# High School Course of Study

**Course Title:** Introduction to Design Engineering and Architecture  
**Course Code:** [KT368-KT369]  

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DATE: March 7, 2018

INDUSTRY SECTOR: Engineering and Architecture

PATHWAY Engineering Design 152

CBEDS TITLE: Introduction to Design 7700

CBEDS Code: 7700

HOURS:  

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COURSE DESCRIPTION: Introduction to design is a high school level foundation course in the PTLW Engineering Program. ID students are introduced to the engineering profession and a common approach to the solution of engineering problems and engineering design process.

PREREQUISITES:

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A – G APPROVAL: ☑ Yes □ No □ Desired

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Introduction to Design Engineering and Architecture

LEVEL:  Introductory  Concentrator  Capstone

CERTIFICATION:

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METHOD OF STUDENT EVALUATION:

- Pre and Post test
- Student Projects
- Written work
- Observation record of student performance
- Completion of assignments and worksheets

METHOD OF INSTRUCTION:

- Lecture
- Group and individual applied projects
- Demonstration
- Field Trips
- Guest Speaker

RECOMMENDED TEXTS:

PLTW curriculum

MODEL CTE PATHWAY:

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CALIFORNIA CAREER TECHNICAL EDUCATION MODEL CURRICULUM STANDARDS

Advanced Manufacturing and Engineering
KNOWLEDGE AND PERFORMANCE ANCHOR STANDARDS

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.
# I. Design Process

The goal is to introduce students to the broad field of engineering and design process that engineers use to develop innovative solutions to real problems. Students become familiar with the traditional big four siciplines of engineering and the extensive array of career opportunities and engineering problems addressed within each discipline.

A. **Essential Question** What is Engineering and why is it important to the world in which we live?

B. Topics
   1. What is engineering?
   2. Engineering Fields
   3. The Design Process
   4. The Engineer's Notebook

## II. Technical Sketching and Drawing

The goal is for students to develop an understanding of the purpose and practice of visual representations and communication within engineering in the form of technical sketching and drawing.

A. Essential Question
   1. What does it mean to visually represent something with a sketch?

B. Topics
   1. Types of Lines
   2. Isometric Sketching
   3. Oblique Sketching
   4. Perspective Sketching
   5. Glass-view Sketching

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### 6. Multi-View Sketching

C. Learn it  
1. Sketching on Isometric Grid  
2. Scale and proportion PLTW  
3. Angles and perspective  
4. Orthographic Projections  
5. 3-D sketching

D. Use it  
1. Draw construction lines  
2. Tonal Shading  
3. Identify product and discuss genre form and function

### III. Measurement and Statistics

The goal of the unit is for students to become familiar with appropriate practices and the applications of measurements using both US Customary and SI units. Students will learn appropriate methods of making and recording measurements, including the use of dial calipers.

A. Essential Question  
1. What is an industry standard and why is it important for something like dimensioning?

B. Topics  
1. The metric system  
2. Dial Calipers  
3. Dimensioning Standards

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### IV. Modelling Skills

This unit introduces students to a variety of modeling methods used to represent systems, components and processes in design.

A. Essential Question  
1. How does modeling and building prototypes support Engineers?

B. Introduce it  
1. 3D Models and Drawings- isometric views, projections  
2. Inventor OR Solid Works Basics

C. Learn it  
1. 2d sketches, Extrude, Revolve, Cut  
2. Name Project  
3. Solid Works/Inventor instructional videos

C. Use it  
3D Models and Drawings- isometric views, projections, Inventor OR Solid Works Basics

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## V. Geometry of Design

In this unit students are provided opportunities to investigate two and three dimensional geometric concepts and apply statics to engineering decision making and problems solving.

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### A. Essential Question
1. What are the “properties of solids” and why is it important to know how to calculate them

### B. Topics
1. Properties of solids
2. Surface Area
3. Volume
4. Mass
5. Density

### C. Introduce it
1. Calculations of Area, Volume, Density
2. Units of measurement
3. Unit conversion

### D. 2-D Sketch Tools

### E. Use it
1. Soap dish project
2. Basic color theory
3. Bottle project
4. Label project
5.

## VI. Reverse Engineering

Unit 6 exposes students to the application of engineering principles and practices to reverse engineer a consumer product. Reverse engineering involves disassembling and analyzing a product or system in order to understand and document the visual, functional and/or structural aspects of its design.

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### A. Essential Question
1. What is the purpose of reverse engineering and how does it continue to impact society today?

