Engineering Technology, Advanced

I. Course Overview
A. UC/CSU “a-g” Subject Area: Seeking G
B. Grade Level: 10 - 12
C. Credits: 10
D. Pre-Requisites: Engineering Technology 1-2
E. Course Description: Engineering Technology, Advanced is an advanced course that develops a mastery of the design and construction skills taught in Engineering Tech 1-2, with a focus on ways to reduce waste and energy use in the construction/production process. Students will be challenged to design and redesign products in a way that makes them more efficient or use sustainable or recycled/recyclable materials. Students will also learn to communicate effectively using the terminology and symbolism that is common in the product design, manufacturing and construction industries. The course may be repeated for additional credit.

II. Course Purpose: Goals and Student Outcomes

Upon successful completion of the course:

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<tr>
<th>Student Outcomes</th>
<th>California State CTE Standards</th>
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| A. Students will demonstrate their knowledge of the laws of physics that affect the designs of mechanical, electrical, fluid, and thermal systems, and the design and building of objects and structures | **Foundation Standards:** SEP 1, 5, 6 PS 1, 2, 10.0, 11.0  
**Pathway Standards:** B4.0, B5.0, B6.0 |
| B. Students will demonstrate an understanding of the components, symbols, abbreviations, formats, and media used in technical drawings and schematics | **Foundation Standards:** 2.3, 10.0  
**Pathway Standards:** B1.1 |
| C. Students will be able to draw flat layouts and 2 and 3 dimensional sketches of objects and structures using CAD and other imaging software | **Foundation Standards:** 10.0, 11.0  
**Pathway Standards:** B 1.3, 2.1, 2.2 |
| D. Students will understand the evolution of electric systems and power sources and the issues and emerging technologies related to the use of electricity, including the transmission as AC or DC power, environmental and safety issues created by electricity generation, and limits and constraints on electric power production. | **Foundation Standards:** PS 3, 6.0, 10.0, 11.0  
**Pathway Standards:** B 3.0 |
| E. Students will understand the relationship between voltage, current, resistance and | **Foundational Standards:** PS 3, 6.0, 10.0, 11.0 |
power, in both AC and DC circuits and be able to interpret schematic drawings of those circuits | **Pathway Standards:**  
B3.1, 3.1, 3.3, 3.6

| F. Students will measure, analyze, repair and design electrical and electronic circuits using appropriate instruments and tools | **Foundational Standards:**  
PS 3, 6.0, 10.0, 11.0  
**Pathway Standards:**  
B 3.7

| G. Students will know how the principles of force, work, rate, power, energy and resistance are used to perform work and to achieve efficiency | **Foundation Standards:**  
PS 2, 6.0, 10.0, 11.0  
**Pathway Standards:**  
B5.0, 5.3, 5.4, 5.5

| H. Students will understand the design process, will know how to research and choose between alternate solutions to solve a problem, and will be able to justify the choices made in determining a solution | **Foundation Standards:**  
2.0, 9.0, 10.0, 11.0  
**Pathway Standards:**  
B 6.0, 6.2, 6.3

| I. Students will understand the factors that influence the choice of materials used in the manufacturing and construction industries, including consumer preferences, cost/benefit analysis, and legal constraints | **Foundation Standards:**  
1.0 (ETS 2, PE12.1) 7.0, 8.0, 10.0  
**Pathway Standards:**  
B 6.0, 6.2, 6.3, B 9.0

| J. Students will understand the laws of patent and copyright as they apply to the design and manufacturer of products | **Foundation Standards:**  
1.0 (PE12.6) 8.0,  
**Pathway Standards:**  
B 9.0

| K. Students will use the design process to create and construct a culminating project that effectively address a significant social issue | **Foundation Standards:**  
2.0, 9.0, 10.0, 11.0  
**Pathway Standards**  
B 6.0, 6.4, 10.1, 10.2, 10.3

| L. Students will use appropriate tools, equipment, methods of measurement and quality assurance techniques to monitor the construction of their culminating project | **Foundation Standards:**  
6.0, 10.0, 11.0  
**Pathway Standards**  
B 7.0

| M. Students will develop a portfolio of their personal work and reflections and write a resume that highlights their career skills and abilities | **Foundation Standards:**  
1.0 (WS 11-12), 2.5, 3.0  
**Pathway Standards**  
B 11.0

### III. Course Outline

#### A. Review of industrial safety guidelines

1. Safety in the classroom
2. Safety in product design
3. Safety in the manufacturing process
   a. Hazardous materials
   b. Dangerous equipment
   c. Electricity
4. Safety in the construction process

B. The Steps in the Design Process-Design as a collaborative activity

1. STEP 1: Identify the Problem
2. STEP 2: Identify Criteria and Constraints including cost limitations
   How to do a cost/benefit analysis
3. STEP 3: Brainstorm Possible Solutions
4. STEP 4: Generate Ideas
5. STEP 5: Explore
   a. Research to understand physical and financial limits to design concepts
   b. Issues of aesthetics and social concern
6. STEP 6: Select an Approach
7. STEP 7: Build a Model or Prototype
8. STEP 8: Evaluate and Refine the Design.

