Advanced Design Applications

Description:	This course has been designed as an advanced study for students engaged in themed academies and general technology studies that lead to the capacity to understand how technology's development, control and use is based on design constraints, and human wants and needs. The structure of the course challenges students to use design processes so that they can think, plan, design and create solutions to engineering and technological problems. Students are actively involved in the organized an integrated application of technological resources, engineering concepts, and scientific procedures. This course consists of four units including Manufacturing, Energy and Power, Construction and Transportation Technologies. 1. The Manufacturing unit examines the advances that maintain manufacturing efficiency, how human consumption affects manufacturing and how process and changing raw materials can produce more desirable products. 2. The Construction unit examines a number of the factors influencing the design and construction of permanent and semi-permanent structures, the practices related to construction maintenance, alteration, and renovation and the functions of the primary systems installed in those structures. 3. The Energy and Power unit explores the relationship between energy and power technologies and all other technologies, and how they impact cultures, societies, and the environment. 4. The Transportation unit examines the complex networks of interconnect subsystems that each transportation system comprises and the roles of these components in the overall functional process of the system. The students will continue their education in Sciences, Technology, Engineering, and Mathematics (STEM) and will experience design engineering in the creation, synthesis, iteration, and presentation of design solutions. This course is designed to prepare high school students who plan to go on to community college technical education or university-level engineering programs. It will help students apply knowledge and skills required to create and transform ideas and concepts into a product that satisfies specific customer requirements in the four learning units.
Pre-requisites	Successful completion of Foundations of Technology Successful completion of Technological Issues Successful completion of Algebra 1 and Geometry Successful completion of Physical Science
Recommended Credits:	1
Recommended Grade Levels:	11^{th} – 12^{th}

ADVANCED DESIGN APPLICATIONS

Standard 1.0
Demonstrate leadership, citizenship, and teamwork skills required for success in the school, community and workplace through Technology Student Association.

Standard 2.0
Demonstrate personal and occupation safety relating to engineering design.

Standard 3.0
Demonstrate knowledge of and skills related to Manufacturing Technologies.

Standard 4.0
Demonstrate knowledge of and skills related to Construction Technologies.

Standard 5.0
Demonstrate knowledge of and skills related to Energy and Power Technologies.

Standard 6.0
Demonstrate knowledge of and skills related to Transportation Technologies.

ADVANCED DESIGN APPLICATIONS

STANDARD 1.0

Demonstrate leadership, citizenship, and teamwork skills required for success in the school, community and workplace through Technology Student Association.

LEARNING EXPECTATIONS

The student will be able to:

1.1 Exhibit positive leadership skills.
1.2 Participate in the Technology Student Association (TSA) as an integral part of classroom instruction.
1.3 Demonstrate the ability to work cooperatively with others in a professional setting.
1.4 Outline leadership skills and team building.
1.5 Identify personal, teamwork and leadership skills used in various occupations.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student should know and be able to:

1.1.1 Conduct a self-study of personal leadership and teamwork styles.
1.1.2 Identify and utilize the strengths of individuals to solve a problem as a team.
1.2.1 Explain the importance of the principles expressed in the TSA Motto and Creed.
1.2.2 Prepare a meeting agenda for a TSA monthly/weekly meeting.
1.3.1 Participate in and conduct meetings according to accepted rules of parliamentary procedure.
1.4.1 Participate in various TSA activities and/or competitive events.
1.5.1 Work with a team to develop, implement and evaluate the effectiveness of a community or school service project

SAMPLE PERFORMANCE TASKS

- Create a leadership inventory and use it to conduct a personal assessment.
- Participate in various TSA programs and/or competitive events.
- Evaluate an activity within the school, community, and/or workplace and project effects of the project.
- Implement an annual program of work.
- Prepare a meeting agenda for a TSA monthly/weekly meeting.
- Attend a professional organization meeting.
- Participate in a leadership conference for TSA.

