Electrical Engineering 137B **Spring 2017**

Introduction to Electric Power Systems

Prof. Alexandra (Sascha) von Meier, GSI Samuel Smith

Syllabus

Lecture MW 4-5:30 in 299 Cory
Discussion Tu 1-2 in 293 Cory

Three hours of lecture and one hour discussion, 4 units, letter grade.
Prerequisites are EE 137A or equivalent; English language comprehension and writing.

Sascha von Meier's office hours: MW 3-4 or by appt. in 406E Cory Hall
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Samuel Smith's office hours Tu 2-3pm in 504 Cory and by appt., *samuelsmith@berkeley.edu*

Course Description

This course is the second in a two-semester series, designed to provide an overview of electric power conversion and delivery with an emphasis on developing an understanding of the electric grid as a complex interconnected system. While the first semester covers the legacy grid with a primary focus at the transmission level, EE 137B studies recent and future changes in grid design and operation, focusing on new and emerging technologies with a special emphasis on distribution systems and loads. Topics in EE 137B include power electronics applications, solar and wind generation, power distribution system design and operation, electric energy storage, demand response, and microgrids. Selected topics will be treated quantitatively, while others will be treated in a descriptive manner. Students entering EE 137B are expected to have completed EE 137A or a comparable introductory power engineering course and bring with them essential knowledge of the legacy grid, in addition to a basic understanding of electromagnetism and the ability to analyze simple RLC circuits. Knowledge of power electronics is beneficial but not required. Note that English language skills will tend to be more important for success in this class than in many typical engineering courses.

Course Objectives

The goal of this course is to develop an understanding of the present and potential future evolution of electric power systems through innovative technologies and operating strategies. By the end of the semester, students having taken EE 137B are expected to be able to:

- Demonstrate knowledge of key "smart grid" technologies and explain how these might address weaknesses of the legacy grid.
- Understand and explain key characteristics of solar and wind generation, energy storage, and demand response.
- Demonstrate basic knowledge of distribution system design and operation, including elementary calculations of voltage profiles and fault currents.
- Understand basic aspects of distribution feeder modeling and simulation.
- Understand and explain the challenges and opportunities introduced by renewable and distributed generation, and by responsive loads, at the system level.
- Intelligently discuss microgrids and related innovations in a systemic context.

Requirements and Logistics

- **Homework** assignments are due weekly on Wednesdays, uploaded on bCourses. Homework problems will typically include some calculations as well as some single-paragraph qualitative answers, which should be written in clear and proper English. Discussion and collaboration on problem solving is encouraged, but students must show their individual work. Solutions will be posted soon after each submission deadline. As a rule, late homework will not be accepted (but you get one free pass for missed homework).
- The last homework assignment will be a team **research project** that includes an oral presentation in class.
- In-class **quizzes** will be routinely given on Mondays at the beginning of class. They are designed to help students review material and will feature multiple-choice questions, short answers and very short calculations.
- The mandatory **midterm** (March 22) and **final** (May 12) **exams** will include some longer problems that aim to integrate material from throughout the semester. Students will be responsible for any material presented or discussed in lecture, whether or not it appears in the reading; students will *not* be responsible for any material in the reading that was not referred to in lecture.
- Regular attendance and good **citizenship** in both lecture and discussion section is expected. Students who have stronger preparation in certain areas are encouraged to help others.
- UC Berkeley has an Academic **Honor Code**. As members of the UC Berkeley community, we are committed to acting with honesty, integrity, and respect for others. See more at http://teaching.berkeley.edu/academic-integrity
- If you need disability-related **accommodations**, have medical information you wish to share, or need any other special arrangements, please come talk to me as soon as possible.

Grading

Homework 30%, midterm 20%, quizzes 15%, final exam 35%. Your lowest quiz score and lowest homework score will be dropped. Oral participation and citizenship in the learning community will be factored into the final grade at the instructor's discretion in case there is more than one missing or incomplete assignment.

Required Text	***Renewable and Efficient Electric Power Systems*, 2nd ed.** Gilbert Masters, Wiley – IEEE, 2013 ISBN 9781118140628
Recommended	***Electric Power Systems: A Conceptual Introduction*** A von Meier, Wiley – IEEE, 2006
	Introduction to Electrical Power and Power Electronics Mukund Patel, CRC Press, 2013 ISBN 9781466556607

Additional reading materials and links will be routinely posted on bCourses. PowerPoint presentations from lecture will also be posted for reference. Be advised, however, that these PowerPoints do not provide a summary of lectures and are no substitute for attendance.

EE 137B Schedule Spring 2016 (subject to revision) Prof. von Meier

Week	Dates	Topic	Reading
1	Jan 18	Why smart grid? Distribution system operation	Masters Ch 1 (Review: Masters Ch 2-3, von Meier Ch 1-3)
2	Jan 23-25	Legacy voltage regulation; Load modeling; Protection	Masters Ch 3.7; von Meier Ch 6.1, 6.6-6.7; Patel Ch 2.7; Schneider, PNNL, Bravo
3	Jan 30-Feb 1	Semiconductors; Power converters	Patel Ch 7, Ch 8 up to p.205, Ch 9 Mohan
4	Feb 6-8	1st Quiz; HVDC	Masters Ch 3.9-3.10 Patel Ch 12.1-12.4, 13.1-13.3 14
5	Feb 13-15	2nd Quiz; PV cells and modules	Masters Ch 5
6	Feb 22	PV systems	Masters Ch 6.1-6.3
7	Feb 27-Mar 1	3rd Quiz; Solar resource, solar thermal power	Masters Ch 4, 8.2
8	Mar 6-8	4th Quiz; Wind power	Masters Ch 7
9	Mar 13-15	5th Quiz; Energy storage; Batteries, fuel cells and hydrogen	Masters Ch 6.5, 9.8
10	Mar 20-22	Midterm exam Mon March 20	
	Mar 27-31	SPRING BREAK	
11	Apr 3-5	Demand Response; Sensing & monitoring, synchrophasors	Masters Ch 9.1-9.4 Bank, von Meier et al.
12	Apr 10-12	6th Quiz; Modeling distribution circuits; State estimation; Distribution automation	von Meier
13	Apr 17-19	7th Quiz; DER Interconnection; Microgrids	Bank & Mather, NREL
14	Apr 24-26	8th Quiz; Strategic scaling and leveraging DER for resilience; Transactive grids	Adapa, Barthold, misc.
15	May 1-3	Review week	
	May 12	Final Exam 8-11 am	