Advanced Energy Systems Management
Subject Code: 010715
Course & Unit Descriptions

Course Description:
Students will apply basic principles of energy accounting, thermodynamics and heat transfer, energy conversion and efficiency to heating, power generation and transportation. Students will apply the principles and practices needed for managing renewable energy sources including, solar thermal, hydrogen generation, photovoltaic, wind, and biomass use. Future energy systems and energy use scenarios are investigated, with a focus on promoting the use of renewable energy resources and technologies.

Unit: Environmental Aspects of Renewable Energy

Students will analyze the positive and negative effects renewable energy may have on our environment. Students will research the purpose and impact government regulations and laws have on the installation of renewable energy processing centers. Students will perform presentations on local and national issues surrounding renewable energy.

Benchmark: 3.10 Business Regulation, Law and Related Issues
Level 1: Identify and describe government regulations and societal issues related to a specific business enterprise or environmental project.
Level 2: Determine the impact of government regulations and societal issues on an environmental project or on the performance of a business enterprise.

Indicators:
3.10.6 Identify governmental agencies and non-governmental organizations that impact agriculture and environmental issues.
3.10.7 Research the history, politics and policies related to issues.
3.10.8 Assess the impact of issues affecting the industry, and recommend solutions.

Academic Standards

English:	Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing). (Reading Process B, 8-10; Reading Process B, 11-12) Analyze the features and structures of documents and critique them for their effectiveness. (Reading Applications: Informational, Technical and Persuasive Text A, 11-12) Compile, organize and evaluate information, take notes and summarize findings. (Research B, 11-12)
Math:	Construct convincing arguments based on analysis of data and interpretation of graphs. (Data Analysis and Probability F, 8-10) Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner. (Mathematical Processes H, 8-10)
Social Studies:	Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment. (Geography B, 11-12)

Obtain and evaluate information from public records and other resources related to a public policy issue. (Social Studies Skills and Methods A, 11-12)
Critique data and information to determine the adequacy of support for conclusions. (Social Studies Skills and Methods B, 11-12)

Benchmark: 5.3 Ecosystems
Level 1: Identify ecosystems, and compare the components of ecosystems.
Level 2: Inventory and evaluate the habitats of specific ecosystems.

Indicators:
5.3.1 Explain and illustrate basic ecological principles and cycles (e.g., nitrogen cycle, food web, energy pyramid).
5.3.2 Explain biotic (plant and animal) interactions with the abiotic (non-living) environment.
5.3.3 Differentiate between renewable and nonrenewable components of ecosystems.
5.3.4 Model positive environmental practices for sustainability of resources.
5.3.5 Inventory and evaluate the characteristics of different ecosystems (e.g., pond, stream, crop lands, open land, brush lands, grasslands, woodlands, wetlands).
5.3.6 Discuss restoration ecology and its role in repairing damaged landscapes.
5.3.7 Identify and contrast biomes globally.
5.3.8 Determine the factors that affect ecological succession.
5.3.9 Determine the impact that native and non-native invasive species have on ecosystems.

Academic Standards:
Math: Construct convincing arguments based on analysis of data and interpretation of graphs. (Data Analysis and Probability F, 8-10)
Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner. (Mathematical Processes H, 8-10)
Science: Explain that many processes occur in patterns within the Earth's systems. (Earth and Space Sciences B, 9-10)
Explain the flow of energy and the cycling of matter through biological and ecological systems (cellular, organismal and ecological). (Life Sciences D, 9-10)
Explain the structure and function of ecosystems and relate how ecosystems change over time. (Life Sciences F, 9-10)
Describe how human activities can impact the status of natural systems. (Life Sciences G, 9-10)
Relate how biotic and abiotic global changes have occurred in the past and will continue to do so in the future. (Life Sciences D, 11-12)
Explain the interconnectedness of the components of a natural system. (Life Sciences E, 11-12)
Social Studies: Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment. (Geography B, 11-12)
Use appropriate data sources and geographic tools to analyze and evaluate public policies. (Geography C, 11-12)
Critique data and information to determine the adequacy of support for conclusions. (Social Studies Skills and Methods B, 11-12)

Unit: Site Selection

Following local, state, and national regulations, students will identify locations where alternative energy processing centers can be designed and built. Students will use design and build principles along with surveying and mapping to determine layout and designs. Students will research local government and societal issues to determine if a site is suitable for construction.

