1. EM444 Solar Engineering

2. Credit Hours (3) / Contact Hours (3)

3. Course Director – Robert Fishman

4. There is no textbook for the course. Instead a variety of sources are used from government and industry websites, reports, standards, journal articles, videos, and other online resources.

5. Specific course information
   a. This course begins with a summary of how energy is generated and used - both on a global and US basis - followed by a deeper dive into US power generation and the operation of the grid. The impacts of energy use, by technology, on climate change is discussed, followed by the means of mitigating these effects. Solar thermal energy systems and their applications are reviewed, followed by photovoltaic technologies and applications. Several solar case studies considering location, time of day and year, weather, and economics are studied. Wind energy technologies and case studies are also considered as are other forms of renewable energy including Geothermal, Waste-to-Energy, Biomass, Hydropower, and Nuclear energy. Long- and medium-term energy storage options including hydrogen, pumped hydro, batteries and thermal are studied as well as short-term storage including flywheels, supercapacitors, and superconducting magnets. The course culminates in students undertaking a group project developing an engineering solution using a specific solar energy application.
   b. Prereq: 1/C engineering major or approval of department chair..
   c. Senior engineering elective course

6. Educational objectives
   a. Describe energy sources, conventional and renewable (particularly in the US power sector), and their operational, environmental, and economic advantages and disadvantages, with an emphasis on solar energy.
   b. Describe how solar energy systems operate, as well as wind, geothermal, waste-to-energy, biomass, hydropower, and nuclear, and analyze their performance and economics.
   c. Describe and evaluate the applications of solar thermal energy as well as solar photovoltaic power.
   d. Describe how the grid operates and how energy storage technologies are essential to achieving grid stability and reliability, particularly when intermittent sources of energy are an increasing part of the generation portfolio.
   e. Develop a solution to an energy requirements scenario using solar energy.

7. Specific program outcomes addressed by this course

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Reinforced		X		X			
Mastered	X		X		X	X	X

8. Brief list of topics to be covered
   a. Module 1: Understanding Power Generation and Use, Climate Change, Life Cycle Carbon Footprint, Climate Change Mitigation
   b. Module 2: Understanding the US power grid

c. Module 3: Understanding the types of solar energy systems, solar radiation, atmospheric effects, astronomy, and geometry
d. Module 4: Review of thermodynamics and heat transfer topics applicable to solar engineering
e. Module 5: Understanding Solar thermal systems and concentrating solar power
f. Module 6: Understanding industrial, special, and low temperature applications of solar energy
g. Module 7: Understanding Photovoltaic Solar Power - types of panels, inverters, tracking systems
h. Module 8: Understanding Solar energy economics, subsidies and tax credits, and carbon pricing
i. Module 9: Solar energy case studies
j. Module 10: Understanding Wind energy
k. Module 11: Wind energy case studies
l. Module 12: Understanding other forms of renewable energy: Geothermal, Waste-to-Energy, Biomass, Hydropower, and Nuclear energy
m. Module 13: Understanding energy storage
n. Module 14: Solar energy group projects