CHINO VALLEY UNIFIED SCHOOL DISTRICT
INSTRUCTIONAL GUIDELINES
INTRODUCTION TO ENGINEERING DESIGN

Course Number	5935
Department	Project Lead the Way
Prerequisite	None
Length of Course	Two (2) Semesters/One (1) Year
Grade Level	9-12
Credit	5 units per semester/10 total credits - elective
Repeatable	Not repeatable for credit
UC/CSU	Does not meet a-g requirement
Board Approved	December 10, 2009

Description of Course – This course will exposure students to design and engineering. The major focus of the IED course is to introduce students to design process, research and analysis, teamwork, communication methods, global and human impacts, engineering standards, and technical documentation. IED gives students the opportunity to develop skills and understanding of course concepts through activity-, project-, and problem-based learning. Students will employ engineering and scientific concepts in the solution of engineering design problems. In addition, students use a 3D solid modeling design software package to help them design solutions to solve proposed problems. Engineering is for students interested in biomechanics, aeronautics, and other applied math and science arenas. This course is aligned to the Project Lead the Way program.

Rationale for Course – From the buildings in which we live and work, to the cars we drive, everything we use was designed to create some sort of marriage between form and function. We are constantly endeavoring to make a product interesting and attractive. The design process behind any successful product demands that all members work as a team, be active participants in problem solving, conduct research, analyze data, understand real-world impacts, think outside the box, and speak to a public audience. These skills are important to becoming a contributing member of society.

Standard 1 (Introduction to Design) – Students understand the different facets of design, proper sketching techniques, measurement and tools used in design.

1.1 Objective: Learn the tools that engineers use to solve problems.

1.1.1 Performance Indicator: Students will apply engineering notebook standards and protocols when documenting their work during the school year.

1.1.2 Performance Indicator: Students will identify and apply group brainstorming techniques and the rules associated with brainstorming.

1.1.3 Performance Indicator: Students will research a product's history, develop a PowerPoint presentation, list chronologically the major innovations to a product, and present findings to a group.

1.1.4 Performance Indicator: Students will use online and published works to research aspects of design problems.

1.1.5 Performance Indicator: Students will identify the design process steps used in given scenarios and be able to list the steps, and identify any steps missing.

1.2 Objective: Know how to draw different types of sketches.

1.2.1 Performance Indicator: Students will identify, sketch, and explain the function of points, construction lines, object lines, and hidden lines.

1.2.2 Performance Indicator: Students will plot points on grid paper to aid in the creation of sketches and drawings.

1.2.3 Performance Indicator: Students will explain the concepts of technical sketching and drawing.

1.2.4 Performance Indicator: Students will sketch an isometric view of simple geometric solids

1.2.5 Performance Indicator: Students will explain how an oblique view of simple geometric solids differs from an isometric view.

1.2.6 Performance Indicator: Students will sketch one-point, two-point, and three-point perspectives of simple geometric solids.

1.2.7 Performance Indicator: Students will describe the concept of proportion as it relates to freehand sketching.

1.2.8 Performance Indicator: Students will sketch multi-view drawings of simple geometric solids.

1.3 Objective: Learn about measurement and statistics.

1.3.1 Performance Indicator: Students will research and design a CD cover or book jacket on the origins of the measurement systems.

1.3.2 Performance Indicator: Students will measure and record linear distances using a scale to a precision of 1/16 inch and 1 mm.

1.3.3 Performance Indicator: Students will Measure and record linear distances using a dial caliper to a precision of 0.001 inch.

1.3.4 Performance Indicator: Students will add and subtract U.S. standard and metric linear measurements.

1.3.5 Performance Indicator: Students will convert linear distance measurements from inches to millimeters and vice versa.

1.3.6 Performance Indicator: Students will apply linear dimensions to a multi-view drawing.

1.3.7 Performance Indicator: Students will calculate the mean, mode, median, and range of a data set.

1.3.8 Performance Indicator: Students will create a histogram of recorded measurements showing data elements or class intervals, and frequency.

1.4 Objective: Learn how to create a product from conception to reality.

1.4.1 Performance Indicator: Students will brainstorm and sketch possible solutions to an existing design problem.

1.4.2 Performance Indicator: Students will select an approach that meets or satisfies the constraints given in a design brief.

