June 7, 2011

ME 3700

College of Engineering

**Introduction to Energy Systems Engineering**

Instructor: Yogendra Joshi, Mechanical Engineering

**Course Description:** To fulfill the transportation, lighting, building comfort, and manufacturing needs desired by our society, energy must be converted from its natural forms to various alternative forms. Laws of thermodynamics state that energy cannot be created or destroyed, and its various forms have different energy qualities in their ability to serve a given need. This course first reviews energy demand that drives the need to use natural forms of energy, followed by a review of the various forms being used to meet that demand. The different energy processes and systems that convert renewable, fossil, and nuclear energy into the desired form necessary to accomplish a given task such as transportation, heating and cooling a building, lighting, and manufacturing are focused on. In systems that produce electrical power, the integration of energy sources with the electrical grid is introduced. Concept of energy storage to meet the mismatch between supply and demand periods is discussed. Energy conservation, and techniques for the mitigation of adverse effects of energy conversion are discussed.

**Text**: Renewable Energy: Power for a Sustainable Future, Second Edition, [Godfrey Boyle](http://www.amazon.com/s/ref=rdr_ext_aut?_encoding=UTF8&index=books&field-author=Godfrey%20Boyle), Ed., Oxford University Press, 2004

**Grading:**

Quizzes: 20%

Mid-term Exam: 20%

Discussion: 10%

Group Project and Presentation: 20%

Final exam: 30%

**Topics**:

**Week 1: Introduction**

Force, energy, power; world energy supplies; environmental impact of energy conversion; renewable energy sources

**Week 2: Energy Conservation and Quality of Energy**

Laws of thermodynamics; forms of energy; conversion and efficiency

**Weeks 3-7: Energy Technologies and Mid-Term Examination**

*Solar Thermal Energy*: The solar irradiation availability; solar collection; water heating; space heating; power generation; other applications; storage; economics

*Solar Photovoltaics*: PV in silicon basic concepts; crystalline photovoltaics; thin film photovoltaics; other PV technologies; remote and grid connected PV systems; economics

*Energy from Biomass*: Bio-fuels and conversion efficiencies; energy crops; waste conversion; solid combustion; production of gaseous fuels; production of liquid fuels; environmental impact; economics;

*Hydroelectric Power*: Current state of hydroelectric power; types of hydroelectric plants; small-scale plants; environmental considerations; economics

*Tidal, Wave, Wind, and Geothermal Energy*: Physical principles; approaches; potential; environmental impact; economics

*Nuclear*: Introduction to nuclear power generation; currently used technologies; waste storage; energy security; environmental safety; economics

**Week 8: Integration of Energy Sources and the Grid**

Integration of renewable; system solution examples;

**Week 9-11: Energy Systems Applications**

*Building Energy Systems*: Energy sources and conversion processes; systems and equipment for space heating and cooling, air-conditioning, lighting and hot water.

*Refrigeration*: Food and process refrigeration

*Transportation*: Principles; energy requirements and performance characteristics of various engines for autos, trucks, trains, ships, and aircraft

**Week 12: Energy Storage**

Mismatch in supply and demand; batteries; thermo-chemical storage, phase change storage

**Week 13: Energy Conservation**

Waste heat recovery; Co-generation; Sensing, modeling, and control

**Week 14:** **Environmental Impact Mitigation of Energy Conversion**

Carbon capture technologies; greenhouse gas reduction; economic implications

**Week 15: Group Project Presentations**