Master Course Description for EE-451 (ABET sheet)

Title: Wind Energy

Credits: 4

UW Course Catalog Description

Coordinator: June Lukuyu, Assistant Professor, Electrical and Computer Engineering

Goals: This course covers how electrical power is obtained from wind, perform basic calculations for wind power based on wind turbine characteristics and terrain, explain what are the main considerations for wind power integration, how to think probabilistically about uncertainties in wind power and solve optimization problems using commercial packages.

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

1. *Understand* the basic components of wind energy systems.
2. *Understand* the basic types of solid-state converter circuits used in wind turbines.
3. *Understand* the operation and control of wind turbines.
4. *Understand* the integration challenges of wind power plants.
5. *Understand* the various techniques to effectively integrate large wind power systems into utility grids.

Textbook: Mohamed A. El-Sharkawi, *Wind Energy: An Introduction*, 2014

Reference Texts: *IEEE Transactions papers.*

Prerequisites by Topic:

1. Elementary power and energy concepts
2. AC circuits
3. Transistors and diodes
4. Calculus

Topics:

1. Kinetic Energy of Winds
2. Wind Turbines
3. Fundamentals of Power Electronic Conversions
4. Different Types of Turbines Induction generatorDoubly-fed Induction GeneratorSynchronous Generator
5. Wind Energy and the Environment
6. Wind Integration Problems Reactive PowerVoltage FlickersFrequency deviations and HarmonicsVoltage stabilityImpact of system FaultsWind Energy Forecasting

7. Wind Integration Solutions Adaptive VAR CompensatorVoltage and frequency controlSystem islandingRide-though FaultsLoad FollowingEnergy RegulationUnit Committment in Stocastic Environment

Course Structure: The class meets for two 110 minutes (1 hour and 50 minutes) lectures a week. There is weekly homework, a midterm and a final.

Computer Resources: All work can be done on any computer using open source software.

Laboratory Resources: N/A

Grading: 30% homework, 30% midterm and 40% final

ABET Student Outcome Coverage: This course addresses the following outcomes:

H = high relevance, M = medium relevance, L = low relevance to course.

(1) *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.* **(H)** Students use models of various elements of wind energy systems including speed to power conversions, turbines, generators, power electronic circuits, protection, and system integration issues.

(2) *An ability to communicate effectively with a range of audiences.* **(L)** The students are required to prepare written answers to some open-ended homework questions. Grades are given for technical and writing quality.

(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.* **(M)** The students are given talks on ethical responsibility pertaining to issues relating the generation of electric energy from wind. This course discusses the balance between societal needs for electric energy, the environmental impacts of generation and utilization and the technical challenges of generating reliable power from wind. Pros and cons of each type of wind turbine is discussed. Attention is given on current energy issues such as cost, environmental impacts and government policies. Students are engaged during the lecture time in discussing and evaluating these issues.

(4) *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.* **(M)** The students are encouraged to search the web and use other resources and learn how the technologies are changing and what are the open problems in the field.

Prepared by: Baosen Zhang

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