Title: Engineering

Job Titles: Architectural and Civil Drafters (17-3011)
Mechanical Drafters (17-3013)
Civil Engineering Technicians (17-3022)
Industrial Engineering Technicians
Mechanical Engineering Technicians
Engineering Technicians, Other

Course Description:
The Engineering course is a 360-hour course that trains students for post-secondary education and/or an entry-level position in a variety of related occupations, such as Engineering Technician, Draftsman, Mechanical Designer, Computer Programmer, and Electronics Technician.

The Introduction to Engineering Module (minimum 168 hours): Students will study the connection between applied physics principles and several branches of engineering: mechanical, computer, electronic, industrial, manufacturing, and materials. In addition, students will investigate specific subsets of Engineering such as units and measurements, machine design, electronic circuits, materials, and manufacturing.

The Principals of Engineering Module (minimum 180 hours): Students will develop a deeper understanding of the topics taught in the introductory class as well as be introduced to more advanced engineering topics such as vector statics, strength of materials, programmable logic controllers, advanced drafting and drawing, engineering project management, and engineering ethics. Students will learn engineering problem solving by calculation, new product development, and designing for manufacturability.

This course is a rigorous algebra-based, computer programming intensive, extensive reading and writing, research, and laboratory engineering program with a strong emphasis on hands-on elements. Students may have an opportunity to compete in local or national engineering competitions.

This course aligns with and incorporates the California Career Technical 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>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Career Ready Practice</td>
<td>12</td>
<td></td>
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</tr>
<tr>
<td>II</td>
<td>Introduction to Engineering</td>
<td>168</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Principals of Engineering</td>
<td>180</td>
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<tr>
<td></td>
<td>Total Hours: 360</td>
<td>360</td>
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</table>

Revised 2013-2014
Los Angeles County Career Technical Education

COURSE OUTLINE

ENGINEERING

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Engineering</th>
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<tbody>
<tr>
<td>CBEDS Code</td>
<td>5574</td>
</tr>
<tr>
<td>State Course ID</td>
<td>6936</td>
</tr>
<tr>
<td>ROCP #</td>
<td>17-361</td>
</tr>
<tr>
<td>Approval Date</td>
<td></td>
</tr>
<tr>
<td>Revision Date</td>
<td>May 2015</td>
</tr>
</tbody>
</table>
| O*Net Codes and Job Titles   | Architectural and Civil Drafters (17-3011)  
                             | Mechanical Drafters (17-3013)  
                             | Civil Engineering Technicians (17-3022)  
                             | Industrial Engineering Technicians  
                             | Mechanical Engineering Technicians  
                             | Engineering Technicians, Other  |
| CTE Industry Sector          | Engineering and Architecture |
| Career Pathway(s)            | Engineering Design (C)  
                             | Engineering Technology (B) |
| UC Credit                    | No                      |
| Industry Certification       | No                      |
| Student Prerequisites        | Minimum age of 16 or 11th grade status |
| Total Course Hours           | 360                     |

Course Description

The Engineering course is a 360-hour course that trains students for post-secondary education and/or an entry-level position in a variety of related occupations, such as Engineering Technician, Draftsman, Mechanical Designer, Computer Programmer, and Electronics Technician.

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California Career Technical Education Model Curriculum Standards, Grades 7-12
Industry Sector Anchor Standards (AS): Engineering and Architecture
Pathway Standards (PS): Engineering Design (C) and Engineering Technology (B)
Standards for Career Ready Practice (CRP):
Common Core State Standards (CCSS): Language Arts (ELA), Mathematics (M)
**Classroom Physical 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. Additionally, space conducive for group theory lessons including flat student desks or worktables and computer tables to accommodate at least four computers with Internet access are 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.

**Minimal Requirements**
Student desks/workstations, teacher’s desk, whiteboard, locked cabinets for storage; computers, Internet access, printer, document camera, projector, DVD player, screen.

**Equipment and Supplies** *(need to update)*

**Electronic equipment:**
- 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).
- Parallax BASIC Stamp Homework Board or Board of Education (1 per 1–3 students)
- Arduino microcontroller (1 per 1-3 students)
- Radio Shack Electronic Learning Lab (1 per 2–3 students)
- Breadboards (1 per 1-3 students)
- Multimeter
- Oscilloscope
- Electronic components (resistors, ICs, transistors, LEDs, etc), battery holders and jumper wires
- Extension cords
- Flashlight
- AA batteries
- Soldering iron

**Software and electronic resources:**
- Microsoft Windows XP or newer, and Microsoft Office Suite 2003 or newer
- 3D Parametric CAD modeler such as Autodesk Inventor, SolidWorks, or Creo Elements.
• Programming environment such as Parallax BASIC Stamp Editor or Arduino.
• Printed circuit design software such as CadSoft Eagle
• Graphic design software such as Adobe Photoshop, GIMP, or Inkscape
• Various Internet resources

**Hand tools:**
- Various size Phillips screwdrivers
- Various size flathead screwdrivers
- Wire cutter
- Wire stripper
- Pliers
- Hex key set
- Measuring tape
- Vice grips
- Flat and curved metal files
- Hacksaw
- Metal punch
- Pry bar
- Various large and small clamps
- Heavy-duty workbench vice
- Adjustable wrench
- Wrench & Socket set (Metric/English)
- Tap & die set
- Hammer
- Rubber mallet
- Rivet Puller

**Power tools:**
- Variable speed saber saw
- Portable drill
- Reciprocating portable saw
- Portable grinder
- Stationary grinder / steel brush
- Belt / disc sander
- Drill press
- Portable circular saw
- Band saw
- Cutoff saw
- Milling machine
- Metal lathe
- Shop vacuum

**Miscellaneous supplies:**
- Workbench
- Tool chest
- Discs for portable grinder
- Protective goggles
- Protective gloves
- 4 foot metal ruler
- Protective earphones
- Vice for drill press
- Clamp for drill press
- Attachments for portable drill (screwdrivers, nut drivers etc.)
- Various size drill bits
- Cobalt drill bit set
- Various size wood/metal blades for saber saw
- Various size wood/metal blades for reciprocating saw
- Various number of teeth blades for band saw
- Various blades for circular saw (wood and metal cutting)
- Metal scribe (marking tool)
- Small parts organizers
- Various size nuts/bolts/metal screws/rivets
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:

- Teacher modeling
- Class discussions
- Lecture and guided practice
- Written assignments correlating with concepts presented in lecture
- Demonstration
- Independent and group research projects
- Independent and group engineering projects
- Laboratory activities which emphasize open-ended hands-on exploration and investigation
- Team and subspecialty teamwork
- Exposure to current trends and information in engineering through reading assignments in current periodicals and journals
- Multimedia and enrichment video presentations
- Individual instruction
- Possible field trips to Cal Tech, JPL, and a manufacturing and/or electronics company
- Work-based learning experiences
• Guest speakers
• Collaboration with community and corporate and agencies
• Mentors - JPL/Cal Tech, University, Community, and/or Corporate
• Web-based research
• 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:
• Student portfolios
• Student demonstrations
• Individual and group presentations
• Supervisor/teacher observations
• Peer evaluations
• Self-reflections
• Critiques
• Rubrics
• Oral assessment
• Reports and research papers
• Individual and group projects
• Engineering design and building projects
• Accomplishment of specific goals in subspecialty teams
• Sketchbooks
• Tests and quizzes
• Performance tasks

Students will be assessed in multiple ways to ensure that a variety of learning styles are addressed. Each module shall conclude in a capstone project which highlights students’ skills gained from the course.

Safety
• All students will successfully complete a safety exam with results kept on file.
• Specialized safety needs related to tools and supplies used.
• Students and instructors should have access to appropriate safety equipment, such as safety glasses, ear protection, gloves, sun protection, and safety vests at all times.

California Career Technical Education Model Curriculum Standards, Grades 7-12
Industry Sector Anchor Standards (AS): Engineering and Architecture
Pathway Standards (PS): Engineering Design (C) and Engineering Technology (R)
Standards for Career Ready Practice (CRP):
Common Core State Standards (CCSS): Language Arts (ELA), Mathematics (M)
Recommended Supplemental Instructional Textbooks and Materials

- The Basic Stamp User’s Manual (Parallax)
- BASIC Stamp Syntax and Reference Manual (Parallax)
- What’s a Microcontroller? – Student Guide v3.0 (Parallax)
- Applied Sensors v2.0 – Student Guide (Parallax)
- Understanding Signals – Student Guide v1.0 (Parallax)
- Basic Analog and Digital – Student Guide v1.3 (Parallax)
- Process Control – Student Guide v1.0 (Parallax)
- Industrial Control – Student Guide v1.1 (Parallax)
- Elements of Digital Logic – Student Guide v1.0 (Parallax)
- Five Hundred and Seven Mechanical Movements
- Machinery’s Handbook
- Marks’ Standard Handbook for Mechanical Engineers
- SME Handbook
- Making Things Move
- Make: Electronics: Learning Through Discovery
- Getting Started with Arduino
- Arduino Cookbook
- Getting Started in Electronics
- Forrest Mims Mini Engineer’s Mini Notebooks
  - Volume I: Timer, Op Amp, and Optoelectronic Circuits & Projects
  - Volume II: Science and Communication Circuits & Projects
  - Volume III: Electronic Sensor Circuits & Projects
  - Volume IV: Electronic Formulas, Symbols & Circuits
- Handbook of Physics
- Statics and Mechanics of Materials – Beer & Johnston
- Introduction to Engineering Ethics
- Interpreting Engineering Drawings, 7th ed.

Magazines and scientific journals:
- Nuts & Volts

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Pathway Standards (PS): Engineering Design (C) and Engineering Technology (R)
Standards for Career Ready Practice (CRP):
Common Core State Standards (CCSS): Language Arts (ELA), Mathematics (M)
- Elektor
- Make
- Scientific American

**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.
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<tr>
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<th>C</th>
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<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.  
• 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.  
• 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*  
• 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 communication.  
• Assess how nonverbal communication affects messages.  
• Explain the impact of personal and professional social media in |   |    |     |
<p>|                                       |                                                                                                                                                                                                                                                                                                      |RI|OJT|RI|OJT | 12 |</p>
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<tr>
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<th>CC</th>
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</thead>
</table>
| I. CAREER READY PRACTICE (Continued) | communication.  
• Describe issues related to communicating in a global society.  
• Explain the appropriate etiquette for answering telephone calls and leaving voicemail messages; receiving and making requests; giving directions and persuading others.  
• Identify the steps to plan a successful oral presentation.  
• Develop an education and career plan aligned with personal goals.  
CRP 3  
• 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  
• Apply the decision-making process to develop a college and career plan. AS 5.0  
• Identify employability skills required for participation in the world of work.  
• Assess interests, skills and aptitudes and match these to career options.  
• Identify further education and/or training needed for career choices.  
• Develop a resume, cover letter and other resources for the job search process.  
• Complete a job application.  
• Identify what employers are looking for when hiring employees.  
• Apply effective interviewing skills and write a thank-you note.  
• Create a career portfolio that links to future college and career options. | RI | OJT | RI | OJT |
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<td>OJT</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. | | | |
| G. Critical Thinking and Problems Solving Skills | • 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. | | | |
| H. Personal Health and Financial Literacy | • 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 performance. | | | |

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</table>
| I. CAREER READY PRACTICE (Continued) | • 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. | RI | OJT | RI | OJT |
| I. Responsible Citizenship | • Act as a responsible citizen in the workplace and the community.  
  CRP 7  
• 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.  
  CRP 8  
• 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.  
  AS 8.0  
• Define integrity and how it relates to the classroom and workplace.  
• Identify characteristics of ethical behavior and leadership. | | | |
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<td><strong>I. CAREER READY PRACTICE (Continued)</strong></td>
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<tr>
<td><strong>K. Human Relations in the Workplace</strong></td>
<td>• Compare and contrast the three basic management styles: authoritarian, democratic, and laissez faire.</td>
</tr>
<tr>
<td><strong>L. Creativity and Innovation</strong></td>
<td>• Work productively in teams while integrating cultural and global competence. <em>CRP 9</em></td>
</tr>
<tr>
<td><strong>M. Research Strategies</strong></td>
<td>• Define human relations.</td>
</tr>
<tr>
<td></td>
<td>• Explain the need for effective human relations skills at school and in the workplace.</td>
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<td></td>
<td>• Contrast the characteristics and consequences of positive and negative attitudes.</td>
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<td>• Recognize the contributions of diversity in society and in the workplace.</td>
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<td>• Assess the value of teamwork in the classroom and workplace.</td>
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<tr>
<td></td>
<td>• Identify strategies that can be used to promote good working relationships within the classroom and in the workplace.</td>
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<td>• Explain the importance of networking.</td>
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<td>• Identify verbal, non-verbal, and physical types of harassment as defined by the state/federal law and determine appropriate behavior in the workplace.</td>
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<td>• Demonstrate creativity and innovation. <em>CRP 10</em></td>
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<td>• Identify how new ideas, thinking, tasks, solutions, and methods can be fostered in the workplace. <em>AS 5.0</em></td>
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<td>• Explain the appropriate and constructive expression of creativity and innovation at school and in a workplace situation.</td>
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<td></td>
<td>• Employ valid and reliable research strategies. <em>CRP 11</em></td>
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<td></td>
<td>• Define plagiarism.</td>
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<td></td>
<td>• Identify strategies for conducting basic research.</td>
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<td>• Explain resources for gathering information on a topic.</td>
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<td>• Explain how to confirm the validity of sources.</td>
</tr>
</tbody>
</table>
## INSTRUCTIONAL CONTENT

