Master Course Description for EE-451 and EE-551 (ABET sheet)

Title: EE 451 and EE 551: Renewable Energy: Technology and Integration

Credits: 4

UW Course Catalog Description

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

Goals: This course explores renewable energy generation, storage, and grid integration, focusing on solar and wind technologies. Students will analyze these technologies from multiple perspectives, including technical, economic, social, and policy dimensions, with a particular focus on addressing intermittency, grid stability, reliability, and equitable access. Through case study assessments and hands-on design activities, students will develop the expertise and skills needed to design innovative solutions, optimize renewable energy integration into modern grids, and influence policy decisions.

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

1. *Explain* the fundamental principles of renewable energy conversion, storage, and efficiency.
2. *Understand* the challenges of integrating renewable energy systems into existing energy infrastructures, considering technical, economic, and policy challenges.
3. *Understand* the various techniques to effectively integrate large wind and solar power systems into utility grids.
4. *Evaluate* the socioeconomic, environmental and policy implications of transitioning to renewable energy systems, with a focus on equity and sustainable development.
5. *Analyze* case studies to explore successful and unsuccessful implementations of renewable energy projects, deriving lessons for future applications.

Additional Learning Objectives for EE 551: At the end of this course, graduate students will also be able to:

6. *Lead discussions* on key challenges in renewable energy development and grid integration, effectively synthesizing technical, economic, and policy perspectives.
7. *Apply research principles* to investigate emerging issues in renewable energy, critically evaluate solutions, and support findings with peer-reviewed literature and industry insights.
8. *Evaluate* innovative system designs, operational strategies, or policy interventions based on current research and industry trends.

Textbook: Sustainable Energy, Second Edition: Choosing Among Options *by Jefferson W. Tester, Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay and William A. Peters*

Reference Texts: *Provided by Instructor.*

Prerequisites by Topic:

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

Topics:

1. Introduction: Energy in the Modern World
2. Wind Energy
3. Solar Energy
4. Energy Storage
5. Off-Grid Systems, Microgrids, and Community Energy Systems
6. Renewable Energy Integration and Grid Fundamentals
7. Economic Feasibility Assessments and Renewable Energy Policies
8. Global Perspectives: Sustainable Energy in Developing Countries

Course Structure: The class meets for two 110 minutes (1 hour and 50 minutes) lectures a week. There is weekly homework, a group case study review, a take-home midterm and a take-home final.

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

Laboratory Resources: N/A

Grading: 25% homework, 25% group case study review, 25% midterm and 25% final

- **Additional Expectations for EE 551:** EE 551 students will engage in research-oriented assessments and activities requiring deeper analysis, synthesis, and application of concepts. Specific requirements include:
  - **Homework Assignments (Contributing to 25% of the Total Homework Grade):** Each assignment will contain an additional mandatory research component requiring graduate students to read and critically analyze a peer-reviewed research paper, formulating an open-ended response requiring them to critically evaluate methodologies, discuss real-world applicability, and propose innovative research directions.
  - **Case Study Review (Contributing to 25% of the Total Case Study Grade):** Graduate students will prepare a more in-depth written report (2,000–2,500 words vs. 1,000–1,500 words for undergraduates) with at least five additional peer-reviewed sources, incorporating a policy and regulatory critique on their renewable project case. Graduate students will also facilitate a post-presentation discussion on the case study, developing 2–3 question prompts to guide peer engagement.
  - **Midterm and Final Exams (Contributing to 25% of each of the Total Exam Grades):** Graduate students will be required to complete an additional mandatory design and application-based question requiring them to incorporating real-world

data, literature and open-source modeling tools into their analyses to assess their ability to apply analytical techniques to evaluate real-world challenges in renewable energy deployment and interpret and synthesize results within technical, economic, societal and policy contexts.

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 apply engineering, science, and mathematics principles to model various elements of wind and solar energy systems, including resource assessment, energy estimation, wind turbine and photovoltaic system performance and power output, storage sizing and grid integration issues.

(2) *An ability to communicate effectively with a range of audiences.* **(H)** Students will collaborate in groups to deliver an oral presentation critically evaluating a real-world renewable energy project, and will be graded on clarity of communication, depth of analysis, and quality of presentation slides. Following the presentation, each student will submit an individual written review, which will be evaluated for technical rigor, analytical depth, 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.* **(H)** Throughout the course, students analyze the societal, economic, policy and environmental implications of renewable energy adoption through in-class activities, case study reviews and lectures. Ethical discussions are embedded in these sessions, requiring students to weigh the benefits of renewable energy expansion against issues such as land use conflicts, social displacement, and economic trade-offs. Students also engage in discussions on the socioeconomic impacts of renewables, addressing issues such as energy poverty, infrastructure equity, and sustainable development in diverse global contexts.

(4) *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.* **(H)** Students actively engage in self-directed learning and are required to search the web and use peer reviewed articles to prepare their case study reviews.

Prepared by: June Lukuyu

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