INTEGRATION/LINKAGES

- International Technology Education Association – Center to Advance the Teaching of Technology and Science (ITEA-CATTS)
- Tech-Know Project Middle School Teacher's Guide A
- Tech-Know Project Middle School Teacher's Guide B
- Human Innovation Technology Series HITS
- Engineering Your Future Project Activities
- Technology Student Association Curriculum Resources Guide for Middle School and High School Events.

ADVANCED DESIGN APPLICATIONS

STANDARD 2.0
Safely use tools, materials, equipment and other technology resources.

LEARNING EXPECTATIONS

The student will be able to:
2.1 Successfully pass a test on general classroom, lab, and/or shop safety guidelines with 100% accuracy.
2.2 Successfully pass a test on the safe use of tools and equipment used in the lab and/or shop with 100% accuracy.
2.3 Successfully pass a test on the safety hazards that exist at home, school and in the workplace.
2.4 Using research relating to OSHA regulations conduct a safety inspection for a lab, school, or business.
2.5 List and explain the importance of safety guidelines for TSA competitive events.
2.6 Understand general laboratory safety rules and regulations when using tools, equipment and performing processes.
2.7 Understand safety, nomenclature and usage of all hand tools used in this course.
2.8 Understand and explain potential safety, chemical, electrical and fire safety hazards that exist in a Technology Engineering classroom and their school.
2.9 List all safety rules required when competing in specific TSA competitive events.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student should know and be able to:
2.1.1 Successfully pass a test on general classroom, lab, and/or shop safety guidelines with 100% accuracy.
2.2.1 Successfully pass a test on the safe use of tools and equipment used in the lab and/or shop with 100% accuracy.
2.3.1 Successfully pass a test on the safety hazards that exist at home, school and in the workplace.
2.4.1 Using research relating to OSHA regulations, conduct a safety inspection for a lab, school, or business.
2.5.1 List and explain the importance of safety guidelines for TSA competitive events.
2.6.1 Understand general laboratory safety rules and regulations when using tools, equipment and performing processes.
2.7.1 Understand safety, nomenclature and usage of all hand tools used in this course.
2.8.1 Understand and explain potential safety, chemical, electrical and fire safety hazards that exist in a Technology Engineering classroom and their school.
2.9.1 List all safety rules required when competing in specific TSA competitive events.

SAMPLE PERFORMANCE TASKS:

- Students successfully pass a written or oral test on fire safety.
- Students successfully pass a written test on all hand tools to be used in the laboratory.

INTEGRATION/LINKAGES

- International Technology Education Association – Center to Advance the Teaching of Technology and Science (ITEA-CATTS)
- Tech-Know Project Middle School Teacher's Guide A
- Tech-Know Project Middle School Teacher's Guide B
- Human Innovation Technology Series HITS
- Engineering Your Future Project Activities
- Technology Student Association Curriculum Resources Guide for Middle School and High School Events.

ADVANCED DESIGN APPLICATIONS

STANDARD 3.0
Demonstrate knowledge of and skills related to Manufacturing Technologies.

LEARNING EXPECTATIONS

The student will be able to:
3.1 Analyze and differentiate between materials and processes utilized to manufacture a variety of products.
3.2 Utilize appropriate design principles while developing an automated manufacturing machine.
3.3 Expose students to how customer, societal, and environmental concerns affect the design of products.
3.4 Explore factors that affect the quality control in manufacturing processes.
3.5 Utilize the applications of the engineering design model and a set of design principles that will guide thinking while solving technological problems.
3.6 Focus on the use of microprocessors that are used in computer integrated manufacturing environments and apply knowledge of basic electronics and circuitry.
3.7 Interact with different types of sensors and explain their functions with the manufacturing process.
3.8 Understand why relays are used and how they work in manufacturing systems.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student should know and be able to:

