a single solution. *PS B 6.5*  
○ Select an approach that meets or satisfies the constraints given in a design brief.  
○ Explain what constraints are and why they are included in a design brief.  
• Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace setting. *AS 9.3*  
• Plan, prepare, and interpret drawings and models through traditional drafting or computer-aided design (CAD) techniques. *PS C10.4*  
○ Create solid computer-aided design (CAD) models of each part from dimensioned sketches using a variety of methods.  
○ Apply geometric numeric and parametric constraints to form CAD modeled parts.  
○ Generate dimensioned multiview drawings from simple CAD |

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12
## III. DESIGN EXERCISES (Continued)

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<td>modeled parts.</td>
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<tr>
<td>o Assemble the product using the CAD modeling software.</td>
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<tr>
<td>• Communicate information and ideas effectively to multiple audiences using a variety of media and formats. <strong>AS 2.5</strong></td>
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<tr>
<td>o Create a three-fold brochure marketing the designed solution for the chosen problem, such as a consumer product, a dispensing system, a new form of control system, or extend a product design to meet a new requirement.</td>
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<tr>
<td>• Interpret and explain terminology and practices specific to the Engineering and Architecture sector. <strong>AS 10.1</strong></td>
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<tr>
<td>o Explain the concept of fluid power, and the difference between hydraulic and pneumatic power systems</td>
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## INSTRUCTIONAL CONTENT

### IV. REVERSE ENGINEERING

#### A. Visual Analysis
1. Visual Design Principles
2. Tangible Design Elements
3. Aesthetic Appeal
4. Visual Characteristics
5. Visual Appeal

- Understand the fundamentals of systems and market influences on products as they are developed and released to production. *PS B9.0*
  - Identify visual design elements within a given object.
  - Explain how visual design principles were used to manipulate design elements within a given object.
  - Explain what aesthetics is, and how it contributes to a design’s commercial success.
  - Identify the purpose of packaging in the design of consumer products.
  - Identify visual design principles and elements that are present within marketing ads.
  - Identify the intent of a given marketing ad and demographics of the target consumer group for which it was intended.

#### B. Functional Analysis
1. Machines
2. Reverse Engineering
3. Observations and Analysis
4. Products Operations

- Interpret and explain terminology and practices specific to the Engineering and Architecture sector. *AS 10.1*
  - Identify the reasons why engineers perform reverse engineering on products.

- Describe the major manufacturing processes. *PS B7.2*
  - Describe the function of a given manufactured object as a sequence of operations through visual analysis and inspection (prior to dissection).

#### C. Structural Analysis
1. Joinery, Fasteners, or Adhesives.
2. Precision Measurement

- Describe the major manufacturing processes. *PS B7.2*
  - Describe the differences between joinery, fasteners, and adhesives.
  - Identify the types of structural connections that exist in a given object.
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<td>IV. REVERSE ENGINEERING (Continued)</td>
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| 3. Operational Conditions, Material Properties, and Manufacturing Methods | o Identify a given object’s material type.  
o Identify material processing methods that are used to manufacture the components of a given commercial product.  
• Estimate and measure the size of objects in both Standard International and United States units. *PS B7.4*  
o Use dial calipers to precisely measure outside and inside diameter, hole depth, and object thickness.  
• Interpret and explain terminology and practices specific to the Engineering and Architecture sector. *AS 10.1*  
o Assign a density value to a material, and apply it to a given solid CAD model.  
o Perform computer analysis to determine mass, volume, and surface area of a given object. |
| D. Product Improvement by Design |                      |
| 1. Analyze Designs | • Demonstrate elements of written and electronic communication, such as accurate spelling, grammar, and format. *AS 2.4*  
o Write design briefs that focus on product innovation.  
• Communicate information and ideas effectively to multiple audiences using a variety of media and formats. *AS 2.5*  
o Identify group brainstorming techniques and the rules associated with brainstorming.  
o Explain the difference between invention and innovation  
• Understand decision matrices and the use of graphic tools in illustrating the development of a product and the processes involved. *PS B9.2*  
o Use decision matrices to make design decisions. |
| 2. Brainstorming Techniques |                      |
| 3. Decision Matrices |                      |
| 4. Technical Writing |                      |
V. OPEN-ENDED DESIGNS

A. Engineering Design Ethics
- Materials of a Product
- Positive and Negative Impacts
- Human and Global Impacts
- Laws and Guidelines
- Recycling

- Demonstrate ethical and legal practices consistent with Engineering and Architecture sector workplace standards. AS 8.3
  - Create a brainstorming list of different products made from common materials that are used daily.
  - Research and construct a product impact timeline presentation of a product from the brainstorming list and present how the product may be recycled and used to make other products after its lifecycle is complete.
  - Identify the five steps of a product’s lifecycle and investigate and propose recyclable uses for the material once the lifecycle of the product is complete.
- Understand that the modern world is an international community and requires an expanded global view. AS 9.5

B. Design Teams
- Teams
- Gantt Charts
- Virtual Teams
- Strengths
- Conflict Management

- Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace setting. AS 9.3
  - Explain why teams of people are used to solve problems. (FS 9.0)
  - Identify group norms that allow a virtual design team to function efficiently.
- Advocate and practice safe, legal, and responsible use of digital media information and communications technologies. AS 2.6
  - Establish file management and file revision protocols to ensure the integrity of current information.
- Interpret verbal and nonverbal communications and respond appropriately. AS 2.3
  - Use internet resources, such as email, to communicate with a virtual design team member throughout a design challenge.
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<th>STUDENT OUTCOMES</th>
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|                       | Solve predictable and unpredictable work-related problems using various types of reasoning (inductive, deductive) as appropriate. *AS 5.2*  
  - Identify strategies for addressing and solving conflicts that occur between team members.  
|                       | Communicate information and ideas effectively to multiple audiences using a variety of media and formats. *AS 2.5*  
  - Create a Gantt chart to manage the various phases of their design challenge. (FS 9.0) |
Engineering and Architecture

- Architectural Design Pathway
- Environmental Engineering Pathway
- Engineering Technology Pathway
- Engineering Design Pathway
# Table of Contents

## Engineering and Architecture

- **Sector Description** .................................................................................................................. 1

- **Knowledge and Performance Anchor Standards** ...................................................................... 2
  
  1.0 Academics .................................................................................................................................. 2
  2.0 Communications .......................................................................................................................... 2
  3.0 Career Planning and Management .............................................................................................. 2
  4.0 Technology .................................................................................................................................. 3
  5.0 Problem Solving and Critical Thinking ....................................................................................... 3
  6.0 Health and Safety ........................................................................................................................ 3
  7.0 Responsibility and Flexibility ....................................................................................................... 4
  8.0 Ethics and Legal Responsibilities ................................................................................................ 4
  9.0 Leadership and Teamwork .......................................................................................................... 5
  10.0 Technical Knowledge and Skills .............................................................................................. 5
  11.0 Demonstration and Application ............................................................................................... 6

- **Pathway Standards** ...................................................................................................................... 7
  
  A. Architectural Design Pathway ...................................................................................................... 7
  B. Engineering Technology Pathway ................................................................................................ 9
  C. Engineering Design Pathway ....................................................................................................... 12
  D. Environmental Engineering Pathway .......................................................................................... 14

- **Academic Alignment Matrix** ..................................................................................................... 18

- **Appendix: CTE Model Curriculum Standards Contributors** .................................................. 36
Engineering and Architecture

Sector Description

This sector is designed to provide a foundation in engineering, architecture, 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 four pathways that emphasize real-world, occupationally relevant experiences of significant scope and depth: Architectural Design; Engineering Technology; Engineering Design; and Environmental Engineering. To prepare students for continued training, advanced educational opportunities, and direct entry to a career, the Engineering and Architecture programs offer the following components: classroom, laboratory, and hands-on contextual learning; project- and work-based instruction; and leadership and interpersonal skills development.
1.0 Academics
Analyze and apply appropriate academic standards required for successful industry sector pathway completion leading to postsecondary education and employment. Refer to the Engineering and Architecture academic alignment matrix for identification of standards.

2.0 Communications
Acquire and accurately use Engineering and Architecture sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats. (Direct alignment with LS 9-10, 11-12.6)

2.1 Recognize the elements of communication using a sender–receiver model.
2.2 Identify barriers to accurate and appropriate communication.
2.3 Interpret verbal and nonverbal communications and respond appropriately.
2.4 Demonstrate elements of written and electronic communication, such as accurate spelling, grammar, and format.
2.5 Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
2.6 Advocate and practice safe, legal, and responsible use of digital media information and communications technologies.

