# Design Projects in Science and Engineering

<u>Course Description:</u>

Design Projects in Science and Engineering is a one semester elective in which students work with a team to plan, design, build, test, and optimize a project of their choosing. Students learn about the engineering design process first hand by creating a unique project and apply their knowledge of physics or other fields of science. Next Generation Science Standards related to Engineering Design are integrated throughout the course. Each week students explore a different module related to a design or engineering topic. Students learn about safety, engineering disciplines, types of engineering drawings, how to write a project proposal, budgeting, Arduino microcontrollers, structures and other engineering elements, time management, computer modeling tools, and 3d printing. Teams show off their project to the student body in an hour-long engineering fair at the end of the semester.

## Course Structure

The course has two strands operating in parallel with one another. The project itself is broken into three "phases". The phases correspond to choosing a project, building a prototype, and optimizing the solution. Most weeks also include a content "module" relating to some specific aspect of the course or technology topic. Each week they take a short quiz on that content.

<u>The Project (3 multi-week phases):</u>
Phase 1: Defining and delimiting an engineering problem: choosing a project
Phase 2: Developing possible solutions: building a prototype
Phase3: Optimizing the design solution: testing and refining the project

<u>The Content (weekly modules):</u>
Module 1: Truss structures
Module 2: Design process
Module 3: Safety
Module 4: Engineering drawing
Module 5: Measurements
Module 6: Arduino
Module 7: Soldering
Module 8: Engineering elements (gears/cams/linkages, etc.)
Module 9: CAD (computer aided design)
Module 10: 3D printing
Module 11: Optimization

**Timing plan for Project Phases and Content**

**---------------------Quarter 1------------------------- -----------------Quarter 2----------------------**

**Week**

**1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18**

**--Phase1--**

**----------------Phase 2----------------------**

**---------------------Phase 3-----------------------**

**-------Modules 1-11 (one each week)---------------------**

**------Weekly project updates-------------**

**The Project**
**Phase 1: Defining and Delimiting an Engineering Problem**
**Time Frame: 2 Weeks**

Narrative: During the first phase of the semester-long project, students identify societal needs and wants as well as appropriate criteria and constraints for solving those challenges. Students work in teams to identify a project that they will spend the remainder of the semester completing. Below are relevant NGSS standards as well as locally designed criteria that will guide this unit.

<table>
<tr><td colspan="2">Anchor Standard:<br><br>NGSS ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</td></tr>
<tr><td colspan="2">Big Ideas: Course Objectives/Content Statement(s)<ul><li>Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.</li><li>Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.</li><li>Analyze complex real-world problems by specifying criteria and constraints for successful solutions.</li><li>New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.</li></ul></td></tr>
<tr><td>Essential Questions<br>What provocative questions will foster inquiry, understanding, and transfer of learning?</td><td>Enduring Understandings<br>What will students understand about the big ideas?</td></tr>
<tr><td><ul><li>What are major global needs/wants?</li><li>What project could I undertake in a semester course?</li><li>What resources can I use to come up with ideas for a project?</li><li>What risks will need to be mitigated in my project?</li><li>What are reasonable criteria and constraints for my project?</li><li>What technologies will be necessary to carry out my project?</li></ul></td><td>Design criteria and constraints, which typically reflect the needs of the end-user of a technology or process, address such things as the product's or system's function (what job it will perform and how), its durability, and limits on its size and cost. Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.<br>Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can</td></tr>
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| | be addressed through engineering. These global challenges also may have manifestations in local communities. But whatever the scale, the first thing that engineers do is define the problem and specify the criteria and constraints for potential solutions.The creative process of developing a new design to solve a problem is a central element of engineering. This process may begin with a relatively open-ended phase during which new ideas are generated both by individuals and by group processes such as brainstorming. Before long, the process must move to the specification of solutions that meet the criteria and constraints at hand. Initial ideas may be communicated through informal sketches or diagrams, although they typically become more formalized through models. The ability to build and use physical, graphical, and mathematical models is an essential part of translating a design idea into a finished product, such as a machine, building, or any other working system. Because each area of engineering focuses on particular types of systems (e.g., mechanical, electrical, biotechnological), engineers become expert in the elements that such systems need. But whatever their fields, all engineers use models to help develop and communicate solutions to design problems.<br>Models allow the designer to better understand the features of a design problem, visualize elements of a possible solution, predict a design's performance, and guide the development of feasible solutions (or, if possible, the optimal solution). A physical model can be manipulated and tested for parameters of interest, such as strength, flexibility, heat conduction, fit with other components, and durability. Scale models and prototypes are particular types of physical models. Graphical models, such as sketches and drawings, permit engineers to easily share and discuss design ideas and to rapidly revise their thinking based on input from others.<br>Mathematical models allow engineers to estimate the effects of a change in one feature of the design (e.g., material composition, ambient temperature) on other features, or on performance as a whole, before the designed product |

