

**ADVANCED DESIGN APPLICATIONS****Course Overview****36 Weeks****REVIEW: TECHNOLOGY AND ENGINEERING REVIEW***(9 Class Periods)***REVIEW PART 1: Brainstorming and Engineering Journal (1 class period)**

**Purpose:** The purpose of this unit is to introduce students to the important and specific task of maintaining an engineering journal. An engineering journal is a way to officially document their use of the design process. Students will begin to use their journals by practicing a major step of the design process, which is brainstorming. Students will understand the process of brainstorming and will use it to develop innovations to existing consumer products. This unit will also stress the importance of creativity in order to create innovations and inventions that will better society.

**Objectives:** The student will be able to:

- Effectively utilize an engineering journal following the specific guidelines.
- Describe the purpose of keeping an engineering journal throughout projects.
- Efficiently document use of the engineering design process.
- Define the process of brainstorming.
- Describe how brainstorming is a major part of the design process.
- Utilize the brainstorming process to generate new and exciting ideas.
- Promote wild, outrageous ideas in the brainstorming project, on which to improve upon.

**REVIEW PART 2: Engineering Design Process (2 class periods)**

**Purpose:** The purpose of this unit is to fully examine, explore, and apply the engineering design process. Design is a part of everything we do everyday. If you look around, you will notice the only thing that is not designed is nature itself. Whether you know it or not you are a designer. You design by simple tasks like selecting what clothes you wear, arranging your bedroom, or cooking dinner.

**Objectives:** The student will be able to:

- Explain that the design process is a systematic, iterative approach to problem solving that yields design solutions.
- Explain that the design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying

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constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating a design, using specifications, refining a design, creating or making it, and communicating processes and results.

- Explain that design problems are seldom presented in a clearly defined form.
- Analyze the phases of the design process.

**REVIEW PART 3: Technological Impacts** (2 class periods)

**Purpose:** The purpose of this unit is to determine the societal, economic, environmental, and political impacts that all forms of technology have. It is important for students to understand that development and use of technologies involve decisions about trade-offs between its positive and negative effects.

**Objectives:** The student will be able to:

- Explain that decisions about the use of technology involve trade-offs between positive and negative effects.
- Cite instances where ethical considerations have impacted the development, selection, and use of technologies.
- Justify the contention that individual citizens have to make informed decisions about the development and use of technology.
- Explain that humans devise technologies to reduce the negative consequences of other technologies.
- Analyze the relationship between technological processes and natural processes.
- Identify and describe instances where societal opinions and demands or corporate interests have influenced the decision to develop a technology.
- Explain that a number of different factors, such as advertising, the strength of the economy, the goals of the company, and the latest fads contribute to shaping the design of and demand for various technologies.
- Explain that new technologies create new processes.
- Analyze how different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values.
- Defend and rationalize the development and use of a proposed technology.
- Examine the impact of oil spills.
- Utilize the engineering design process problem solving approach to create a device that will effectively clean up an oil spill.

**REVIEW PART 4: Tools, Machines, Materials, and Safety** (4 class periods)

**Purpose:** The purpose of this unit is to allow students to gain the appropriate knowledge of all tools and machines to effectively manipulate materials. The students will become experts in the safe use of all tools and machines. The students will also explore all types of materials that are available for use today. With

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knowledge of tools, machines, and materials, students will then be able to design and construct their own projects.

**Objectives:** The student will be able to:

- Utilize all machines safely and effectively.
- Explain the proper use of all machines in the lab.
- Locate and describe all parts of machines in the lab.
- Identify and safely use all hand-tools located in the lab.
- Select and utilize the proper materials for projects.
- Analyze the development and impact of some common materials.
- Explain that it is frequently found that “trade-offs” among the needed properties must be made to be consistent with the processing selected and the structural state desired or possible.
- Explain that, since the birth of materials science and engineering, materials researchers have consistently improved materials that have, in turn, enhanced the performance of the technologies that used them.