3.1.1 Identify and explain how external factors affect the design of a product before it is manufactured.
3.1.2 Identify and explain what a spinoff is.
3.1.3 Identify and explain the function of a trade-off.
3.2.1 Identify how people, materials, tools and training affect product quality.
3.2.2 Explain how quality control is affected by input and output factors when applied to a manufacturing process.
3.2.3 Develop examples of criteria and constraints that affect a product design.
3.2.4 Acquire and organize data needed in the creation of a product design solution.
3.3.1 Develop and conduct a product survey including an analysis of the acquired data.
3.3.2 Give examples of the impacts that available and engineered materials have had on the design of products.
3.4.1 Apply design characteristics to the development of a product.
3.4.2 Develop a working drawing and pictorial of a product design using standard technical drawing conventions.
3.4.3 Identify and demonstrate the use of scales and precision measuring tools used in the design and manufacture of products.
3.4.4 Estimate the cost of manufacturing a product.
3.4.5 Construct a jig or fixture for use in manufacturing a product.
3.4.6 Develop a production process flow chart for the assembly of a product.
3.5.1 Create a manufacturing scenario that uses CAD/CAM technologies for the development and production of a product.
3.5.2 Understand why relays are used and how they work.
3.5.3 Create a single, pole, single throw relay.
3.5.4 Use a dip relay to control a solenoid valve.
3.5.5 Use a schematic to design a servo motor.
3.6.1 Focus on the use of microprocessors that are used in computer integrated manufacturing environments and apply knowledge of basic electronics and circuitry.
3.7.1 Interact with different types of sensors and explain their functions with the manufacturing process.
3.8.1 Understand why relays are used and how they work in manufacturing systems.

ADVANCED DESIGN APPLICATIONS

SAMPLE PERFORMANCE TASKS:

- Students will design a Lunchable (Oscar Meyer product) box that can be used b adults in a business environment. They will illustrate their ideas on a piece of flow chart paper and share their ideas with the class. (TE: Pgs. 21-25)
- In groups, design a soap container and determine soap types. (TE: Pgs 13-16; 26-28)
- Students in groups of 4 will look at product and design of packaging. TE: Pgs. 29-34)
- In teams, students create a jig to check the length of paper clips. They will provided with samples of different types of jigs or Internet access to conduct research to find their own examples. (TE: Pgs. 46 – 48)
- The class will be divided into teams of 5-7 students. Each team should receive one disassembled flashlight.
- From the subcomponents and the constraints listed in the Student Guide, students are to design and create a human assembly line that considers the five basic design principles. (TE: Pgs. 66-80)
- Build and Manipulate a Servo Motor System. TE: Pgs. 107-117)

INTEGRATION/LINKAGES

- International Technology Education Association – Center to Advance the Teaching of Technology and Science (ITEA-CATTS)
- Tech-Know Project Middle School Teacher's Guide A
- Tech-Know Project Middle School Teacher's Guide B
- Human Innovation Technology Series HITS
- Engineering Your Future Project Activities
- Technology Student Association Curriculum Resources Guide for Middle School

ADVANCED DESIGN APPLICATIONS

STANDARD 4.0
Demonstrate knowledge of and skills related to Construction Technologies.

LEARNING EXPECTATIONS

The student will be able to:
4.1 Individually design a house to meet certain criteria provided by a hypothetical client.
4.2 Understand the techniques and tools used in technical drawing and modeling.
4.3 Analyze and design the elements for a new or existing neighborhood that promote positive and negative interactions between residents of a community.
4.4 Identify the infrastructural systems that are involved in most large-scale construction.
4.5 Identify and describe the key ideas of how green building trends are changing the way residential buildings are being designed and built.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student should know and be able to:
4.2.1 Identify and demonstrate the use of scales and measuring devices commonly used by civil engineers and architects.
4.2.2 Design a structure and then create a scaled drawing and three-dimensional model of the design.
4.3.1 Analyze the elements of community architecture that affect interaction between residents.
4.3.2 Design appropriate features that encourage community interaction within a new or existing neighborhood.
4.4.1 Identify the infrastructural elements of a city.
4.4.2 Explain the ways in which infrastructural elements are chosen, designed, constructed, and regulated.
4.4.3 Specified criteria develop a concept plan for a planned development.
4.4.4 Specified criteria design and draw floor plans of a residence.
4.4.5 Sketch elementary construction details such as foundations, framing, roofing, and sheathing.
4.4.6 Identify the key concepts used in green building.
4.5.1 Design and create a model depicting a building method that demonstrates the application of energy-saving and efficient techniques such as OVE framing
4.5.2 Prepare a report or presentation on local zoning laws and issues.