Benchmark: 3.10 Business Regulation, Law and Related Issues
Level 1: Identify and describe government regulations and societal issues related to a specific business enterprise or environmental project.
Level 2: Determine the impact of government regulations and societal issues on an environmental project or on the performance of a business enterprise.

Indicators:
3.10.2 Explain the purpose and impact of government regulations.
3.10.3 Identify local, state and federal regulations relative to compliance.
3.10.4 Assess business liability, and describe the consequences of noncompliance.
3.10.5 Adhere to business related documentation requirements.
3.10.6 Identify governmental agencies and non-governmental organizations that impact agriculture and environmental issues.

Academic Standards

English: Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing). (Reading Process B, 8-10; Reading Process B, 11-12)
Analyze the features and structures of documents and critique them for their effectiveness. (Reading Applications: Informational, Technical and Persuasive Text A, 11-12)
Compile, organize and evaluate information, take notes and summarize findings. (Research B, 11-12)

Math: Construct convincing arguments based on analysis of data and interpretation of graphs. (Data Analysis and Probability F, 8-10)
Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner. (Mathematical Processes H, 8-10)

Social Studies: Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment. (Geography B, 11-12)
Obtain and evaluate information from public records and other resources related to a public policy issue. (Social Studies Skills and Methods A, 11-12)
Critique data and information to determine the adequacy of support for conclusions. (Social Studies Skills and Methods B, 11-12)

Benchmark: 4.10 Design and Estimate
Level 1: Utilize the elements and principles of design for an agriculture application.
Level 2: Design a basic agriculture application for a desired outcome.

Indicators:
4.10.1 Identify, interpret and use symbols, lines, dimensions, views, sections, site plans, floor plans, specifications, common scales, detail drawings and abbreviations on drawings and prints.
4.10.2 Complete a site inventory and analysis (e.g., physical conditions, design needs, code requirements, environmental impact, utilities requirements).
4.10.3 Develop a program list, including intended use, budget, economics, customer wants and needs, and maintenance.
4.10.7 Calculate the space requirements, and compute various attributes, including length, angle measurement, surface area and volume.
4.10.8 Prepare sketches, drawings, prints, specifications and construction details.
4.10.10 Identify construction documents, common scales and specifications, and select materials used in construction or fabrication.
4.10.11 Estimate material, construction and equipment needs and costs.
4.10.12 Establish the sequential steps of construction and installation.

Academic Standards

English: Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly. (Writing Applications C, 11-12)
Evaluate how features and characteristics make information accessible and usable and how structures help authors achieve their purposes. (Reading Applications: Informational, Technical and Persuasive Text A, 8-10)

Math: Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions. (Number, Number Sense and Operations G, 8-10)
Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision. (Measurement E, 8-10)
Write and solve real-world, multi-step problems involving money, elapsed time and temperature, and verify reasonableness of solutions. (Measurement F, 8-10)
Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators. (Data Analysis and Probability A, 11-12) Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner. (Mathematical Processes H, 8-10)
Apply mathematical modeling to workplace and consumer situations, including problem formulation, identification of a mathematical model, interpretation of solution within the model, and validation to original problem situation. (Mathematical Processes J, 11-12)

Social Studies: Use appropriate data sources and geographic tools to analyze and evaluate public policies. (Geography C, 11-12)
Critique data and information to determine the adequacy of support for conclusions. (Social Studies Skills and Methods B, 11-12)

Benchmark: 4.11 Surveying and Mapping

Level 1: Interpret maps and topographic site plans.
Level 2: Use surveying equipment to construct a basic site plan.

Indicators:

4.11.1 Identify civil drafting symbols and abbreviations.
4.11.2 Read maps, topographic site plans, deeds, and/or aerial and/or satellite imagery.
4.11.3 Perform site measurements.