### 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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<td>N. Decision-Making</td>
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</table>
II. INTRODUCTION TO ENGINEERING

A. What is Engineering?
1. History of engineering
2. The role of engineers in society
3. Historically significant engineering accomplishments
4. Present day engineering projects
5. Upcoming challenges in engineering
6. Fields of Engineering: Mechanical, Civil, Electrical, Aerospace, Biomedical, Computer, Chemical, Industrial & Manufacturing
7. Post-secondary studies
8. Careers in engineering

- Understand historical and current events related to engineering design and their effects on society. *PS C1.0*
- Know historical and current events that have relevance to engineering design. *PS C1.1*
- Research past, present, and projected technological advances as they impact a particular pathway. *AS 4.5*
- Understand that the modern world is an international community and requires an expanded global view. *AS 9.5*
- Interpret and explain terminology and practices specific to the Engineering and Architecture sector. *AS 10.1*
  - Explore the relatedness between mechanical, civil, computer, electronic, industrial, chemical, aerospace, and materials engineering.
  - Describe how the technological fields of mechanics, electronics, controls, and computers intersect.
  - Select several major fields of engineering and give a brief description of each.
- Identify and ask significant questions that clarify various points of view to solve problems. *AS 5.1*
  - Understand that engineering is solving problems by applying principles of mathematics, science, and technology.
- Research the scope of career opportunities available and the requirements for education, training, certification, and licensure. *AS 3.4*
  - Understand the major fields of engineering and with the diverse work functions that engineers perform.
  - Familiar with the paths and certifications that can lead to careers in engineering and engineering technology.
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<tr>
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</table>
|  | o List several functions an engineer might perform in a particular industry.  
|  | o Describe the level of education typically required to be an engineer or engineering technician.  
|  | o Investigate science and technology careers, as well as university programs in engineering.  
|  | • Understand the need to adapt to changing and varied roles and responsibilities. *AS 7.3*  
|  | • Demonstrate ethical and legal practices consistent with Engineering and Architecture sector workplace standards. *AS 8.3*  
|  | o Understand that engineers have a moral obligation to the public.  
|  |  |
| **B. Safety** |  |
| 1. Necessity of safety |  |
| 2. Types of hazards |  |
| 3. Protective Equipment |  |
| 4. Tool and Equipment usage |  |
| 5. Electrical hazards and precautions |  |
| 6. Evacuation procedures |  |
| 7. Fire suppression |  |
| 8. Lifting techniques |  |
| 9. Industry standards |  |
| 10. Accident Examples |  |
|  | • Interpret policies, procedures, and regulations for the workplace environment, including employer and employee responsibilities. *AS 6.2*  
|  | • Identify good work habits and industry-standard safety practices.  
|  | o Use health and safety practices for storing, cleaning, maintaining tools, equipment, and supplies. *AS 6.3*  
|  | o Practice personal safety when lifting, bending, or moving equipment and supplies. *AS 6.6*  
|  | • Demonstrate how to prevent and respond to work-related accidents or injuries; this includes demonstrating an understanding of ergonomics. *AS 6.5*  
|  | o Identify job-site hazards.  
|  | o Identify and wear personal protective equipment.  
|  | o Demonstrate knowledge of electrical hazards and safety precautions.  
|  | o Identify exits and explain evacuation procedures.  
|  | o Know how to use a fire extinguisher.  
|  | • Maintain a safe and healthful working environment. *AS 6.6*  

California Career Technical Education Model Curriculum Standards, Grades 7-12  
Industry Sector Anchor Standards (AS): Engineering and Architecture  
Pathway Standards (PS): Engineering Design (C) and Engineering Technology (B)  
Standards for Career Ready Practice (CRP):  
Common Core State Standards (CCSS): Language Arts (ELA), Mathematics (M)
### II. INTRODUCTION TO ENGINEERING (Continued)

#### C. Design Process

1. Identify key steps in the engineering design process
2. Identify resources involved in each step of the engineering design process
3. Resource-driven design
4. Mission Statements
5. Requirements and Constraints
6. Design Objectives
7. System Design Drivers
8. Product Design Specifications
9. Component and Materials Sourcing
10. Manufacturability
11. Performance, Cost, and Reliability
12. Selection of subsystems
13. Communicate processes and results
14. Iterative design and refinement

#### STUDENT OUTCOMES

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<tr>
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<th>I C</th>
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<td>RI</td>
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<td>RI</td>
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</table>

- Demonstrate safe use of equipment and tools and proper organization of work space.
- Be informed of laws/acts pertaining to the Occupational Safety and Health Administration (OSHA). *AS 6.7*
- Interpret the development of graphic language in relation to engineering design. *PS C1.2*
- Employ the design process to solve analysis and design problems. *PS B6.0*
- Apply the concepts of engineering design to the tools, equipment, projects, and procedures of the Engineering Design Pathway. *PS C3.3*
- Outline the steps in the design process.
- Solve predictable and unpredictable work-related problems using various types of reasoning (inductive, deductive) as appropriate. *AS 5.2*
- Understand the steps in the design process. *PS B6.1*
- Understand the design process and how to solve analysis and design problems.
- Identify the principles that are relevant to a problem.
- Disassemble an existing design to understand construction details.
- Prepare a thorough technical documentation of a conceptual design.
- Develop supporting text, data, and diagrams for a design presentation.
- Complete a design project incorporating each step of the design process.
- Revise a design based on test results.
- Use electronic reference materials to gather information and produce products and services. *AS 4.1*
## II. INTRODUCTION TO ENGINEERING (Continued)

### 15. Design Project Documentation

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<tr>
<td></td>
<td>o Research previous and existing similar designs using internet resources.</td>
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<td></td>
<td>• Interpret information and draw conclusions, based on the best analysis, to make informed decisions. <a href="#"><em>AS 5.4</em></a></td>
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<td></td>
<td>o Determine what information and principles are relevant to a problem and its analysis. <a href="#"><em>PS B2.2</em></a></td>
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<td>o Translate word problems into mathematical statements when appropriate.</td>
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<td></td>
<td>• Use systems thinking to analyze how various components interact with each other to produce outcomes in a complex work environment. <a href="#"><em>AS 5.3</em></a></td>
<td>II</td>
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<td>o Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution. <a href="#"><em>PS B6.3</em></a></td>
<td>II</td>
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<tr>
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<td>o Demonstrate the process of developing multiples details, within design constraints, into a single solution. <a href="#"><em>PS B6.5</em></a></td>
<td>II</td>
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<tr>
<td></td>
<td>o Develop the details of one solution.</td>
<td>II</td>
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<td></td>
<td>• Understand the concepts and procedures necessary for producing drawings. <a href="#"><em>PS C5.1</em></a></td>
<td>II</td>
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<tr>
<td></td>
<td>• Plan, prepare, and interpret drawings and models through traditional or computer-aided (CAD) techniques. <a href="#"><em>PS C10.4</em></a></td>
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<td>o Select and finalize the solutions and complete a working drawing (i.e. freehand or CAD drawing).</td>
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<td></td>
<td>o Use appropriate materials, tools, and processes to fabricate a model (form) of the solution.</td>
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<td>o Construct a prototype from plans and test it. <a href="#"><em>PS B6.6</em></a></td>
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<td>o Evaluate and redesign a prototype on the basis of collected test data. <a href="#"><em>PS B6.7</em></a></td>
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<td>• Collaborate with industry experts for specific technical knowledge and skills. <a href="#"><em>AS 10.4</em></a></td>
<td>RI</td>
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<tr>
<td></td>
<td>o Collaborate with community and corporate mentors.</td>
<td>OJT</td>
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*AS 5.4, PS B2.2, PS B6.3, PS B6.5, PS B6.7, PS C5.1, PS C10.4, AS 10.4*
## II. INTRODUCTION TO ENGINEERING (Continued)

- Understand the concepts and procedures necessary for producing drawings. *PS C5.1*
  - Prepare a three-view drawing of the design showing the subsystem layout.

- Communicate information and ideas effectively to multiple audiences using a variety of media and formats. *AS 2.5*
  - Participate in the delivery of the final design presentation to fellow students and invited guests.

### D. Units of Measure

1. Distance
2. Area
3. Volume
4. Angle
5. Weight
6. Mass
7. Force
8. Pressure
9. Speed
10. Acceleration
11. Torque
12. Work
13. Power
14. Electric potential
15. Resistance
16. Current
17. Capacitance
18. Time
19. Frequency
20. Unit Conversions

- Understand measurement systems as they apply to engineering design. *PS C4.0*
  - Understand the units by which common engineering and scientific quantities are measured.
  - Understand the relationships between various units and the derivation of higher order units from lower order units.
  - Perform conversion between units of different magnitude for a given measured quantity.
  - Understand and perform conversion between units in the Standard International, and United States systems.
  - Select appropriate units based on the magnitude of the quantity being measured or referenced.

- Know how the various measurement systems are used in engineering drawings. *PS C4.1*
### II. INTRODUCTION TO ENGINEERING (Continued)

#### E. Engineering Measurements and Error

1. Measurement Estimation
2. Measuring tools
3. Scale, caliper, micrometer, coordinate measuring machine, range finder.
5. Accuracy in measurements and data acquisition
6. Sources of error and identify data outliers
7. Accuracy and precision
8. Quality Assurance
9. Error stackup

- Understand the degree of accuracy necessary for engineering design. *PS 4.2*
  - Understand that measurements may have inherent inaccuracies that must be accounted for.
  - Quantify and explain sources of measurement error.
  - Explain the difference between accuracy and precision.
  - Explain how various sources of error can cumulatively create error stackup of larger magnitude.
  - Calibrate precision measurement tools and instruments to measure objects. *PS B7.6*
- Employ engineering design equipment using the appropriate methods and techniques. *PS C2.1*
- Apply conventional engineering design equipment procedures accurately, appropriately, and safely. *PS C2.2*
  - Measure with precision using measurement tools and instruments.
  - Understand the use of electronic test equipment and units of measure.
  - Select and apply appropriate equipment or tools.
- Understand measurement systems as they apply to engineering design. *PS C4.0*
  - Estimate a measurement in relative terms based on a known reference.
  - Identify types of measurements and data-gathering techniques commonly used in engineering projects.
  - Analyze data and apply concepts of minimum, maximum, and average.
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</table>
| II. INTRODUCTION TO ENGINEERING (Continued) | o Analyze data trends and over time.  
o Formulate and solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems. *PS B5.5*  
o Translate word problems into mathematical statements when appropriate. *PS B6.4*  
- Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources. *AS 4.3*  
- Construct projects and products specific to the Engineering and Architecture sector requirements and expectations. *AS 10.3*  
o Understand how computers play a role in engineering data acquisition.  
o Understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality assurance. *PS B7.0* |
| F. Physics Concepts |  
1. Newton’s 3 Laws of Motion  
2. Mass and weight  
3. Displacement, Velocity, and Acceleration  
4. Force, Torque, Work, Power  
5. Friction  
6. Linear and angular speed  
7. Ohm’s Law  
8. AC and DC currents  
9. The six simple machines  
10. Mechanical advantage |  
- Understand the concepts of physics that are fundamental to engineering technology. *PS B4.0*  
- Describe Newton’s laws and how they affect and define the movement of objects. *PS B4.1*  
- Understand that weight is a force caused by the acceleration of gravity, and that mass is not the same as weight.  
- Solve constant acceleration problems using Newton’s second law. Solve static equilibrium problems involving levers.  
- Explain how the laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. *PS B4.2*  
- Understand that work is the product of force and distance.  
- Understand that torque is the effect of force applied at a distance from a center of rotation. |
## II. INTRODUCTION TO ENGINEERING (Continued)

- Compare and explore the six simple machines and their applications. *PS B5.3*
- Understand the effects of friction, and demonstrate knowledge of coefficients of friction of various materials.
- Solve problems involving constant linear and angular speed.
- Solve problems using appropriate units in engineering systems.
- Apply Ohm’s Law.
- Analyze how electric and magnetic phenomena are related and know common practical applications. *PS B4.5*
- Identify the fundamentals of the theory, measurement, control, and application of electrical energy, including alternating and direct currents. *PS B3.0*
  - Give examples of common AC and DC systems.
  - Understand the mathematical processes and applications that lead to solutions of electronic problems.
  - Solve Direct-Current (DC) circuit analysis problems using Ohm’s Law.
  - Calculate fundamental Alternating Current (AC) parameters.
- Formulate and solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems. *PS B5.5*
  - Manipulate scientific notation in problem solutions.
  - Derive algebraic equations to determine unknown values in circuits. Utilize a scientific calculator as a tool for problem solving.
  - Solve multi-step problems including word problems using linear equations in one variable.