3.0 Career Planning and Management
Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans. (Direct alignment with SLS 11-12.2)

3.1 Identify personal interests, aptitudes, information, and skills necessary for informed career decision making.
3.2 Evaluate personal character traits, such as trust, respect, and responsibility, and understand the impact they can have on career success.
3.3 Explore how information and communication technologies are used in career planning and decision making.
3.4 Research the scope of career opportunities available and the requirements for education, training, certification, and licensure.
3.5 Integrate changing employment trends, societal needs, and economic conditions into career planning.
3.6 Recognize the role and function of professional organizations, industry associations, and organized labor in a productive society.
3.7 Recognize the importance of small business in the California and global economies.
3.8 Understand how digital media are used by potential employers and postsecondary agencies to evaluate candidates.

3.9 Develop a career plan that reflects career interests, pathways, and postsecondary options.

4.0 Technology
Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Engineering and Architecture sector workplace environment. (Direct alignment with WS 11-12.6)

4.1 Use electronic reference materials to gather information and produce products and services.

4.2 Employ Web-based communications responsibly and effectively to explore complex systems and issues.

4.3 Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources.

4.4 Discern the quality and value of information collected using digital technologies, and recognize bias and intent of the associated sources.

4.5 Research past, present, and projected technological advances as they impact a particular pathway.

4.6 Assess the value of various information and communication technologies to interact with constituent populations as part of a search of the current literature or in relation to the information task.

5.0 Problem Solving and Critical Thinking
Conduct short, as well as more sustained, research projects to create alternative solutions to answer a question or solve a problem unique to the Engineering and Architecture sector using critical and creative thinking; logical reasoning, analysis, inquiry, and problem-solving techniques. (Direct alignment with WS 11-12.7)

5.1 Identify and ask significant questions that clarify various points of view to solve problems.

5.2 Solve predictable and unpredictable work-related problems using various types of reasoning (inductive, deductive) as appropriate.

5.3 Use systems thinking to analyze how various components interact with each other to produce outcomes in a complex work environment.

5.4 Interpret information and draw conclusions, based on the best analysis, to make informed decisions.

6.0 Health and Safety
Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Engineering and Architecture sector workplace environment. (Direct alignment with RSTS 9-10, 11-12.4)
6.1 Locate, and adhere to, Material Safety Data Sheet (MSDS) instructions.
6.2 Interpret policies, procedures, and regulations for the workplace environment, including employer and employee responsibilities.
6.3 Use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies.
6.4 Practice personal safety when lifting, bending, or moving equipment and supplies.
6.5 Demonstrate how to prevent and respond to work-related accidents or injuries; this includes demonstrating an understanding of ergonomics.
6.6 Maintain a safe and healthful working environment.
6.7 Be informed of laws/acts pertaining to the Occupational Safety and Health Administration (OSHA).

7.0 Responsibility and Flexibility
Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the Engineering and Architecture sector workplace environment and community settings. (Direct alignment with SLS 9-10, 11-12.1)

7.1 Recognize how financial management impacts the economy, workforce, and community.
7.2 Explain the importance of accountability and responsibility in fulfilling personal, community, and workplace roles.
7.3 Understand the need to adapt to changing and varied roles and responsibilities.
7.4 Practice time management and efficiency to fulfill responsibilities.
7.5 Apply high-quality techniques to product or presentation design and development.
7.6 Demonstrate knowledge and practice of responsible financial management.
7.7 Demonstrate the qualities and behaviors that constitute a positive and professional work demeanor, including appropriate attire for the profession.
7.8 Explore issues of global significance and document the impact on the Engineering and Architecture sector.

8.0 Ethics and Legal Responsibilities
Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms. (Direct alignment with SLS 11-12.1d)

8.1 Access, analyze, and implement quality assurance standards of practice.
8.2 Identify local, district, state, and federal regulatory agencies, entities, laws, and regulations related to the Engineering and Architecture industry sector.
8.3 Demonstrate ethical and legal practices consistent with Engineering and Architecture sector workplace standards.
8.4 Explain the importance of personal integrity, confidentiality, and ethical behavior in the workplace.

8.5 Analyze organizational culture and practices within the workplace environment.

8.6 Adhere to copyright and intellectual property laws and regulations, and use and appropriately cite proprietary information.

8.7 Conform to rules and regulations regarding sharing of confidential information, as determined by Engineering and Architecture sector laws and practices.

9.0 Leadership and Teamwork

Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution as practiced in the SkillsUSA career technical student organization. (Direct alignment with SLS 11-12.1b)

9.1 Define leadership and identify the responsibilities, competencies, and behaviors of successful leaders.

9.2 Identify the characteristics of successful teams, including leadership, cooperation, collaboration, and effective decision-making skills, as applied in groups, teams, and career technical student organization activities.

9.3 Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace setting.

9.4 Explain how professional associations and organizations and associated leadership development and competitive career development activities enhance academic preparation, promote career choices, and contribute to employment opportunities.

9.5 Understand that the modern world is an international community and requires an expanded global view.

9.6 Respect individual and cultural differences and recognize the importance of diversity in the workplace.

9.7 Participate in interactive teamwork to solve real Engineering and Architecture sector issues and problems.

10.0 Technical Knowledge and Skills

Apply essential technical knowledge and skills common to all pathways in the Engineering and Architecture sector, following procedures when carrying out experiments or performing technical tasks. (Direct alignment with WS 11-12.6)

10.1 Interpret and explain terminology and practices specific to the Engineering and Architecture sector.

10.2 Comply with the rules, regulations, and expectations of all aspects of the Engineering and Architecture sector.
10.3 Construct projects and products specific to the Engineering and Architecture sector requirements and expectations.

10.4 Collaborate with industry experts for specific technical knowledge and skills.

11.0 Demonstration and Application
Demonstrate and apply the knowledge and skills contained in the Engineering and Architecture anchor standards, pathway standards, and performance indicators in classroom, laboratory and workplace settings, and through the SkillsUSA career technical student organization.

11.1 Utilize work-based/workplace learning experiences to demonstrate and expand upon knowledge and skills gained during classroom instruction and laboratory practices specific to the Engineering and Architecture sector program of study.

11.2 Demonstrate proficiency in a career technical pathway that leads to certification, licensure, and/or continued learning at the postsecondary level.

11.3 Demonstrate entrepreneurship skills and knowledge of self-employment options and innovative ventures.

11.4 Employ entrepreneurial practices and behaviors appropriate to Engineering and Architecture sector opportunities.

11.5 Create a portfolio, or similar collection of work, that offers evidence through assessment and evaluation of skills and knowledge competency as contained in the anchor standards, pathway standards, and performance indicators.
A. Architectural Design Pathway

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

Sample occupations associated with this pathway:

- Drafter
- Architect
- Structural Designer
- Building Department Plan Examiner
- City Planner

A1.0 Understand how history shaped architecture and know significant events in the history of architectural design.

A1.1 Know significant historical architectural projects and their effects on society.

A1.2 Understand the development of architectural systems in relation to aesthetics, efficiency, and safety.

A2.0 Compare the theoretical, practical, and contextual issues that influence design.

A2.1 Describe the influence of community context and zoning requirements on architectural design.

A2.2 Understand the ways in which sociocultural conditions and issues influence architectural design.

A2.3 Compare the theoretical and practical effects of human and physical factors on the development of architectural designs.

A2.4 Analyze project design and compile a cost analysis.

A3.0 Understand the sketching processes used in concept development.

A3.1 Apply sketching techniques to a variety of architectural models.

A3.2 Produce proportional two- and three-dimensional sketches and designs.

A3.3 Present conceptual ideas, analysis, and design concepts using freehand graphic communication techniques.

A4.0 Understand the use of computer-aided drafting (CAD) in developing architectural designs.

A4.1 Develop a preliminary architectural proposal using CAD software.

A4.2 Analyze viability of a project as the design is developed using Building Information Modeling (BIM).
A5.0 Compare the relationship between architecture and the external environment.
   A5.1 Understand the significance of sustainable building design practices that incorporate beneficial energy and environmental design policies.
   A5.2 Develop a site analysis that considers passive energy techniques, sustainability issues, and landscaping.
   A5.3 Create a building design that incorporates passive and/or active energy-efficient technologies.