Academic Standards

English: Use multiple resources to enhance comprehension of vocabulary. (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)
Analyze whether graphics supplement textual information and promote the author's purpose. (Reading Applications: Informational, Technical and Persuasive Text C, 8-10)

Math: Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions. (Number, Number Sense and Operations G, 8-10)
Use proportional reasoning and apply indirect measurement techniques, including right triangle trigonometry and properties of similar triangles, to solve problems involving measurements and rates. (Measurement D, 8-10)
Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision. (Measurement E, 8-10)
Use trigonometric relationships to verify and determine solutions in problem situations. (Geometry and Spatial Sense A, 11-12)
Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner. (Mathematical Processes H, 8-10)

Social Studies: Use appropriate data sources and geographic tools to analyze and evaluate public policies. (Geography C, 11-12)

Unit: Biomass

Students will analyze ethanol, biodiesel, and anaerobic digestion as a renewable energy source. Students will describe the chemical reactions and physical processes that occur during processing. Following industry standards, students will convert biomass feedstocks to biofuel products and test for quality.

Benchmark: Manufactured Fuels from Biomass – (i.e. Alcohols, Biodiesel, Methane, Biolubricants, Biological Hydrogen)
Level 1:
Level 2:

Indicators
1. Describe the physical properties and technical standards of biofuels
2. Identify feedstocks used to produce biofuels and compare the efficiencies of each.
3. Pretreat feedstocks in preparation of processing and test for quality factors
4. Describe the chemical reactions and physical processes that occur during the manufacturing process.
5. Describe and differentiate manufacturing processes and equipment used to convert biomass to biofuel products.
6. Convert biomass feedstocks to biofuel products.
7. Identify the coproducts generated in the production of biofuels and apply methods for their extraction.
8. Describe primary applications for biofuels
9. Describe systems used for distributing and storing biofuels
10. Test for quality factors in final product

Academic Standards
English:
Math:
Science:

Unit: Principles of Electricity

Students will demonstrate how electricity works along with the components that go with the collection, storage, and distribution of electrical power and their supply systems. Students will interpret wiring diagrams, install electrical wiring and equipment. Students will measure the amperage, volts, watts, and resistance in electrical systems.

Benchmark: 4.7 Electrical and Electronic Systems
Level 1: Identify, inspect and test electrical systems.
Level 2: Diagnose and repair electrical systems.

Indicators
4.7.1 Interpret symbols and wiring diagrams.
4.7.2 Analyze, diagnose and test electrical systems and components (e.g., charging, starting, lighting, accessories, ignition systems).
4.7.4 Utilize electrical testing equipment.
4.7.6 Remove, inspect. and repair and/or replace electrical system components.
4.7.7 Describe the features, benefits and applications of electrical systems.
4.7.8 Apply principles of electricity to electrical systems and motors.
4.7.10 Identify, analyze, diagnose and test electronic control systems, sensors and actuators.

Academic Standards

English: Use multiple resources to enhance comprehension of vocabulary. (Acquisition of Vocabulary F, 8-10; Acquisition of Vocabulary E, 11-12)

Math: Explain differences among accuracy, precision and error, and describe how each of those can affect solutions in measurement situations. (Measurement A, 11-12)
Apply various measurement scales to describe phenomena and solve problems. (Measurement B, 11-12)
Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations. (Patterns, Functions and Algebra D, 8-10)

Science: Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems. (Physical Sciences D, 11-12)
Explain the ways in which the processes of technological design respond to the needs of society. (Science and Technology A, 9-10)

Benchmark: 4.14 Electrical

Level 1: Identify tools and materials, draw a wiring diagram of a circuit, and install the circuit.
Level 2: Develop a schematic that illustrates the kind, number and location of outlets and switches in a wiring system, and install the design.

Indicators

4.14.1 Describe the theory of producing electricity (the relationships among amperes, volts and watts; ohms law).
4.14.2 Compare and contrast AC and DC electrical systems and system components.
4.14.3 Measure the amperage, volts, watts and resistance in AC and DC electrical systems and system components.
4.14.4 Calculate service requirements for electrical systems.
4.14.5 Describe distribution system components.
4.14.6 Determine the types of branch circuits needed in a wiring system.
4.14.7 Determine the kind, size, number and location of wiring system components (e.g., outlets, switches, lights, wire, circuit breakers, motors).
4.14.8 Prepare and connect wires with appropriate fasteners and anchors to receptacles, switches and fixtures, to standards of the electrical industry.
4.14.9 Explain the color coding of electrical connections.
4.14.10 Install and identify over-current protective devices.
4.14.11 Install and service low-voltage systems (e.g., control systems and lighting systems).

