ENGT 2801  Principles of Energy Management (3 Semester Credit Hours)

I. Course Overview: Energy is consumed by every member of society, yet knowledge of its sources, impact on the environment and the economy as well as its general outlook is not common. It is important that members of society become more knowledgeable about energy issues if they have to participate fully in our democracy. This course is an energy literacy course that attempts to introduce non-technical/non-vocational students to the principles of energy management. It provides an overview of the energy industry and the worldwide energy outlook. The various forms of energy, the dynamics of energy consumption and growth, and the principle methods of energy usage are discussed. Also covered in this course are the environmental and economic impacts and consequences of energy production and use.

II. Expected Learning Outcomes: The central objective of this course is to equip the student with the knowledge and skills required to participate in the democratic decision making process about energy. The student who successfully completes this course will therefore become informed about the dynamics of worldwide energy consumption and growth; become aware of the environmental and economic impacts and consequences of the use of various forms of energy; and become knowledgeable of the fundamental methods of energy use. Additionally, students who successfully complete the course will be able to:

- Demonstrate ability to manage energy effectively
- Differentiate between the various forms of energy
- Classify energy sources based on their environmental impacts
- Classify energy sources based on their cost efficiencies
- Locate world fossil fuel reserves on the map
- Make a reasonable projection of world energy consumption and growth
- Discuss energy and global politics

III. General Information for Students:

Textbook: The primary textbook for this course is “Introduction to Energy: Resources, Technology, and Society; 2nd Edition” by Edward S. Cassedy and Peter Z. Grossman, Cambridge University Press. Reference materials are listed in the pertinent module syllabi. Students are advised to see the department’s student handbook and the university catalogue for applicable rules and regulations as the classes for this course will be conducted strictly according to those rules and regulations. Other rules of conduct may be announced by the instructor.

Prerequisites: Sophomore Standing. This course cannot be used to meet degree requirements in engineering technology or engineering.

IV. Instruction Units/Modules: This course is designed to develop the cognitive skills of the learner. No extensive laboratory exercises other than demonstrations by the instructor are involved. A full description of each of the following units of instruction covered in the course is given in the module syllabus:

- Unit 1. – Forms of energy and energy resources
- Unit 2. – Conventional methods of energy conversion
- Unit 3. – World energy demand
- Unit 4. – Global perspectives on energy consumption
- Unit 5. – Fossil fuels impact and technology
- Unit 6. – Energy demands on water resources
- Unit 7 – The economics of electric power
- Unit 8 – Alternative energy technologies
- Unit 9 – Global energy and environmental management
- Unit 10 – Energy and water saving options

V. Evaluation of Learning Outcome

A variety of instruments and methods will be used to evaluate students’ understanding of the topics covered in the course. These include a test at the completion of one or two instruction modules, and a term paper. Specific instruments for evaluating the effectiveness of the instructional activities and strategies for each unit are listed in the module syllabi.

VI. Course Specifications

<table>
<thead>
<tr>
<th>#</th>
<th>Instruction Unit</th>
<th>Level of Training/priority</th>
<th>% of Course time</th>
<th>Allocated Time (Weeks)</th>
<th>Location and/or Facilities</th>
<th>Materials and Supplies</th>
<th>Resources/ references</th>
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<td>07</td>
<td>1</td>
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<td></td>
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<td></td>
<td>The Impending World Oil Shortage by Kenneth S. Deffeyes, New Ed edition; Princeton Univ. Press</td>
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<tr>
<td>4</td>
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<td>14</td>
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<td>Very High</td>
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<td>Gen set</td>
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<td>Electricity Markets; Pricing, Structures and Economics by Chris Harris; Wiley</td>
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<td>0</td>
<td>Energy and water saving options</td>
<td>Very High</td>
<td>14</td>
<td>2</td>
<td>Lecture room, Lab</td>
<td>Energy Efficiency Demo Station</td>
<td>Energy and Water Resource Management by Robert Aulbach; Educational Inst of the Amer Hotel; 2 Sub edition</td>
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Table 1. Course Specifications Matrix
Instruction Unit – One: Forms of energy and energy resources

Introduction: In its classic definition, energy is ability to do work. This implies that we need and use energy in our every day activities. This energy comes in different forms – thermal, light, mechanical, etc., and all forms of energy are stored in different ways, in the energy sources that we use every day. These sources are divided into two groups – renewable and non-renewable. The purpose of this unit of instruction is to introduce the student to the various forms of energy and the energy sources. The student will be equipped to make judgment on the various forms of energy that we use everyday.