### G. Shapes and Structures

1. Common two-dimensional geometric shapes

- Use the concepts of geometric construction in the development of design drawings. *PS C5.4*
  - Understand that three-dimensional solids can be derived from...
## II. INTRODUCTION TO ENGINEERING (Continued)

2. Three-dimensional shapes and their two-dimensional counterparts.
3. Area and volume of shapes.
4. Identify shape in engineered structures

### H. Engineering Materials

1. Metals
2. Alloys
3. Plastics
4. Composites
5. Wood
6. Concrete
7. Textiles
8. Isotropic vs. Anisotropic materials
9. Material applications

### I. Manufacturing Processes

1. Prototype fabrication methods
2. Hand and power tools

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<td>II. INTRODUCTION TO ENGINEERING (Continued)</td>
<td>the extrusion or revolution of two-dimensional shapes.</td>
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<td>o Calculate the area of two dimensional geometric shapes.</td>
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<td>o Calculate the volume of three-dimensional geometric shapes.</td>
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<td>o Understand the relationship between area and volume.</td>
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<td>o Identify cross sections.</td>
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<td>o Identify historically significant structures.</td>
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<td>• Apply appropriate geometric dimensioning and tolerancing (GD&amp;T) practices. <em>PS B7.5</em></td>
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<td></td>
<td>• Apply concepts of engineering design to the tools, equipment, projects, and procedures of the Engineering Design Pathway. <em>PS C2.3</em></td>
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<td>o Identify a material by its physical properties such as appearance, feel, and density.</td>
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<td>o Compare and contrast the physical properties of various materials.</td>
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<td>o Understand common uses of various engineering materials.</td>
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<td>o Know the relative strength of various materials.</td>
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<td>o Understand the difference between isotropic and anisotropic materials, and provide examples of each.</td>
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<td>o Understand material classifications, characteristics, and testing in order to select appropriate materials for engineering products.</td>
</tr>
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<td></td>
<td>• Apply concepts of engineering design to the tools, equipment, projects, and procedures of the Engineering Design Pathway. <em>PS C2.3</em></td>
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<td>o Identify differences between prototype manufacturing and</td>
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## II. INTRODUCTION TO ENGINEERING (Continued)

3. Sawing and shearing  
4. Welding and soldering  
5. Drilling  
6. Milling  
7. Turning  
8. Casting and Molding  
9. Punching  
10. Bending  
11. Plasma, laser, and waterjet cutting  
12. Heat treatment  
13. Industrial machinery  
14. Manufacturing Cost  
15. Production volume  

## J. Material Fastening

1. Permanent fastening methods - welding  
2. Non-permanent fastening methods – threaded fasteners  
3. Semi-permanent

- Apply concepts of engineering design to the tools, equipment, projects, and procedures of the Engineering Design Pathway. **PS C2.3**  
  - Compare and contrast various types of material fasteners.  
  - Understand screw thread classifications in both the Metric and Unified National systems.  
  - Identify various styles of threaded fasteners and tools used to...
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<tr>
<td>fastening methods – rivets</td>
<td>o Design and construct a structural joint with appropriate fastening based on design parameters.</td>
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<td>4. Adhesives</td>
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<td>5. Design of structural joints and connections</td>
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<td>6. Application of various fastening methods</td>
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<td><strong>K. Electricity and Electronics</strong></td>
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<tr>
<td>1. Conductors, insulators, and semiconductors</td>
<td>• 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. <em>PS B3.1</em></td>
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<tr>
<td>2. AC and DC circuits</td>
<td>• Analyze relationships between voltage, current, resistance, and power related to direct (DC) circuits. <em>PS B3.2</em></td>
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<td>3. Multi-phase AC circuits</td>
<td>• Calculate, construct, measure, and interpret both AC and DC circuits. <em>PS B3.3</em></td>
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<td>4. Series and Parallel Circuits</td>
<td>• Understand the difference between digital and analog circuits and give examples of each.</td>
</tr>
<tr>
<td>5. Ohm’s law</td>
<td>• Calculate solutions to Ohm’s Law problems.</td>
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<td>6. Kirchoff’s Voltage Law</td>
<td>• Solve problems involving Kirchoff’s laws.</td>
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<td>7. Kirchoff’s Current Law</td>
<td>• Calculate power lost as heat in a resistor as a function of current and voltage drop.</td>
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<td>8. Discrete components</td>
<td>• Measure and record current, voltage and resistance in various segments of parallel and series circuits.</td>
</tr>
<tr>
<td>9. Color Coding</td>
<td>• Calculate equivalent resistance for series and parallel resistor circuits.</td>
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<td>10. Types of switches</td>
<td>• Analyze, repair, or measure electrical and electronic systems,</td>
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<td>11. Electrical symbols and schematics</td>
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<td>12. Digital vs. Analog</td>
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<td>13. Breadboarding</td>
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<td>14. Transistors</td>
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<td>15. Integrated circuits</td>
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### II. INTRODUCTION TO ENGINEERING (Continued)

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| 16. Resistor-capacitor circuits | circuits, or components using appropriate electronic instruments.  
*PS B3.7*  
- Understand the procedures and processes related to electronic assembly.  
- Conduct laboratory experiments, which include detailed problem, theory, results, and discussion sections, including the use of lab equipment for measurement.  
- Determine resistors’ values by identifying color codes.  
- Explain the classification and use of various components, symbols, abbreviations, and media common to technical drawings.  
*PS B1.1*  
- Interpret the function of an electrical device by reading the schematic, identifying component symbols, and analyzing connections.  
- Identify various types of electrical switches and understand associated industry standard specifications and ratings.  
- Apply concepts of engineering design to the tools, equipment, projects, and procedures of the Engineering Design Pathway.  
*PS C2.3*  
- Construct an electronic device following a schematic diagram as a sole reference.  
- Use tools for their intended applications perform electronic assembly work such as: soldering, stripping/crimping wire, routing wires, making wiring harnesses, and rendering electrical/electronic layouts.  
- Select an appropriate wire gauge size for a given electrical current and connection distance.  
- Draw an electrical schematic by hand.  
- Draw a schematic and design a printed circuit board using computer software. |
| 17. Power dissipation |                                                                                 |
| 18. Electronic circuit measurements |                                                                                 |
| 19. Wire Gauge Sizes |                                                                                 |
## II. INTRODUCTION TO ENGINEERING (Continued)

### L. Motors and Magnetism
- 1. Relationship between electricity and magnetism
- 2. Parts of a motor
- 3. Permanent magnet brushed DC motors
- 4. Generators & Alternators
- 5. Brushless DC motors
- 6. Stepper and servo motors
- 7. AC induction motors
- 8. AC synchronous motors
- 9. Speed control of AC and DC motors
- 10. Sizing of motors for application
- 11. Motor specification curves and charts

### M. Energy Storage
- 1. Batteries – various chemistries
- 2. Application of various battery types
- 3. Capacitors
- 4. Springs
- 5. Determination and calculation of spring

## STUDENT OUTCOMES

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| • Analyze how electric and magnetic phenomena are related and know common practical applications. *PS B4.5*  
  o Understand that current flow in a wire creates a magnetic field according to the “right hand rule.”  
  o Compare and contrast various types of AC and DC electric motors.  
  o Compare generators and alternators to motors, and describe the function of each.  
  o Select a motor to power an electromechanical device based on design parameters and operating characteristics.  
  o Understand the relationship between speed, torque, voltage, and current and the linear operating nature for a permanent-magnet brushed DC motor.  
  o Read and interpret motor specification sheets and performance curves.  
  o Understand the role of servo and stepper motors in industrial automation.

| • Understand how the principles of force, work, rate, power, energy, and resistance related to mechanical, electrical, fluid, and thermal engineering systems. *PS B5.0*  
  o Understand various means of storing energy.  
  o Compare and contrast various types of primary and rechargeable batteries, and give usage examples for each.  
  o Research the application of various batteries as they pertain to consumer electronics, transportation, and industrial systems.
## II. INTRODUCTION TO ENGINEERING (Continued)

- Constants, forces, and displacements.
- Gravitational potential energy
- Stored kinetic energy
- Compressed gas
- Chemical energy

### N. Mechanical Power Transmission

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1. Types, characteristics, and specifications of gears
2. Pulleys, belts, sprockets, and chains
3. Bearings
4. Compound gearing
5. Design of gear trains
6. Calculation of gear ratios
7. Trade-off between speed and torque
8. Attachment of gears, sprockets, pulleys, and wheels to shafts
9. Strength of gears

- Understand how energy is stored in capacitors and give practical applications.
- Calculate the force exerted by a spring as the product of its spring constant and the displacement.
- Solve problems involving springs by using Hooke’s Law.
- Understand how the principles of force, work, rate, power, energy, and resistance related to mechanical, electrical, fluid, and thermal engineering systems. *PS B5.0*

### Application of Concepts

- Apply concepts of engineering design to the tools, equipment, projects, and procedures of the Engineering Design Pathway. *PS C2.3*
- Understand the necessity for mechanical power transmission mechanisms in mechanical devices.
- Identify various types of gearing such as spur, planetary, helical, bevel, and worm.
- Understand common gear specifications such as pitch, pressure angle, face width, and bore.
- Calculate gear ratios based on input and output parameters.
- Understand that multiple stages of gearing can be combined to compound the gear ratio.
- Understand that in a gear-train, speed and torque are inversely proportional.
- Identify applications for belt and pulley and sprocket and chain drives.
- Understand that rotating shafts must be supported by bearings, and identify commercially-available bearings suitable for a certain load and speed.
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| O. Fluid Power | - Understand how the principles of force, work, rate, power, energy, and resistance related to mechanical, electrical, fluid, and thermal engineering systems. *PS B5.0*  
  - Identify devices that utilize fluid power.  
  - Identify and explain basic components and functions of fluid power devices.  
  - Differentiate between the characteristics of pneumatic and hydraulic systems.  
  - Distinguish between hydrodynamic and hydrostatic systems.  
- Formulate and solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems. *PS B5.5*  
  - Design, create, and test a hydraulic device.  
  - Design, create, and test a pneumatic device.  
  - Calculate values in a fluid power system utilizing Pascal’s Law.  
  - Distinguish between pressure and absolute pressure.  
  - Distinguish between temperature and absolute temperature.  
  - Calculate values in a pneumatic system, utilizing the perfect gas laws.  
  - Calculate flow rate, flow velocity, and mechanical advantage in a hydraulic system. |
| P. Machine Design | - Apply concepts of engineering design to the tools, equipment, projects, and procedures of the Engineering Design Pathway. *PS C2.3* |

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II. INTRODUCTION TO ENGINEERING (Continued)

2. Human interface
3. Structure
4. Machine component selection
5. Manufacturability

Q. Surface Treatments and Corrosion
1. Paints, powder coats, and epoxies
2. Electroplating & Anodizing
3. Formation of oxidation and corrosion
4. Effects of corrosion

R. Aeronautics and Aviation
1. Lift
2. Thrust
3. Aircraft structures – fuselage, wings, tail, etc
4. Construction of a rubber-band powered model airplane

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- Identify design objectives and requirements.
- Select an energy source and prime-movers based on design objectives and requirements.
- Identify the various subsystems needed to construct an operational machine.
- Design a human interface for a mechanical system.
- Design a structure as a framework on which to support the machine’s subsystems.
- Select individual components and materials best suited to the design.
- Select appropriate methods to manufacture various machine components.

- Apply concepts of engineering design to the tools, equipment, projects, and procedures of the Engineering Design Pathway. **PS C2.3**
  - Describe various material surface treatments and coatings and their applications.
  - Understand the chemical process of corrosion and oxidation and its effects on metals.

- Apply concepts of engineering design to the tools, equipment, projects, and procedures of the Engineering Design Pathway. **PS C2.3**
  - Understand the effects of lift and how it relates to Bernoulli’s principle and equation.
  - Understand how thrust is generated in aircraft.
  - Identify major components of an aircraft structure.
  - Construct, test, adjust, and revise a model airplane.
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<tr>
<td><strong>II. INTRODUCTION TO ENGINEERING (Continued)</strong></td>
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</table>
| 5. History and concepts of human spaceflight | o Research how aviation has transformed over history.  
o Investigate significant technological achievements in human spaceflight. |
| **S. Communication and Teamwork** | |
| 1. Brainstorming and Feedback | • Recognize the elements of communication using a sender-receiver model. AS 2.1  
o Understand and demonstrate communication skills necessary in the field of engineering.  
o Determine what known information is relevant. |
| 2. Communicating Ideas and Data | • Participate in interactive teamwork to solve real Engineering and Architecture sector issues and problems. AS 9.7  
o Contribute to the successful completion of a team project. |
| 3. Working in Teams | • Communicate information and ideas effectively to multiple audiences using a variety of media and formats. AS 2.5  
o Make an oral presentation utilizing multimedia visual aids such as PowerPoint.  
o Express data in tables, graphs, charts, and other visual formats.  
o Prepare technical documentation including the use of advanced publishing software or graphic programs. |
| **T. Technology and Society** | |
| 1. Impact of Technological Advances on Society | • Research past, present, and projected technological advances as they impact a particular pathway. AS 4.5  
o Describe why technological advances may have both desirable and undesirable impacts on society.  
o Interpret the impacts of technological advances on the environment.  
o Analyze how technological advances affect local, nationals |
| 2. Impact of Technological Advances on the Environment | |
| 3. Impact of Technological | |

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II. INTRODUCTION TO ENGINEERING (Continued)

Advances on Culture
4. Interface of Technology and Ethics
5. Controlling Technology
6. The Future of Technology

and global economies.
- Discuss societies' ability/inability to control the technologies they have created.
- Project and forecast the development of future technological needs and uses.
- Demonstrate ethical and legal practices consistent with Engineering and Architecture sector workplace standards. AS 8.3
  - Explain the interface between technological advances and human ethics.
  - Describe how humans are faced with moral and ethical issues because technology is enabling very significant modifications of the natural world.
- Explore issues of global significance and document the impact on the Engineering and Architecture sector. AS 7.8
- Understand that the modern world is an international community and requires an expanded global view. AS 9.5
- Respect individual and cultural differences and recognize the importance of diversity in the workplace. AS 9.6
  - Discuss the impacts of technological advances and cultural norms/customs on each other.