A6.0 Understand methods used to analyze simple structures.
   A6.1 Understand load transfer mechanisms.
   A6.2 Understand stress-strain relationships of building structures.
   A6.3 Interpret structural design considerations, including load-bearing relationships of shear walls, columns, and beams.
   A6.4 Design a simple structure by using structural analysis principles.

A7.0 Understand the properties of structural materials.
   A7.1 Understand the integration of architectural factors, such as soil mechanics, foundation design, engineering materials, and structure design.
   A7.2 Develop a stress analysis chart of typical structural components.
   A7.3 Evaluate available building materials (e.g., steel, concrete, and wood) by considering their properties and their effect on building form.
   A7.4 Develop a preliminary building plan using the appropriate materials.

A8.0 Systematically complete an architectural project.
   A8.1 Describe the various components of structures, including lighting; heating, ventilating, and air-conditioning (HVAC); mechanical; electrical; plumbing; communication; security; and vertical transportation systems.
   A8.2 Develop a preliminary proposal for presentation of an architectural design.
   A8.3 Read and interpret architectural and construction plans, drawings, diagrams, and specifications.
   A8.4 Develop a complete set of architectural plans and drawings.
   A8.5 Estimate the materials needed for a project by reading an architectural drawing.
   A8.6 Plan a project using site and building restrictions imposed by various entities (e.g., Planning, Zoning, Building, and Home Owners Association [HOA]).
   A8.7 Plan the sequence of events leading to an architectural project.

A9.0 Using various methods create both written and digital portfolios to represent architectural renderings.
   A9.1 Develop a binder or digital portfolio representative of completed work for presentation.
   A9.2 Prepare an effective oral presentation of the portfolio content.
B. Engineering Technology Pathway

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

Sample occupations associated with this pathway:
- Surveyor
- Research and Development Analyst
- Engineering Technologist
- Field Engineer
- Operations Engineer

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.
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.

Sample occupations associated with this pathway:

- Mechanical/Electrical Drafter
- Design Engineer
- Manufacturing Design Engineer
- Project Architect

C1.0 Understand 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 Interpret the development of graphic language in relation to engineering design.

C2.0 Understand the effective use of engineering design equipment.

C2.1 Employ engineering design equipment using the appropriate methods and techniques.

C2.2 Apply conventional engineering design equipment 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.

C3.0 Understand the sketching process used in concept development.

C3.1 Apply sketching techniques to a variety of architectural models.

C3.2 Produce proportional two- and three-dimensional sketches and designs.

C3.3 Present conceptual ideas, analysis, and design concepts using freehand, graphic, communication techniques.

C4.0 Understand measurement systems as they apply to engineering design.

C4.1 Know how the various measurement systems are used in engineering drawings.

C4.2 Understand the degree of accuracy necessary for engineering design.

C5.0 Use proper projection techniques to develop orthographic drawings.

C5.1 Understand the concepts and procedures necessary for producing drawings.

C5.2 Develop multiview drawings using the orthographic projection process.

C5.3 Understand the various techniques for viewing objects.

C5.4 Use the concepts of geometric construction in the development of design drawings.

C5.5 Apply pictorial drawings derived from orthographic multiview drawings and sketches.
C6.0 Understand the applications and functions of sectional views.
   C6.1 Understand the function of sectional views.
   C6.2 Clarify hidden features of an object using a sectional view and appropriate cutting planes.

C7.0 Understand the applications and functions of auxiliary views.
   C7.1 Understand the function of auxiliary views.
   C7.2 Use auxiliary views to clarify the true shape and size of an object.

C8.0 Understand and apply proper dimensioning standards to drawings.
   C8.1 Know a variety of drafting applications and understand the proper dimensioning standards for each.
   C8.2 Apply dimension to various objects and features.

C9.0 Understand the tolerance relationships between mating parts.
   C9.1 Understand what constitutes mating parts in engineering design.
   C9.2 Interpret geometric tolerancing symbols in a drawing.
   C9.3 Use tolerancing in an engineering drawing.

C10.0 Understand the methods of applying text to a drawing.
   C10.1 Describe the processes of lettering and/or text editing.
   C10.2 Implement standard methods of title block creation and use.
   C10.3 Develop drawings using notes and specifications.
   C10.4 Plan, prepare, and interpret drawings and models through traditional drafting or computer-aided design (CAD) techniques.

C11.0 Understand the methods of creating both written and digital portfolios.
   C11.1 Develop a binder or digital portfolio representative of completed work for presentation.
   C11.2 Give an effective oral presentation of a portfolio.
D. Environmental Engineering Pathway

The Environmental Engineering pathway includes design and development processes, equipment, and systems that are used to create, monitor, prevent, or correct environmental events and conditions.

Sample occupations associated with this pathway:
- Environmental Safety Technician
- Environmental Specialist
- Environmental Analyst
- Environmental Scientist
- Air Pollution Control Engineer

D1.0 Communicate and interpret information clearly in industry-standard visual and written formats.
  D1.1 Know the current industry standards for illustration and layout.
  D1.2 Understand the classification and use of various electronic components, symbols, abbreviations, and media common to electronic drawings.
  D1.3 Organize and complete site plans.

D2.0 Understand the design process and how to solve analysis and design problems.
  D2.1 Understand the steps in the design process.
  D2.2 Determine what information and principles are relevant to a problem and its analysis.
  D2.3 Choose between alternate solutions in solving a problem and be able to justify choices in determining a solution.
  D2.4 Understand the process of developing multiple details into a single solution.
  D2.5 Translate word problems into mathematical statements when appropriate.
  D2.6 Build a prototype from plans and test it.
  D2.7 Evaluate and redesign a prototype on the basis of collected test data.

D3.0 Understand the fundamentals of earth science as they relate to environmental engineering.
  D3.1 Know the fundamental stages of geochemical cycles.
  D3.2 Understand the effects of pollution on hydrological features.
  D3.3 Classify the three major groups of rocks, according to their origin, on the basis of texture and mineral composition.
  D3.4 Analyze the importance and use of soil and evaluate how soil may be preserved and conserved.
  D3.5 Assess and evaluate geological hazards.
D3.6 Interpret and evaluate topographical maps and images.
D3.7 Locate and evaluate soil or geological conditions or features using global positioning systems equipment and related technology.
D3.8 Analyze soil erosion and identify the causes.

D4.0 Understand the effects of the weather, the hydrosphere, and the atmosphere on the environment.
D4.1 Know the common causes of atmospheric contamination.
D4.2 Understand the effects of weather fronts on regional air pollution.
D4.3 Understand the relationship between the health of the marine environment and climate control.
D4.4 Understand the effects of human activity on the atmospheric environment.
D4.5 Analyze and predict conditions of meteorological events.
D4.6 Analyze the mechanisms for air mass movement.
D4.7 Analyze atmospheric pressure and weather systems.

D5.0 Understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems.
D5.1 Know the six simple machines and their applications.
D5.2 Know how energy is transferred and the effects of resistance in mechanical, electrical, fluid, and thermal systems.
D5.3 Understand scalars and vectors
D5.4 Solve problems by using the concept of vectoring to predict the resultant forces.
D5.5 Solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems.

D6.0 Evaluate regional interactive systems and elements that create harmful environmental effects.
D6.1 Describe the sources of, and impacts attributable to, pollution and contamination.
D6.2 Recognize the actions that cause resource depletion.
D6.3 Define the causes of erosion and soil depletion.
D6.4 Describe the attributes and proliferation of hardscape.
D6.5 Identify the sources of, and impacts attributable to, habitat alteration.

D7.0 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 Understand how electric and magnetic phenomena are related and know common practical applications.

D7.4 Analyze the fundamentals and properties of waveforms and how waveforms may be used to carry energy.

D8.0 Understand the effective use of environmental and natural science equipment.

D8.1 Use appropriate methods and techniques for employing environmental and natural science equipment.

D8.2 Apply conventional environmental and natural science processes and procedures accurately, appropriately, and safely.

D8.3 Apply the concepts of environmental and natural science to the tools, equipment, projects, and procedures of the Environmental Engineering Pathway.

D9.0 Identify the role and impact of waste management systems, and their operations, on the environment.

D9.1 Understand the role of waste and storm water management systems, their operation, and their impact on the environment.

D9.2 Explore the causes and effects of pollution linked to wastewater treatment facilities.

D9.3 Identify wastewater treatment processes that lessen environmental impacts and improve water reuse.

D9.4 Explain the types and sources of hazardous waste and associated safety practices and legal requirements for handling and disposing of such waste.