Required Entry Behavior: Students are expected to be conscious consumers of energy and can identify at least one source of energy they consume.

Behavioral Objectives: At the completion of this unit, the student will be able to:
- Name the various forms of energy.
- Name the sources of energy.
- Classify source energy as renewable or nonrenewable.

Equipment and Supplies: None

Learning Activities and Strategies: This unit consists of classroom presentations. The following is a tentative plan for covering the instructional materials for achieving unit objectives:
- The Definition of Energy/Introduction 30 minutes
- Forms of Energy 30 minutes
- Sources of Energy 30 minutes
- Renewable Energy Sources 30 minutes
- Nonrenewable Energy Sources 30 minutes
- Test 30 minutes
Total time 180 minutes (1 week)

Unit Evaluation: Short test

Reference Materials: www.energyliteracy.org; www.ucsusa.org; Other
Instruction Unit – Two: Conventional methods of energy conversion

Introduction: Energy may be transformed from one form to another to make it usable by other natural processes or machines, or to provide some service such as heat, light, or motion. Energy conversion is any process of transforming one form of energy to another. For example, energy stored in fossil fuels, solar radiation, or nuclear fuels can be converted into energy forms such as electrical, propulsive, or heating that are more useful to us. These conversions are usually achieved by the use of machines and devices generally called transducers such as internal combustion engine and solar cells. The purpose of this unit of instruction is to introduce the student to the various methods by which energy is transformed from sources to useful forms.

Required Entry Behavior: Students are expected to be conscious consumers of energy. Students are expected to be familiar with the various forms of energy and the various energy sources.

Behavioral Objectives: At the completion of this unit, the student will be able to:
- Name the form in which energy is stored in conventional sources.
- Name the various forms of energy transformation.
- Identify the transducers required for energy conversion.
- Describe the products (outputs) of energy conversion process.

Equipment and Supplies: None

Learning Activities and Strategies: This unit consists of classroom presentations. The following is a tentative plan for covering the instructional materials for achieving unit objectives:
- Fossil Fuels/Hydrocarbons 30 minutes
- Nuclear fuel 30 minutes
- Biomass and Natural gas 30 minutes
- Thermal Sources and solar sources 30 minutes
- Wind and other mechanical sources 30 minutes
- Test 30 minutes
Total time 180 minutes (1 week)

Unit Evaluation: Short test

Reference Materials: Energy Resources: Occurrence, Production, Conversion, Use (Kindle Edition) by Wendell H. Wiser
Instruction Unit – Three:  World energy demand

Introduction: The recently released International Energy Outlook 2006" (IEO2006) by the Energy Information Administration (EIA) indicates that worldwide marketed energy consumption is projected to grow by 71 percent between 2003 and 2030. The IEO2006 shows the strongest energy consumption growth in developing countries particularly China and India, where robust economic growth drives the increase in energy use. This new trend has made more essential for the citizen to to become more energy conscious and to participate in the energy dialogue. The purpose of this unit is to inform the student of the factors affecting energy supply and demand. Alternative means of reducing the dependence on oil to meet the demand will be discussed.

Required Entry Behavior: Students are expected to be conscious consumers of energy and can identify at least one source of energy they consume.

Behavioral Objectives: At the completion of this unit, the student will be able to:
- Interpret IEO projections.
- Describe worldwide energy outlook.
- Discuss energy consumption specifics by sector and by region.