Academic Standards

Math: Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions. (Number, Number Sense and Operations G, 8-10)
Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision. (Measurement E, 8-10)

Science: Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance. (Physical Sciences C, 9-10) Explain the ways in which the processes of technological design respond to the needs of society. (Science and Technology A, 9-10)

Unit: Wind Energy

Students will learn the importance of wind energy as an alternative energy source by identifying the processes of collecting, storing, and distributing wind energy and accompanying systems. Students will

determine what type of wind collection system is needed by testing environmental and geographical factors surrounding an area by performing site surveys.

Benchmark: Energy – Wind used to convert wind for use in energy production.
Level 1:
Level 2:

Indicators

1. Describe environmental and geophysical factors that influence the amount and availability of light, wind, heat and water for use in energy production.
2. Identify social and economic factors that influence the development and use of alternative energy.
3. Describe and differentiate types of technology used to convert light, wind, heat and water for use in energy production (Size and scale seems to be something to consider)
4. Describe the function and operation of technology used to convert light, wind, heat and water for energy production
5. Identify and describe technology used for distributing and storing captured energy
6. Obtain and interpret data to establish performance expectations for use in systems calculations.
7. Quantify electrical load and energy use and energy needs.
8. Conduct a site survey and collect relevant data to determine suitable locations for installation of technology
9. Identify appropriate system design and establish timeline, sequence, material and equipment required for installation.
10. Install and label equipment using drawings, schematics and recommended procedures.
11. Adapt mechanical and electrical designs to installation needs.
12. Program, adjust and configure installed equipment
13. Perform a system checkout and inspection
14. Measure system performance and operating parameters and compare with specifications and expectations, and assess operating condition of system and equipment.

Academic Standards
Math:
Science:
Social Studies:

Benchmark: 4.3 Equipment Operation
Level 1: Inspect and safely operate precalibrated equipment.
Level 2: Inspect and safely operate specialized equipment with some limitations to adjustments and functions.

Indicators:

4.3.1 Follow manufacturer's recommended operating procedures and adjustment specifications.
4.3.2 Describe the functions, limitations and proper use of equipment, equipment controls and instrumentation.
4.3.3 Perform pre-operation inspection and adjustments.
4.3.4 Perform appropriate startup, operating and shutdown procedures.
4.3.5 Identify, select and exhibit the desired application of hand and power tools.
4.3.6 Perform post-operating inspections and adjustments.

Academic Standards

English: Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing). (Reading Process B, 8-10; Reading Process B, 11-12)
Use appropriate self-monitoring strategies for comprehension. (Reading Process C, 8-10; Reading Process C, 11-12)
Math: Apply mathematical knowledge and skills routinely in other content areas and practical situations. (Mathematical Processes B, 8-10)

Unit: Solar Energy

Students will learn the importance of solar energy from sunlight as an alternative energy source by analyzing the processes of collecting, storing, and distributing solar energy. Students will determine if a site is suitable for a solar collection system by researching environmental and geographical factors. Students will explain and demonstrate the uses of photovoltaic cells. Students will adapt mechanical and electrical designs to installation such as water distribution systems.

Benchmark: Energy – Solar, Wind, Geothermal, Hydro – used to convert light, wind, heat and water for use in energy production.
Level 1:
Level 2:

Indicators

1. Describe environmental and geophysical factors that influence the amount and availability of light, wind, heat and water for use in energy production
2. Identify social and economic factors that influence the development and use of alternative energy.
3. Describe and differentiate types of technology used to convert light, wind, heat and water for use in energy production (Size and scale seems to be something to consider)
4. Describe the function and operation of technology used to convert light, wind, heat and water for energy production
5. Identify and describe technology used for distributing and storing captured energy
6. Obtain and interpret data to establish performance expectations for use in systems calculations.
7. Quantify electrical load and energy use and energy needs.
8. Conduct a site survey and collect relevant data to determine suitable locations for installation of technology
9. Identify appropriate system design and establish timeline, sequence, material and equipment required for installation.
10. Install and label equipment using drawings, schematics and recommended procedures.
11. Adapt mechanical and electrical designs to installation needs.
12. Program, adjust and configure installed equipment
13. Perform a system checkout and inspection
14. Measure system performance and operating parameters and compare with specifications and expectations, and assess operating condition of system and equipment.