D9.5 Design solid waste disposal processes that lessen environmental impacts and improve recycling.

D10.0 Understand the field of land use management and its potential for environmental impact.

D10.1 Describe the need for and role of habitat preservation.

D10.2 Describe the composition, role, and function of ecosystems, including trends affecting viability.

D10.3 Explain the laws and regulations pertaining to ecosystem preservation and use.

D10.4 Demonstrate the need for, and methods of, land use planning.

D10.5 Identify the aspects of land use planning and describe current trends.

D10.6 Summarize the relationship between land use planning and energy use and distribution.

D10.7 Explain the laws and regulations pertaining to land use planning.

D10.8 Develop strategies to maximize the effectiveness of land use planning.

D11.0 Research the role of air quality management and systems, their operations, and their impact on the environment.

D11.1 Understand the elements that create outdoor air quality.
D11.2 Summarize the causes of air pollutants and their chemical composition.
D11.3 Research air pollutants and their threat to human health.
D11.4 Understand U.S. and California laws and regulations related to air pollution control programs and health effects of air pollution.
D11.5 Describe the basic U.S. Environmental Protection Agency (EPA) and California Air Resources Board (ARB) roles and regulations.

D12.0 Implement processes to support energy efficiency.
D12.1 Understand the relationship between power and energy efficiency.
D12.2 Outline how domestic and industrial appliances and systems affect the environment, such as water units and heating and cooling systems.
D12.3 Compare costs of alternate/renewable energy sources, systems, and appliances and traditional energy sources, systems, and appliances.
D12.4 Conduct an energy audit.

D13.0 Research drinking-water sources, systems, treatment, and conservation.
D13.1 Understand water reuse: issues, strategies, technologies, and applications.
D13.2 Analyze strategies for improving energy efficiencies in water collection and distribution.
D13.3 Describe the role of environmental engineering and green energy in water systems.
D13.4 Understand the functions and operations of water storage, reservoirs, aqueducts, and dams.
D13.5 Identify and explain the applicable codes and regulations.

D14.0 Evaluate the impact and flow management of storm water, rivers, and groundwater.
D14.1 Understand the designs and tools used in water flow management.
D14.2 Describe watershed modeling.
D14.3 Understand the principles and applications of drainage engineering.
D14.4 Use the Hydrologic Engineering Centers River Analysis System (HEC-RAS).
D14.5 Analyze and interpret contaminated harbor and river sediment.
D14.6 Describe the concerns and strategies for catastrophic storm water events and management.
## Academic Alignment Matrix

### ENGLISH LANGUAGE ARTS

#### Language Standards – LS (Standard Area, Grade Level, Standard #)

<table>
<thead>
<tr>
<th>Standard</th>
<th>A. Architectural Design</th>
<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-12.1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</td>
<td>A9.0</td>
<td>B1.0</td>
<td>C11.0</td>
<td>D1.0</td>
</tr>
<tr>
<td>11-12.2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</td>
<td>A9.0</td>
<td>B1.0</td>
<td>C11.0</td>
<td>D1.0</td>
</tr>
</tbody>
</table>

#### Reading Standards for Informational Text – RSIT (Standard Area, Grade Level, Standard #)

<table>
<thead>
<tr>
<th>Standard</th>
<th>A. Architectural Design</th>
<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-12.2. Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.</td>
<td>A1.0, A2.0, A5.0, A8.0</td>
<td>B1.0</td>
<td>C1.0</td>
<td>D1.0</td>
</tr>
<tr>
<td>11-12.7. Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.</td>
<td>A1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Reading Standards for Literacy in History/Social Studies – RHSS (Standard Area, Grade Level, Standard #)

<table>
<thead>
<tr>
<th>Standard</th>
<th>A. Architectural Design</th>
<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-12.2. Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.</td>
<td>A1.0, A2.0</td>
<td></td>
<td>C1.0</td>
<td></td>
</tr>
<tr>
<td>11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.</td>
<td>A1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-12.10. By the end of grade 12, read and comprehend history/social studies texts in the grades 11–12 text complexity band independently and proficiently.</td>
<td>A1.0, A2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Reading Standards for Literacy in Science and Technical Subjects – RLST (Standard Area, Grade Level, Standard #)

<table>
<thead>
<tr>
<th>Standard</th>
<th>A. Architectural Design</th>
<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-12.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.</td>
<td>A1.0, A5.0, A9.0</td>
<td>B4.0, B5.0, B7.0, B8.0, B9.0</td>
<td>C1.0, C4.0, C11.0</td>
<td>D2.0, D3.0, D4.0, D6.0</td>
</tr>
</tbody>
</table>
### Academic Alignment Matrix

#### ENGINEERING AND ARCHITECTURE

<table>
<thead>
<tr>
<th>Reading Standards for Literacy in Science and Technical Subjects – RLST (Standard Area, Grade Level, Standard #) (continued)</th>
<th>PATHWAYS</th>
<th>A. Architectural Design</th>
<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.</td>
<td>A9.0</td>
<td>B11.0</td>
<td>C11.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.</td>
<td>A1.0, A9.0</td>
<td>B9.0, B10.0, B11.0</td>
<td>C1.0, C11.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-12.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11-12 text complexity band independently and proficiently.</td>
<td>A1.0, A5.0</td>
<td>B1.0, B4.0, B5.0, B7.0, B8.0, B9.0</td>
<td>C1.0, C4.0</td>
<td>D1.0, D2.0, D3.0, D4.0, D3.0, D6.0</td>
<td></td>
</tr>
</tbody>
</table>

#### Writing Standards – WS (Standard Area, Grade Level, Standard #)

| 11-12.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. | B11.0 |
| 11-12.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. | A9.0 | B11.0 | C11.0 |
| 11-12.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. | A9.0 | C11.0 |
| 11-12.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. | A9.0 | C11.0 |
| 11-12.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. | A9.0 | C11.0 |
| 11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. | A9.0 | C11.0 |
**Writing Standards – WS (Standard Area, Grade Level, Standard #) (continued)**

11-12.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation including footnotes and endnotes.

<table>
<thead>
<tr>
<th>Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects – WHSST</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</td>
</tr>
<tr>
<td>11-12.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</td>
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**MATHEMATICS**

**Algebra – A-CED – Creating Equations**

Create equations that describe numbers or relationships

1. Create equations and inequalities in one variable including ones with absolute value and use them to solve problems in and out of context, including equations arising from linear functions.

<table>
<thead>
<tr>
<th>1.1 Judge the validity of an argument according to whether the properties of real numbers, exponents, and logarithms have been applied correctly at each step. (CA Standard Algebra II – 11.2)</th>
</tr>
</thead>
</table>

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<tr>
<th>Algebra – A-CED – Creating Equations</th>
</tr>
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<tbody>
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<td>1.1 Judge the validity of an argument according to whether the properties of real numbers, exponents, and logarithms have been applied correctly at each step. (CA Standard Algebra II – 11.2)</td>
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</tbody>
</table>

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<thead>
<tr>
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<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9.0</td>
<td>C11.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A9.0</td>
<td>B1.0</td>
<td>B1.0, B11.0</td>
<td>C11.0</td>
</tr>
<tr>
<td>A9.0</td>
<td>B1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- A9.0: Architecture Design
- B1.0: Engineering Technology
- C11.0: Engineering Design
- D2.0: Environmental Engineering
## Academic Alignment Matrix

### ENGINEERING AND ARCHITECTURE

<table>
<thead>
<tr>
<th>Algebra – A-CED – Creating Equations (continued)</th>
<th>PATHWAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A. Architectural Design</td>
</tr>
<tr>
<td>2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</td>
<td>A2.0, A6.0</td>
</tr>
<tr>
<td>3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</td>
<td>A2.0, A6.0</td>
</tr>
<tr>
<td>4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm’s law $V = IR$ to highlight resistance $R$.</td>
<td>A6.0</td>
</tr>
</tbody>
</table>

### Algebra – A-REI – Reasoning with Equations and Inequalities

**Understand solving equations as a process of reasoning and explain the reasoning**

| 1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. | A2.0, A8.0 | B3.0, B10.0 |
| 2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. | A2.0, A8.0 | B3.0, B10.0 |

### Solve equations and inequalities in one variable

| 3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. |
| 3.1 Solve equations and inequalities involving absolute value. (CA Standard Algebra I - 3.0 and CA Standard Algebra II - 1.0) | A2.0, A8.0 | B3.0, B10.0 |