Equipment and Supplies: None

Learning Activities and Strategies: This unit consists of classroom presentations. The following is a tentative plan for covering the instructional materials for achieving unit objectives:
- Energy Information Administration and IEO Projections 30 minutes
- Worldwide marketed energy consumption/Total energy use 30 minutes
- Energy use in the transportation sector 30 minutes
- Demand for oil in the United States 30 minutes
- Worldwide demand for oil 30 minutes
- Test 30 minutes
Total time 180 minutes (1 week)

Unit Evaluation: Short test

Reference Materials: The Impending World Oil Shortage by Kenneth S. Deffeyes, New Ed edition; Princeton Univ. Press; tonto.eia.doe.gov; www.dius.gov.uk; other
Instruction Unit – Four: Global perspectives on energy consumption

Introduction: One hundred years of high production growth, technical innovation, and expanded consumption, have contributed to a number of critical energy challenges arising from unequal resource distribution, changing demand patterns, emerging and fast growing economies, environmental limitations, and political turbulence and conflicts. Our dependence on fossil fuels must be reduced not because of any imminent resource shortages but because the widespread burning of oil, coal, and natural gas damages the biosphere and presents increasing economic and security problems due to our reliance on increasingly expensive and unpredictable supplies of Middle Eastern crude oil. This unit of instruction examines the global perspective on energy consumption and supplies. The location of world energy resources, its distribution patterns and factors affecting supply and demand as well as energy costs are examined.

Required Entry Behavior: Students are expected to be familiar with the worldwide energy demand projections.

Behavioral Objectives: At the completion of this unit, the student will be able to:
- Locate world oil reserves.
- Discuss the factors affecting energy supply and demand.
- Discuss global implications of high fossil fuel consumption.
- Describe possible ways of reducing dependence on Middle East oil supply.

Equipment and Supplies: None

Learning Activities and Strategies: This unit consists of classroom presentations. The following is a tentative plan for covering the instructional materials for achieving unit objectives:
- World Oil Reserves/Factors affecting supply 60 minutes
- Overview of the Twentieth Century's Long-term Trends and Achievements in Energy Production 60 minutes
- Energy prices, the real cost of energy, and energy linkages 60 minutes
- Effect of Energy Issues on the Economy, on Quality of Life, on the Environment, and in Wartime 60 minutes
- The pitfalls of forecasting/Predicting Consumption Growth 60 minutes
- Test 60 minutes
Total time 360 minutes (2 weeks)

Unit Evaluation: Hour test

Instruction Unit – Five: Fossil fuels impact and technology

Introduction: Any material that can be burned or otherwise consumed to produce heat can be defined as fuel. Among these are fossil fuels which are incompletely oxidized and decayed animal and vegetable materials, including coal, peat, lignite, petroleum and natural gas. Fossil fuels play an indispensable role in our everyday lives in modern society. They are retrieved from the ground and under the sea and then converted into electricity and other forms of energy. Approximately 90% of the world's electricity demand is generated from the use of fossil fuels. So also are these fuels the dominant source of energy for transportation.

There is a growing concern about the implication of fossil fuels in environmental pollution. Debates regarding this contamination have become commonplace in today's effort to sustain the earth's health. These have produced much interest in the development of technologies to mitigate the polluting effects of these crucial sources of energy. This unit of instruction is a discussion on the impact of fossil fuels on the environment and the global economy. Also presented are some of the emerging technologies and efforts to produce clean energy from fossil fuels.

Required Entry Behavior: Students are expected to be consumers of energy for transportation and other uses. Students are expected to be familiar with environmental pollution issues in the news.

Behavioral Objectives: At the completion of this unit, the student will be able to:
- Name the various forms of fossil fuels and their uses.
- Name the major environmental impacts of fossil fuel use.
- Describe some emerging clean energy technologies.
- Name the greenhouse gases and their sources.
- Discuss the health implications of emissions from the use of fossil fuels.

Learning Activities and Strategies: This unit consists of classroom presentations. The following is a tentative plan for covering the instructional materials for achieving unit objectives:
- Fossil Fuels and Their Uses. 60 minutes
- Environmental Impacts of Fossil Fuel Use 60 minutes
- Economic Impacts of Fossil Fuel 60 minutes
- Emerging Clean Energy Technologies 60 minutes
- Health Implications of Emissions from The Use of Fossil Fuels. 60 minutes
- Test 60 minutes
Total time 360 minutes (2 weeks)