**SECTION 1: APPROPRIATE TECHNOLOGY**

*8 Class Periods*

**UNIT 1.1: Questioning Technology (1 Class Period)**

**Purpose:** The purpose of this unit is to further explore the impacts of technology and how we can minimize them. We need to ask ourselves, is the technology we use necessary? If it is, then we need to examine the whole life cycle of the technology to find ways to minimize any negative impacts.

**Objectives:** The student will be able to:

- Assess the appropriateness of a technological solution when engaged in design activities.
- Assess and modify designs using specific criteria, including: cost effectiveness, available resources, and environmental impact.
- Describe what technology is and how it evolved.
- Identify and analyze the interrelationships between science, technology, and society.
- Demonstrate awareness that today’s science and technology decisions will influence the future of society.
- Describe the impact of energy, power, and transportation systems on society and the environment.
- Describe the interactions between society, technology, use of energy sources, and the design of energy systems.

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**Unit 1.2: What is Appropriate Technology** (1 Class Period)

**Purpose:** Appropriate Technology is technology that is most suitable to a given situation. Designers of AT must analyze a problem and try to solve it without creating more problems. The solution must consider the possible impacts on the environment and society. The unit will provide students with the knowledge of appropriate technology and sustainability as well as provide them with principles that they can instill in their lives.

**Objectives:** The student will be able to:

- Evaluate forms of appropriate technology.
- Define and defend the definitions and principles of Appropriate Technology.
- Determine the benefits of Appropriate Technology.
- Assess the appropriateness of technological solution when engaged in design activities.
- Compare ways of using emerging and alternative energy sources to power mechanical devices.
- Describe the impact of energy, power, and transportation systems on society and the environment.
- Describe the interactions between society, technology, use of energy sources, and the design of energy systems.

**Unit 1.3: Going Global** (1 Class Period)

**Purpose:** As we go about our daily lives, it is easy to think that everyone lives as we do, and that we all share the same concerns. Yet the industrialized or developed nations make up 19 percent of the world's population and consume 52.3 percent of the world's energy. At least 2.4 billion people do not have access to toilets and over 1.1 billion people do not have access to clean drinking water. This unit looks at how technology transfers throughout different countries and cultures, while trying to enhance sustainability.

**Objectives:** The student will be able to:

- Assess the appropriateness of technological solution when engaged in design activities.
- Describe how globalization affects product design, manufacturing, production, and marketing processes and systems.
- Identify environmental, social, and cultural diversity considerations associated with the design of products, systems, and graphic images.
- Describe world population growth and the factors contributing to it.
- Outline scientific and technological solutions to the problems associated with population growth.
- Compare the consumption of resources in developed countries with that in developing countries.

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**UNIT 1.4: Solar Cookers** (5 class periods)

**Purpose:** Now that the students have brief background in appropriate technology and sustainability throughout the world, they can dive in a little deeper. The purpose of this unit is to allow students to explore one issue of sustainability. The unit will take a brief look at the fuel crisis around the world and give the students a chance to design and construct a solar cooker geared toward use in another country.

**Objectives:** The student will be able to:

- Assess the appropriateness of a technological solution when engaged in design activities.
- Describe how globalization affects product design.
- Describe the impact of manufacturing, production, and marketing processes and systems on society and the environment.
- Identify environmental, social, and cultural diversity considerations associated with the design of products, systems, and graphic images.
- Apply research methods and techniques to solve design problems.
- Use appropriate tools and materials to develop and present design ideas.
- Synthesize knowledge and concepts from other disciplines and the community in the process of designing.
- Construct a device or system that is energy efficient.

**SECTION 2: TECHNICAL DESIGN AND DRAWING**

*8 Class Periods*

**UNIT 2.1: Introduction to Technical Design and Drawing** (2 Class Periods)

**Purpose:** The purpose of this unit is to explore and utilize standards in the technical communication of sketching. These standards relate to technical drawing, which is far more precise than freehand sketching, but their conventions should be used as a guide when sketching.

