Spring 2016
EE 368L – Power System, Apparatus, and Laboratory
(meets with **EE 394L)**
TTH 9:30 – 11:00 am, GDC 2.210

Instructor:	S. Santoso (ssantoso@mail.utexas.edu)
Office Hours:	MW 1-2P and by appointment at UTA 7.229
Laboratory Schedule:	ECJ 1.316, M 6:30-9:30P, T 3:30- 6:30P, T 6:30-9:30P, W 5:00-8:00P
Teaching Assistants:	Quan H. Nguyen (quan.nguyenhuy@utexas.edu) Suma Jothibasu (sumabasu@utexas.edu)

Course Objective: The objective of the course is to provide students with fundamental principles of electric power systems design and analysis emphasized through theory, simulation and modeling, as well as hands-on laboratory experiments. This course focuses on balanced three-phase power systems, their operation, and elements of power systems encompassing generation, transmission, and distribution systems. In addition, this course introduces wind power generation and its interconnection requirements. This course serves as the first course in the electric power systems and renewable energy sequence. It provides a foundation for a career in the power and energy industry.

Pre-requisites:	EE 331 or EE 438 with a grade of at least C (minimum pre-requisite).
Textbook:	J. D Glover, M. S Sarma: Power System Analysis and Design, Brooks/Cole, 5^{h} ed., 2011.
Recommended references:	J. Grainger, W. Stevenson, Power System Analysis, Mc-Graw Hill, 1994. H. Sadaat, Power System Analysis, PSA Publishing, 3rd, 2010. Electrical Transmission and Distribution Reference Book, Westinghouse Electric & Manufacturing Company, 1942. S. J Chapman, Electric Machinery Fundamentals, 4th or 5th ed., 2011. B. Wu, et.al, Power Conversion and Control of Wind Energy Systems, 2011.
Course website:	http://canvas.utexas.edu/
Course structure:	Two one-and-a-half hour classes and one three-hour lab per week, hands-on experiments (12 to 17 sets), four small exams, one final exam.

Planned Topics:

0. Overview of generation, transmission, and distribution systems.

1. Balanced three-phase power systems (Ch. 2): phasors, single-phase circuits, balanced three-phase circuits, real, reactive, and complex power, interpretation, power factor and reactive power compensation.

Experiments:
- Concepts of RMS values and Real and Reactive Power (part 1)
- Real Power and Reactive Power (part 2)
- Power Factor Correction

2. Transformers and per-unit systems (Ch. 3): ideal transformer, equivalent circuit, per-unit system, three-phase transformers, three-winding transformers, autotransformers.

Experiments:
- Single-Phase Transformers; Transformer Polarity
- Transformer Regulation; Autotransformer

3. Synchronous machines (Sadaat Ch. 3, Grainger Ch. 3): internal voltage, equivalent circuit, phasor diagram, power and torque, operation as motors and generators.

Experiments:
- Phase Sequence
- Synchronous Machines as Generators
- Synchronization of Synchronous Generators and Active and Reactive Power Control

Planned Topics:

4. Transmission Line Parameters (Ch. 4): design consideration, resistance, conductance, inductance, capacitance, computation of line impedance.

5. Transmission Lines - Steady-state Operation (Ch. 5): Short, medium, and long transmission line models, equivalent pi and lossless models, maximum power flow, line loadability, reactive power compensation.

Experiments:

- Power Flow and Voltage Regulation of a Simple Transmission Line
- Phase Angle and Voltage Drop Between Sender and Receiver
- Parameters which Affect Real and Reactive Power Flow

6. Wind generators: technology (Types 1 – 4), squirrel cage induction machines, concept of rotor slip, equivalent circuit, power and torque characteristics, operation as motors and generators, wind power applications, reactive power requirements.

Experiments (tentative):

- Prime Mover and Torque Measurement
- Squirrel-Cage Induction Motor
- Wound Rotor Induction Motor
- Direct Connect Fixed Speed Wind Turbine
- Reactive Power Requirement for a Wind Turbine
- Islanded Operation of IG Wind Turbine

7. Power flows: Definition of the power flow problem, power flow solutions, Gauss-Seidel, Newton-Raphson, control of power flow

Experiments:

- Power flow using PowerWorld

8. Symmetrical faults (Ch. 7): three-phase short-circuit and circuit breaker and fuse selection

9. Short-circuit analysis (Ch. 8 and 9): symmetrical components, sequence networks of power apparatus, and single line-to-ground faults

10. System protection (Ch. 10): circuit breakers, reclosers, fuses, relays (overcurrent), zones of protection, relays (distance and differential)

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

Problem assignments: 0 points	Laboratory assignments: 35 points
Midterm exams: 4 x 10 points	Final Exam: 20 points
Class and lab participation: 5 points	

Homework: Homework will be collected and only recorded for completion. It is intended as preparation for exams and to increase your overall competency in the subject material. Homework will be due approximately one week from the day it is assigned. Failure to do homework will leave you at a severe disadvantage in successfully completing the course. More importantly, not putting in the time and effort to successfully solve the homework means you will lack valuable experience compared to your peers and you will be disadvantaged in future courses and ultimately during your job search upon graduation. It is permissible to work with other students to complete homework assignments.

Reading Assignments: Reading assignments will be given in class. You are expected to have read the material before the associated lecture. You are responsible for items in the reading that may not have been emphasized in lecture.

Computing Tools: Matlab and PowerWorld

Exam Expectations:

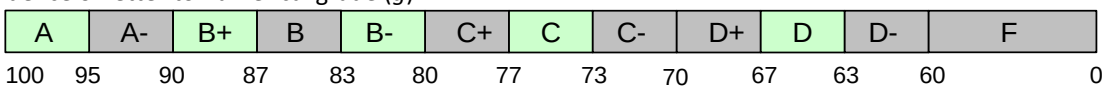
- **All answers need units.** Box (not circle) all answers. Only boxed answers will be graded. If you do not box an answer, it shows me (the instructor) you did not have an answer. I will not search your exam for a result that may match the correct answer – you need to confidently present the answer to a problem by boxing it.

- **Be neat.** Due to the difficulty (often an absolute impossibility) of following sloppy work, students with such work can expect a lower exam grade. *It is essential that your work on an exam be neat and orderly. Disorderly work is evidence that the facts and techniques are not ordered properly in your head.*
- **Exam answers must be supported by the analysis on the exam paper.** Unsupported answers, even if correct, will not receive credit. I will grade all of the analysis on your paper. Be sure to erase or cross out any work that you do not want considered during grading. I give partial credit when the analysis is meaningful and partially correct.
- **If you have any questions about the grading of your exam, follow this procedure**: write down your concerns on a sheet of paper, staple it to your exam, highlight your exam with a colored pen as needed to support your case, and return it to Dr. Santoso within one week. I reserve the right to re-grade the entire exam; your overall result may go up or down.

Exam dates

Exam 1 – Thursday, Feb. 11, 2016
Exam 2 – Thursday, Mar. 10, 2016
Exam 3 – Thursday, April 14 2016
Exam 4 – Thursday, May 5, 2015

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



Classroom behavior: Class meets on TTH between 9:30 and 11:00 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 electronic devices unrelated to the learning process is strictly prohibited. Laptop computers may be used for taking notes and running simulation models.

Policies for submitting laboratory reports and other assignments: 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 reports or assignments without instructor or TA 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.