Electrical Engineering 137A **Fall 2017**

Introduction to Electric Power Systems

Prof. Alexandra (Sascha) von Meier

Syllabus

Lecture MW 5-6:30p in 241 Cory
Discussion Fri 12-1p in 24 Wheeler **or** 1-2p in 293 Cory

Three hours of lecture and one hour discussion, 4 units, letter grade.
Prerequisites are differential equations & linear algebra (Math 54 or equivalent); electricity & magnetism (Physics 7B or equivalent); introduction to electric circuits (EE 16AB or equivalent).

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Course Description

This course is designed to provide an overview of conventional electric power conversion and delivery, with an emphasis on developing a conceptual understanding of the electric grid as a complex interconnected system. Study of the legacy grid in EE 137A, with a primary focus at the transmission level, will serve as a foundation for EE 137B to study 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 137A include general aspects of system design, electric generators, components of transmission and distribution systems, power flow analysis, system operation, and performance measures. Selected topics will be treated quantitatively, while others will be treated in a descriptive manner. Students entering EE 137A are expected to have a basic understanding of electromagnetism and be able to analyze simple RLC circuits.

Course Objectives

The goal of this course is to develop a systemic understanding of the electric grid through study of its major components and their respective roles and interactions.
By the end of the semester, students having taken EE 137A are expected to be able to:

1. Understand and explain the essential functions, design considerations and operational constraints of major components of electric power systems, including generators, transmission lines, transformers, and switchgear.
2. Quantitatively analyze the behavior of a.c. power system components in selected cases under appropriate simplifying assumptions.
3. Demonstrate a basic understanding of methodology and approximations for power flow analysis, interpret inputs and outputs, and run scenarios using *PowerWorld*.
4. Understand and explain key aspects of power system operation to address real and reactive power balance, stability, security and reliability at the transmission level.
5. Articulate limitations of legacy power systems and identify opportunities for technological innovation.

Requirements and Logistics

- **Homework** assignments will be due weekly on Tuesdays. 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 are expected to show their individual work, edited for clarity of presentation. Calculations should be annotated with brief explanations about what is being calculated and why. Homework must be submitted electronically on bCourses; it may be neatly handwritten and scanned. Solutions will be posted soon after each submission deadline. Late homework is generally not accepted.
- Short in-class **quizzes** will be routinely given on Mondays at the *beginning* of class, at 5:10 pm. These are designed to help students review material and will feature multiple-choice questions, short answers and very short calculations for which no calculators should be needed.
- The **mandatory midterm** (Oct 11) and **final exams** (Dec 15) will include qualitative and quantitative problems (somewhere between quiz and homework problems in length and difficulty). Students will be responsible for any material presented or discussed in lecture, regardless of whether it appears in the reading; students will *not* be responsible for material from reading assignments that was never explicitly referred to in lecture. Please check your schedule now to make sure you will be able to take exams in person on those dates. Routine conflicts such as travel itineraries, family obligations or job interviews are generally not good reasons for arranging an alternate exam time.
- Regular attendance and good **citizenship** in the classroom is expected. Students who have stronger preparation in certain areas are encouraged to offer help to others. While attendance at discussion section is optional, students are highly encouraged to participate.
- 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

Grading

The approximate weighting of scores is homework 25%, midterm 25%, 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 Materials	***Power System Analysis*** *(2nd edition ©2000)* Arthur R. Bergen and Vijay Vittal, Prentice Hall, ISBN 0-13-691990-1
	PowerWorld software (free demo Version 19, *Windows* only), available either by downloading from http://www.powerworld.com/download-purchase/demo-software or through an instructional EECS computer account via http://inst.eecs.berkeley.edu/webacct.
Recommended	***Electric Power Systems: A Conceptual Introduction*** *(©2006)* A von Meier, Wiley-IEEE, ISBN 978-0471178590
	Renewable and Efficient Electric Power Systems *(2nd edition ©2013)* Gilbert Masters, Wiley-IEEE, ISBN 978-1118140628 Note: This is a required text for 137B.

Other reading materials and links will be posted online. PowerPoint presentations from lecture will also be posted for your reference and note-taking convenience, but they do not represent a complete summary of lectures and are no substitute for attendance.

EE 137A Schedule Fall 2017

Week	Dates	Topic	Readings	Homework
1	Aug 23	The Legacy Electric Grid	Bergen & Vittal (B&V) Ch 1 von Meier (vM) Ch 6.1; NAS Ch 2	
2	Aug 28-30	Complex Power, phasor notation	B&V Ch 2.0-2.2; vM Ch 3	
3	Sep 6	Reactive compensation	B&V Ch 2.3	HK 1 due Sep 5
4	Sep 11-13	Three-phase power, wye and delta +/-/0 sequence components	B&V Ch 2.4-2.7, 12.1-12.2; vM Ch 6.2, 8.4; Grady; McEachern	HK 2 due Sep 12
5	Sep 18-20	Intro to transmission lines	B&V Ch 3; vM Ch 6.4-6.5	HK 3 due Sep 19
6	Sep 25-27	Transmission line modeling	B&V Ch 4	HK 4 due Sep 26
7	Oct 2-4	Transformers	B&V Ch 5; vM Ch 6.3-6.5	HK 5 due Oct 5
8	Oct 9-11	Midterm Oct 11		
9	Oct 16-18	Per-unit system; Rotating machines and generator control	B&V Ch 6; vM Ch 4	HK 6 due Oct 19
10	Oct 23-25	Stability, swing equation	B&V Ch 14.0-14.5; vM 8.3	HK 7 due Oct 26
11	Oct 30- Nov 1	Network matrices, power flow problem	B&V Ch 9, 10.0-10.2; vM Ch 7	HK 8 due Nov 2
12	Nov 6-8	Power flow solution	B&V Ch 10.5-10.8	HK 9 due Nov 9
13	Nov 13-15	System operation, load-frequency control, economic dispatch	B&V Ch 11; vM 9.1	HK 10 due Nov 16
14	Nov 20	Security and reliability Intro to Protection	vM 8.1-8.2, 6.7; B&V 13.0-13.3	HK 11 due Nov 22
15	Nov 27-29	Extreme events and major outages	2003TaskForce; NAS Ch 3, NAS App E	
	Dec 4-6	Review		HK 12 due Dec 7
	Dec 15	Final Exam Friday 3-6 pm		