**Objectives:** The student will be able to:

- Identify, sketch, and explain the function of points, construction lines, object lines, and hidden lines.
- Plot points on grid paper to aid in the creation of sketches and drawings.
- Utilize and explain the coordinate system.
- Explain the concepts of technical sketching and drawing.
- Sketch an isometric view of simple geometric solids.
- Explain how an oblique view of simple geometric solids differs from an isometric view.

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- Describe the concept of proportion as it relates to freehand sketching.
- Sketch multi-view drawings of simple geometric solids.
- Determine the front view for a given object.

**UNIT 2.2: Introduction to Design Software (3 class periods)**

**Purpose:** This unit will allow students to take their understanding of technical sketching and apply it to 3-D Design Software. This software will produce accurate plans for creating any project. In this unit the students will become familiar with basic 2-D and 3-D commands as well as visualizing the 3-D coordinate system.

**Objectives:** The student will be able to:

- Explore different types of computer aided design software.
- Accurately utilize design software.
- Utilize X, Y, Z coordinate plans to create spatially accurate designs.
- Geometrically constrain objects on design software.
- Apply fundamentals of technical design and drawing to design software.

**UNIT 2.3: Advanced Designing (3 class periods)**

**Purpose:** This unit allows the students to take their use of the 3-D design software to a higher level. The students will now take 3-D designs and create accurately dimensioned multi-view drawings. These drawings will be used as plans to create their designs. The students will also practice creating multiple part projects. With these multiple part projects the students will be able to create assembly drawings and presentations.

**Objectives:** The student will be able to:

- Create multi-view drawings on design software.
- Accurately place dimensions needed on multi-view drawings.
- Create a multiple part project on design software.
- Geometrically assemble and constrain a multiple part product on design software.
- Create presentation videos of assembling a multiple part product on design software.

**SECTION 3: RENEWABLE/INEXHAUSTIBLE ENERGY AND POWER SYSTEMS**

*25 Class Periods*

**UNIT 3.1: Introduction to Energy and Power Systems (1 class period)**

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**Purpose:** The purpose of this unit is to introduce students to the concept of energy and power technologies. The students will be exposed to several types of innovative renewable and inexhaustible energy sources.

**Objectives:** The student will be able to:

- Define and explain electricity, energy and power.
- Examine the Laws of Thermodynamics.
- Compare and Contrast renewable and non-renewable energy sources.
- Explain the effects of energy consumption.
- Research several forms of renewable energy.
- Create a multimedia presentation on a renewable energy sources.
- Effectively provide a multimedia presentation.

**Unit 3.2: Basic Electronics** (4 class periods)

**Purpose:** The purpose of this unit is to explore the basics of electrical circuits. The students will need the basic skills of circuit analysis in order to complete many of the design challenges of this course. In order to be able to explore and experiment with types of renewable/inexhaustible energies, sustainable construction techniques and alternative forms of transportation, students need to understand the basics of electricity.

**Objectives:** The student will be able to:

- Define electrical and electronic technology.
- Explain electron flow.
- Differentiate between direct current and alternating current.
- Mathematically analyze a basic circuit using Ohm's Law.
- Operate a digital multi-meter.
- Identify basic components of an electrical circuit.
- Utilize the correct symbols for creating schematics.
- Examine the concepts of electric motors and electric generators.
- Build a fully functional power generator.

**UNIT 3.3: GEARS** (4 class periods)

**Purpose:** The purpose of this unit is to understand how to effectively utilize gears. Gears are used in many mechanical devices in our lives. Gears are used to transmit and control torque and speed. They can also be used to change the direction of motion. Two or more gear wheels that mesh are called a gear train. Gear trains are used in many machines to control the power of the engine or motor. Students will utilize gears in the challenges throughout this course.