| Areas of Focus: Proficiencies (Progress Indicators) | Examples, Outcomes, Assessments |
|---|---|
| **Students will**:<br>1 Identifying the problem to be solved<br>a Students analyze a major global problem. In their analysis, students:<br>i. Describe the challenge with a rationale for why it is a major global challenge;<br>ii. Describe, qualitatively and quantitatively, the extent and depth of the problem and its major consequences to society and/or the natural world on both global and local scales if it remains unsolved; and<br>iii. Document background research on the problem from two or more sources, including research journals.<br><br>2 Defining the process or system boundaries, and the components of the process or system<br>a In their analysis, students identify the physical system in which the problem is embedded, including the major elements and relationships in the system and boundaries so as to clarify what is and is not part of the problem.<br>b In their analysis, students describe societal needs and wants that are relative to the problem (e.g., for controlling $CO_2$ emissions, societal needs include the need for cheap energy).<br><br>3 Defining the criteria and constraints<br>a Students specify qualitative and quantitative criteria and constraints for acceptable solutions to the problem. | <u>Instructional Focus:</u><br><br>Major and minor global problems and how they can be approached from a design perspective in this class. Students work in teams to identify a project that they will pursue solutions for during the remainder of the semester.<br><br><u>Sample Assessments:</u><br><br>A written analysis of a major global problem that can be addressed with the design process.<br><br>Brainstormed ideas for project directions.<br><br><u>Projects/Post Assessment</u><br><br>The analysis of a major global problem points students in the direction of their semester long design problem<br><br><u>Interdisciplinary Connections</u><br><br>*Common Core State Standards Connections: ELA/Literacy -*<br>**RST. 11-12 .7** 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. (HS-ETS1-1)<br>**RST. 11-12 .8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. *(HS-ETS1-1)*<br>**RST. 11-12 .9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting |

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| | information when possible. (HS-ETS1-1)<br>*Mathematics -*<br>**MP.2** Reason abstractly and quantitatively. (HS-ETS1-1)<br>**MP.4** Model with mathematics. (HS-ETS1-1)<br><br>● Technology Integration<br><br>Students will consider various how technology could be applied to a design project<br><br>● Media Literacy Integration<br>Use of internet based sources to identify global problems<br><br>● Global Perspectives<br><br>Considering problems that have global consequences (i.e. global warming) |

**The Project**
**Phase 2: Developing Possible Solutions**
**Timeframe: 8 weeks**

Narrative: During this project phase, students come up with concrete solutions to the problem identified in phase 1. Working with their team, they write a proposal outlining the details of a real design solution. Once the proposal is approved, students begin working on a prototype solution in class, with the goal of finishing a first prototype (or the main aspect of the prototype) by the end of the quarter.

**Anchor Standards**:

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

**Big Ideas**: *Course Objectives/Content Statement(s)*

- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.
- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

| **Essential Questions**<br>*What provocative questions will foster inquiry, understanding, and transfer of learning?* | **Enduring Understandings**<br>*What will students understand about the big ideas?* |
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| • *What are the individual parts of my project?*<br>• *How can we task group members with leadership roles?*<br>• *By what criteria will my project result be judged?* | Complicated problems may need to be broken down into simpler components in order to develop and test solutions. When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. Testing should |

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| | lead to improvements in the design through an iterative procedure.<br>Both physical models and computers can be used in various ways to aid in the engineering design process. Physical models, or prototypes, are helpful in testing product ideas or the properties of different materials. Computers are useful for a variety of purposes, such as in representing a design in 3-D through CAD software; in troubleshooting to identify and describe a design problem; in running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.<br>Multiple solutions to an engineering design problem are always possible because there is more than one way to meet the criteria and satisfy the constraints. But the aim of engineering is not simply to design a solution to a problem but to design the best solution. Determining what constitutes "best," however, requires value judgments, given that one person's view of the optimal solution may differ from another's.<br>Optimization often requires making trade-offs among competing criteria. For example, as one criterion (such as lighter weight) is enhanced, another (such as unit cost) might be sacrificed (i.e., cost may be increased due to the higher cost of lightweight materials). In effect, one criterion is devalued or traded off for another that is deemed more important. When multiple possible design options are under consideration, with each optimized for different criteria, engineers may use a trade-off matrix to compare the overall advantages and disadvantages of the different proposed solutions.<br>The decision as to which criteria are critical and which ones can be traded off is a judgment based on the situation and the perceived needs of the end-user of the product or system. Because many factors—including environmental or health impacts, available technologies, and the expectations of users—change over time and vary from place to place, a design solution that is considered optimal at one time and place may appear far from optimal at other times and places. Thus different designs, each of them optimized |