### Solve quadratic equations in one variable

| a. Use the method of completing the square to transform any quadratic equation in $x$ into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form. | A8.0 | B3.0, B4.0, B10.0 | D7.0 |
| b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers $a$ and $b$. | | | | |
## Academic Alignment Matrix

### ENGINEERING AND ARCHITECTURE

| Algebra – A-REI – Reasoning with Equations and Inequalities (continued) | PATHWAYS |
|---|---|---|---|
| Solve systems of equations | A. Architectural Design | B. Engineering Technology | C. Engineering Design | D. Environmental Engineering |
| 5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions. | A8.0 | | | |
| 6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. | A8.0 | B3.0, B10.0 | | |
| 7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = -3x and the circle x^2 + y^2 = 3. | A8.0 | | | |

### Functions – F-IF – Interpreting Functions

| Understand the concept of a function and use function notation |  |
|---|---|---|---|
| 1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If \( f \) is a function and \( x \) is an element of its domain, then \( f(x) \) denotes the output of \( f \) corresponding to the input \( x \). The graph of \( f \) is the graph of the equation \( y = f(x) \). | A3.0 | B2.0, B10.0 | C3.0 |

| Analyze functions using different representations |  |
|---|---|---|---|
| 7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. | A3.0 | B2.0, B10.0 | C3.0 |
| a. Graph linear and quadratic functions and show intercepts, maxima, and minima. | | | |
| b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. | | | |
| c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. | | | |
| d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior. | | | |
| e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. | | | |
### Academic Alignment Matrix

#### ENGINEERING AND ARCHITECTURE

<table>
<thead>
<tr>
<th>PATHWAYS</th>
<th>A. Architectural Design</th>
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</tr>
</thead>
<tbody>
<tr>
<td>8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.</td>
<td>A3.0</td>
<td>B2.0, B10.0</td>
<td>C3.0</td>
<td></td>
</tr>
<tr>
<td>a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t; y = (0.97)^t; y = (1.01)^{(12t)}; y = (1.2)^{(10t)}$, and classify them as representing exponential growth or decay.</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

#### Functions – F-LE – Linear, Quadratic, and Exponential Models

<table>
<thead>
<tr>
<th>PATHWAYS</th>
<th>A. Architectural Design</th>
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<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Distinguish between situations that can be modeled with linear functions and with exponential functions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.</td>
<td></td>
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</tr>
<tr>
<td>b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.</td>
<td></td>
<td></td>
<td></td>
<td>D5.0</td>
</tr>
<tr>
<td>c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.</td>
<td></td>
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</tr>
</tbody>
</table>

#### Functions – F-TF – Trigonometric Functions

**Extend the domain of trigonometric functions using the unit circle**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.</td>
<td>A6.0</td>
<td>B3.0, B4.0, B10.0</td>
<td>C4.0</td>
<td>D6.0, D7.0</td>
</tr>
<tr>
<td>1.1 Understand the notion of angle and how to measure it, in both degrees and radians. Convert between degrees and radians. (CA Standard Trigonometry - 1.0)</td>
<td></td>
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</tr>
<tr>
<td>2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.</td>
<td>A6.0</td>
<td>B3.0, B4.0, B10.0</td>
<td></td>
<td>D7.0</td>
</tr>
</tbody>
</table>
# Academic Alignment Matrix

## ENGINEERING AND ARCHITECTURE

### Functions – F-TF – Trigonometric Functions

(continued)

3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for \(\frac{\pi}{3}\), \(\frac{\pi}{4}\) and \(\frac{\pi}{6}\), and use the unit circle to express the values of sine, cosine, and tangent for \(\pi - x\), \(\pi + x\), and \(2\pi - x\) in terms of their values for \(x\), where \(x\) is any real number.

- 3.1 Know the definitions of the tangent and cotangent functions and graph them. (CA Standard Trigonometry - 5.0)
- 3.2 Know the definitions of the secant and cosecant functions and graph them. (CA Standard Trigonometry - 6.0)

<table>
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<tbody>
<tr>
<td>A6.0</td>
<td>B3.0, B4.0, B10.0</td>
<td></td>
<td></td>
<td>D7.0</td>
</tr>
</tbody>
</table>

#### Model periodic phenomena with trigonometric functions

5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

- 6.1 Know the definitions of the inverse trigonometric functions and graph the functions. (CA Standard Trigonometry - 8.0)

### Geometry – G-CO – Congruence

#### Make geometric constructions

12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

### Geometry – G-GMD – Geometric Measurement and Dimensions

#### Explain volume formulas and use them to solve problems

5. Determine how changes in dimensions affect the perimeter, area, and volume of common geometric figures and solids.

<table>
<thead>
<tr>
<th>PATHWAYS</th>
<th>A. Architectural Design</th>
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</tr>
</thead>
<tbody>
<tr>
<td>A3.0, A5.0, A7.0, A8.0</td>
<td>B2.0, B10.0</td>
<td>C3.0, C5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B6.0, B7.0, B10.0</td>
<td>C8.0</td>
<td>D2.0</td>
<td></td>
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<tr>
<td>Academic Alignment Matrix</td>
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<thead>
<tr>
<th>ENggEERING AND ARCHITECTURE</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Geometry – G-MG – Modeling with Geometry</strong></td>
<td>A3.0, A5.0, A7.0, A8.0</td>
<td>B6.0, B10.0</td>
<td>C8.0, C9.0</td>
<td>D2.0</td>
</tr>
<tr>
<td>Apply geometric concepts in modeling situations</td>
<td></td>
<td></td>
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<tr>
<td>3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</td>
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</tbody>
</table>

| **Geometry – G-SRT – Similarity, Right Triangles, and Trigonometry** | A3.0, A5.0, A7.0, A8.0 | B2.0, B10.0 | C3.0 | |
|-----------------------------------------------------------------|------------------------|-----------------|-------------|
| Understand similarity in terms of similarity transformations | | | | |
| 1. Verify experimentally the properties of dilations given by a center and a scale factor: | | | | |
| a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged. | | | | |
| b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor. | | | | |

| **Number and Quantity – N-Q – Quantities** | A2.0, A6.0, A8.0 | B3.0, B4.0, B10.0 | D7.0 | |
|---------------------------------------------|------------------|-------------------|-------------|
| Reason quantitatively and use units to solve problems | | | | |
| 1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. | | | | |
| 2. Define appropriate quantities for the purpose of descriptive modeling. | | | | |
| 3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. | | | | |

<table>
<thead>
<tr>
<th><strong>Number and Quantity – N-VM – Vector and Matrix Quantities</strong></th>
<th>A6.0</th>
<th>B5.0, B10.0</th>
<th>C8.0</th>
<th>D4.0, D5.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Represent and model with vector quantities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., ( \vec{v} ), (</td>
<td>\vec{v}</td>
<td>), ( \parallel \vec{v} ), ( \vec{v} )).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.</td>
<td>A6.0</td>
<td>B5.0, B10.0</td>
<td>C8.0</td>
<td>D4.0, D5.0</td>
</tr>
<tr>
<td>3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.</td>
<td>A6.0</td>
<td>B5.0, B10.0</td>
<td>C8.0</td>
<td>D4.0, D5.0</td>
</tr>
</tbody>
</table>
### Academic Alignment Matrix

#### ENGINEERING AND ARCHITECTURE

| **Number and Quantity – N-VM – Vector and Matrix Quantities (continued)** | **PATHWAYS** |
|---|---|---|---|
| **Perform operations on vectors** | **A. Architectural Design** | **B. Engineering Technology** | **C. Engineering Design** | **D. Environmental Engineering** |
| 4. (+) Add and subtract vectors. | A6.0 | B5.0, B10.0 | | D4.0 |
| a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. | | | | |
| b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. | | | | |
| c. Understand vector subtraction \( v - w \) as \( v + (-w) \), where \(-w\) is the additive inverse of \( w \), with the same magnitude as \( w \) and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. | | | | |
| 5. (+) Multiply a vector by a scalar. | A6.0 | B5.0, B10.0 | C8.0 | D4.0, D5.0 |
| a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as \( c(v_x, v_y) = (cv_x, cv_y) \). | | | | |
| b. Compute the magnitude of a scalar multiple \( cv \) using \( lcvl = lclvl \). Compute the direction of \( cv \) knowing that when \( lclvl \neq 0 \), the direction of \( cv \) is either along \( v \) (for \( c > 0 \)) or against \( v \) (for \( c < 0 \)). | | | | |
| **Perform operations on matrices and use matrices in applications** | | | | D4.0, D5.0 |
| 6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network. | A6.0 | B5.0, B9.0, B10.0 | | D4.0, D5.0 |
| 7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled. | A6.0 | B5.0, B9.0, B10.0 | | D4.0, D5.0 |
| 8. (+) Add, subtract, and multiply matrices of appropriate dimensions. | A6.0 | B5.0, B9.0, B10.0 | | D4.0, D5.0 |
| 9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties. | A6.0 | B5.0, B9.0, B10.0 | | D4.0, D5.0 |
| 10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse. | A6.0 | B5.0, B9.0, B10.0 | | D4.0, D5.0 |
### Academic Alignment Matrix