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**Objectives:** The student will be able to:

- Identify and describe the different types of gears.
- Explain the purpose of using gears.
- Define, describe, and manipulate torque and speed in gear trains.
- Utilize gear ratios to determine the best desired output of a gear train.
- Calculate power, RPMs, and speed of a gear train.
- Design and create an electric winch with the best gear ratio for pulling the most weight.

**UNIT 3.4: Wind Energy** (10 class periods)

**Purpose:** This unit is designed to allow students to apply their knowledge of energy, power, electricity, circuit analysis, and gear ratios to create a personal form of renewable energy. The students will have the opportunity to research wind energy and create their own design of a wind turbine. This will help students understand the possibilities that wind energy can offer.

**Objectives:** The student will be able to:

- Examine what is driving the increased use of wind energy.
- Explain why current methods of energy production are problematic.
- Identify and describe different types of wind turbines.
- Analyze wind turbine blade design.
- Explain the science behind wind.
- Analyze environmental impacts of wind energy.
- Design, create, and test a wind turbine.
- Utilize knowledge of gears to create a wind turbine that will create the most energy.
- Utilize knowledge of basic circuitry to wire a wind turbine.
- Create a circuit that will allow a wind turbine to illuminate lights and charge batteries.
- Incorporate wind energy into the design of a model home.

**UNIT 3.4: Solar Energy** (10 class periods)

**Purpose:** The purpose of this unit is to allow the students to explore the possibilities of solar energy. The students will be able to see how they can apply solar energy to their everyday lives.

**Objectives:** The student will be able to:

- Explain solar photovoltaic energy production and solar thermal water and air heating.
- Describe how photovoltaic cells take sunlight and convert it into electricity.

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- Examine how solar energy is incorporated into sustainable construction.
- Create a circuit to charge batteries using photovoltaic cells.
- Create a circuit that can possibly charge an iPod using solar energy.

**SECTION 4: SUSTAINABLE CONSTRUCTION SYSTEMS**

*25 Class Periods*

**UNIT 4.1: Introduction to Sustainable Construction** (1 class period)

**Purpose:** This unit is designed to provide a foundation of the principals of construction for the students to use in their future projects.

**Objectives:** The student will be able to:

- Explain that the design of structures includes a number of requirements.
- Explain that structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use.
- Explain that structures can include prefabricated materials.
- Analyze heavy engineering structures such as highways, rail lines, bridges, airports, canals, pipelines, power transmission and communication towers, and hydroelectric and flood control dams.
- Analyze types of buildings such as residential, commercial, and industrial.
- Analyze the steps in the construction process including preparing the site, setting foundations, building the framework, enclosing the structure, installing utilities, finishing the interior and exterior, and completing the site.

**Unit 4.2: The Art of Construction** (2 class periods)

**Purpose:** This unit is designed to allow the students to understand the basics of altering materials to withstand stronger forces in order to use them as effective structural members. This unit is an introduction to the principles of architecture.

**Objectives:** The student will be able to:

- Mathematically analyze shapes to determine types and magnitude of forces supported in different structural members.
- Explain the history of construction from caves to skyscrapers.
- Define, describe and analyze the stresses and forces acting on an object.
- Design, construct and test a model beam to support the greatest amount of weight.
- Prepare and present a mathematical analysis of structural designs.
- Compare and contrast live and dead loads.

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- Analyze how shape can change the strength of an object.
- Define and explain the forces that act upon structures.

**UNIT 4.3: Construction Materials** (2 class periods)

**Purpose:** This unit is designed to let the students explore the many different types of materials that we use in the construction industry every day. Students will analyze the applications and creation of various forms of construction materials.

**Objectives:** The student will be able to:

- Apply the basics of construction to the selection of materials.
- Compare the use of construction materials to their application.
- Describe the application of glass, concrete, stone, processed wood products, hardwoods, softwoods, brick, and metal in construction.
- Design ideas based on the physical properties of different materials.
- Define R value of materials.
- Synthesize construction ideas that properly and efficiently use the correct materials.
- Determine the differences between hardwoods and softwoods.
- Observe and analyze the process of lumber production.
- Define the terms involved in the logging process.
- Describe the different parts and layers of a tree.
- Determine the processes of steel production.
- Analyze the importance of Green building materials.