### B. Topics
1. Visual/Functional Analysis
2. Disassembly of items
3. Software modeling
4. Documentation

### C. Introduce it
1. Elements of Visual design
2. Reverse Engineering Presentation

### D. Learn it
1. Functional Analysis
2. Visual Analysis

### STANDARDS
- Academic: G-CO 12, 13
- SEP 5,6,8
- CC 3
- NGSS
- ETS2.A
- HS ETS1
- HS ETS 1-4
- AS.SL.4
- G.MG.1
- G.MG.2
- G.MG.3
- CTE Anchor: 5.0
- 11.0
- CTE Pathway: C5.4

- Academic: RHSS 11-12.2, 12.7
- RLST 11-12.7
- G-GMD 5
- G-MD 3
- N-VM 2, 3, 4, 5
- NGSS
- SEP 4, 5, 6, 8
- CC 3
- HS ETS2.A

- CTE Anchor: 2.0
- 5.0
- CTE Pathway: C1.1
- C 8.0
## E. Use it
1. Pencil Project
2. Wind up toy reverse engineering
3. Structural Analysis

### VII. Documentation

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<td>In this unit students will enhance their basic knowledge of technical drawing representation learned earlier in the course to include the creation of alternate (section and auxiliary) view and appropriate dimensioning and annotation of technical drawings.</td>
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### A. Essential Question
1. What would happen if engineers failed to document their work?

### B. Topics
1. Tolerances
2. Documentation

### C. Introduce it
1. Dimensioning Standards
2. Tolerances

### D. Learn it
1. The Hole Project
2. Activities on Dimensioning Standards, Sectional Views and Tolerances

### E. Use it
1. Pencil Animation
2. Assembly models and drawings

## VIII. ADVANCED COMPUTER MODELING

In this unit students will learn advanced 3D computer modeling skills. These advanced skills include creating animated assembly views of multi-part products and using mathematical functions to represent relationships to enforce dimensional and motion constraints. Students will use the skills and knowledge previously bidd in the course to develop and document the solution to a design challenge using iterative design process.

### A. Essential Question
How does software help ensure the best possible outcomes with regards to Engineering Design?

### B. Topics
1. Advanced software techniques – SolidWorks/Autodesk Inventor
2. Using research to advance ideas and skills
3. Presentation skills

### Academic:
- LS 11-12.1, 12.2
- RLST 11-12.2, 12.4, 12.7
- WS11-12.2, 12.4, 12.5, 12.6, 12.7, 12.8
- WHSSST 11-12.2, 12.6
- G-MG 3

### NGSSE:
- SEP 4, 5, 6, 7, 8 CC 3
- HS ETS2.A 2.B

### CTE Anchor:
- 2.0
- 5.0

### CTE Pathway:
- C9
- C10
- C11

### Academic:
- LS 11-12.1, 12.2
- RLST 11-12.2, 12.4, 12.7
- WS11-12.2, 12.4, 12.5, 12.6, 12.8
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### NGSSE:
- SEP 4, 5, 6, 7, 8 CC 3
- HS ETS2.A 2.B

### CTE Anchor:
- 4.0
- 5.0

### CTE Pathway:
- C9.0
<table>
<thead>
<tr>
<th>IX. Design Challenges</th>
<th>CR</th>
<th>LAB/CC</th>
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</thead>
<tbody>
<tr>
<td>C. Introduce it</td>
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<tr>
<td>1. Parametric Modeling</td>
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<tr>
<td>2. Advanced modelling tools</td>
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<tr>
<td>D. Learn it</td>
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<tr>
<td>1. Train: Standard Parts</td>
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<td>2. Activities using Solid Works</td>
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<td>E. Use it</td>
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<td>1. Activities using SolidWorks</td>
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<td>IX. Design Challenges</td>
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<tr>
<td>A. Essential Question</td>
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<tr>
<td>How can we use the topics covered in this class to answer more challenging and global problems?</td>
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<td>B. Topics</td>
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<tr>
<td>1. Advanced Design Process</td>
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<td>2. Advanced software techniques – SolidWorks/Autodesk Inventor</td>
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<td>C. Introduce it/Learn it</td>
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<tr>
<td>1. Project Design Challenge</td>
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<tr>
<td>Expectations/Requirements</td>
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<td>D. Use it</td>
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<td>1. Project design challenge</td>
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<thead>
<tr>
<th>X. EMPLOYMENT PORTFOLIO</th>
<th>CR</th>
<th>LAB/CC</th>
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<tbody>
<tr>
<td>A. Students will prepare a professional portfolio.</td>
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<td>7</td>
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<tr>
<td>1. Portfolio showcases best professional level work</td>
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<td>2. Portfolio is organized</td>
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<td>3. Job application</td>
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<td>4. Resume</td>
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<td>5. References</td>
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NGSS
SEP 4, 5, 6, 7, 8
CC 3
HS ETS2.A 2.B

CTE Anchor:
2.0
5.0
7.0
8.0
9.0
11.0

CTE Pathway:
C9.2, C9.3
C11.2

Academic:
LS 11-12.1, 12.2
RLST 11-12.2, 12.4
WS 12.2, 4, 5, 6, 7

NGSS
SEP 6
ETS2.A

CTE Anchor:
2.0
3.0
7.0
11.0

CTE Pathway:
C10.0
C11.0