**ENGINEERING AND ARCHITECTURE**

<table>
<thead>
<tr>
<th><strong>Number and Quantity – N-VM – Vector and Matrix Quantities (continued)</strong></th>
<th><strong>PATHWAYS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.</td>
<td>A6.0</td>
</tr>
<tr>
<td>12. (+) Work with 2 x 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.</td>
<td>A6.0</td>
</tr>
</tbody>
</table>

**Statistics and Probability – S-ID – Interpreting Categorical and Quantitative Data**

**Summarize, represent, and interpret data on a single count or measurement variable**

| 1. Represent data with plots on the real number line (dot plots, histograms, and box plots). | A2.0 | B1.0, B8.0, B10.0 |

| 2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. | A2.0 | B1.0, B10.0 |

| 3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). | A2.0 | B1.0, B10.0 |

| 4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. | A2.0 | B1.0, B10.0 |

**Summarize, represent, and interpret data on two categorical and quantitative variables**

| 5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data. | | B1.0, B8.0, B10.0 |

| 6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. | | B1.0, B10.0 |

| a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. | | |

| b. Informally assess the fit of a function by plotting and analyzing residuals. | | |

| c. Fit a linear function for a scatter plot that suggests a linear association. | | |
## Academic Alignment Matrix

### ENGINEERING AND ARCHITECTURE

| Statistics and Probability – APPS – Advanced Placement Probability and Statistics | PATHWAYS |
|---|---|---|---|
| 1.0 Students solve probability problems with finite sample spaces by using the rules for addition, multiplication, and complementation for probability distributions and understand the simplifications that arise with independent events. | B5.0 | D5.0 |
| 2.0 Students know the definition of conditional probability and use it to solve for probabilities in finite sample spaces. | B5.0 | D5.0 |
| 3.0 Students demonstrate an understanding of the notion of discrete random variables by using this concept to solve for the probabilities of outcomes, such as the probability of the occurrence of five or fewer heads in 14 coin tosses. | B5.0 | D5.0 |
| 4.0 Students understand the notion of a continuous random variable and can interpret the probability of an outcome as the area of a region under the graph of the probability density function associated with the random variable. | B5.0 | D5.0 |
| 5.0 Students know the definition of the mean of a discrete random variable and can determine the mean for a particular discrete random variable. | B5.0 | D5.0 |
| 6.0 Students know the definition of the variance of a discrete random variable and can determine the variance for a particular discrete random variable. | B5.0 | D5.0 |
| 7.0 Students demonstrate an understanding of the standard distributions (normal, binomial, and exponential) and can use the distributions to solve for events in problems in which the distribution belongs to those families. | B5.0 | D5.0 |
| 8.0 Students determine the mean and the standard deviation of a normally distributed random variable. | B5.0 | D5.0 |
| 9.0 Students know the central limit theorem and can use it to obtain approximations for probabilities in problems of finite sample spaces in which the probabilities are distributed binomially. | B5.0 | D5.0 |
| 10.0 Students know the definitions of the mean, median and mode of distribution of data and can compute each of them in particular situations. | B5.0 | D5.0 |
| 11.0 Students compute the variance and the standard deviation of a distribution of data. | B5.0 | D5.0 |
| 12.0 Students find the line of best fit to a given distribution of data by using least squares regression. | B5.0 | D5.0 |
| 13.0 Students know what the correlation coefficient of two variables means and are familiar with the coefficient’s properties. | B5.0 | D5.0 |
# Academic Alignment Matrix

## ENGINEERING AND ARCHITECTURE

<table>
<thead>
<tr>
<th>Statistics and Probability – APPS – Advanced Placement Probability and Statistics (continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.0 Students organize and describe distributions of data by using a number of different methods, including frequency tables, histograms, standard line graphs and bar graphs, stem-and-leaf displays, scatterplots, and box-and-whisker plots.</td>
</tr>
<tr>
<td>15.0 Students are familiar with the notions of a statistic of a distribution of values of the sampling distribution of a statistic. And of the variability of a statistic.</td>
</tr>
<tr>
<td>16.0 Students know basic facts concerning the relation between the mean and the standard deviation of a sampling distribution and the mean and the standard deviation of the population distribution.</td>
</tr>
<tr>
<td>17.0 Students determine confidence intervals for a simple random sample from a normal distribution of data and determine the sample size required for a desired margin of error.</td>
</tr>
<tr>
<td>18.0 Students determine the P- value for a statistic for a simple random sample from a normal distribution.</td>
</tr>
<tr>
<td>19.0 Students are familiar with the chi-square distribution and chi-square test and understand their uses.</td>
</tr>
</tbody>
</table>

## SCIENCE

### Scientific and Engineering Practices – SEP

1. Asking questions (for science) and defining problems (for engineering) | A5.0, A8.0 | B1.0, B3.0, B6.0, B8.0, B9.0, B10.0 | D5.0, D7.0 |
2. Developing and using models | A4.0, A5.0, A6.0, A8.0 | B1.0, B2.0, B3.0, B6.0, B8.0, B10.0 | D3.0, D4.0, D5.0, D7.0 |
3. Planning and carrying out investigations | B2.0, B3.0, B6.0, B8.0, B10.0 | | D5.0, D7.0 |
4. Analyzing and interpreting data | A2.0, A4.0, A5.0, A6.0, A7.0, A8.0 | B1.0, B2.0, B3.0, B6.0, B7.0, B8.0, B10.0 | C3.0, C4.0, C7.0, C8.0, C9.0 | D2.0, D3.0, D5.0, D7.0 |
5. Using mathematics and computational thinking | A2.0, A4.0, A5.0, A6.0, A7.0, A8.0 | B1.0, B3.0, B4.0, B5.0, B6.0, B7.0, B8.0, B10.0 | C3.0, C4.0, C5.0, C6.0, C7.0, C8.0, C9.0 | D4.0, D5.0, D6.0, D7.0 |
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</thead>
<tbody>
<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
<td>A5.0</td>
<td>B3.0, B4.0, B5.0, B6.0, B10.0</td>
<td>C2.0, C3.0, C4.0, C5.0, C6.0, C7.0, C8.0, C9.0</td>
<td>D5.0, D7.0</td>
</tr>
<tr>
<td>7. Engaging in argument from evidence</td>
<td>A9.0</td>
<td>B3.0, B6.0, B10.0, B11.0</td>
<td>C11.0</td>
<td>D5.0, D7.0</td>
</tr>
<tr>
<td>8. Obtaining, evaluating, and communicating information</td>
<td>A2.0, A4.0, A5.0, A6.0, A7.0, A8.0, A9.0</td>
<td>B1.0, B2.0, B3.0, B4.0, B5.0, B6.0, B7.0, B9.0, B10.0, B11.0</td>
<td>C3.0, C5.0, C6.0, C7.0, C8.0, C9.0, C10.0, C11.0</td>
<td>D1.0, D2.0, D3.0, D4.0, D5.0, D6.0, D7.0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Crosscutting Concept – CC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Patterns</td>
</tr>
<tr>
<td>2. Cause and effect: Mechanism and explanation</td>
</tr>
<tr>
<td>3. Scale, proportion, and quantity</td>
</tr>
<tr>
<td>4. Systems and system models</td>
</tr>
<tr>
<td>5. Energy and matter: Flows, cycles, and conservation</td>
</tr>
<tr>
<td>6. Structure and function</td>
</tr>
<tr>
<td>7. Stability and change</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Sciences – PS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS1: Matter and Its Interactions</td>
</tr>
<tr>
<td>PS1.A: Structure and Properties of Matter</td>
</tr>
<tr>
<td>PS1.B: Chemical Reactions</td>
</tr>
<tr>
<td>PS1.C: Nuclear Processes</td>
</tr>
<tr>
<td>Physical Sciences – PS (continued)</td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td><strong>PATHWAYS</strong></td>
</tr>
<tr>
<td><strong>Physical Sciences – PS (continued)</strong></td>
</tr>
<tr>
<td>PS2: Motion and Stability: Forces and Interactions</td>
</tr>
<tr>
<td>PS2.A: Forces and Motion</td>
</tr>
<tr>
<td>PS2.B: Types of interactions</td>
</tr>
<tr>
<td>PS2.C: Stability and Instability in Physical Systems</td>
</tr>
<tr>
<td><strong>PS3: Energy</strong></td>
</tr>
<tr>
<td>PS3.A: Definitions of Energy</td>
</tr>
<tr>
<td>PS3.B: Conservation of Energy and Energy Transfer</td>
</tr>
<tr>
<td>PS3.C: Relationship Between Energy and Forces</td>
</tr>
<tr>
<td>PS3.D: Energy in Chemical Processes and Everyday Life</td>
</tr>
<tr>
<td><strong>PS4: Waves and Their Applications in Technologies for Information Transfer</strong></td>
</tr>
<tr>
<td>PS4.A: Wave Properties</td>
</tr>
<tr>
<td>PS4.B: Electromagnetic Radiation</td>
</tr>
<tr>
<td>PS4.C: Information Technologies and Instrumentation</td>
</tr>
<tr>
<td><strong>Earth and Space Sciences – ESS</strong></td>
</tr>
<tr>
<td><strong>ESS2: Earth’s Systems</strong></td>
</tr>
<tr>
<td><strong>ESS2.C: The Roles of Water in Earth’s Surface Processes</strong></td>
</tr>
<tr>
<td><strong>ESS2.D: Weather and Climate</strong></td>
</tr>
<tr>
<td><strong>ESS2.E: Biogeology</strong></td>
</tr>
</tbody>
</table>
## Academic Alignment Matrix