U. Capstone Project
1. Project Topic
2. Research element
3. Hands-on element
4. Documentation
5. Presentation

- Construct projects and products specific to the Engineering and Architecture sector requirements and expectations. AS 10.3
  - Complete a capstone project utilizing skills and knowledge gained from various areas of the course.
  - The project topic shall be instructor-directed.
- Use electronic reference materials to gather information and produce products and services. AS 4.1
- Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources. AS 4.3
## II. INTRODUCTION TO ENGINEERING (Continued)

- 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. *AS 4.6*
- Conduct research utilizing a variety of print and electronic sources.
  - Create a physical product by employing a variety of hands-on methods.
- Communicate information and ideas effectively to multiple audiences using a variety of media and formats. *AS 2.5*
  - Document the project through written work and photographic or video documentation.
  - Conduct a professional presentation utilizing multimedia aids before an audience of peers and/or industry professionals.
### III. PRINCIPALS OF ENGINEERING

#### A. Applied Physics

1. Newton’s 3 Laws of Motion
2. Mass and weight
3. Displacement, Velocity, and Acceleration
4. Force, Torque, Work, Power
5. Friction
6. Linear and angular speed
7. Ohm’s Law
8. Kirchhoff’s Laws
9. AC and DC currents

- Understand the concepts of physics that are fundamental to engineering technology. *PS B4.0*
  - Use Newton’s three laws of motion to solve practical problems involving motion and static equilibrium.
  - Solve constant acceleration problems using Newton’s second law.

- Employ the design process to solve analysis and design problems. *PS B6.0*
  - Solve static equilibrium problems involving levers.
  - Calculate work as the product of force and distance.
  - Calculate torque as the product of applied force and distance from a center of rotation.
  - Explain and demonstrate the effects of friction, and test coefficients of friction for various materials.
  - Solve problems involving constant linear and angular speed.
  - Solve problems using appropriate units in engineering systems.
  - Apply fundamental physics concepts to the design of mechanisms, machinery, or systems.
  - Utilize a scientific calculator as a tool for problem solving.
  - Solve multi-step problems including word problems using linear equations in one variable.

- Identify the fundamentals of theory, measurement, control, and applications of electrical energy, including alternating and direct currents. *PS B3.0*
  - Apply Ohm’s Law and Kirchhoff’s Laws to solve direct-current circuit analysis problems.
  - Use appropriate electrical units to solve problems.
### III. PRINCIPALS OF ENGINEERING (Continued)

#### B. Applied Design Process

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<tr>
<td></td>
<td>1. Utilize resources involved in each step of the engineering design process.</td>
<td>• Understand the mathematical processes and applications that lead to solutions of electronic problems.</td>
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<tr>
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<td>2. Resource-driven design</td>
<td>• Calculate fundamental Alternating Current (AC) parameters. Manipulate scientific notation in problem solutions.</td>
</tr>
<tr>
<td></td>
<td>3. Requirements and Constraints</td>
<td>• Derive algebraic equations to determine unknown values in circuits.</td>
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</table>
|   | 4. Design Objectives                                                                  | • Employ the design process to solve analysis and design problems.  

*PS B6.0*

• Understand the steps in the design process.  

*PS B6.1*

• Research previous and existing similar designs using internet resources.  

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

*PS B6.2*

• Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution.  

*PS B6.3*

• Translate word problems into mathematical statements when appropriate.  

*PS 6.4*

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

*AS 5.1*

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

*AS 5.2*

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

*AS 5.3*

• Demonstrate the process of developing multiple details, within design constraints, into a single solution.  

*PS B6.5*

• Select and finalize the solutions and complete a working drawing (i.e. freehand or CAD drawing).  

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<td><strong>III. PRINCIPALS OF ENGINEERING (Continued)</strong></td>
<td>Use appropriate materials, tools, and processes to fabricate a model (form) of the solution. Design and construct a culminating project effectively using engineering technology. <em>PS B10.0</em> Understand the methods of creating both written and digital portfolios. <em>PS B11.0</em> Construct a prototype from plans and test it. <em>PS B6.6</em> Evaluate and redesign a prototype on the basis of collected test data. <em>PS B6.7</em> Prepare a thorough technical documentation of a detailed design. Develop supporting text, data, and diagrams for a design presentation. Prepare a three-view drawing of the design showing the subsystem layout. Complete a design project incorporating each step of the design process. Collaborative with industry experts for specific technical knowledge and skills. <em>AS 10.4</em> Collaborate with community and corporate mentors. Give an effective oral presentation of a portfolio/project. <em>PS B11.2</em> Participate in the delivery of the final design presentation to fellow students and invited guests. Complete a design project incorporating each step of the design process. Analyze the relationships between voltage, current, resistance, and power as pertaining to direct-current circuits. <em>PS B3.2</em> Understand the difference between digital and analog circuits and give examples of each. Calculate power lost as heat in a resistor as a function of</td>
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## III. PRINCIPALS OF ENGINEERING (Continued)

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<tr>
<td>sitematics</td>
<td>current and voltage drop.</td>
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<tr>
<td>5. Digital vs. Analog</td>
<td>o Understand the procedures and processes related to electronic assembly.</td>
</tr>
<tr>
<td>7. Transistors</td>
<td>o Construct advanced electronic circuits utilizing integrated circuits.</td>
</tr>
<tr>
<td>8. Integrated circuits</td>
<td>o Understand how to find and interpret manufacturer’s datasheets for integrated circuits.</td>
</tr>
<tr>
<td>9. Resistor-capacitor circuits</td>
<td>• Perform tests, collect data, analyze relationships, and display data in a simulated or modeled system using appropriate tools and technology. <strong>PS B8.3</strong></td>
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<tr>
<td>10. Power dissipation</td>
<td>o Conduct laboratory experiments, which include detailed problem, theory, results, and discussion sections, including the use of lab equipment for measurement.</td>
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<tr>
<td>11. Electronic circuit measurements</td>
<td>• Calibrate precision measurement tools and instruments to measure objects. <strong>PS B7.6</strong></td>
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<tr>
<td>12. Wire Gauge Sizes</td>
<td>• Determine resistors’ values by identifying color codes.</td>
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<td>• Solve predictable and unpredictable work-related problems using various types of reasoning (inductive, deductive) as appropriate. <strong>PS 5.2</strong></td>
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<td>• Interpret and explain terminology and practices specific to the Engineering and Architecture sector. <strong>AS 10.1</strong></td>
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<td>o Interpret the function of an electrical device by reading the schematic, identifying component symbols, and analyzing connections.</td>
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<td>o Identify various types of electrical switches and understand associated industry standard specifications and ratings.</td>
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<td>o Construct an electronic device following a schematic diagram as a sole reference.</td>
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<td></td>
<td>• Construct projects and products specific to the Engineering and Architecture sector requirements and expectations. <strong>AS 10.3</strong></td>
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California Career Technical Education Model Curriculum Standards, Grades 7-12
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### III. PRINCIPALS OF ENGINEERING (Continued)

#### D. Applied Machine Design

1. Selection of energy source and prime movers
2. Human interface
3. Physics calculations
4. Electronics
5. Structure
6. Machine component selection
7. Manufacturability
8. Drawings

- Use tools for their intended applications perform electronic assembly work such as: soldering, stripping/crimping wire, routing wires, making wiring harnesses, and rendering electrical/electronic layouts.
- Select an appropriate wire gauge size for a given electrical current and connection distance.
- Draw an electrical schematic by hand.
- Draw a schematic and design a printed circuit board using computer software.

- Understand the steps in the design process. *PS 6.1*
- Determine what information and principles are relevant to a problem and its analysis. *PS B6.2*
  - Determine design objectives and requirements.
  - Select an energy source and prime-movers based on design objectives and requirements.
  - Determine the various subsystems needed to construct an operational machine.

- Construct projects and projects specific to the Engineering and Architecture sector requirements and expectations. *AS 10.3*
  - Design a human interface for a mechanical system.
  - Design a structure as a framework on which to support the machine’s subsystems.
  - Apply physics principals to find optimal design parameters.
  - Integrate electronics and controls into a design.
  - Select individual components and materials best suited to the design.
  - Prepare a Bill of Materials and cost estimate for a design.
  - Prepare detailed drawings, specifications, and documentation for producing a design.

- Describe the major manufacturing processes. *PS B7.2*
### INSTRUCTIONAL CONTENT

#### III. PRINCIPALS OF ENGINEERING (Continued)

**E. Programmable Logic Control Systems**

1. What is a microcontroller?
2. Computing capability as a function of programming language, chip architecture, clock speed, memory, and interfaces.
3. Memory types – Flash, RAM, EEPROM.
4. Digital logic
5. Inputs and outputs
6. Binary (Base 2) numbers
7. Computer programming in languages such as PBASIC, C, Java, Arduino, or LabView.
8. Variables and data types
9. Program logic structures
10. Process control flow charts
11. Conditional statements
12. Loop structures
13. Multi-tasking
14. Time-sensitive functions
15. Boolean logic

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<td>o Select appropriate methods to manufacture various machine components based on cost-effectiveness and/or available resources.</td>
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<td>• Understand fundamental control system design and develop systems that complete preprogrammed tasks. <strong>PS 8.0</strong></td>
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<td>• Identify the elements and processes necessary to develop a controlled system that performs a task. <strong>PS 8.1</strong></td>
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<tr>
<td>• Write, store, edit, and analyze programs for control of electromechanical devices.</td>
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<td>• Perform tests, collect data, analyze relationships, and display data in a simulated or modeled system using appropriate tools and technology. <strong>PS 8.3</strong></td>
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<tr>
<td>• Demonstrate the use of sensors for data collection and process correction in controlled systems. <strong>PS B8.2</strong></td>
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<tr>
<td>• Interface sensors and other hardware components to microcontrollers.</td>
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<td>• Program a computing device to control systems or process. <strong>PS 8.4</strong></td>
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<tr>
<td>o Write conceptual pseudo-code to explain the function of a computer program code.</td>
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<td>o Construct a process flow-chart of an industrial control program.</td>
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<td>o Understand the syntax conventions of a computer programming language.</td>
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<td>o Understand program control structures such as if-else and switch-case statements.</td>
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<td>o Convert numbers from base ten to binary and be able to perform simple arithmetic based on the binary, octal, and hexadecimal number systems.</td>
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<td>o Predict the output of systems which have AND, NOT, OR</td>
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<td>III. PRINCIPALS OF ENGINEERING (Continued)</td>
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<tr>
<td>16. Truth tables</td>
<td><strong>NOR, NAND, and XOR operations.</strong></td>
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<tr>
<td>17. Pulse Width Modulation and waveform creation.</td>
<td><strong>Interpret and explain terminology and practices specific to the Engineering</strong></td>
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<tr>
<td>18. Interfacing to circuits and hardware</td>
<td><strong>and Architecture sector. AS 10.1</strong></td>
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<td>19. Gathering environment variables by reading</td>
<td>o Construct truth tables and use them to solve logic problems.</td>
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<td>various sensors</td>
<td>o Understand data types and how they relate to numbers and the memory space</td>
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<td>20. Industrial automation control</td>
<td>o Describe the use of computers in the following areas: interfacing to systems,</td>
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<tr>
<td>21. Open loop and closed loop systems</td>
<td>data acquisition, and microcomputers in control systems.</td>
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<tr>
<td>22. Proportional-Integral-Derivative control.</td>
<td><strong>Construct projects and products specific to the Engineering and Architecture</strong></td>
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<tr>
<td>23. Understanding and filtering signal noise and</td>
<td><strong>sector requirements and expectations. AS 10.3</strong></td>
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<tr>
<td>switch bounce</td>
<td>o Demonstrate knowledge of the single-chip microcomputer, including its</td>
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<tr>
<td>24. Interfacing with and programming advanced</td>
<td>instruction set, internal architecture, and how it interfaces with outside</td>
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<td>sensors such as accelerometers, gyroscopes, and GPS</td>
<td>hardware.</td>
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<td>locators.</td>
<td>o Construct a control system by interfacing inputs and outputs with a</td>
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<td>microcontroller and writing embedded code.</td>
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<td>o Estimate and analyze program execution time.</td>
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<td>o Create multi-tasking programs on a single-threaded microcontroller by using</td>
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<td>timers.</td>
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<td>o Observe and analyze output waveforms on an oscilloscope.</td>
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<td>o Observe program function using a digital logic analyzer.</td>
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<td>o Reduce spurious signal noise through hardware and software methods.</td>
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<td>o Create a control program using advanced sensors such as accelerometers and</td>
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<td>gyroscopes.</td>
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<td>o Tune the function of a Proportional-Integral-Derivative controller by adjusting</td>
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<td>gain constants.</td>
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### III. PRINCIPALS OF ENGINEERING (Continued)

#### F. Vector Statics

1. Free body diagrams
2. Force, Moment, and distributed force
3. Two force members
4. Truss structures
5. Two dimensional problems
6. Three dimensional problems
7. Cartesian coordinate vector breakdown and addition.