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| | for different conditions, are often needed. |
| **Areas of Focus: Proficiencies<br>(Progress Indicators)** | **Examples, Outcomes, Assessments** |
| **Students will**:<br>1 Using scientific knowledge to generate the design solution<br>a Students restate the original complex problem into a finite set of two or more sub-problems (in writing or as a diagram or flow chart).<br>b For at least one of the sub-problems, students propose two or more solutions that are based on student-generated data and/or scientific information from other sources.<br>c Students describe how solutions to the sub-problems are interconnected to solve all or part of the larger problem.<br><br>2 Describing criteria and constraints, including quantification when appropriate<br>a Students describe criteria and constraints for the selected sub-problem.<br>b Students describe the rationale for the sequence of how sub-problems are to be solved, and which criteria should be given highest priority if tradeoffs must be made.<br><br>1 Evaluating potential solutions<br>a In their evaluation of a complex real-world problem, students:<br>i. Generate a list of three or more realistic criteria and two or more constraints, including<br>such relevant factors as cost, safety, reliability, and aesthetics that specifies an<br>acceptable solution to a complex real-world problem;<br>ii. Assign priorities for each criterion and constraint that allows for a logical and<br>systematic evaluation of alternative solution proposals;<br>iii. Analyze (quantitatively where appropriate) and describe* the strengths and | Instructional Focus:<br>Writing a project proposal<br><br>Building a prototype solution<br><br>Sample Assessments:<br>The project proposal will include the following parts: Goals and challenges; knowledge areas needed; facilities and tools needed; description of prototype; sketches of prototype; materials and budget; work plan; references<br><br>Projects/Post Assessment<br>Student work during this unit culminates in a real prototype that students will begin testing and optimizing in the next unit<br><br>Interdisciplinary Connections<br><br>*Common Core State Standards Connections: Mathematics -*<br>**MP.4** Model with mathematics. (HS-ETS1-2)<br><br>● Technology Integration<br>Students use various kinds of technology (3d printing, computer modeling, Arduino, etc., to help them build a prototype<br><br>● Media Literacy Integration |

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| weaknesses of the solution with respect to each criterion and constraint, as well as<br>social and cultural acceptability and environmental impacts;<br>iv. Describe* possible barriers to implementing each solution, such as cultural, economic,<br>or other sources of resistance to potential solutions; and<br>v. Provide an evidence-based decision of which solution is optimum, based on prioritized<br>criteria, analysis of the strengths and weaknesses (costs and benefits) of each<br>solution, and barriers to be overcome.<br>2 Refining and/or optimizing the design solution<br>a In their evaluation, students describe* which parts of the complex real-world problem may<br>remain even if the proposed solution is implemented. | Use of internet to find solution ideas<br><br>● Global Perspectives<br>Creating solutions for global problems |

**The Project**
**Phase 3: Optimizing the Design Solution**
**Timeframe: 8 weeks**

During the final phase of the project, students test and evaluate their initial prototype. They work to optimize the prototype with help from a computer simulation. The prototype is refined and retested with further optimization as time permits. The final form of the project is due by the end of the semester to be displayed at an in-school engineering fair.