### ENGINEERING AND ARCHITECTURE

<table>
<thead>
<tr>
<th>Earth and Space Sciences – ESS (continued)</th>
<th>PATHWAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A. Architectural Design</td>
</tr>
<tr>
<td>ESS3: Earth and Human Activity</td>
<td>A5.0</td>
</tr>
<tr>
<td>ESS3.A: Natural Resources</td>
<td></td>
</tr>
<tr>
<td>ESS3.B: Natural Hazards</td>
<td></td>
</tr>
<tr>
<td>ESS3.C: Human Impacts on Earth Systems</td>
<td>A5.0</td>
</tr>
<tr>
<td>ESS3.D: Global Climate Change</td>
<td>A5.0</td>
</tr>
<tr>
<td>Engineering, Technology, and the Applications of Science – ETS</td>
<td></td>
</tr>
<tr>
<td>ETS1: Engineering Design</td>
<td></td>
</tr>
<tr>
<td>ETS1.A: Defining and Delimiting an Engineering Problem</td>
<td>A5.0, A6.0, A8.0</td>
</tr>
<tr>
<td>ETS1.B: Developing Possible Solutions</td>
<td>A5.0, A6.0, A8.0</td>
</tr>
<tr>
<td>ETS1.C: Optimizing the Design Solution</td>
<td>A5.0, A6.0, A8.0</td>
</tr>
<tr>
<td>ETS2: Links Among Engineering, Technology, Science, and Society</td>
<td></td>
</tr>
<tr>
<td>ETS2.A: Interdependence of Science, Engineering, and Technology</td>
<td>A5.0, A6.0, A7.0</td>
</tr>
<tr>
<td>ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World</td>
<td>A1.0, A2.0, A5.0, A8.0</td>
</tr>
</tbody>
</table>

### HISTORY/SOCIAL SCIENCE

<table>
<thead>
<tr>
<th>Principles of American Democracy and Economics – AD</th>
<th>PATHWAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.3 Students evaluate and take and defend positions on what the fundamental values and principles of civil society are (i.e., the autonomous sphere of voluntary personal, social, and economic relations that are not part of government), their Interdependence, and the meaning and importance of those values and principles for a free society.</td>
<td>B9.0</td>
</tr>
</tbody>
</table>
### Principles of American Democracy and Economics – AD (continued)

12.7 Students analyze and compare the powers and procedures of the national, state, tribal, and local governments.

12.7.5. Explain how public policy is formed, including the setting of the public agenda and implementation of it through regulations and executive orders.

### Principles of Economics – PE

12.1 Students understand common economic terms and concepts and economic reasoning.

12.1.4. Evaluate the role of private property as an incentive in conserving and improving scarce resources, including renewable and nonrenewable natural resources.

12.2 Students analyze the elements of America’s market economy in a global setting.

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’ borders.

### U.S. History and Geography – US

11.2 Students analyze the relationship among the rise of industrialization, large-scale rural-to-urban migration, and massive immigration from Southern and Eastern Europe.

11.5 Students analyze the major political, social, economic, technological, and cultural developments of the 1920s.

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.

11.6 Students analyze the different explanations for the Great Depression and how the New Deal fundamentally changed the role of the federal government.

11.6.4. Analyze the effects of and the controversies arising from New Deal economic policies and the expanded role of the federal government in society and the economy since the 1930s (e.g., Works Progress Administration, Social Security, National Labor Relations Board, farm programs, regional development policies, and energy development projects such as the Tennessee Valley Authority, California Central Valley Project, and Bonneville Dam).
## Academic Alignment Matrix

### ENGINEERING AND ARCHITECTURE

<table>
<thead>
<tr>
<th>PATHWAYS</th>
<th>A. Architectural Design</th>
<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U.S. History and Geography – US</strong> <em>(continued)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.8 Students analyze the economic boom and social transformation of post-World War II America.</td>
<td>A1.0, A2.0, A5.0</td>
<td>B9.0</td>
<td>C1.0</td>
<td></td>
</tr>
<tr>
<td>11.11 Students analyze the major social problems and domestic policy issues in contemporary American society.</td>
<td>A1.0, A2.0, A5.0</td>
<td>B9.0</td>
<td>C1.0</td>
<td>D3.0</td>
</tr>
<tr>
<td>11.11.5. Trace the impact of, need for, and controversies associated with environmental conservation, expansion of the national park system, and the development of environmental protection laws, with particular attention to the interaction between environmental protection advocates and property rights advocates.</td>
<td>A1.0, A2.0, A5.0</td>
<td></td>
<td></td>
<td>D10.0, D11.0, D13.0</td>
</tr>
</tbody>
</table>

### World History, Culture, and Geography – WH

<table>
<thead>
<tr>
<th>PATHWAYS</th>
<th>A. Architectural Design</th>
<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.3 Students analyze the effects of the Industrial Revolution in England, France, Germany, Japan, and the United States.</td>
<td>A1.0, A2.0, A5.0</td>
<td>B9.0</td>
<td>C1.0</td>
<td></td>
</tr>
<tr>
<td>10.9 Students analyze the international developments in the post-World World War II world.</td>
<td>A1.0</td>
<td>B9.0</td>
<td>C1.0</td>
<td></td>
</tr>
<tr>
<td>10.10 Students analyze instances of nation-building in the contemporary world in at least two of the following regions or countries: the Middle East, Africa, Mexico and other parts of Latin America, and China.</td>
<td>A1.0</td>
<td>B9.0</td>
<td>C1.0</td>
<td></td>
</tr>
<tr>
<td>10.11 Students analyze the integration of countries into the world economy and the information, technological, and communications revolutions (e.g., television, satellites, computers).</td>
<td>A1.0, A2.0, A3.0, A5.0</td>
<td>B9.0</td>
<td>C1.0</td>
<td></td>
</tr>
</tbody>
</table>

### Chronological and Spatial Reasoning – CSR

<table>
<thead>
<tr>
<th>PATHWAYS</th>
<th>A. Architectural Design</th>
<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students compare the present with the past, evaluating the consequences of past events and decisions and determining the lessons that were learned.</td>
<td>A1.0</td>
<td></td>
<td>C1.0</td>
<td></td>
</tr>
<tr>
<td>2. Students analyze how change happens at different rates at different times; understand that some aspects can change while others remain the same; and understand that change is complicated and affects not only technology and politics but also values and beliefs.</td>
<td>A1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Students relate current events to the physical and human characteristics of places and regions.</td>
<td></td>
<td></td>
<td>C1.0</td>
<td></td>
</tr>
</tbody>
</table>
### Academic Alignment Matrix