Academic Standards
English:
Math:
Science:
Social Studies:

Benchmark: 4.15 Water Distribution Systems
Level 1: Identify tools and materials, design a water supply line with fixtures, and install it.
Level 2: Design and install a basic water and wastewater distribution system using multiple zones.

Indicators:
4.15.2 Identify the common components of a water distribution system, and describe their functions.
4.15.3 Describe the types and operating principles of pumps and controls used in water supplies.
4.15.5 Detect, test and repair problems in the water supply system.
4.15.7 Install water supply and treatment systems with both plastic and metal components.
4.15.8 Perform pressure and leak tests on water supply and drainage systems.

4.15.9 Describe the types and sources of contamination in water supplies (i.e., fuel storage tanks, septic systems, pesticide mixing areas, hazardous waste, manure storage, livestock yard and silage effluent) and methods for disinfecting water.
4.15.10 Protect pipes from freezing and mechanical damage.

Academic Standards

Math: Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions. (Number, Number Sense and Operations G, 8-10)
Use proportional reasoning and apply indirect measurement techniques, including right triangle trigonometry and properties of similar triangles, to solve problems involving measurements and rates. (Measurement D, 8-10)
Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision. (Measurement E, 8-10)

Science: Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources. (Earth and Space Sciences D, 9-10)
Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future. (Earth and Space Sciences C, 11-12)
Explain the ways in which the processes of technological design respond to the needs of society. (Science and Technology A, 9-10)
Predict how human choices today will determine the quality and quantity of life on Earth. (Science and Technology A, 11-12)

Unit: Equipment Maintenance

Students will inspect and perform maintenance to basic machinery and instruments used on stationary and mobile equipment used in the production and operation of renewable energy facilities. Students will inspect and safely operate specialized equipment with some limitations to adjustments and functions

Benchmark: 4.2 Stationary and Mobile Equipment Maintenance
Level 1: Inspect and provide primary maintenance to basic machinery, instruments, stationary and mobile equipment and facilities.
Level 2: Inspect and maintain specialized machinery and equipment according to schedule.
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Indicators:
4.2.1 Perform a machine condition inspection.
4.2.2 Lubricate machinery and equipment.
4.2.3 Ensure the presence and functionality of safety systems and hardware.
4.2.4 Service basic electrical systems (e.g., fuses and bulbs).
4.2.5 Perform machine adjustments (e.g., belts, clippers, drive chains).
4.2.6 Service filtration systems.
4.2.7 Identify, select and maintain fluid levels.
4.2.8 Maintain machinery, equipment, instruments and facility cleanliness, appearance and safety.
4.2.9 Inspect and maintain fluid conveyance and storage components (e.g., hoses and lines, valves, nozzles).
4.2.10 Conduct preventative maintenance, and identify causes of malfunctions and failures.
4.2.11 Calibrate metering, monitoring and sensing equipment.
4.2.12 Inspect and maintain tooling.
4.2.13 Maintain lifting equipment (e.g., cranes, chains, slings).

Academic Standards

English: Use appropriate self-monitoring strategies for comprehension. (Reading Process C, 8-10; Reading Process C, 11-12)

Math: Apply mathematical knowledge and skills routinely in other content areas and practical situations. (Mathematical Processes B, 8-10)

The following safety indicators are embedded and assumed throughout the whole course.

Benchmark: 4.1 Safety Procedures
Level 1: Follow safety procedures in general situations with basic tools and equipment, evaluate the work environment, and seek assistance to rectify the problem.
Level 2: Follow safety procedures in specific situations with specialized tools and equipment, evaluate the situation, and take corrective action.

Indicators:
4.1.1 Demonstrate knowledge of safety rules and regulations.
4.1.2 Interpret safety signs and symbols.
4.1.3 Model safe attitudes and behaviors (e.g., lifting, climbing).
4.1.4 Identify safety hazards, and take corrective measures.
4.1.5 Use safety equipment in accordance with established procedures.
4.1.6 Follow established procedures for the administration of first aid, and contact emergency medical personnel when necessary.