**UNIT 4.4: Green Construction** (2 class periods)

**Purpose:** The purpose of this unit is to introduce students to the ideas of sustainable and LEED certified construction technologies. This unit will help increase awareness of sustainability that is vital for the future of our planet. The unit is also designed to help students understand simple, old technologies and high tech new technologies that will benefit the environment and humans.

**Objectives:** The student will be able to:

- Plan to design and construct a model house using Green technologies.
- Evaluate forms of Green construction.
- Define and defend the definitions and principles of sustainability.
- Determine the benefits of sustainable and Green construction.
- Create ideas on building Green homes.
- Analyze the LEED grading practice and government benefits.
- Explore alternate sources of energy.

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**UNIT 4.5: Architectural Design** (7 class periods)

**Purpose:** The purpose of this unit is to allow students to utilize the engineering design process in the creation of single-family homes. The students will learn the fundamentals of brainstorming and architectural designing. The students will research construction basics and standards to use in their designs. The student will create bubble plans, floor plans, elevation views, and home walkthroughs using basic drafting skills and computer programs.

**Objectives:** The student will be able to:

- Utilize computer software to design a single family home and create virtual walkthroughs.
- Analyze and evaluate the standards in the design of a home.
- Use mathematical basics to develop appropriate design scale and to calculate square footage.
- Create bubble plans, floor plans, and elevation views of a house.
- Apply the fundamentals of architecture in the design of a single-family home.

**UNIT 4.6: Advanced Framing** (8 class periods)

**Purpose:** The purpose of this unit is to introduce student to the actual construction and framing of a home. The students will analyze advanced framing and Green construction techniques. With the acquired information the student will design a virtual house using computer software and then construct a model follow LEED guidelines.

**Objectives:** The student will be able to:

- Analyze and evaluate the standards in the design of a home.
- Use mathematical basics to develop appropriate design scale and to calculate square footage.
- Determine the benefits of Green construction and advance framing techniques.
- Analyze and apply the fundamentals of home construction in:
  - Building a basement
  - Framing floors
  - Framing walls
  - Framing roofs.
- Use the engineering design process to brainstorm, design and create a model home that meets the criteria of the design brief.
- Properly use advanced framing techniques.
- Calculate scales to create an accurate model home.
- Utilize computer design software to create floor plans and virtual walkthroughs of a model home.

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**UNIT 4.7: Sustainable Development** (3 class periods)

**Purpose:** The purpose of this unit is to allow students to put together all facets of sustainable technologies and apply it to the design of an entire city. The students can then see how all areas of construction and development work as a whole.

**Objectives:** The student will be able to:

- Design and construct a model sustainable city.
- Evaluate forms of Green construction.
- Evaluate forms of appropriate technology.
- Define and describe sustainable development.
- Determine the benefits of appropriate technology and Green construction.
- Create ideas on city development.
- Analyze the LEED grading practice and government benefits.
- Explore alternate sources of energy.

**SECTION 5: LEAN MANUFACTURING SYSTEMS**

*25 Class Periods*

**UNIT 5.1: Introduction to Manufacturing** (2 class periods)

**Purpose:** This unit is designed to introduce the students to manufacturing systems and processes. This unit will also focus on how manufacturing companies can work to be responsible in their waste of materials, use of energy, and product lifecycle.

**Objectives:** The student will be able to:

- Explore the manufacturing process of designing, development, making, and servicing products and systems.
- Classify manufacturing systems as customized production, batch production, and continuous production.
- Design forecasting techniques to evaluate the results of altering natural systems.
- Examine that materials have different qualities and may be classified as natural, synthetic, or mixed.
- Compare and contrast durable and non-durable goods.
- Define the mechanical processes that change the form of materials through the processes of separating, forming, combining, and conditioning them.
- Explain sustainable industry concepts.

