Master Course Description for EE-351 (ABET sheet)

Title: Energy Systems

Credits: 5

UW Course Catalog Description

Develops understanding of modern energy systems through theory and analysis of the system and its components. Discussions of generation, transmission, and utilization are complemented by environmental and energy resources topics as well as electromechanical conversion, power electronics, electric safety, renewable energy, and electricity blackouts.

Coordinator: Baosen Zhang, Associate Professor, Electrical Engineering

Goals: To introduce students to:

- Basic components of power systems
- Energy resources and Environmental impact of energy generation and utilization
- Conventional Power Plants
- Solar PV
- Wind turbines and power generation
- Power electronics
- Transformers, generators and motors
- Electric safety
- Power grid and blackouts

Learning Objectives:
At the end of this course, students will be able to

1. *Understand* the function of the basic elements of energy systems,
2. *Demonstrate* an awareness of the environmental impact of energy generation and utilization,
3. *Understand* the various technologies for renewable energy resources,
4. *Understand* the operation of the power system under normal and stressed conditions,
5. *Understand* the electric safety issues and the various protection methods, and
6. *Work* in teams to perform laboratory experiments.

Textbooks:

- There is no currently required textbook
- *EE 351 Laboratory Manual*

Reference Texts:

- Lecture material,

- Web material
- *Electric Energy: An Introduction*, *Third Edition* by Mohamed A. El-Sharkawi, CRC press, 2012

Prerequisites by Topic:

1. Linear circuit theory
2. Phasors
3. Basic calculus and trigonometry
4. Basic semiconduction and mechanical physics

Topics:

1. History of Power Systems, Review of Circuit Theory
2. Phasor Analysis
3. Power Electronics
4. Solar Energy
5. Wind Energy
6. Conventional Generation
7. Energy Resources and Demand
8. Three Phase
9. Transformers
10. Synchronous Machines
11. Induction Motor
12. Safety and Blackouts

Course Structure: The class meets for two 1 hour and 50 minute (110 minutes) lectures a week. There is weekly homework, one midterm and one final. There is a three-hour laboratory every other week (3 labs total), preceded by a one-hour laboratory discussion.

Computer Resources: Lecture material, homework and lab assignments are posted online. Students use the internet to complete some of the assignments.

Laboratory Resources: The course uses the Energy instructional laboratory benches and instrumentation including multimeters, digital data acquisition and oscilloscopes.

Grading: Generally 25% of the grade is for laboratory performance, 25% is for homework, 25% for midterm, and 25% for the final exam.

Laboratory Experiments

1. Power electronic converter
2. Renewable energy
3. Electric energy generation and synchronization with utility grid

Outcome Coverage:

(1) *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.* Students are required to solve engineering problems throughout the course. Students use mathematical models of various elements of energy systems including power plants, generators, motors, power electronic circuits, transformers and transmission system. (H)

(2) *An ability to communicate effectively with a range of audiences.* The students are required to prepare written reports. Grades are given for technical and writing quality. (M)

(3) *An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.* The students are given talks on ethical responsibility pertaining to issues relating the generation of electric energy to the environment. This course discusses the balance between societal needs for electric energy and the environmental impacts of generation and utilization. Pros and cons of each type of generation are discussed. Attention is given on current energy issues such as renewable energy, environmental impacts and blackouts. Students are engaged during the lecture time in discussing and evaluating these issues. (M)

(4) *An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.* Students form teams of 3 students in the laboratory. The students may have different background strengths, but are cooperatively working to achieve the objectives of the experiments. This cooperation is also extended to after the laboratory where the group prepares a report. Each person in the group is assigned a portion of the report, and the assignment is rotating. (M)

(5) *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.* Students submit pre-laboratory reports outlining their understanding of the objectives, circuit design and measuring instruments needed to perform the experiments. The pre-laboratory report also outlines the safety measures needed to conduct the experiments. The students interpret the measurements to determine whether the experiment results meet the objectives of the laboratory. (H)

(6) *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.* The course material contains areas where technologies are not fully developed yet. The students are encouraged to search the web and other resources and learn on their own the advances in various relating technologies. (M)

Prepared By: Baosen Zhang

Last revised: 12/2024