# Engineering
## Introduction to Engineering Design

<table>
<thead>
<tr>
<th>ORGANIZING THEME/TOPIC</th>
<th>FOCUS STANDARDS &amp; SKILLS</th>
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<tbody>
<tr>
<td><strong>Unit 1: Design Process</strong></td>
<td>Implement the design process used by professional engineers to create innovative solutions.</td>
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</table>
| • Design Process  
• Brainstorming  
• Prototype testing and Scientific method  
• Principles and Elements of Design  
• Portfolio Development | • KS 21006.02.01 Explain the steps of the design process.  
• KS 21006.02.02 Assess the value of working as a team and benefits of collaboration.  
• KS 21006.02.03 Investigate the principles and elements of design and demonstrate their use in the design process.  
• KS 21006.02.04 Identify career opportunities in design engineering and their job functions.  
• KS 21006.02.05 Express understanding of the principles and elements of design utilized in products, print media, and art forms.  
• KS 21006.03.04 Develop a portfolio to organize and display evidence of their work.  
• KS 21006.06.01 Apply the creative thinking process |
| **Time Frame:** 3 weeks | |
| **Unit 2: Sketching and Visualization** | Create various technical representations used in visualization, communicating and documenting design ideas. |
| • Techniques  
• Pictorial  
• Annotated Sketches | • KS 21006.04.01 Integrate proper sketching techniques and styles in the creation of sketches.  
• KS 21006.04.02 Demonstrate the ability to produce two-dimensional geometric figures.  
• KS 21006.04.04 Formulate pictorial sketches to develop ideas, solve problems, and understand relationships during the design process.  
• KS 21006.04.06 Select a sketching method that is efficient in its use of color, form, and symbols representing abstract data.  
• KS 21006.04.08 Evaluate and select the necessary views to graphically communicate design solutions.  
• KS 21006.04.10 Integrate annotated sketches in presentations, portfolio, and documentation processes.  
• KS 21006.04.11 Develop properly annotated sketches to accurately convey data in design solution. |
| **Time Frame:** 2 weeks | |
**Unit 3: Measurement and Statistics**

- US Customary units
- Metric units
- Unit Conversion
- Precision and accuracy
- Linear dimensions
- Statistical analysis with spreadsheets

Statistics and quality

Time Frame: 3 weeks

Utilize precise measurement and accurate statistical analysis in the application of the design process.

- KS 21006.02.01 Apply the steps of the design process.
  - Construct a testable prototype of a problem solution.
  - Analyze the performance of a design during testing and judge the solution as viable or non-viable with respect to meeting the design requirements.
  - Use statistics to quantify information, support design decisions and justify problem solutions.
  - Use a spreadsheet problem to store and manipulate raw data and perform calculations using formulas.
- KS 21006.08.15 Set up and integrate the use of a customized common dimensioning standard.
- KS 21004.13.02 Design and create tables, charts, and graphs to illustrate data collected.

**Unit 4: Modeling Skills**

- Conceptual models
- Graphical models
- 3D Computer Models
- Physical models
- Mathematical models

Time Frame: 4 weeks

Apply a variety of modeling methods and formats to represent systems, components, and processes.

- KS 21006.06.04 Communicate their idea through written and verbal formats.
- KS 21006.06.06 Select and utilize the appropriate graphical format to a problem.
- KS 21006.06.07 Analyze and develop graphical representation of given data.
- KS 21006.06.08 Demonstrate an understanding of the different physical modeling techniques.
- KS 21006.06.09 Present a model with its correct proportions.
- KS 21006.06.11 Evaluate a problem using mathematical formulas.
- KS 21006.06.12 Analyze a solution to a problem using the correct format of analysis.
- KS 21006.06.13 Interpret a sketch using a CAD package.
- KS 21006.06.14 Explain the difference between parametric and adaptive designs and be able to specify their uses.
- KS 21006.06.15 Draw a two-dimensional sketch using CAD package.
- KS 21006.06.17 Demonstrate the ability to generate a three-dimensional model.
- KS 21006.06.18 Demonstrate the use of work features and how they are applied while constructing a solid model.
- KS 21006.06.19 Recognize the use and need of work planes, axes, and points in the development of a computer model.
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<tr>
<th>Unit 5: Geometry of Design</th>
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<th>Apply 2 and 3-dimensional geometric concepts and skills to problem solving and engineering design.</th>
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<tr>
<td>• Forms and Shapes</td>
<td>• KS 21006.05.01 Define and contrast points, lines and line segments.</td>
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<td>• Geometric Constraints</td>
<td>• KS 21006.05.02 Identify major geometric shapes.</td>
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<tr>
<td>• Cartesian Coordinate System</td>
<td>• KS 21006.05.03 Using a compass, ruler and triangle, construct geometric shapes.</td>
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<td>• Parametric Design</td>
<td>• KS 21006.05.04 Define terminology associated with arcs and circles.</td>
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<td></td>
<td>• KS 21006.05.06 Distinguish and define geometric constraints.</td>
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<td>• KS 21006.05.07 Identify geometric constraints in given three dimensional models.</td>
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<td>• KS 21006.05.08 Apply the right hand rule to identify the X, Y, and Z axes of the Cartesian Coordinate System.</td>
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<td>• KS 21006.05.09 Apply a combination of absolute, relative, and polar coordinates to construct a three-dimensional model.</td>
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<td>• KS 21006.05.10 Define the origin planes in the Coordinate System.</td>
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<td>• KS 21006.06.16 Apply geometrical and dimensional constraints to a sketch.</td>
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**Time Frame: 3 weeks**