1.4.3 Performance Indicator: Students will create simple extruded solid Computer Aided Design (CAD) models from dimensioned sketches.

1.4.4 Performance Indicator: Students will generate dimensioned multi-view drawings from simple CAD models.

1.4.5 Performance Indicator: Students will measure and fabricate parts for a functional prototype from the CAD multi-view drawings.

1.4.6 Performance Indicator: Students will assemble the product using the CAD modeling software.

1.4.7 Performance Indicator: Students will test and evaluate the prototype and record results.

1.4.8 Performance Indicator: Students will apply geometric and numeric constraints to CAD sketches.

1.4.9 Performance Indicator: Students will identify the purpose of packaging in the design of consumer products.

Standard 2 (Design Solutions) – Students understand the in depth study of geometric shapes and solids, dimensioning, 3D modeling software, and advanced design.

2.1 Objective: Calculate area, surface area, volume, and weight of geometric shapes.

2.1.1 Performance Indicator: Students will identify common geometric shapes and forms by name.

2.1.2 Performance Indicator: Students will calculate the area of simple geometric shapes.

2.1.3 Performance Indicator: Students will calculate the surface area and volume of simple geometric forms.

2.1.4 Performance Indicator: Students will identify and explain the various geometric relationships that exist between the elements of two-dimensional shapes and three-dimensional forms.

2.1.5 Performance Indicator: Students will identify and define the axes, planes, and sign conventions associated with the Cartesian coordinate system.

2.1.6 Performance Indicator: Students will apply geometric and numeric constraints to CAD sketches.

2.1.7 Performance Indicator: Students will utilize sketch-based, work reference, and placed features to develop solid CAD models from dimensioned drawings.

2.1.8 Performance Indicator: Students will explain how a given object's geometry is the result of sequential additive and subtractive processes.

2.2 Objective: Understand design language.

2.2.1 Performance Indicator: Students will explain the differences between size and location dimensions

2.2.2 Performance Indicator: Students will differentiate between datum dimensioning and chain dimensioning.

2.2.3 Performance Indicator: Students will identify and dimension fillets, rounds, diameters, chamfers, holes, slots, and screw threads in orthographic projection drawings.

2.2.4 Performance Indicator: Students will explain the rules that are associated with the application of dimensions to multi-view drawings.

2.2.5 Performance Indicator: Students will identify, sketch, and explain the difference between general tolerances, limit dimensions, unilateral, and bilateral tolerances.

2.2.6 Performance Indicator: Students will differentiate between clearance and interference fits.

2.3 Objective: Learn about the 3D functions used to develop CAD solid models.

2.3.1 Performance Indicator: Students will sketch and model an auxiliary view of a given object to communicate the true size and shape of its inclined surface.

2.3.2 Performance Indicator: Students will describe the purpose and demonstrate the application of section lines and cutting plane lines in a section view drawing.

2.3.3 Performance Indicator: Students will sketch a full and half section view of a given object to communicate its interior features.

2.3.4 Performance Indicator: Students will identify algebraic relationships between the dimensional values of a given object.

2.3.5 Performance Indicator: Students will apply assembly constraints to individual CAD models to create mechanical systems.

2.3.6 Performance Indicator: Students will perform part manipulation during the creation of an assembly model.

2.3.7 Performance Indicator: Students will explain how assembly constraints are used to systematically remove the degrees of freedom for a set of components in a given assembly.

2.3.8 Performance Indicator: Students will create an exploded model of a given assembly.

2.3.9 Performance Indicator: Students will determine ratios and apply algebraic formulas to animate multiple parts within an assembly model.

2.3.10 Performance Indicator: Students will create and describe the purpose of the following items: exploded isometric assembly view, balloons, and parts list.

2.4 Objective: Teams apply the design process to solve a problem.

2.4.1 Performance Indicator: Students will brainstorm and sketch possible solutions to an existing design problem.

2.4.2 Performance Indicator: Students will create a decision making matrix.

2.4.3 Performance Indicator: Students will select an approach that meets or satisfies the constraints given in a design brief.

2.4.4 Performance Indicator: Students will create solid computer-aided design (CAD) models of each part from dimensioned sketches using a variety of methods.