- Differentiate between scalars and vectors. *PS B5.1*
- Solve problems by using the concept of vectoring to predict resultants. *PS B5.2*
  - Utilize the Cartesian coordinate system in drawing and solving vectors.
  - Construct free-body diagrams of systems of forces and moments.
  - Reduce vectors to orthogonal component vectors using trigonometric functions.
  - Interpret word problems and graphic representations to form systems of vector equations.
- Understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems. *PS 5.0*
  - Understand the difference between internal and external forces.
  - Understand that for a system to be in static equilibrium, the sum of all the forces must equal zero, and the sum of all the moments must equal zero.
  - Solve two and three dimensional systems of forces in static equilibrium by performing vector addition and applying trigonometric and algebraic principles.
  - Calculate forces, moments, and torques on structures.
  - Understand the effect of bending in simply supported and cantilevered beams.
  - Construct shear and bending moment diagrams for cantilevered and simply supported beams under point loads.
### III. PRINCIPALS OF ENGINEERING (Continued)

#### G. Strength of Materials
1. Stress and strain
2. Poisson’s ratio
3. Young’s modulus
4. Tension, compression, shear, torsion, and bending.
5. Combined loading
6. Elastic and plastic deformation
7. Simply supported beams
8. Cantilevered beams
9. Shear and bending moment diagrams
10. Column buckling
11. Selection of materials based on stress and strain analysis.
12. Stress concentrations
13. Factor of safety

- Understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems. *PS 5.0*
  - Understand the relationship between stress and strain in linear elastic materials.
  - Investigate the properties of materials as they relate to strength, durability, and deformation.
  - Solve problems involving tensile, shear, and compressive stresses.
  - Explain the effect of Poisson’s ratio on material deformation.
  - Explain the difference between elastic and plastic deformation.
  - Solve problems involving simply supported and cantilevered beams with point loads and distributed loads.
  - Calculate bending stresses.
  - Define factor of safety as it applies to strength of materials.
  - Understand the phenomenon of column buckling.
  - Select appropriate materials based on stresses and factor of safety.
  - Describe geometric features that can lead to stress concentrations.

#### H. Drawing, Drafting, and Tolerancing
1. Two dimensional hand drawings of simple three dimensional geometric

- Interpret and explain terminology and practices specific to the Engineering and Architecture sector. *AS 10.1*
  - Understand the importance computer-aided technologies essential to the language of the engineering and design industry.
### INSTRUCTIONAL CONTENT

### III. PRINCIPALS OF ENGINEERING (Continued)

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<tr>
<td>shapes</td>
<td>• Produce proportional two- and three-dimensional sketches and designs. <em>PS C3.2</em></td>
</tr>
<tr>
<td>2. Drawing in 1:1 scale, reduced scale, and enlarged scale</td>
<td>• Understand the concepts and procedures necessary for producing drawings. <em>PS C5.1</em></td>
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<tr>
<td>3. Third-angle orthographic projections</td>
<td>o Determine the “front” view of a part.</td>
</tr>
<tr>
<td>4. Hidden lines</td>
<td>o Understand industry-standard formats for drawing layouts, lines, and annotations.</td>
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<tr>
<td>5. Isometric views</td>
<td>o Understand the degree of accuracy necessary for engineering design. <em>PS C4.2</em></td>
</tr>
<tr>
<td>6. Determination of the front view</td>
<td>• Develop multiview drawings using the orthographic projection process. <em>PS C5.2</em></td>
</tr>
<tr>
<td>7. Datums</td>
<td>• Know a variety of drafting applications and understand the proper dimensioning standards for each. <em>PS C8.1</em></td>
</tr>
<tr>
<td>8. Linear dimensioning</td>
<td>o Determine proper placement for dimensions.</td>
</tr>
<tr>
<td>9. Types of tolerancing</td>
<td>o Understand how choice of dimension placement on a drawing can affect a part’s accuracy with respect to individual geometric features.</td>
</tr>
<tr>
<td>10. Selecting appropriate tolerancing for chosen manufacturing method and cost-effectiveness</td>
<td>o Develop ability to select dimensions and placement for geometric features.</td>
</tr>
<tr>
<td>11. Drawing annotation</td>
<td>o Reference the location of geometric features to datums.</td>
</tr>
<tr>
<td>12. Three-dimensional parametric solid modeling using industry-standard software such as Autodesk Inventor, SolidWorks, or Creo Elements.</td>
<td>o Understand how two-dimensional shapes can be transformed into three-dimensional solids.</td>
</tr>
<tr>
<td>13. Creation of 3D shapes from 2D sketches</td>
<td>• Apply dimension to various objects and features. <em>PS C8.2</em></td>
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<tr>
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<td>o Draw two-dimension orthographic views of three-dimensional shapes using third-angle projections.</td>
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<td>• Construct projects and products specific to the Engineering and Architecture sector requirements and expectations. <em>AS 10.3</em></td>
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<td>o Construct drawings at 1:1 scale, enlarged scale, and reduced scale.</td>
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<td>o Implement standard methods of title block creation and use. <em>PS C10.2</em></td>
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*California Career Technical Education Model Curriculum Standards, Grades 7-12  
Industry Sector Anchor Standards (AS): Engineering and Architecture  
Pathway Standards (PS): Engineering Design (C) and Engineering Technology (B)  
Standards for Career Ready Practice (CRP):  
Common Core State Standards (CCSS): Language Arts (ELA), Mathematics (M)
### III. PRINCIPALS OF ENGINEERING (Continued)

14. Creation of 2D three-view drawings from 3D solids
15. Proper dimensioning on three-view drawings.
17. Use of sketch constraints such as horizontal, vertical, coincident, collinear, concentric, tangent, parallel, Perpendicular, and equal.
18. Placement of parts into assemblies
19. Assembly and exploded view diagrams
20. Geometric Dimensioning and tolerancing to ANSI Y14.5 standards.
21. Section and detail views.

- Plan, prepare, and interpret drawings and models through traditional drafting or computer-aided design (CAD) techniques. *PS C10.4*
- Prepare complete drawings with sufficient information to send a part for manufacturing.
- Prepare two-dimensional drawings using CAD software and the Cartesian coordinate system.
- Use the concepts of geometric construction in the development of design drawings. *PS C5.4*
- Prepare three-dimensional parametric models using CAD software.
- Create assemblies of individual part models with proper constraints applied.
- Create exploded views of assembly models.
- Annotate drawings to indicate features not described by dimensions alone.
- Prepare drawings including detail and section views to show advanced or hidden geometry
  - Understand the tolerance relationships between mating parts. *PS C9.0*
  - Understand how tolerance is related to manufacturing processes and cost.
  - Explain the concept of tolerance stackup.
  - Select appropriate tolerances for all dimensions based upon design objectives and requirements.
  - Use tolerancing in an engineering drawing. *PS C9.3*
  - Apply dimension, annotation, and tolerance to drawings using Geometric Dimensioning and Tolerancing by ANSI Y14.5 standards.
### III. PRINCIPALS OF ENGINEERING (Continued)

#### I. Aesthetics in Engineering Design
1. Design for visual appeal
2. Positive and negative space
3. Symmetry and asymmetry
4. Color
5. Balance

#### J. Project Management
1. Component and materials sourcing
2. Time scheduling
3. Personnel resource
4. Communication
5. Documentation
6. Group collaboration
7. Leadership

- **Apply high-quality techniques to product or presentation design and development. AS 7.5**
  - Incorporate artistic elements into engineering designs to enhance visual appeal.
  - Apply the use of balance, color, symmetry, and positive and negative space to create visually pleasing product designs.
  - Speculate on how advances in technology might change the definition of the visual arts.

- **Apply the concepts of engineering technology to the tools, equipment, projects, and procedures of the Engineering Technology Pathway. PS B10.3**
  - Manage electronic files, documentation, and references pertaining to a collaborative engineering design project.
  - Outline the steps needed to take a project from concept to completion.
  - Gather and utilize available resources to ensure successful completion of a project.
  - Develop and follow an engineering project timeline with deadlines and milestone goals.
  - Track the progress of a project as it pertains to the established timeline.
  - Prepare formal written communication and project documentation.
  - Present project results visually and verbally.

- Identify the characteristics of successful teams, including
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| III. PRINCIPALS OF ENGINEERING (Continued)  | leadership, cooperation, collaboration, and effective decision-making skills, as applied in groups, teams, and career technical student organization activities. AS 9.2  
|                                             | o Coordinate design reviews among sub-group members, and coordinate inter-group meetings.  
|                                             | o Display leadership while coordinating group efforts.                                                                                                                                                         |       |
| K. Alternative Energy Systems               | • Interpret and explain terminology and practices specific to the Engineering and Architecture sector. AS 10.1  
|                                             | o Investigate various alternative energy systems in use around the world.  
|                                             | o Compare and contrast advantages and disadvantages of various energy systems in terms of factors such as initial cost, operating cost, and environmental impact.  
|                                             | o Research and report on an alternative energy power plant.                                                                                                                                                     |       |
| L. Engineering Ethics                       | • Demonstrate ethical and legal practices consistent with Engineering and Architecture sector workplace standards. AS 8.3  
|                                             | • Explain the importance of personal integrity, confidentiality, and ethical behavior in the workplace. AS 8.4  
|                                             | o Understand the dangers of unethical actions when human safety is at risk.  
|                                             | o Consider philosophical perspectives in the ethical decision making process.  
|                                             | o Perform a case study of an incident when engineering ethics were not applied, and analyze what ethical faults occurred.                                                                                      |       |
| M. Capstone Project                         | • Design and construct a culminating project effectively using engineering technology. PS B10.0  
<p>|                                             | o Complete a capstone project utilizing skills and knowledge gained from various areas of the course.                                                                                                          |       |</p>
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| 4. Documentation      | o The project topic or focus shall be student-directed and allow a student to explore his or her own areas of interest to a greater degree.  
| 5. Presentation       | o Conduct research utilizing a variety of print and electronic sources.  
|                       | o Create a physical product by employing a variety of hands-on methods.  
|                       | • Use methods and techniques for employing all engineering technology equipment appropriately. *PS B10.1*  
|                       | • Apply conventional engineering technology processes and procedures accurately, appropriately, and safely. *PS B10.2*  
|                       | • Apply the concepts of engineering technology to the tools, equipment, projects, and procedures of the Engineering Technology Pathway. *PS B10.3*  
|                       | o Document the project through written work and photographic or video documentation.  
|                       | • Give an effective oral presentation of a portfolio/project. *PS 11.2*  
|                       | • Communicate information and ideas effectively to multiple audiences using a variety of media and formats. *AS 2.6*  
|                       | o Conduct a professional presentation utilizing multimedia aids before an audience of peers and/or industry professionals. |

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Engineering and Architecture

Architectural Design Pathway

Environmental Engineering Pathway

Engineering Technology Pathway

Engineering Design Pathway
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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.
Engineering and Architecture
Pathway Standards

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

## ENGINEERING AND ARCHITECTURE

<table>
<thead>
<tr>
<th>ENGLISH LANGUAGE ARTS</th>
<th>PATHWAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A.</td>
</tr>
<tr>
<td></td>
<td>Architectural Design</td>
</tr>
<tr>
<td>Language Standards – LS (Standard Area, Grade Level, Standard #)</td>
<td></td>
</tr>
<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>
</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>
</tr>
<tr>
<td>Reading Standards for Informational Text – RSIT (Standard Area, Grade Level, Standard #)</td>
<td></td>
</tr>
<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>
</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>
</tr>
<tr>
<td>Reading Standards for Literacy in History/Social Studies – RHSS (Standard Area, Grade Level, Standard #)</td>
<td></td>
</tr>
<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>
</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>
</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>
</tr>
<tr>
<td>Reading Standards for Literacy in Science and Technical Subjects – RLST (Standard Area, Grade Level, Standard #)</td>
<td></td>
</tr>
<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>
</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>
</tr>
</thead>
<tbody>
<tr>
<td><strong>11-12.4.</strong> 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>
</tr>
<tr>
<td><strong>11-12.7.</strong> 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>
</tr>
<tr>
<td><strong>11-12.10.</strong> By the end of grade 12, read and comprehend science/technical texts in the grades 11-12 text complexity band independently and proficiently.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Writing Standards – WS (Standard Area, Grade Level, Standard #)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>11-12.1.</strong> Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.</td>
</tr>
<tr>
<td><strong>11-12.2.</strong> 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.</td>
</tr>
<tr>
<td><strong>11-12.4.</strong> Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</td>
</tr>
<tr>
<td><strong>11-12.5.</strong> 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>
</tr>
<tr>
<td><strong>11-12.6.</strong> 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.</td>
</tr>
<tr>
<td><strong>11-12.7.</strong> 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.</td>
</tr>
</tbody>
</table>
### Academic Alignment Matrix

#### ENGINEERING AND ARCHITECTURE

<table>
<thead>
<tr>
<th>Writing Standards – WS (Standard Area, Grade Level, Standard #) (continued)</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>11-12.8. 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.</td>
<td>A9.0</td>
<td>C11.0</td>
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</tr>
</tbody>
</table>

#### Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects – WHSST

| 11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. | 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. | B1.0 | | |
| 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 | B1.0, B11.0 | 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. | B1.0 | | |
| 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 specific 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. | B1.0 | | |

#### 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.

   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)