SAMPLE PERFORMANCE TASKS:

- Have your students create concept maps of the unit in their Inventor's Logbook.
- Create a scale model of the existing site.
- Design the common space and community elements for the development.
- Design overall land use, including infrastructure.
- Design and model specific building techniques.
- Build full-size examples of framing methods consistent with green building standards.

INTEGRATION/LINKAGES

- International Technology Education Association – Center to Advance the Teaching of Technology and Science (ITEA-CATTS)
- Tech-Know Project Middle School Teacher's Guide A
- Tech-Know Project Middle School Teacher's Guide B
- Human Innovation Technology Series HITS
- Engineering Your Future Project Activities
- Technology Student Association Curriculum Resources Guide for Middle School

ADVANCED DESIGN APPLICATIONS

STANDARD 5.0
Demonstrate knowledge of and skills related to Energy and Power Technologies.

LEARNING EXPECTATIONS

The student will be able to:
5.1 Build and experiment with different energy and power systems.
5.2 Examine issues related to ethical, environmental, social and political influences behind the energy and power choices we make.
5.3 Utilize simple electronics equipment to provide basic introduction to the theory of electricity.
5.4 Explore and test simple fluid and mechanical power systems.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student should know and be able to:
5.1.1 Explain how wind and water are used to generate electricity.
5.1.2 Explain how kinetic and potential energies can be used to create new energy sources.
5.1.3 Identify the primary sources of fuel that are used most often to power electric generation plants in Tennessee.
5.2.1 Use print and electronic sources to create a graphic and text based timeline of a specific source of energy.
5.2.2 Explain how a technology can cause both good and harm and how do humans prepare for or respond these impacts?
5.2.3 Prepare a report or presentation on the positive and negative impacts of various current and emerging energy sources.
5.2.3 Create and deliver an electronic presentation on new energy sources that will help save the environment.
5.2.4 Build a simple electric generator that meets certain specifications.
5.3.1 Construct working electronic circuits from a diagram.
5.3.2 Demonstrate a complete understanding of the proper use of measuring devices.
5.3.3 Draw a schematic for an electrical device.
5.3.4 Construct and test electrical circuits that utilize parallel and series connections.
5.3.5 Build a complete electrical circuit using a circuit board or other available components.
5.4.1 Sketch and build a three-dimensional model that demonstrates how mechanical systems can be used to provide energy or power.

SAMPLE PERFORMANCE TASKS:

- Divide the students into teams you feel are appropriate. Cover safety rules and /or demonstrations at this time. Teams will create a poster or another appropriate presentation of their energy source for use during an energy roundtable. The roundtable is meant to be a brief session where each team is allowed 3 to 5 minutes to present and discuss its energy devices and things that the students learned while building the devices.
  Device 1 - Steam Powered Hero Engine4 teams will be choose and they will Design and build a hydroelectric power generator. (EPT-TE: Pgs. 8-10)
  Device 2 – Stirling Cycle Engine (EPT-TE: Pgs. 11-15)
  Device 3 – Solar Powered Fan (EPT-TE: Pgs. 16-17)
  Device 4 – Wind Generator (EPT-TE: Pgs. 18-20)
  Device 5 – Battery Model (EPT-TE: Pgs. 21-25)
- After conducting some research on aqueduct and canal systems, you will use your new knowledge to design and construct a model aqueduct system that will raise water a height of twelve inches over a course of six feet. This will require the use of various mechanical and/or hydraulic power systems. Make sure that you utilize the design problem-solving process to solve this engineering design problem.