2.4.5 Performance Indicator: Students will apply geometric numeric and parametric constraints to form CAD modeled parts.

2.4.6 Performance Indicator: Students will generate dimensioned multi-view drawings from simple CAD modeled parts.

2.4.7 Performance Indicator: Students will assemble the product using the CAD modeling software.

2.4.8 Performance Indicator: Students will explain what constraints are and why they are included in a design brief.

2.4.9 Performance Indicator: Students will create a three-fold brochure marketing the designed solution for the chosen problem, such as a consumer product, a dispensing system, a new form of control system, or extend a product design to meet a new requirement.

2.4.10 Performance Indicator: Students will explain the concept of fluid power, and the difference between hydraulic and pneumatic power systems.

Standard 3 (Reverse Engineering) – Students analyze product function, structure, and visual elements.

3.1 Objective: Learn the principles and elements of design and be able to communicate their understanding in a variety of medium.

3.1.1 Performance Indicator: Students will identify visual design elements within a given object.

3.1.2 Performance Indicator: Students will explain how visual design principles were used to manipulate design elements within a given object.

3.1.3 Performance Indicator: Students will explain what aesthetics is, and how it contributes to a design's commercial success.

3.1.4 Performance Indicator: Students will identify the purpose of packaging in the design of consumer products.

3.1.5 Performance Indicator: Students will identify visual design principles and elements that are present within marketing ads.

3.1.6 Performance Indicator: Students will identify the intent of a given marketing ad and demographics of the target consumer group for which it was intended.

3.2 Objective: Learn the reverse engineering process.

3.2.1 Performance Indicator: Students will identify the reasons why engineers perform reverse engineering on products.

3.2.2 Performance Indicator: Students will describe the function of a given manufactured object as a sequence of operations through visual analysis and inspection (prior to dissection).

3.3 Objective: Build several solid models of a product and determine the mass properties of a product.

3.3.1 Performance Indicator: Students will describe the differences between joinery, fasteners, and adhesives.

3.3.2 Performance Indicator: Students will identify the types of structural connections that exist in a given object.

3.3.3 Performance Indicator: Students will use dial calipers to precisely measure outside and inside diameter, whole depth, and object thickness.

3.3.4 Performance Indicator: Students will identify a given object's material type.

3.3.5 Performance Indicator: Students will identify material processing methods that are used to manufacture the components of a given commercial product.

3.3.6 Performance Indicator: Students will assign a density value to a material, and apply it to a given solid CAD model.

3.3.7 Performance Indicator: Students will perform computer analysis to determine mass, volume, and surface area of a given object.

3.4 Objective: Identify visual, structural, or functional issues with their reverse engineered products, initiate product improvements, and communicate their designs through technical reports.

3.4.1 Performance Indicator: Students will write design briefs that focus on product innovation.

3.4.2 Performance Indicator: Students will identify group brainstorming techniques and the rules associated with brainstorming.

3.4.3 Performance Indicator: Students will use decision matrices to make design decisions.

3.4.4 Performance Indicator: Students will explain the difference between invention and innovation.

Standard 4 (Design Problems) – Students combine knowledge and information learned in the previous units to an open ended design problem.

4.1 Objective: Investigate different materials, manufacturing processes, and the short and long term impacts that their decision-making may have on society.

4.1.1 Performance Indicator: Students will create a brainstorming list of different products made from common materials that are used daily.

4.1.2 Performance Indicator: Students will research and construct a product impact timeline presentation of a product from the brainstorming list and present how the product may be recycled and used to make other products after its lifecycle is complete.

4.1.3 Performance Indicator: Students will identify the five steps of a product's lifecycle and investigate and propose recyclable uses for the material once the lifecycle of the product is complete.

4.2 Objective: Virtual design teams with students from other Project Lead the Way schools will solve the selected design problem. Develop and deliver individual presentations that chronicle design's development.

4.2.1 Performance Indicator: Students will explain why teams of people are used to solve problems.

4.2.2 Performance Indicator: Students will identify group norms that allow a virtual design team to function efficiently.

4.2.3 Performance Indicator: Students will establish file management and file revision protocols to ensure the integrity of current information.

4.2.4 Performance Indicator: Students will use internet resources, such as email, to communicate with a virtual design team member throughout a design challenge.

4.2.5 Performance Indicator: Students will identify strategies for addressing and solving conflicts that occur between team members.

4.2.6 Performance Indicator: Students will create a Gantt chart to manage the various phases of their design challenge.