   - A2.0, A6.0
   - B6.0, B10.0
   - D2.0
### Academic Alignment Matrix

#### ENGINEERING AND ARCHITECTURE

<table>
<thead>
<tr>
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</thead>
<tbody>
<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>
<td>B6.0, B10.0</td>
<td></td>
<td>D2.0</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>
<td>B6.0, B10.0</td>
<td></td>
<td>D2.0</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>
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</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 | | |

**Solve equations and inequalities in one variable**

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 | | |

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 | | |

4. 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

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<tbody>
<tr>
<td><strong>Solve systems of equations</strong></td>
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<tr>
<td>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.</td>
<td>A8.0</td>
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<tr>
<td>6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</td>
<td>A8.0</td>
<td>B3.0, B10.0</td>
<td></td>
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<tr>
<td>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 ).</td>
<td>A8.0</td>
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</tbody>
</table>

#### Functions – F-IF – Interpreting Functions

<table>
<thead>
<tr>
<th><strong>Understand the concept of a function and use function notation</strong></th>
<th>A3.0</th>
<th>B2.0, B10.0</th>
<th>C3.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>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) ).</td>
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</table>

#### Analyze functions using different representations

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

**ENGINEERING AND ARCHITECTURE**

<table>
<thead>
<tr>
<th>PATHWAYS</th>
<th>A. Architectural Design</th>
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<th>D. Environmental Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.</strong></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>
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<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)^{t/10} ), and classify them as representing exponential growth or decay.</td>
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<tr>
<td><strong>Functions – F-LE – Linear, Quadratic, and Exponential Models</strong></td>
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</tr>
<tr>
<td>1. Distinguish between situations that can be modeled with linear functions and with exponential functions.</td>
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<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>
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<tr>
<td>b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.</td>
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<tr>
<td>c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.</td>
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<tr>
<td><strong>Functions – F-TF – Trigonometric Functions</strong></td>
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<tr>
<td><strong>Extend the domain of trigonometric functions using the unit circle</strong></td>
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<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>
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<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

<table>
<thead>
<tr>
<th>Functions – F-TF – Trigonometric Functions (continued)</th>
<th>PATHWAYS</th>
</tr>
</thead>
</table>
| 3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, 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) | A6.0 | B3.0, B4.0, B10.0 | D7.0 |

#### Model periodic phenomena with trigonometric functions

5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. | B3.0, B4.0, B10.0 | D2.0, D6.0 |

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) | D6.0 |

#### 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. | A3.0, A5.0, A7.0, A8.0 | B2.0, B10.0 | C3.0, C5.0 |

13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle. | C5.0 |

#### 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. | B6.0, B7.0, B10.0 | C8.0 | D2.0 |
### Geometry – G-MG – Modeling with Geometry

*Apply geometric concepts in modeling situations*

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).

<table>
<thead>
<tr>
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<tbody>
<tr>
<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>
</tbody>
</table>

### Geometry – G-SRT – Similarity, Right Triangles, and Trigonometry

*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.

<table>
<thead>
<tr>
<th>A3.0, A5.0, A7.0, A8.0</th>
<th>B2.0, B10.0</th>
<th>C3.0</th>
</tr>
</thead>
</table>

### Number and Quantity – N-Q – Quantities

*Reason quantitatively and use units to solve problems*

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>A2.0, A6.0, A8.0</th>
<th>B3.0, B4.0, B10.0</th>
<th>D7.0</th>
</tr>
</thead>
</table>

### Number and Quantity – N-VM – Vector and Matrix Quantities

*Represent and model with vector quantities*

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., \( \vec{v} \), \( |\vec{v}| \), \( ||\vec{v}|| \), \( \vec{v} \)).

2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.

<table>
<thead>
<tr>
<th>A6.0</th>
<th>B5.0, B10.0</th>
<th>C8.0</th>
<th>D4.0, D5.0</th>
</tr>
</thead>
</table>

### Academic Alignment Matrix

#### ENGINEERING AND ARCHITECTURE

| Number and Quantity – N-VM – Vector and Matrix Quantities (continued) | PATHWAYS |
|---|---|---|---|---|
| A. Architectural Design | B. Engineering Technology | C. Engineering Design | D. Environmental Engineering |
| Perform operations on vectors | | |  |
| 4. (+) Add and subtract vectors. | | |  |
| 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. | A6.0 | B5.0, B10.0 | C8.0 | D4.0, D5.0 |
| b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. | | | | |
| c. Understand vector subtraction \( \mathbf{v} - \mathbf{w} \) as \( \mathbf{v} + (-\mathbf{w}) \), where \(-\mathbf{w}\) is the additive inverse of \( \mathbf{w} \), with the same magnitude as \( \mathbf{w} \) 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 \( c(\mathbf{v}_x, \mathbf{v}_y) = (cv_x, cv_y) \). | | | | |
| b. Compute the magnitude of a scalar multiple \( cv \) using \( llcvll = lclvl \). Compute the direction of \( cv \) knowing that when \( lclvl \neq 0 \), the direction of \( cv \) is either along \( \mathbf{v} \) (for \( c > 0 \)) or against \( \mathbf{v} \) (for \( c < 0 \)). | | | | |
| Perform operations on matrices and use matrices in applications | | |  |
| 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, B5.0, B9.0, B10.0, D4.0, D5.0</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, B5.0, B9.0, B10.0, D4.0, D5.0</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. |
### Statistics and Probability – APPS – Advanced Placement Probability and Statistics

<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>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.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>2.0 Students know the definition of conditional probability and use it to solve for probabilities in finite sample spaces.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>8.0 Students determine the mean and the standard deviation of a normally distributed random variable.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>11.0 Students compute the variance and the standard deviation of a distribution of data.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>12.0 Students find the line of best fit to a given distribution of data by using least squares regression.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
<tr>
<td>13.0 Students know what the correlation coefficient of two variables means and are familiar with the coefficient's properties.</td>
<td>B5.0</td>
<td></td>
<td>D5.0</td>
<td></td>
</tr>
</tbody>
</table>
### Statistics and Probability – APPS – Advanced Placement Probability and Statistics (continued)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Architectural Design</th>
<th>Engineering Technology</th>
<th>Engineering Design</th>
<th>Environmental Engineering</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>
<td>B5.0</td>
<td></td>
<td></td>
<td>D5.0</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>
<td>B5.0</td>
<td></td>
<td></td>
<td>D5.0</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>
<td>B5.0</td>
<td></td>
<td></td>
<td>D5.0</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>
<td>B5.0</td>
<td></td>
<td></td>
<td>D5.0</td>
</tr>
<tr>
<td>18.0 Students determine the P-value for a statistic for a simple random sample from a normal distribution.</td>
<td>B5.0</td>
<td></td>
<td></td>
<td>D5.0</td>
</tr>
<tr>
<td>19.0 Students are familiar with the chi-square distribution and chi-square test and understand their uses.</td>
<td>B5.0</td>
<td></td>
<td></td>
<td>D5.0</td>
</tr>
</tbody>
</table>

### Scientific and Engineering Practices – SEP

<table>
<thead>
<tr>
<th>Practice</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. Asking questions (for science) and defining problems (for engineering)</td>
<td>A5.0, A8.0</td>
<td>B1.0, B3.0, B6.0, B8.0, B9.0, B10.0</td>
<td>B5.0, B7.0</td>
<td>D5.0, D7.0</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>A4.0, A5.0, A6.0, A8.0</td>
<td>B1.0, B2.0, B3.0, B6.0, B8.0, B10.0</td>
<td>B5.0</td>
<td>D3.0, D4.0, D5.0, D7.0</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td>A2.0, A4.0, A5.0, A6.0, A7.0, A8.0</td>
<td>B1.0, B2.0, B3.0, B6.0, B7.0, B8.0, B10.0</td>
<td>C3.0, C4.0, C7.0, C8.0, C9.0</td>
<td>D2.0, D3.0, D5.0, D7.0</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td>A2.0, A4.0, A5.0, A6.0, A7.0, A8.0</td>
<td>B1.0, B3.0, B4.0, B5.0, B6.0, B7.0, B8.0, B10.0</td>
<td>C3.0, C4.0, C5.0, C6.0, C7.0, C8.0, C9.0</td>
<td>D4.0, D5.0, D6.0, D7.0</td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
<td>A2.0, A4.0, A5.0, A6.0, A7.0, A8.0</td>
<td>B1.0, B3.0, B4.0, B5.0, B6.0, B7.0, B8.0, B10.0</td>
<td>C3.0, C4.0, C5.0, C6.0, C7.0, C8.0, C9.0</td>
<td>D4.0, D5.0, D6.0, D7.0</td>
</tr>
</tbody>
</table>
### Academic Alignment Matrix

#### Scientific and Engineering Practices – SEP (continued)

<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>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>
</tr>
</tbody>
</table>

**Crosscutting Concept – CC**

| 1. Patterns | A2.0, A3.0, A7.0 | B3.0, B4.0, B5.0, B6.0, B8.0, B10.0 | D1.0, D2.0, D3.0, D4.0, D5.0 |
| 2. Cause and effect: Mechanism and explanation | A1.0, A5.0, A7.0 | B3.0, B4.0, B5.0, B6.0, B8.0, B10.0 | D2.0, D3.0, D4.0, D5.0, D6.0 |
| 3. Scale, proportion, and quantity | A1.0, A2.0, A3.0, A4.0, A5.0, A7.0, A8.0 | B1.0, B3.0, B4.0, B5.0, B6.0, B7.0, B8.0, B10.0 | C2.0, C4.0, C5.0, C6.0, C7.0, C8.0, C9.0, C10.0 | D1.0, D2.0, D3.0, D4.0, D5.0, D6.0 |
| 4. Systems and system models | A5.0 | B3.0, B4.0, B5.0, B6.0, B8.0, B9.0, B10.0 | C7.0 | D2.0, D3.0, D4.0, D5.0, D6.0 |
| 5. Energy and matter: Flows, cycles, and conservation | A5.0 | B3.0, B4.0, B5.0, B10.0 | D2.0, D3.0, D4.0, D5.0, D6.0 |
| 6. Structure and function | A1.0, A2.0, A3.0, A5.0, A7.0, A8.0 | B6.0, B7.0, B8.0, B10.0 | C2.0 | D2.0, D5.0 |
| 7. Stability and change | A5.0, A7.0 | B3.0, B10.0 | C2.0 | D2.0, D3.0, D5.0, D6.0 |

**Physical Sciences – PS**

<table>
<thead>
<tr>
<th>PS1: Matter and Its Interactions</th>
</tr>
</thead>
<tbody>
<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>
</tbody>
</table>
## Academic Alignment Matrix

<table>
<thead>
<tr>
<th>ENGINEERING AND ARCHITECTURE</th>
<th>PATHWAYS</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>A. Architectural Design</td>
</tr>
<tr>
<td><strong>Physical Sciences – PS (continued)</strong></td>
<td></td>
</tr>
<tr>
<td>PS2: Motion and Stability: Forces and Interactions</td>
<td></td>
</tr>
<tr>
<td>PS2.A: Forces and Motion</td>
<td>A6.0, A7.0</td>
</tr>
<tr>
<td>PS2.B: Types of interactions</td>
<td>A6.0, A7.0</td>
</tr>
<tr>
<td>PS2.C: Stability and Instability in Physical Systems</td>
<td>A1.0, A6.0, A7.0</td>
</tr>
<tr>
<td>PS3: Energy</td>
<td></td>
</tr>
<tr>
<td>PS3.A: Definitions of Energy</td>
<td>A5.0</td>
</tr>
<tr>
<td>PS3.B: Conservation of Energy and Energy Transfer</td>
<td>A5.0</td>
</tr>
<tr>
<td>PS3.C: Relationship Between Energy and Forces</td>
<td></td>
</tr>
<tr>
<td>PS3.D: Energy in Chemical Processes and Everyday Life</td>
<td>A5.0</td>
</tr>
<tr>
<td>PS4: Waves and Their Applications in Technologies for Information Transfer</td>
<td></td>
</tr>
<tr>
<td>PS4.A: Wave Properties</td>
<td></td>
</tr>
<tr>
<td>PS4.B: Electromagnetic Radiation</td>
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</tr>
<tr>
<td>PS4.C: Information Technologies and Instrumentation</td>
<td></td>
</tr>
<tr>
<td><strong>Earth and Space Sciences – ESS</strong></td>
<td></td>
</tr>
<tr>
<td>ESS2: Earth’s Systems</td>
<td></td>
</tr>
<tr>
<td>ESS2.A: Earth Materials and Systems</td>
<td></td>
</tr>
<tr>
<td>ESS2.B: Plate Tectonics and Large-Scale System Interactions</td>
<td></td>
</tr>
<tr>
<td>ESS2.C: The Roles of Water in Earth’s Surface Processes</td>
<td></td>
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<tr>
<td>ESS2.D: Weather and Climate</td>
<td></td>
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<tr>
<td>ESS2.E: Biogeology</td>
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</table>
## 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>
</table>

### Earth and Space Sciences – ESS (continued)

<table>
<thead>
<tr>
<th>ESS3: Earth and Human Activity</th>
<th>A5.0</th>
<th>B3.0</th>
<th>D3.0, D7.0, D9.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS3.A: Natural Resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESS3.B: Natural Hazards</td>
<td></td>
<td>B3.0</td>
<td>D2.0, D7.0</td>
</tr>
<tr>
<td>ESS3.C: Human Impacts on Earth Systems</td>
<td>A5.0</td>
<td>B3.0</td>
<td>D2.0, D3.0, D7.0, D9.0, D10.0, D12.0</td>
</tr>
<tr>
<td>ESS3.D: Global Climate Change</td>
<td>A5.0</td>
<td>B3.0</td>
<td>D3.0, D7.0, D10.0, D11.0, D12.0</td>
</tr>
</tbody>
</table>