<table>
<tr><td colspan="2">Anchor Standard:<br>HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</td></tr>
<tr><td colspan="2">Big Ideas: Course Objectives/Content Statement(s)<ul><li>Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.</li><li>Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales.</li><li>Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.</li></ul></td></tr>
<tr><td>Essential Questions<br>What provocative questions will foster inquiry, understanding, and transfer of learning?</td><td>Enduring Understandings<br>What will students understand about the big ideas?</td></tr>
<tr><td>1 Representation<br>a Students identify the following components from a given computer simulation:<br>i. The complex real-world problem with numerous criteria and constraints;<br>ii. The system that is being modeled by the computational simulation, including the boundaries of the systems;<br>iii. What variables can be changed by the user to evaluate the proposed solutions,<br>tradeoffs, or other decisions; and<br>iv. The scientific principle(s) and/or relationship(s) being used by the model.<br>2 Computational Modeling<br>a Students use the given computer simulation to</td><td>The aim of engineering is not simply to find a solution to a problem but to design the best solution under the given constraints and criteria. Optimization can be complex, however, for a design problem with numerous desired qualities or outcomes. Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. The comparison of multiple designs can be aided by a trade-off matrix. Sometimes a numerical weighting system can help evaluate a design against multiple criteria. When evaluating solutions, all relevant considerations, including cost, safety, reliability, and aesthetic, social, cultural, and environmental impacts, should be included. Testing should lead to design</td></tr>
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| model the proposed solutions by:<br>i. Selecting logical and realistic inputs; and<br>ii. Using the model to simulate the effects of different solutions, tradeoffs, or other decisions.<br>3 Analysis<br>a Students compare the simulated results to the expected results.<br>b Students interpret the results of the simulation and predict the effects of the proposed solutions within and between systems relevant to the problem based on the interpretation.<br>c Students identify the possible negative consequences of solutions that outweigh their benefits.<br>d Students identify the simulation's limitations | improvements through an iterative process, and computer simulations are one useful way of running such tests. |
| **Areas of Focus: Proficiencies (Progress Indicators)** | **Examples, Outcomes, Assessments** |
| **Students will**:<br>1 Evaluating potential solutions<br>a In their evaluation of a complex real-world problem, students:<br>i. Generate a list of three or more realistic criteria and two or more constraints, including such relevant factors as cost, safety, reliability, and aesthetics that specifies an acceptable solution to a complex real-world problem;<br>ii. Assign priorities for each criterion and constraint that allows for a logical and systematic evaluation of alternative solution proposals;<br>iii. Analyze (quantitatively where appropriate) and describe the strengths and weaknesses of the solution with respect to each criterion and constraint, as well as social and cultural acceptability and environmental impacts;<br>iv. Describe possible barriers to implementing each solution, such as cultural, economic, or other sources of resistance to potential solutions; and | Instructional Focus:<br>Testing and optimizing their prototype until a final project form is ready to be shared with the school community.<br><br>Unveiling of final projects at engineering fair.<br><br>Sample Assessments:<br>Criteria for testing and optimization are identified and applied to the design solution.<br><br>The final design solution is evaluated at the engineering fair.<br><br>Projects/Post Assessment<br>Students self evaluate their project.<br><br>Interdisciplinary Connections<br><br>*Common Core State Standards Connections:* |

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| v. Provide an evidence-based decision of which solution is optimum, based on prioritized criteria, analysis of the strengths and weaknesses (costs and benefits) of each<br>solution, and barriers to be overcome.<br>2 Refining and/or optimizing the design solution<br>a In their evaluation, students describe which parts of the complex real-world problem may remain even if the proposed solution is implemented. | *Mathematics -*<br>**MP.2** Reason abstractly and quantitatively. *(HS-ETS1-4)*<br>**MP.4** Model with mathematics. (HS-ETS1-4)<br><br>● Technology Integration<br>Use of computer based optimization tools<br><br>● Media Literacy Integration<br>Use of internet for design optimization research and solutions.<br><br>● Global Perspectives<br>Evaluation of the global design solution |

## The Modules

**<u>Module 1: Truss Structures</u>**. In this module, students are introduced to some basic structures concepts. Content includes: the triangle as a fundamental unit; compression and tension; members and pin joints; advantages and disadvantages of truss structures. Students are introduced to a short, week-long design challenge where they work in teams to satisfy various constraints and criteria. In the past students have built truss structures from 100 plastic straws and 100 pins to span a 45 cm gap. Weights are hung from the structure and increased until structure fails. Students then reflect on the design process that they went through to arrive at their final design.

**<u>Module 2: The Design Process</u>**. In this module students learn about the engineering design process. The approach adopted from the course comes from NASA, which lists eight distinct steps. They are: 1) Identify the Problem; 2) Identify Criteria and Constraints; 3) Brainstorm Possible Solutions; 4) Generate Ideas; 5) Explore Possibilities; 6) Select an Approach; 7)Build a Model or Prototype; 8) Refine the Design.

Of course these steps are not definite or absolute, but they represent a formalization of what may be an informal design process. Students reflect on which steps they did and did not work through during the truss structures activity. They then begin thinking about global challenges that could be solved with the application of the engineering design process. This module is integrated with the first project phase. Students are quizzed on the design process.