#### ENGINEERING AND ARCHITECTURE

<table>
<thead>
<tr>
<th>Historical Research, Evidence, and Point of View – HR</th>
<th>A. Architectural Design</th>
<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Students construct and test hypotheses; collect, evaluate, and employ information from multiple primary and secondary sources; and apply it in oral and written presentations.</td>
<td></td>
<td>A1.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Historical Interpretation – HI</th>
<th>A. Architectural Design</th>
<th>B. Engineering Technology</th>
<th>C. Engineering Design</th>
<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students show the connections, causal and otherwise, between particular historical events and larger social, economic, and political trends and developments.</td>
<td>A1.0</td>
<td></td>
<td>C1.0</td>
<td></td>
</tr>
<tr>
<td>3. Students interpret past events and issues within the context in which an event unfolded rather than solely in terms of present-day norms and values.</td>
<td>A1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix: CTE Model Curriculum Standards Contributors

Engineering and Architecture

Lloyd McCabe, Administrator, California Department of Education
John Dunn, Education Consultant, California Department of Education

Standards Review Team

Mark Martin, Director, Laney College
Arnold Ruskin, Instructor, San Diego Union High School District
Barbara Worden, Instructor, Liberty Union High School District

Standards Writing Team

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Debra Crane, Instructor, Galt Joint Union High School District
Chris Schlesselman, Instructor, Sacramento City Unified School District
Barbara Worden, Instructor, Liberty Union High School District

Common Core Alignment Team

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Jeff Kamansky, Instructor, Oceanside Unified School District
Sheryl Roccoforte, Instructor, Oceanside Unified School District
Zach Ronnenberg, Instructor, Davis Joint Unified School District
Frank Zuidema, Instructor, Oceanside Unified School District
Introduction to Engineering Design (PLTW) Proficiencies

(Please choose from the following proficiencies – not to exceed 35 lines)

1. Uses technical skills and academic knowledge.
2. Communicates effectively.
3. Researches, accesses and manages career-related resources.
4. Develops a career plan and life goals.
5. Accepts personal and responsible citizenship.

Demonstrates the following job skills:
6. Applies engineering notebook standards and protocols when documenting their work during the school year.
7. Identifies and applies group brainstorming techniques and the rules associated with brainstorming.
8. Researches a product’s history, develops a PowerPoint presentation, lists chronologically the major innovations to a product, and presents findings to a group.
9. Uses online and published works to research aspects of design problems.
10. Identifies the design process steps used in given scenarios and be able to list the steps, if any are missing.
11. Identifies, sketches, and explains the function of points, construction lines, object lines, and hidden lines.
12. Plots points on grid paper to aid in the creation of sketches and drawings.
13. Explains the concepts of technical sketching and drawing.
15. Explains how an oblique view of simple geometric solids differs from an isometric view.
16. Sketches one-point, two-point, and three-point perspectives of simple geometric solids.
17. Describes the concept of proportion as it relates to freehand sketching.
19. Determines the front view for a given object.
20. Researches and design a CD cover or book jacket on the origins of the measurement systems.
21. Measures and records linear distances using a scale to a precision of 1/16 inch and 1 mm.
22. Measures and records linear distances using a dial caliper to a precision of 0.001 inch.
24. Converts linear distance measurements from inches to millimeters and vice versa.
25. Applies linear dimensions to a multiview drawing.
26. Calculates the mean, mode, median, and range of a data set.
27. Creates a histogram of recorded measurements showing data elements or class intervals, and frequency.
28. Brainstorms and sketch possible solutions to an existing design problem.
29. Selects an approach that meets or satisfies the constraints given in a design brief.
30. Creates simple extruded solid Computer Aided Design (CAD) models from dimensioned sketches.
32. Measures and fabricates parts for a functional prototype from the CAD multiview drawings.
33. Assembles the product using the CAD modeling software.
34. Tests and evaluates the prototype and record results.
35. Applies geometric and numeric constraints to CAD sketches.
36. Identifies the purpose of packaging in the design of consumer products.
37. Identifies common geometric shapes and forms by name.
38. Calculates the area of simple geometric shapes.
39. Calculates the surface area and volume of simple geometric forms.
40. Identifies and explains the various geometric relationships that exist between the elements of two-dimensional shapes and three-dimensional forms.
41. Identifies and defines the axes, planes, and sign conventions associated with the Cartesian coordinate system.
42. Applies geometric and numeric constraints to CAD sketches.
43. Utilizes sketch-based, work reference, and placed features to develop solid CAD models from dimensioned drawings.
44. Explains how a given object’s geometry is the result of sequential additive and subtractive processes.
45. Explains the differences between size and location dimensions.
46. Differentiates between datum dimensioning and chain dimensioning.
47. Identifies and dimensions fillets, rounds, diameters, chamfers, holes, slots, and screw threads in orthographic projection drawings.
48. Explains the rules that are associated with the application of dimensions to multiview drawings.
49. Identifies, sketches, and explains the difference between general tolerances, limit dimensions, unilateral, and bilateral tolerances.
50. Differentiates between clearance and interference fits.
51. Sketches and models an auxiliary view of a given object to communicate the true size and shape of its inclined surface.
52. Describes the purpose and demonstrates the application of section lines and cutting plane lines in a section view drawing.
53. Sketches a full and half section view of a given object to communicate its interior features.
54. Identifies algebraic relationships between the dimensional values of a given object.
55. Applies assembly constraints to individual CAD models to create mechanical systems.
56. Performs part manipulation during the creation of an assembly model.
57. Explains how assembly constraints are used to systematically remove the degrees of freedom for a set of components in a given assembly.
58. Creates an exploded model of a given assembly.
59. Determines ratios and apply algebraic formulas to animate multiple parts within an assembly model.
60. Creates and describes the purpose of the following items: exploded isometric assembly view, balloons, and parts list.
61. Brainstorms and sketches possible solutions to an existing design problem.
62. Creates a decision making matrix.
63. Selects an approach that meets or satisfies the constraints given in a design brief.
64. Creates solid computer-aided design (CAD) models of each part from dimensioned sketches using a variety of methods.
65. Applies geometric computer-aided design (CAD) modeled parts.
66. Generates dimensioned multi-view drawings from simple CAD modeled parts.
67. Assembles the product using the CAD modeling software.
68. Explains what constraints are and why they are included in a design brief.
69. Creates a three-fold brochure marketing the designed solution for the chosen problem, such as a consumer product, a dispensing system, a new form of control system, or extend a product design to meet a new requirement.

70. Explains the concept of fluid power, and the difference between hydraulic and pneumatic power systems

71. Identifies visual design elements within a given object.

72. Explains how visual design principles were used to manipulate design elements within a given object.

73. Explains what aesthetics is, and how it contributes to a design's commercial success.

74. Identifies the purpose of packaging in the design of consumer products.

75. Identifies visual design principles and elements that are present within marketing ads.

76. Identifies the intent of a given marketing ad and demographics of the target consumer group for which it was intended.

77. Identifies the reasons why engineers perform reverse engineering on products.

78. Describes the function of a given manufactured object as a sequence of operations through visual analysis and inspection (prior to dissection).

79. Describes the differences between joinery, fasteners, and adhesives.

80. Identifies the types of structural connections that exist in a given object.

81. Uses dial calipers to precisely measure outside and inside diameter, hole depth, and object thickness.

82. Identifies a given object's material type.

83. Identifies material processing methods that are used to manufacture the components of a given commercial product.

84. Assigns a density value to a material, and apply it to a given solid CAD model.

85. Performs computer analysis to determine mass, volume, and surface area of a given object.

86. Writes design briefs that focus on product innovation.

87. Identifies group brainstorming techniques and the rules associated with brainstorming.

88. Uses decision matrices to make design decisions.

89. Explains the difference between invention and innovation.

90. Creates a brainstorming list of different products made from common materials that are used daily.

91. Researches and constructs a product impact timeline presentation of a product from the brainstorming list and presents how the product may be recycled and used to make other products after its lifecycle is complete.

92. Identifies the five steps of a product's lifecycle and investigates and proposes recyclable uses for the material once the lifecycle of the product is complete.

93. Explains why teams of people are used to solve problems.

94. Identifies group norms that allow a virtual design team to function efficiently.

95. Establishes file management and files revision protocols to ensure the integrity of current information.

96. Uses internet resources, such as email, to communicate with a virtual design team member throughout a design challenge.

97. Identifies strategies for addressing and solving conflicts that occur between team members.

98. Creates a Gantt chart to manage the various phases of their design challenge.