### Engineering, Technology, and the Applications of Science – ETS

<table>
<thead>
<tr>
<th>ETS1: Engineering Design</th>
<th>A5.0, A6.0, A8.0</th>
<th>B3.0, B6.0, B8.0, B10.0</th>
<th>D5.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETS1.A: Defining and Delimiting an Engineering Problem</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETS1.B: Developing Possible Solutions</td>
<td>A5.0, A6.0, A8.0</td>
<td>B3.0, B6.0, B8.0, B10.0</td>
<td>D5.0</td>
</tr>
<tr>
<td>ETS1.C: Optimizing the Design Solution</td>
<td>A5.0, A6.0, A8.0</td>
<td>B3.0, B6.0, B8.0, B10.0</td>
<td>D5.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ETS2: Links Among Engineering, Technology, Science, and Society</th>
<th>A5.0, A6.0, A7.0</th>
<th>B3.0, B4.0, B5.0, B10.0</th>
<th>C2.0, C3.0, C4.0, C5.0, C7.0, C8.0, C9.0, C10.0, C11.0</th>
<th>D2.0, D4.0, D6.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETS2.A: Interdependence of Science, Engineering, and Technology</td>
<td></td>
<td></td>
<td></td>
<td></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>
<td>B9.0, B10.0</td>
<td>C11.0</td>
<td></td>
</tr>
</tbody>
</table>

### History/Social Science

<table>
<thead>
<tr>
<th>Principles of American Democracy and Economics – AD</th>
<th>B9.0</th>
<th>C1.0</th>
<th>D2.0</th>
</tr>
</thead>
</table>

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.
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<tbody>
<tr>
<td>12.7 Students analyze and compare the powers and procedures of the national, state, tribal, and local governments.</td>
<td>A1.0, A2.0, A5.0</td>
<td>B9.0</td>
<td>C1.0</td>
<td>D2.0</td>
</tr>
<tr>
<td>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.</td>
<td>A2.0</td>
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<td>D10.0, D11.0, D13.0</td>
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<thead>
<tr>
<th>Principles of Economics – PE</th>
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<tbody>
<tr>
<td>12.1 Students understand common economic terms and concepts and economic reasoning.</td>
<td>A1.0, A2.0, A5.0</td>
<td>B9.0</td>
<td>C1.0</td>
<td>D2.0, D3.0</td>
</tr>
<tr>
<td>12.1.4. Evaluate the role of private property as an incentive in conserving and improving scarce resources, including renewable and nonrenewable natural resources.</td>
<td></td>
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<td>D10.0, D11.0, D13.0</td>
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</tr>
<tr>
<td>12.2 Students analyze the elements of America’s market economy in a global setting.</td>
<td>A2.0, A5.0</td>
<td>B9.0</td>
<td>C1.0</td>
<td>D3.0</td>
</tr>
<tr>
<td>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.</td>
<td>A1.0</td>
<td>B9.0</td>
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<tr>
<th>U.S. History and Geography – US</th>
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<tbody>
<tr>
<td>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.</td>
<td>A1.0</td>
<td></td>
<td>C1.0</td>
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<tr>
<td>11.5 Students analyze the major political, social, economic, technological, and cultural developments of the 1920s.</td>
<td>A1.0</td>
<td></td>
<td>C1.0</td>
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<tr>
<td>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.</td>
<td>A1.0</td>
<td></td>
<td>C1.0</td>
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<tr>
<td>11.6 Students analyze the different explanations for the Great Depression and how the New Deal fundamentally changed the role of the federal government.</td>
<td>A1.0, A5.0</td>
<td></td>
<td>C1.0</td>
<td></td>
</tr>
<tr>
<td>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).</td>
<td></td>
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<td>C1.0</td>
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</tbody>
</table>
## A. Architectural Design

### U.S. History and Geography – US

<table>
<thead>
<tr>
<th>Standard</th>
<th>Pathways</th>
</tr>
</thead>
<tbody>
<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       B9.0     C1.0</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       B9.0     C1.0       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></td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Standard</th>
<th>Pathways</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       B9.0     C1.0</td>
</tr>
<tr>
<td>10.9 Students analyze the international developments in the post-World World War II world.</td>
<td>A1.0       B9.0     C1.0</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>A5.0       B9.0     C1.0</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      B9.0     C1.0</td>
</tr>
</tbody>
</table>

### Chronological and Spatial Reasoning – CSR

<table>
<thead>
<tr>
<th>Standard</th>
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</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       C1.0</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>
</tr>
<tr>
<td>4. Students relate current events to the physical and human characteristics of places and regions.</td>
<td>C1.0</td>
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</table>
### Historical Research, Evidence, and Point of View – HR

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.

<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>HR</td>
<td>A1.0</td>
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</table>

### Historical Interpretation – HI

1. Students show the connections, causal and otherwise, between particular historical events and larger social, economic, and political trends and developments.

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<tbody>
<tr>
<td>HI</td>
<td>A1.0</td>
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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.

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<tr>
<td>HI</td>
<td>A1.0</td>
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</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

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Zach Ronnenberg, Instructor, Davis Joint Unified School District
Frank Zuidema, Instructor, Oceanside Unified School District
Engineering 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. Understand that engineering is solving problems by applying principles of mathematics, science, and technology.
7. Understand the major fields of engineering and with the diverse work functions that engineers perform.
8. Understand that engineers have a moral obligation to the public.
9. Familiar with the paths and certifications that can lead to careers in engineering and engineering technology.
10. Explore the relatedness between mechanical, civil, computer, electronic, industrial, chemical, aerospace, and materials engineering.
11. Select several major fields of engineering and give a brief description of each.
12. Describe how the technological fields of mechanics, electronics, controls, and computers, intersect.
13. List several functions an engineer might perform in a particular industry.
14. Describe the level of education typically required to be an engineer or engineering technician.
15. Investigate science and technology careers, as well as university programs in engineering.
16. Identify good work habits and industry-standard safety practices.
17. Identify job-site hazards.
18. Identify and wear personal protective equipment.
19. Demonstrate safe use of equipment and tools and proper organization of work space.
20. Demonstrate knowledge of electrical hazards and safety precautions.
21. Identify exits and explain evacuation procedures.
22. Know how to use a fire extinguisher.
23. Demonstrate proper lifting techniques.
24. Describe appropriate OSHA rules and regulations.
25. Analyze accidents and determine methods of prevention.
26. Understand the design process and how to solve analysis and design problems.
27. Identify the principles that are relevant to a problem. (Research previous and existing similar designs using internet resources.
28. Outline the steps in the design process.
29. Determine what known information is relevant to a problem and analyze options for the solution of the engineering problem.
30. Choose between alternate solutions and develop the details to justify the choice.
31. Translate word problems into mathematical statements when appropriate.
32. Develop the details of one solution.
33. Select and finalize the solutions and complete a working drawing (i.e. freehand or CAD drawing).
34. Use appropriate materials, tools, and processes to fabricate a model (form) of the solution.

Effective 2014-2015
35. Test model as appropriate.
36. Develop a working model and/or prototype.
37. Collaborate with community and corporate mentors.
38. Disassemble an existing design to understand construction details.
39. Prepare a thorough technical documentation of a conceptual design.
40. Develop supporting text, data, and diagrams for a design presentation.
41. Prepare a three-view drawing of the design showing the subsystem layout.
42. Participate in the delivery of the final design presentation to fellow students and invited guests.
43. Complete a design project incorporating each step of the design process.
44. Revise a design based on test results.
45. Understand the units by which common engineering and scientific quantities are measured.
46. Understand the relationships between various units and the derivation of higher order units from lower order units.
47. Perform conversion between units of different magnitude for a given measured quantity.
49. Select appropriate units based on the magnitude of the quantity being measured or referenced.
50. Estimate a measurement in relative terms based on a known reference.
51. Identify types of measurements and data-gathering techniques commonly used in engineering projects.
52. Understand how computers play a role in engineering data acquisition.
53. Understand the use of electronic test equipment and units of measure.
54. Select and apply appropriate equipment or tools.
55. Understand that measurements may have inherent inaccuracies that must be accounted for.
56. Analyze data and apply concepts of minimum, maximum, and average.
57. Analyze data trends and over time.
58. Quantify and explain sources of measurement error.
59. Explain the difference between accuracy and precision.
60. Measure with precision measurement tools and instruments.
61. Understand industrial processes, including the use of tools, methods of measurement, quality assurance, and the systems used to manufacture products in today's society.
62. Explain how various sources of error can cumulatively create error stackup of larger magnitude.
63. Understand how Newton's three laws of motion are applied to motion and static equilibrium problems.
64. Describe the six simple machines and give practical examples of each.
65. Understand that weight is a force caused by the acceleration of gravity, and that mass is not the same as weight.
66. Solve constant acceleration problems using Newton's second law.
67. Solve static equilibrium problems involving levers.
68. Understand that work is the product of force and distance.
69. Understand that torque is the effect of force applied at a distance from a center of rotation.
70. Understand the effects of friction, and demonstrate knowledge of coefficients of friction of various materials.
71. Solve problems involving constant linear and angular speed.
72. Solve problems using appropriate units in engineering systems.
73. Apply Ohm’s Law.
74. Use appropriate electrical units to solve problems.
75. Give examples of common AC and DC systems.
76. Understand the mathematical processes and applications that lead to solutions of electronic problems.
77. Solve Direct-Current (DC) circuit analysis problems using Ohm’s Law.
78. Calculate fundamental Alternating Current (AC) parameters.
79. Manipulate scientific notation in problem solutions.
80. Derive algebraic equations to determine unknown values in circuits.
81. Utilize a scientific calculator as a tool for problem solving.
82. Solve multi-step problems including word problems using linear equations in one variable.
83. Understand that three-dimensional solids can be derived from the extrusion or revolution of two-dimensional shapes.
84. Calculate the area of two dimensional geometric shapes.
85. Calculate the volume of three-dimensional geometric shapes.
86. Understand the relationship between area and volume.
87. Identify cross sections.
88. Identify historically significant structures.
89. Identify a material by its physical properties such as appearance, feel, and density.
90. Compare and contrast the physical properties of various materials.
91. Understand common uses of various engineering materials.
92. Know the relative strength of various materials.
93. Understand the difference between isotropic and anisotropic materials, and provide examples of each.
94. Understand material classifications, characteristics, and testing in order to select appropriate materials for engineering products.
95. Identify differences between prototype manufacturing and production manufacturing.
96. Compare and contrast various manufacturing methods.
97. Understand how manufacturing cost is related to tolerance and production volume.
98. Select an appropriate manufacturing method based on design parameters and cost.
99. Identify multiple manufacturing methods suitable to make a given part of a design.
100. Use tools and equipment to construct a prototype or finished part.
101. Understand the role of automated machinery and Computer Aided Manufacturing in high-precision and high-volume production.
102. Investigate how manufactured parts are inspected and determined to be pass or fail.
103. Compare and contrast various types of material fasteners.
104. Understand screw thread classifications in both the Metric and Unified National systems.
105. Identify various styles of threaded fasteners and tools used to install or remove them.
106. Design and construct a structural joint with appropriate fastening based on design parameters.
107. Understand the relationships between voltage, current, resistance, and power as pertaining to direct-current circuits.
108. Understand the difference between alternating and direct current circuits, and give examples of applications of each.