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**Unit 5.2: Lean Manufacturing Enterprise** (23 class periods)

**Purpose:** This unit is designed to allow the students to set up their own manufacturing enterprise. The students will be assigned to different jobs in order to responsibly manufacture a product for a specific purpose. The students will design, create, test, manufacture, and market a product that is controlled for quality.

**Objectives:** The student will be able to:

- Explain the functionality of a manufacturing enterprise.
- Work together collaboratively to form a manufacturing company.
- Design a product to be mass-produced for a specific purpose.
- Produce multiple products that are controlled for quality.
- Create functional fixtures and jigs for creating a product.
- Market and package a product appropriately.

**SECTION 6: ALTERNATIVE TRANSPORTATION SYSTEMS**

*25 class periods*

**UNIT 6.1: Introduction to alternative transportation systems** (3 class periods)

**Purpose:** The purpose of this unit is to allow students to explore various transportation systems. The students will analyze the processes and systems of transportation. Students will also utilize the engineering design process to design and create alternative vehicles. Students will use mathematical formulas to calculate mechanical advantage, work, power, velocity, force, and momentum.

**Objectives:** The student will be able to:

- Describe how technological systems are interdependent with one another.
- Examine the process of how a product is transported from creation to home use.
- Define all modes of transportation.
- Identify the six subsystems of any vehicle.
- Examine types of motors and engines.
- Calculate force, mechanical advantage, power, velocity, acceleration, and momentum using mathematical formulas.
- Explore alternative types of transportation.
- Create a commercial on alternative transportation types.

**Unit 6.2: Alternative Fuels** (6 class periods)

**Purpose:** In this unit students will complete experiments on the burning of

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alternative fuel types. These experiments will be used to determine the positive and negative issues with each type of fuel. These results will be analyzed and compared to that of traditional fuel sources.

**Objectives:** The student will be able to:

- Utilize the scientific experiment process.
- Mathematically analyze different fuels types.
- Apply the results of experimentation to real world issues.
- Development opinions on fuel sources and usage.

**UNIT 6.3: Electric Vehicles** (8 class periods)

**Purpose:** This unit will introduce students to electric vehicles that that produce zero emissions. The students will analyze these vehicles and use the design process to create a model of one. The student must apply their knowledge of gears and basic electronics in order to create their vehicles. The students will also look at how their solar panels and wind turbines can be used to power these vehicles. The students can also create electric skateboards or bicycles powerful enough to transport an actual passenger.

**Objectives:** The student will be able to:

- Distinguish between the pros and cons of using electric powered vehicles.
- Investigate how electric powered vehicles can be used with other sources of energy, such as, solar power or hybrid electric technologies to lower the use of fossil fuels.
- Develop a design of an electric powered vehicle according to given criteria.
- Create 3D designs of an electric powered vehicle using computer design software.
- Apply knowledge of gears so an electric vehicle can complete the given challenges.
- Apply knowledge of basic electronics in order to power a vehicle using solar panels and wind turbines.
- Create an electric vehicle to transport a student as a passenger.

**UNIT 6.3: Hydrogen Fuel Cells** (8 class periods)

**Purpose:** This unit is designed for students to explore the functioning of hydrogen fuel cells. The students will create a hydrogen fuel cell vehicle that will be put to several challenges.

**Objectives:** The student will be able to:

- Distinguish between the pros and cons of using hydrogen fuel cells.

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- Investigate how hydrogen fuel cell vehicles can be used with other sources of energy, such as, solar power or hybrid electric technologies to lower the use of fossil fuels.
- Develop a design of a hydrogen fuel cell vehicle according to given criteria.
- Create 3D designs of a hydrogen fuel vehicle using computer design software.
- Apply knowledge of gears so a vehicle can complete the given challenges.
- Apply knowledge of basic electronics in order to power a vehicle using solar panels and wind turbines.