ADVANCED DESIGN APPLICATIONS

INTEGRATION/LINKAGES

- International Technology Education Association – Center to Advance the Teaching of Technology and Science (ITEA-CATTS)
- Tech-Know Project Middle School Teacher's Guide A
- Tech-Know Project Middle School Teacher's Guide B
- Human Innovation Technology Series HITS
- Engineering Your Future Project Activities
- Technology Student Association Curriculum Resources Guide for Middle School

ADVANCED DESIGN APPLICATIONS

STANDARD 6.0
Demonstrate knowledge of and skills related to Transportation Technologies.

LEARNING EXPECTATIONS

The student will be able to:
6.1 Understand and define the four modes of transportation technology.
6.2 Explain the principles of appropriate technology and how to analyze the risks and benefits of a transportation design.
6.3 Calculate and determine distance and direction.
6.4 Describe how structure and support systems are related within a transportation device and how both systems affect passenger and cargo safety.
6.5 Explore the technical concept of control and begin to understand how these controls are applied to transportation systems.
6.6 Explore and understand the concepts of torque, gear trains, gear ratios, and how to increase and decrease the torque of a small electric motor.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student should know and be able to:
6.1.1 Research and define the four modes of transportation; terrestrial, marine, atmospheric, and space.
6.2.1 Design and build an appropriate technology device using pedal power from recyclable or freely obtained resources.
6.2.2 Explain the principles of appropriate technology.
6.2.3 Determine how to analyze the risks and benefits of a transportation design.
6.2.4 Develop an operations and maintenance manual that ensures that another student or team will be able to county you selected will be able to use and repair the device.
6.3.1 Calculate distances using mathematics and the Pythagorean Theorem.
6.3.2 Construct and determine the accuracy of a transit.
6.4.1 Design, test and analyze a vehicle's suspension system.
6.4.2 Describe how structural systems in a personal vehicle affect passenger and cargo safety.
6.4.3 Describe how suspension systems in a personal vehicle affect passenger and cargo safety.
6.4.4 Identify at least one example where each suspension system is used in real transportation devices.
6.5.1 Utilize a variety of systems for controlling distance and direction of a vehicle.
6.5.2 Analyze the relationship between force and distance, using mechanical systems.
6.5.3 Properly select control systems for a given application.
6.5.4 Design and build a carriage system.
6.6.1 Conduct a torque experiment.
6.6.2 Experiment with gears and gear configurations.
6.6.3 Design and build a vehicle to pull with the greatest force.

SAMPLE PERFORMANCE TASKS:

- In teams of 4 or 5 assigned by the instructor, students will be constructing an appropriate technology device using pedal power; such as, concrete mixers, generators, corn grinders, and water pumps.
- Create a presentation that includes a demonstration of your device, the merits of your designed solution, and the potential positive and negative effects of implementing your solution on the country of your choice.
- Identify additional political and social decisions that have affected passenger safety that were not identified in Reflection I and describe the impact(s) of those decisions.
- Conduct research and develop a report or presentation about the latest safety features that appear in your favorite automobile. Choose one of these features and follow its history and development from conception to its presence in your favorite car.
- Conduct research and write a report or give a presentation about the historical development of child-restraining devices.
- Construct three different levers (one from each class) illustrating how to measure force.

ADVANCED DESIGN APPLICATIONS

PERFORMANCE TASKS:

- Design and construct a Rube Goldberg contraption (i.e., a device that strings together a number of steps to do simple tasks in the most complicate way possible) that incorporates at least two different classes of levers to control parts of the contraption.
- Set up an experiment to measure the torque produced by a bicycle in various gears.
- Prepare a presentation about torque and gear trains suitable for a middle school technology, mathematics, or science class and volunteer to make a presentation at a middle school or to another academic class in your high school.
- Find a discarded device that contains gears and take it apart. Using reverse engineering, find out why gears were used in the device and what gear ratios were for each gear train.

INTEGRATION/LINKAGES

- International Technology Education Association – Center to Advance the Teaching of Technology and Science (ITEA-CATTS)
- Tech-Know Project Middle School Teacher's Guide A
- Tech-Know Project Middle School Teacher's Guide B
- Human Innovation Technology Series HITS
- Engineering Your Future Project Activities
- Technology Student Association Curriculum Resources Guide for Middle School