Effective 2014-2015
109. Understand the difference between digital and analog circuits and give examples of each.
110. Calculate solutions to Ohm’s Law problems.
111. Solve problems involving Kirchhoff’s laws.
112. Calculate power lost as heat in a resistor as a function of current and voltage drop.
113. Measure and record current, voltage and resistance in various segments of parallel and series circuits.
114. Calculate equivalent resistance for series and parallel resistor circuits.
115. Understand the procedures and processes related to electronic assembly.
116. Conduct laboratory experiments, which include detailed problem, theory, results, and discussion sections, including the use of lab equipment for measurement.
117. Determine resistors’ values by identifying color codes.
118. Interpret the function of an electrical device by reading the schematic, identifying component symbols, and analyzing connections.
119. Identify various types of electrical switches and understand associated industry standard specifications and ratings.
120. Construct an electronic device following a schematic diagram as a sole reference.
121. Use tools for their intended applications perform electronic assembly work such as: soldering, stripping/crimping wire, routing wires, making wiring harnesses, and rendering electrical/electronic layouts.
122. Select an appropriate wire gauge size for a given electrical current and connection distance.
123. Draw an electrical schematic by hand.
124. Draw a schematic and design a printed circuit board using computer software.
125. Understand that current flow in a wire creates a magnetic field according to the “right hand rule”.
126. Compare and contrast various types of AC and DC electric motors.
127. Compare generators and alternators to motors, and describe the function of each.
128. Select a motor to power an electromechanical device based on design parameters and operating characteristics.
129. Understand the relationship between speed, torque, voltage, and current and the linear operating nature for a permanent-magnet brushed DC motor.
130. Read and interpret motor specification sheets and performance curves.
131. Understand the role of servo and stepper motors in industrial automation.
132. Understand various means of storing energy.
133. Compare and contrast various types of primary and re-chargeable batteries, and give usage examples for each.
134. Research the application of various batteries as they pertain to consumer electronics, transportation, and industrial systems.
135. Understand how energy is stored in capacitors and give practical applications.
136. Calculate the force exerted by a spring as the product of its spring constant and the displacement.
137. Solve problems involving springs by using Hooke’s Law.
138. Understand the necessity for mechanical power transmission mechanisms in mechanical devices.
139. Identify various types of gearing such as spur, planetary, helical, bevel, and worm.
140. Understand common gear specifications such as pitch, pressure angle, face width, and bore.
141. Calculate gear ratios based on input and output parameters.
142. Understand that multiple stages of gearing can be combined to compound the gear ratio.  
143. Understand than in a gear-train, speed and torque are inversely proportional.  
144. Identify applications for belt and pulley and sprocket and chain drives.  
145. Understand that rotating shafts must be supported by bearings, and identify commercially-available bearings suitable for a certain load and speed.  
146. Investigate various methods of attaching gears, sprockets, pulleys, and wheels to shafts.  
147. Estimate the necessary specifications for a gear based on loading and mathematical calculation.  
148. Design a gear train for given design parameters.  
149. Identify what causes resistance in a fluid system.  
150. Give examples of hydraulic and pneumatic systems.  
151. Understand the role of various components in closed fluid systems.  
152. Identify the operating pressures of standard hydraulic and pneumatic systems.  
153. Explain safety precautions for pressurized systems.  
154. Identify design objectives and requirements.  
155. Select an energy source and prime-movers based on design objectives and requirements.  
156. Identify the various subsystems needed to construct an operational machine.  
157. Design a human interface for a mechanical system.  
158. Design a structure as a framework on which to support the machine’s subsystems.  
159. Select individual components and materials best suited to the design.  
160. Select appropriate methods to manufacture various machine components.  
161. Describe various material surface treatments and coatings and their applications.  
162. Understand the chemical process of corrosion and oxidation and its effects on metals.  
163. Understand the effects of lift and how it relates to Bernoulli’s principle and equation.  
164. Understand how thrust is generated in aircraft.  
165. Identify major components of an aircraft structure.  
166. Construct, test, adjust, and revise a model airplane.  
167. Research how aviation has transformed over history.  
168. Investigate significant technological achievements in human spaceflight.  
169. Understand and demonstrate communication skills necessary in the field of engineering and will employ an individual and team approach while solving engineering problems.  
170. Determine what known information is relevant.  
171. Make an oral presentation utilizing multimedia visual aids such as PowerPoint.  
172. Express data in tables, graphs, charts, and other visual formats.  
173. Prepare technical documentation including the use of advanced publishing software or graphic programs.  
174. Contribute to the successful completion of a team project.  
175. Understand the impact that technological advances and society have on society, environment, and culture.  
176. Describe why technological advances may have both desirable and undesirable impacts on society.  
177. Interpret the impacts of technological advances on the environment.  
178. Discuss the impacts of technological advances and cultural norms/customs on each other.  
179. Analyze how technological advances affect local, nationals and global economies.  
180. Explain the interface between technological advances and human ethics.  
181. Discuss how humans are faced with moral and ethical issues because technology is enabling very significant modifications of the natural world.  
182. Discuss societies’ ability/inability to control the technologies they have created.
183. Project and forecast the development of future technological needs and uses.
184. Complete a capstone project utilizing skills and knowledge gained from various areas of the course.
185. Conduct research utilizing a variety of print and electronic sources.
186. Create a physical product by employing a variety of hands-on methods.
187. Document the project through written work and photographic or video documentation.
188. Conduct a professional presentation utilizing multimedia aids before an audience of peers and/or industry professionals.
189. Use Newton’s three laws of motion to solve practical problems involving motion and static equilibrium.
190. Solve constant acceleration problems using Newton’s second law.
191. Solve static equilibrium problems involving levers.
192. Calculate work as the product of force and distance.
193. Calculate torque as the product of applied force and distance from a center of rotation.
194. Explain and demonstrate the effects of friction, and test coefficients of friction for various materials.
195. Solve problems involving constant linear and angular speed.
196. Solve problems using appropriate units in engineering systems.
197. Apply fundamental physics concepts to the design of mechanisms, machinery, or systems.
198. Apply Ohm’s Law and Kirchoff’s Laws to solve direct-current circuit analysis problems.
199. Use appropriate electrical units to solve problems.
200. Understand the mathematical processes and applications that lead to solutions of electronic problems.
201. Calculate fundamental Alternating Current (AC) parameters.
203. Derive algebraic equations to determine unknown values in circuits.
204. Utilize a scientific calculator as a tool for problem solving.
205. Solve multi-step problems including word problems using linear equations in one variable.
206. Utilize the design process to perform analysis and design related to applied problems.
207. Research previous and existing similar designs using internet resources.
208. Determine what known information is relevant to a problem and analyze options for the solution of the engineering problem.
209. Choose between alternate solutions and develop the details to justify the choice.
210. Translate word problems into mathematical statements when appropriate.
211. Develop the details of one solution.
212. Select and finalize the solutions and complete a working drawing (i.e. freehand or CAD drawing).
213. Use appropriate materials, tools, and processes to fabricate a model (form) of the solution.
214. Test model as appropriate.
215. Develop a working model and/or prototype.
216. Collaborate with community and corporate mentors.
217. Prepare a thorough technical documentation of a detailed design.
218. Develop supporting text, data, and diagrams for a design presentation.
219. Prepare a three-view drawing of the design showing the subsystem layout.
220. Participate in the delivery of the final design presentation to fellow students and invited guests.
221. Complete a design project incorporating each step of the design process.
222. Revise a design based on test results.
223. Understand the relationships between voltage, current, resistance, and power as pertaining to direct-current circuits.
224. Understand the difference between digital and analog circuits and give examples of each.
225. Calculate power lost as heat in a resistor as a function of current and voltage drop.
226. Understand the procedures and processes related to electronic assembly.
227. Construct electronic circuits on breadboards.
228. Construct advanced electronic circuits utilizing integrated circuits.
229. Understand how to find and interpret manufacturer’s datasheets for integrated circuits.
230. Conduct laboratory experiments, which include detailed problem, theory, results, and discussion sections, including the use of lab equipment for measurement.
231. Determine resistors’ values by identifying color codes.
232. Interpret the function of an electrical device by reading the schematic, identifying component symbols, and analyzing connections.
233. Identify various types of electrical switches and understand associated industry standard specifications and ratings.
234. Construct an electronic device following a schematic diagram as a sole reference.
235. Use tools for their intended applications perform electronic assembly work such as: soldering, stripping/crimping wire, routing wires, making wiring harnesses, and rendering electrical/electronic layouts.
236. Select an appropriate wire gauge size for a given electrical current and connection distance.
237. Draw an electrical schematic by hand.
238. Draw a schematic and design a printed circuit board using computer software.
239. Determine design objectives and requirements.
240. Select an energy source and prime-movers based on design objectives and requirements.
241. Determine the various subsystems needed to construct an operational machine.
242. Design a human interface for a mechanical system.
243. Design a structure as a framework on which to support the machine’s subsystems.
244. Apply physics principals to find optimal design parameters.
245. Integrate electronics and controls into a design.
246. Select individual components and materials best suited to the design.
247. Select appropriate methods to manufacture various machine components based on cost-effectiveness and/or available resources.
248. Prepare a Bill of Materials and cost estimate for a design.
249. Prepare detailed drawings, specifications, and documentation for producing a design.
250. Understand the nature and operation of control systems.
251. Write, store, edit, and analyze programs for control of electromechanical devices.
252. Interface sensors and other hardware components to microcontrollers.
253. Write conceptual pseudo-code to explain the function of a computer program code.
254. Construct a process flow-chart of an industrial control program.
255. Understand the syntax conventions of a computer programming language.
256. Understand program control structures such as if-else and switch-case statements.
257. Convert numbers from base ten to binary and be able to perform simple arithmetic based on the binary, octal, and hexadecimal number systems.
258. Predict the output of systems which have AND, NOT, OR NOR, NAND, and XOR operations.
259. Construct truth tables and use them to solve logic problems.
260. Understand data types and how they relate to numbers and the memory space needed to store them.
261. Describe the use of computers in the following areas: interfacing to systems, data acquisition, and microcomputers in control systems.
262. Demonstrate knowledge of the single-chip microcomputer, including its programming model, instruction set, internal architecture, and how it interfaces with outside hardware.
263. Construct a control system by interfacing inputs and outputs with a microcontroller and writing embedded code.
264. Estimate and analyze program execution time.
265. Create multi-tasking programs on a single-threaded microcontroller by using timers.
266. Observe and analyze output waveforms on an oscilloscope.
267. Observe program function using a digital logic analyzer.
268. Reduce spurious signal noise through hardware and software methods.
269. Create a control program using advanced sensors such as accelerometers and gyroscopes.
270. Tune the function of a Proportional-Integral-Derivative controller by adjusting gain constants.
271. Utilize the Cartesian coordinate system in drawing and solving vectors.
272. Construct free-body diagrams of systems of forces and moments.
273. Reduce vectors to orthogonal component vectors using trigonometric functions.
274. Understand the difference between internal and external forces.
275. Understand that for a system to be in static equilibrium, the sum of all the forces must equal zero, and the sum of all the moments must equal zero.
276. Solve two and three dimensional systems of forces in static equilibrium by performing vector addition and applying trigonometric and algebraic principles.
277. Calculate forces, moments, and torques on structures.
278. Understand the effect of bending in simply supported and cantilevered beams.
279. Construct shear and bending moment diagrams for cantilevered and simply supported beams under point loads and distributed loads.
280. Understand the relationship between stress and strain in linear elastic materials.
281. Investigate the properties of materials as they relate to strength, durability, and deformation.
282. Solve problems involving tensile, shear, and compressive stresses.
283. Explain the effect of Poisson’s ratio on material deformation.
284. Explain the difference between elastic and plastic deformation.
285. Solve problems involving simply supported and cantilevered beams with point loads and distributed loads.
286. Calculate bending stresses.
287. Define factor of safety as it applies to strength of materials.
288. Understand the phenomenon of column buckling.
289. Select appropriate materials based on stresses and factor of safety.
290. Describe geometric features that can lead to stress concentrations.
291. Understand the importance computer-aided technologies essential to the language of the engineering and design industry.
293. Determine the “front” view of a part.
294. Construct drawings at 1:1 scale, enlarged scale, and reduced scale.
295. Understand industry-standard formats for drawing layouts, lines, and annotations.
296. Prepare a complete and detailed drawing title block.
297. Understand the degree of accuracy necessary for engineering design.
298. Prepare complete drawings with sufficient information to send a part for manufacturing.
299. Determine proper placement for dimensions.
300. Understand how choice of dimension placement on a drawing can affect a part’s accuracy with respect to individual geometric features.
301. Develop ability to select dimensions and placement for geometric features.
302. Reference the location of geometric features to datums.
303. Prepare two-dimensional drawings using CAD software and the Cartesian coordinate system.
304. Demonstrate the use of geometric sketch constraints.
305. Understand how two-dimensional shapes can be transformed into three-dimensional solids.
306. Prepare three-dimensional parametric models using CAD software.
307. Create assemblies of individual part models with proper constraints applied.
308. Create exploded views of assembly models.
309. Understand how tolerance is related to manufacturing processes and cost.
310. Explain the concept of tolerance stack-up.
311. Select appropriate tolerances for all dimensions based upon design objectives and requirements.
312. Annotate drawings to indicate features not described by dimensions alone.
313. Dimension, annotate, and tolerance drawings using Geometric Dimensioning and Tolerancing by ANSI Y14.5 standards.
314. Prepare drawings including detail and section views to show advanced or hidden geometry.
315. Incorporate artistic elements into engineering designs to enhance visual appeal.
316. Apply the use of balance, color, symmetry, and positive and negative space to create visually pleasing product designs.
317. Speculate on how advances in technology might change the definition of the visual arts.
318. Manage electronic files, documentation, and references pertaining to a collaborative engineering design project.
319. Outline the steps needed to take a project from concept to completion.
320. Gather and utilize available resources to ensure successful completion of a project.
321. Develop and follow an engineering project timeline with deadlines and milestone goals.
322. Track the progress of a project as it pertains to the established timeline.
323. Coordinate design reviews among sub-group members, and coordinate inter-group meetings.
324. Display leadership while coordinating group efforts.
325. Prepare formal written communication and project documentation.
326. Present project results visually and verbally.
327. Investigate various alternative energy systems in use around the world.
328. Compare and contrast advantages and disadvantages of various energy systems in terms of factors such as initial cost, operating cost, and environmental impact.
329. Research and report on an alternative energy power plant.
330. Understand the importance of ethics and morals in the engineering profession.
331. Understand the dangers of unethical actions when human safety is at risk.
332. Consider philosophical perspectives in the ethical decision making process.
333. Perform a case study of an incident when engineering ethics were not applied, and analyze what ethical faults occurred.
334. Complete a capstone project utilizing skills and knowledge gained from various areas of the course.
335. The project topic or focus shall be student-directed and allow a student to explore his or her own areas of interest to a greater degree.
336. Conduct research utilizing a variety of print and electronic sources.
337. Create a physical product by employing a variety of hands-on methods.
338. Document the project through written work and photographic or video documentation.
339. Conduct a professional presentation utilizing multimedia aids before an audience of peers and/or industry professionals.