Unit Evaluation: Hour Test

Instruction Unit – Six: Energy Demands on Water Resources

Introduction: The interdependency between energy and water issues has become a major strategic concern for many policy makers around the world as the societies and governments have started to recognize that energy and water usage are inextricably linked. Water is an essential element in energy resource development and utilization. It is used in energy-resource extraction, refining and processing, and transportation. Water is also an energy source for electric-power generation – the so called hydroelectricity. Water is also used extensively for cooling and emissions scrubbing in thermoelectric generation. U.S. energy sector now withdraws about 140 billion gallons per day (Bgal/day) of fresh water and 60 Bgal/day of saline water, accounting for 39 percent of daily fresh water withdrawals and 50 percent of total water withdrawals. The Energy Information Administration projections show a significant increase in water demand for energy particularly in the Southeastern, Southwestern and Western regions which are already suffering stressed water supplies. To offset the increased demand on both energy and water resources, managers should take advantage of efficiencies between the two with careful planning. This unit presents a discussion of the energy and water resource challenges.

Required Entry Behavior: Students are expected to familiar with the terms such as fresh water, salt water, irrigation (agricultural use of water) as well as other non-agricultural consumptions.

Behavioral Objectives: At the completion of this unit, the student will be able to:

- Demonstrate an awareness of the amount of water consumption for power generation.
- Demonstrate an awareness of the amount of water consumption for fuel production.
- Discuss water supply trends in the US.
- Discuss water consumption trends in the US.
- Discuss energy and water resource challenges.

Learning Activities and Strategies: This unit consists of classroom presentations. The following is a tentative plan for covering the instructional materials for achieving unit objectives:

- Energy Demands for Water
- Water Availability/Water Resources
- Addressing Energy and Water Resources Challenges

Total time: 180 minutes (1 week)

Unit Evaluation: Short Paper

Reference Materials: www.swhydro.arizona.edu/07symposium/presentationpdf; Energy and Water Resource Management by Robert Aulbach; Educational Inst of the Amer Hotel; 2 Sub edition; Other
Instruction Unit – Seven: The Economics of Electric Power

Introduction: Most of the energy we consume is electric energy. It is by far the most used energy within the household and at work. Electric energy is the one form of energy that affects every citizen. In order to understand how electricity can behave as a commodity, one needs a basic understanding of its physical characteristics. This unit gives the student the fundamental knowledge of electricity, resorting to non technical ‘folk’ definitions and analogies, which will enable her to understand electricity markets. It then proceeds to acquaint the student with the market structure for electricity. The structure, operation and management of the electricity supply chain are discussed. Also presented in this unit are the policies and influencers that affect the industry.

Required Entry Behavior: Students are expected to be conscious consumers of electric energy. A background in technical science will be advantageous.

Behavioral Objectives: At the completion of this unit, the student will be able to:
- Demonstrate knowledge of fundamentals of electricity.
- Demonstrate knowledge of the policy issues, the drivers and influencers.
- Describe the structure, operation and management of the electric supply chain.
- Describe the market structure for electricity.

Equipment and Supplies: None

Learning Activities and Strategies: This unit consists of classroom presentations. The following is a tentative plan for covering the instructional materials for achieving unit objectives:
- Electricity Basics 30 minutes
- The structure, operation and management of the electric supply chain 60 minutes
- Policy – Issues, Priorities, Stakeholders, and Influencers 30 minutes
- Market Structures for Electricity 30 minutes
- Test 30 minutes
Total time 180 minutes (1 week)

Unit Evaluation: Short test

Instruction Unit – Eight: Alternative Energy Technologies

Introduction: Much of the instructions in this class, so far, have focused on the management of conventional energy. In instruction unit five the impact of fossil fuel use on the environment was discussed. The issue of energy and the environment will be further explored in unit nine. Furthermore, it is clear from earlier discussions that world energy demand and consumption will not be met if we continue to rely on fossil fuels only. There is therefore a need to introduce alternative energy technologies as a means of both meeting the rising world energy demand and stemming the harmful effects of fossil fuels on the environment and human health. The purpose of this unit of instruction is to introduce the student to the various alternative energy sources and technologies. The student gains knowledge of these clean renewable energy technologies will become better equipped to gain energy independence from the grid and other conventional sources.

Required Entry Behavior: Students are expected to be familiar with global energy issues including world demand and consumption. Students are expected to know the conventional energy sources and their effects on the environment.