C. Reverse-Engineering/Value Engineering a consumer product

1. How value engineering and reverse engineering are used in modern industry
   a. Patent law
   b. Copyright and trademark law
2. Creating schematics that identify circuits and parts in the consumer product
   a. Dimensions and measuring; metric v. imperial units
   b. Freehand drawings of a product
   c. Creating 2 and 3D drawings in AutoCAD
   d. Drawing electrical circuits using industry-standard symbols and techniques/protocols
3. Evaluating the ergonomics, mechanical and energy efficiency of the product
   a. Research paper on the ergonomics issues related to the product
   b. Analyzing the efficiency of the mechanical and electrical systems built into the product and recommending improvements
4. Calculating the material costs of the product
   a. Primary materials
   b. Finishes
   c. Sourcing production supplies
5. Quality Assurance and Control
   a. Calibrating tools
   b. Tolerances and errors
   c. Industry specifications and standards

D. Automation

1. Mechanical sensors
2. Electronic sensors
3. Flow charts that identify how sensors will be used to perform a task
4. Prototyping circuits for automated devices
5. Prototyping devices operated by sensors

E. Building a Better Mousetrap

1. Recognizing and evaluating a perceived problem that could be solved by a better designed product
   a. Evaluating the market for your product
   b. Identifying the cost constraint around your product
2. Using the design process to create and construct a culminating project that effective uses available technology
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3. Using the appropriate tools and relevant engineering concepts to produce the prototype  
4. Determining the production cost per unit of your finished product  

F. Career Exploration  
1. Career Opportunities  
2. Educational requirements  
3. Licensing and industry standards  
4. Updating your resume  
5. Completing a job application  
6. Building a portfolio of work samples  

IV. Key Assignments  
A. Multimedia presentation on some aspect of shop safety/first aid  
   (Foundation Standards: WS 11-12, 2.4, 2.5, 4.0, 6.0; Pathway Standards: B 10.0)  
B. Packaging for a product that meets the criteria for good design, is aesthetically interesting, protects the product during transit, and uses environmentally safe materials.  
   (Foundation Standards: 1.0 (G-GMD), 10.0, 11.0, Pathway Standards: B9.0, B10.0, B11.0)  
C. A complete set of mechanical drawings and appropriate diagrams to reverse engineer a consumer product .  
   (Foundation Standards: 1.0 (G-GMD), 10.0, 11.0, Pathway Standards: B1.0, B2.0, B11.0)  
   - Geometric construction  
   - Multi-view drawing  
   - Dimensioning  
   - Sectional views  
   - Auxiliary views  
   - Working drawings  
D. Ergonomics research paper .  
   (Foundation Standards: 1.0(WHHST 11-12, PE 12.6), 2.0, 10.0, 11.0, Pathway Standards: B6.0, B9.0, B10.0)  
   Students will research the ergonomics issues related to the use of the consumer product they have reversed engineered, using sources from technical journals to learn about and to explain the way the designers addressed ergonomic concerns and ways that the product could be improved to reduce strain on the user  
E. Market Research Paper  
   (Foundation Standards: 1.0(WHHST 11-12, PE 12.6), 2.0, 8.0, 10.0, 11.0, Pathway Standards: B6.0, B9.0)  
   Students will research the specific social problem their product was designed to solve and will identify the potential global market that exists for that item. They will identify, through government and business data, the extent to which the problem is found around the world, and then set the price point that would make that item available to most of its potential customers and use that financial constraint as one of the parameters of their design  
F. Resume and job application  
   (Foundation Standards: 2.0, 3.0, Pathway Standards: B6.0, B9.0, B10.0, B 11.0)  
G. Portfolio presentation  
   (Foundation Standards: 2.0, 3.0, 4.0, 7.0, 8.0 Pathway Standards: B6.0, B9.0, B10.0, B 11.0)  
   Students will add selected works from this class to their portfolio and give a multimedia presentation of their work
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V. Instructional Methods and/or Strategies
A. Conventional classroom lecture and teaching techniques.
B. Instruction videos
C. Computer monitoring and instruction software
D. Classroom textbooks with reading and review sheet assignments
E. Demonstrations
F. Guest speakers
G. Design projects
H. Use of the school library
I. Job shadowing
J. Field trips

VI. Assessment Methods and/or Tools
A. Tests and quizzes
B. Research projects
C. Oral presentations
D. Sketches and drawings
E. Written reports

VII. Textbook(s) and Supplemental Instructional Materials
A. Student Textbooks:
   Architecture Drafting and Design: Donald Heppler, Paul Wallach; McGraw Hill
   Basic Technical Drawing: Spencer Dygdon; Glencoe
   AutoCAD Tutorial, AutoDesk Company.
B. Supplemental Instructional Materials:
   Home Planners Gold