**<u>Module 3: Safety</u>**. Students are introduced to basic rules of safety for the makerspace classroom. Wearing eye protection, tying back long hair, wearing closed toe shoes, cutting away from the body, never using dull tools, clamping work before drilling and sawing, are just some of the basic rules covered. Students are shown specific safety rules regarding the 3d Printer, electric drills and saws, and the drill press. Students are also prohibited from using the mitre saw in class. After learning about safety rules, students take a short quiz on the information received and they take home a safety contract to be signed by a parent/guardian. The safety contract must be returned before any tools in the maker space can be used.

**<u>Module 4: Engineering Drawing.</u>** In this module, students are introduced to various types of Engineering Drawing. Coverage includes isometric, orthographic, and schematic drawings. Emphasis is on drawing skills necessary for the project proposal, which is due around this time. Students with mechanical projects must learn to draw an isometric view as well as several orthographic projections. Students with circuit or computer aspects in their project should learn to draw basic schematic drawings. Students should indicate parts with labels and show all dimensions as needed. Students are quizzed on basic terminology related to this topic.

**<u>Module 5: Measurements</u>**. During this module, students learn about measuring tools, units of measure, and uncertainty in measurements. Focus is on hands-on use of measuring tools that we have in class, such as balances, measuring tapes, thermometers, Vernier calipers, etc. We discuss the pros and cons of English vs Metric measurements. Measurement tricks such as the inside measurement of a door jamb with a measuring tape are demonstrated. Students take a quiz about the use of various measuring tools.

**Module 6: Soldering.** Students are introduced to the basic technique of soldering. Preparation and cleanup are considered in this complete operation. The right and wrong techniques of soldering are demonstrated with a video and with a hands-on demo. Students are warned of potential pitfalls of soldering incorrectly, applying too much heat, and safety considerations. A quiz is given on a few of the important aspects of soldering.

**Module 7: Arduino**. Arduino has become an important tool for controlling many of the projects created in this class. Arduino is an inexpensive, robust, and easily customizable microcontroller that students can tinker with or master during their project phase. Basic information about Arduino types, pins, uses, the programming environment, power, etc, are presented in this module. Examples of past projects that have utilized the Arduino environment are presented, and students are encouraged to integrate Arduino into their project. A quiz on Arduino basics is given.

**Module 8: Engineering elements.** Students review the six simple machines: levers, pulleys, wedges, wheels and axles, inclined planes, and screws. The transformation of input and output force is emphasized, with a definition of mechanical advantage given. Students are introduced to gears and the idea of gear ratios. How speeds (rpm) are changed in gear combinations, but torques are affected inversely. Students are also introduced to linkages and the idea of degrees of freedom. Finally, cams are introduced with applications such as a car camshaft. A quiz is given over the highlighted topics.

**Module 9: Computer Aided Design.** In this module students are introduced to available resources for computer aided design. Particular emphasis is given to the use of these programs for 3d printing. Students are shown an online program called TinkerCAD and how it can be used to make a model that can be used for 3d printing. Important basics of CAD drawing are covered, such as cutting a hole in a piece, grouping and ungrouping, measurements and dimensions and transformations. Students are quizzed over a few basic CAD techniques.

**Module 10: 3D Printing.** Students are introduced to techniques and strategies for 3D Printing real parts. From the CAD design file to the finished model, students cover the basics of how 3D printing works. Currently the makerspace has a Makerbot Replicator 2, so the specifics of how to use this printer are covered in detail. We discuss how to orient parts, choosing rafts and supports, layer thickness, and other considerations. Pros and cons of plastic printed parts are analyzed. Specific consideration is given to 3D printing as an iterative design process where a prototype part can be modified many times. A quiz is given over some of the most important aspects.

**Module 11: Optimization**. In this module we cover the need for optimization in engineering design. The second half of this semester course is about testing, evaluating, and improving designs. We discuss the concept of optimization, the need for good data, and a qualitative or mathematical optimization approach. Students are encouraged to use a computer tool for optimization if possible. This module is an introduction to the last phase of the project, where students refine their projects until they are displayed at the end of the semester.