Behavioral Objectives: At the completion of this unit, the student will be able to:
- Name the various forms of renewable energy.
- Describe the principles of an alternative energy Technology.
- Choose an energy source based on environmental and cost considerations.

Equipment and Supplies: PV System, Solar hot water system

Learning Activities and Strategies: This unit consists of classroom presentations and demonstrations in the laboratory. The following is a tentative plan for covering the instructional materials for achieving unit objectives:
- The Definition of Renewable Energy/Introduction 60 minutes
- Photovoltaic energy system 60 minutes
- Solar Water Heating 60 minutes
- Wind Energy 60 minutes
- Micro-hydro and other Renewable Energy Sources 60 minutes
- Test 60 minutes
Total time 360 minutes (2 weeks)

Unit Evaluation: Hour test

Introduction: The dilemmas due to society's crucial dependence on energy, particularly fossil fuels and the impact of its use on the environment have provoked a worldwide debate on energy issues such as pollution, resource depletion, global warming, and nuclear power. These problems demand timely solutions, international cooperation and perhaps more importantly, the participation of the educated citizenry. As a result, several international institutions and organizations as well as the civic society and NGOs in various countries have become engaged in those issues at the forefront of the current energy debate such as energy sustainability, climate change, and nuclear proliferation. The purpose of this unit of instruction is to introduce the student to the work of various international and domestic organizations and institutions involved in the global energy debate. This module also presents the various international treaties, and the state and federal regulations that deal with energy and the environment. The impact of the deregulation of the power industry is also examined. The student will be equipped to make judgments on the various international treaties, and regulatory regimes.

Required Entry Behavior: Students are expected to be conscious consumers of energy and good environmental custodians. Students are expected to be familiar with the global perspectives on energy consumption.

Behavioral Objectives: At the completion of this unit, the student will be able to:
- Name the various International organizations (IGOs and NGOs) on energy.
- Discuss the main attributes of some ISEA international treaties on energy.
- Name the various International organizations on the environment.
- Describe the missions and activities of some international, national, state and local agencies that regulate energy and environment.

Learning Activities and Strategies: This unit consists of classroom presentations. The following is a tentative plan for covering the instructional materials for achieving unit objectives:
- International Organizations and Environmental Policy 60 minutes
- International Organizations in Vienna 60 minutes
- International Energy Agreements 60 minutes
- Energy Research Organizations and Information Sources 60 minutes
- Energy and Environmental Regulatory Agencies 60 minutes
- Test 60 minutes
Total time 360 minutes (2 weeks)

Unit Evaluation: Hour test

Instruction Unit – Ten: Energy and water saving options

Introduction: In unit six we concentrated on energy impact on water resources and infrastructure in a way to buttress the argument that one of the environmental and economic impacts of energy production and use is the depletion of our water resources. This discussion did not explore the nexus between water use and energy use in its totality. The fact is that just as energy production and use consumes water, so thus water production and use consume energy. It is therefore clear that in order to stem the escalation of climate change we must simultaneously address both water and energy efficiencies and conservation simultaneously. This is what intricately links the principles of energy management to those of water management. The purpose of this unit of instruction is to present to the student energy efficiency practices integrated into the daily management and long-term planning of the water sector. In other words, this unit will prepare the student to produce and use water in a way that will conserve energy while saving water.

Required Entry Behavior: Students are expected to be familiar with energy demands on water resources.

Behavioral Objectives: At the completion of this unit, the student will be able to:
- Identify causes of inefficiency in water use.
- Identify causes of inefficiency in energy use.
- Generate options for energy efficiency.
- Generate options for water efficiency.
- Answer the question: Does water efficiency save energy?
- Answer the question: Does energy efficiency save money?
- Optimize energy and water management.

Equipment and Supplies: None

Learning Activities and Strategies: This unit consists of classroom presentations. The following is a tentative plan for covering the instructional materials for achieving unit objectives:
- Identifying Causes of Inefficiency in Water Use. 60 minutes
- Option Generation for Water Efficiency. 60 minutes
- Identifying Causes of Inefficiency in Energy Use. 60 minutes
- Option Generation for Energy Efficiency. 60 minutes
- Optimizing Energy and Water Management. 60 minutes
- Test 60 minutes
Total time 360 minutes (6 weeks)

Unit Evaluation: Short test