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<tr>
<th>Unit 6 Reverse Engineering</th>
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<th>Disassemble and analyze a product or system in order to understand and document the visual, functional, and/or structural aspects of its design.</th>
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<tr>
<td>• Visual, functional and structural aspects of design</td>
<td>• KS 21006.08.01 Students will demonstrate how to extract data from solid models.</td>
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<td>• Functional analysis</td>
<td>o Evaluate and compare the impact of materials and fastener choices on product design cost, performance, marketability, environment and service life.</td>
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<td>• Strengths and weaknesses of product and manufacturing process</td>
<td>o Accurately measure linear distances and mass.</td>
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<td>o Create sketches and orthographic projections of an object to fully detail parts.</td>
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<td>o Generate CAD multi-view technical drawings, including orthographic projections, sections view(s), detail view(s), auxiliary view(s) and pictorial views.</td>
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**Time Frame: 3 weeks**

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<th>Unit 7 Documentation</th>
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<th>Create engineering working drawings that document measurements collected during reverse engineering process and to propose new designs.</th>
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<td>• Working Drawings</td>
<td>• KS 21006.08.02 Evaluate the accuracy of mass properties calculations.</td>
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<td>• Dimensioning</td>
<td>• KS 21006.08.03 Describe how analysis data can be used to update parametric models.</td>
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<td>• Annotation</td>
<td>• KS 21006.08.04 Generate an isometric view from orthographic drawing views.</td>
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<td>• Dimensional tolerances</td>
<td>• KS 21006.08.05 Determine the correct application for the various section views.</td>
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<tr>
<td>• 3D Computer models</td>
<td>• KS 21006.08.07 Create the appropriate section view for a specified view.</td>
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<td>• KS 21006.08.08 Create a detail view that corresponds to appropriate orthographic view.</td>
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<td>• KS 21006.08.09 Create an auxiliary view to show the detail on an inclined surface.</td>
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<td>• KS 21006.08.11 Apply common dimensioning systems, rules and practices.</td>
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<td>• KS 21006.08.13 Apply size and location dimensions to annotated drawings.</td>
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<td>• KS 21006.08.17 Solve tolerance problems.</td>
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<td>• KS 21006.08.19 Formulate general and proprietary specifications to further communicate information relating to product design.</td>
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**Time Frame: 5 weeks**
### Unit 8: Advanced Computer Modeling

- Adding Components
- Assembly Constraints
- Part Libraries
- Sub-Assemblies
- Driving Constraints
- Adaptive Design
- Mass Properties
- Mathematical functions

**Time Frame:** 3 weeks

Utilize 3D computer modeling skills to create exploded and animated assembly views of multi-part products.

- KS 21006.07.01 Demonstrate assembly modeling skills to solve design problems.
- KS 21006.07.03 Create components effectively in the assembly modeling environment.
- KS 21006.07.05 Replace components with modified external parts.
- KS 21006.07.06 Perform part manipulation during the creation of an assembly model.
- KS 21006.07.07 Demonstrate assembly modeling skills to solve design problems.
- KS 21006.07.09 Apply assembly constraints to successfully construct a multi-part object.
- KS 21006.07.10 Utilize part libraries effectively during the assembly modeling process.
- KS 21006.07.12 Employ sub-assemblies during the production of assemblies.
- KS 21006.07.14 Apply drive constraints to simulate the motion of parts in assemblies.
- KS 21006.07.16 Apply adaptive design concepts during development of sketches, features, parts and assemblies.

### Unit 9: Design Team and Design Challenge

- Collaborative teamwork
- Virtual communication
- Shared decision-making
- Ethical responsibilities
- Diversity and cultural competence.
- Societal and environmental impacts
- Engineering design process
- Scientific method
- Mathematical models

**Time Frame:** 9 weeks

Apply the concepts and skills of engineering to create and test a solution for a real-world problem.

- KS 140101.13.09 Develop and use mathematical models to represent and justify mathematical relationships found in a variety of situations.
- KS 140101.04 Apply scientific methods in qualitative and quantitative analysis, data gathering, direct and indirect observation, predictions, and problem identification.
- KS 140101.18 Apply leadership, teamwork and effective communication to achieve a common goal.
  - Apply appropriate technology to support collaboration in the design process.
  - Develop and utilize a decision matrix based on accepted outcome criteria and constraints.
  - Justify and validate a selected solution path.
  - Document design process using technical drawings and design journal.
  - Incorporate visual elements and principles of design in the engineered product.
  - Justify and present problem solution.