**Career-Ready Practices**
**CRP1**: Act as a responsible and contributing citizen and employee.
**CRP2**: Apply appropriate academic and technical skills.
**CRP3**: Attend to personal health and financial well-being.
**CRP4**: Communicate clearly and effectively and with reason.
**CRP5**: Consider the environmental, social and economic impacts of decisions.
**CRP6**: Demonstrate creativity and innovation.
**CRP7**: Employ valid and reliable research strategies.
**CRP8**: Utilize critical thinking to make sense of problems and persevere in solving them.
**CRP9**: Model integrity, ethical leadership and effective management.
**CRP10**: Plan education and career paths aligned to personal goals.
**CRP11**:. Use technology to enhance productivity.
**CRP12**: Work productively in teams while using cultural global competence.

## Instructional Strategies:

## Supports for English Language Learners:

| Sensory Supports | Graphic Supports | Interactive Supports |
|---|---|---|
| Real-life objects (realia) | Charts | In pairs or partners |
| Manipulatives | Graphic organizers | In triads or small groups |
| Pictures & photographs | Tables | In a whole group |
| Illustrations, diagrams, & drawings | Graphs | Using cooperative group structures |
| Magazines & newspapers | Timelines | With the Internet (websites) or software programs |
| Physical activities | Number lines | In the home language |
| Videos & films | | With mentors |
| Broadcasts | | |
| Models & figures | | |

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## Differentiation Strategies:

| Accommodations | Interventions | Modifications |
|---|---|---|
| Allow for verbal responses | Multi-sensory techniques | Modified tasks/ expectations |
| Repeat/confirm directions | Increase task structure (e.g., directions, checks for understanding, feedback) | Differentiated materials |
| Permit response provided via computer or electronic device | Increase opportunities to engage in active academic responding (e.g., writing, reading aloud, answering questions in class) | Individualized assessment tools based on student need |
| Audio Books | Utilize prereading strategies and activities: previews, anticipatory guides, and semantic mapping | Modified assessment grading |

**Summit Public Schools**
Summit, New Jersey

# Curricular Addendum

| Career-Ready Practices | Interdisciplinary Connections |
| --- | --- |
| **CRP1**: Act as a responsible and contributing citizen and employee.<br>**CRP2**: Apply appropriate academic and technical skills.<br>**CRP3**: Attend to personal health and financial well-being.<br>**CRP4**: Communicate clearly and effectively and with reason.<br>**CRP5**: Consider the environmental, social and economic impacts of decisions.<br>**CRP6**: Demonstrate creativity and innovation.<br>**CRP7**: Employ valid and reliable research strategies.<br>**CRP8**: Utilize critical thinking to make sense of problems and persevere in solving them.<br>**CRP9**: Model integrity, ethical leadership and effective management.<br>**CRP10**: Plan education and career paths aligned to personal goals.<br>**CRP11**:. Use technology to enhance productivity.<br>**CRP12**: Work productively in teams while using cultural global competence. | • Close Reading of works of art, music lyrics, videos, and advertisements<br>• Use Standards for Mathematical Practice and Cross-Cutting Concepts in science to support debate/inquiry across thinking processes<br><br>**Technology Integration**<br>Ongoing:<br>• Listen to books on CDs, Playaways, videos, or podcasts if available.<br>• Use document camera or overhead projector for shared reading of texts.<br><br>Other:<br>• Use Microsoft Word, Inspiration, or SmartBoard Notebook software to write the words from their word sorts.<br>• Use available technology to create concept maps of unit learning. |

## Instructional Strategies:
## Supports for English Language Learners:

| Sensory Supports | Graphic Supports | Interactive Supports |
|---|---|---|
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| Physical activities | Number lines | In the home language |
| Videos & films | | With mentors |
| Broadcasts | | |
| Models & figures | | |

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## Media Literacy Integration

- Use multiple forms of print media (including books, illustrations/photographs/artwork, video clips, commercials, podcasts, audiobooks, Playaways, newspapers, magazines) to practice reading and comprehension skills.

## Global Perspectives

- The Global Learning Resource Library

## Differentiation Strategies:

| Accommodations | Interventions | Modifications |
|---|---|---|
| Allow for verbal responses | Multi-sensory techniques | Modified tasks/ expectations |
| Repeat/confirm directions | Increase task structure (e.g., directions, checks for understanding, feedback) | Differentiated materials |
| Permit response provided via computer or electronic device | Increase opportunities to engage in active academic responding (e.g., writing, reading aloud, answering questions in class) | Individualized assessment tools based on student need |
| Audio Books | Utilize prereading strategies and activities: previews, anticipatory guides, and semantic mapping | Modified assessment grading |