

Spring 2013 – EE 394J-2 (16965) Power System Engineering 2

MWF 10:00 – 10:50 am, ENS 306

Instructor: S. Santoso (ssantoso@mail.utexas.edu)

Office Hours: ENS 527, M 3-4, W 1-2 pm, and by appointment

Course Objective: This course provides first-year graduate students with a solid foundation and in-depth understanding of power system analysis. It focuses on network equations for solving large power networks, power flow analysis, balanced and unbalanced fault analysis, transient stability (small and large signal disturbances), power system controls (voltage and frequency), and overvoltages and insulation coordination.

Pre-requisites: Graduate standing
This course assumes understanding and mastery of basic concepts of power system analysis: phasor algebra, balanced three-phase systems, complex power, per-unit quantities, steady state models of synchronous and induction machines, transformers, and transmission lines, operation of power systems in steady-state.

**Textbooks
(Optional)**

- J. Grainger, W. Stevenson, Power System Analysis, McGraw-Hill, 1994
- J. D Glover, M. S Sarma: Power System Analysis and Design, Brooks/Cole, 5^h ed., 2011
- B. M Weedy, B.J Cory, Electric Power Systems, 4th (1998) or 5th (2012) editions.
- A. R. Bergen, V. Vittal, Power System Analysis, 2nd, Prentice Hall, 1999
- H. Saadat, Power System Analysis, 3rd, PSA Publishing, 2010
- J. Machowski, J. Bialek, J. Bumby, Power System Dynamics: Stability and Control, Wiley, 2008 (electronic version available from UT Libraries)
- P. Kundur, Power System Stability and Control, McGraw-Hill, 1994
- Electrical Transmission and Distribution Reference Book, Westinghouse Electric & Manufacturing Company, 1942.

Course website <https://courses.utexas.edu/>

Course structure Three 50-minute class time with problem assignments and projects

Planned Subjects:

1. Network matrices: admittance matrix, network solution and reduction, admittance matrix structure and manipulation, bus impedance matrix, inverse elements. Bergen (Chapter 9), Grainger (Chapters 7 and 8)
2. Power flow analysis: the power flow problem, Gauss-Seidel and Newton-Raphson solutions, control of power flow, decoupled power flow, error analysis, DC power flow, applications. Glover/Sarma (Chapter 6), Grainger (Chapter 9)
3. Symmetrical faults: transients in RL series circuits, three-phase short circuits in unloaded synchronous machines, internal voltages of loaded machines under fault conditions, fault calculation using Zbus, selection of circuit breakers. Grainger (Chapter 10)
4. Breaker Transient Recovery Voltage Analysis: transient analysis, breaker TRV capability envelopes, TRV analysis for single- and three-phase faults, solutions to improve breaker capability (tentative). Greenwood (Chapter 3), and IEEE Std C37.011-2011

5. Symmetrical components and sequence networks: synthesis, wye and delta circuits, wye and delta circuits, transmission lines, synchronous machines, transformers, sequence networks. Grainger (Chapter 11), Glover/Sarma (Chapter 8)
6. Unsymmetrical faults: single line-to-ground, line-to-line, double line-to-ground, open-conductor faults. Grainger (Chapter 12)
7. Power system stability: general classification of power system dynamics phenomena, rotor dynamics, swing equation, power-angle equation, equal-area criterion, two-machine stability, multi-machine stability, solution of the swing curve. Grainger (Chapter 16), Sadaat (Chapter 11), Machowski (Chapter 1), Kundur(Chapters 1, 2).
8. Power system control: generator control loops, load frequency and automatic generation control, reactive power and voltage control. Sadaat (Chapter 12)
9. Overvoltage and insulation coordination: lightning and switching surges, overvoltage protection, insulation coordination, propagation and traveling of surges. Weedy (Chapter 10)

Grading Policy: Numerical grades (*g*) are as follows, with a total of 100 points

Problem assignments: 40 points
Small projects: 60 points

The correspondence of letter to numerical grade (*g*)

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F	
100	95	90	87	83	80	77	73	70	67	63	60	0

Computing Tools Matlab by Mathworks, PSCAD/EMTDC, and PowerWorld

Classroom behavior: Class meets on MWF between 10 and 11 am except during University designated holidays. Although I do not take class attendance, all students are encouraged to be present in all scheduled classes. Late arrivals are indicative of lack of commitment and disruptive to everyone in the class. Be sure to arrive at least 5 minutes before the start of class. I reserve the right to refuse entry to students arriving 10 or more minutes late. Repeat offenders will be subjected to a 25% total grade reduction. The use of all handheld devices (phones, tablets, I pads) unrelated to the learning process is strictly prohibited. Laptop computers may be used for taking notes and running simulation models.

Policies for submitting assignments, projects, take-home exams, computer scripts: All assignments must be submitted on the due date. Missed exams may be made up due to illness or other emergencies; otherwise a zero is assigned. Grades for late assignments without instructor consent will be reduced by 25%/day.

Academic Integrity: Any scholastic dishonesty will not be tolerated. Please review this link: http://deanofstudents.utexas.edu/sjs/acint_student.php

Accommodations for Student with Disabilities: The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of Dean of Students at 471-6259 and visit this link: http://www.utexas.edu/diversity/ddce/ssd/for_cstudents.php

Q drop Policy: The State of Texas has enacted a law that limits the number of course drops for academic reasons to six (6). As stated in Senate Bill 1231:

“Beginning with the fall 2007 academic term, an institution of higher education may not permit an undergraduate student a total of more than six dropped courses, including any course a transfer student has dropped at another institution of higher education, unless the student shows good cause for dropping more than that number.”

Emergency Evacuation Policy: Occupants of buildings on the UT Austin campus are required to evacuate and assemble outside when a fire alarm is activated or an announcement is made. Please be aware of the following policies regarding evacuation:

- Familiarize yourself with all exit doors of the classroom and the building. Remember that the nearest exit door may not be the one you used when you entered the building.
- If you require assistance to evacuate, inform me in writing during the first week of class.
- In the event of an evacuation, follow my instructions or those of class instructors.

Do not re-enter a building unless you are given instructions by the Austin Fire Department, the UT Austin Police Department, or the Fire Prevention Services office.

Religious Holy Days: By UT Austin policy, you must notify me of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, I will give you an opportunity to complete it within a reasonable time after the absence.