Lahore University of Management Sciences

EE353 – Electrical Power Systems

Spring 2016-17

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Course URL (if any)	

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 min each
Recitation/Lab (per week)	Nbr of Lec(s) Per Week	1	Duration	50 min
Tutorial (per week)	Nbr of Lec(s) Per Week	As needed	Duration	

Course Distribution	
Core	N
Elective	Y
Open for Student Category	Electrical Engineering, Computer Science, Physics
Close for Student Category	

COURSE DESCRIPTION
This is an introductory course in the field of electrical power systems covering the core areas of generation, transmission/sub-transmission, distribution and load. Power systems are complex interaction of these areas and students of this course would study the basics of each area to learn how these are interconnected and controlled for a well-managed system. Electrical energy is one of the most convenient forms of energy and is used in many different applications requiring a wide range of power. Most of us depend on central generation and distribution of electrical power which may span geopolitical boundaries but the same concepts can be applied to distributed generation and usage. This course will cover the fundamental concepts in planning and operation of modern electric power generation, transmission and distribution systems. Topics to be covered include: Power system structure and operation, modeling of components such as transmission lines, transformers, generating plants and loads, power flow analysis and power system dynamics. Concepts of Smart Grids as applied to topics covered will be discussed qualitatively.

COURSE PREREQUISITE(S)	
• EE240	• Circuits 1
• EE242	• Circuits 2

COURSE OBJECTIVES	
1.	Provide the students a detailed understanding of the basic components that make up Electrical Power Systems from generation till supply of electrical power to end consumer.
2.	Study each element, its operation and modeling and how it integrates to form a system.
3.	Introduce the concepts and analysis techniques used for control of electrical power flow and different elements needed to ensure a safe, steady and robust supply of power under varying demand and supply conditions

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Learning Outcomes	
1.	Students will be able to understand the structure of Large Power Systems and role of components in that system
2.	Will be able to model modern power systems
3.	Will be able to apply their understanding to design and analyze power systems under steady state operating conditions
4.	Appreciate the challenges in moving to Smart Grids and start thinking about possible solutions

Grading Breakup and Policy
Assignment(s): Home Work: 06 → 5% Quiz(s): ~12 – min 7 → 15 – 20% Class Participation: Attendance: Midterm Examination: 01 → 30% Project: (Optional) Presentation of work on advanced topics → 10% (otherwise to be adjusted in Quizzes and Final) Final Examination: Comprehensive → 40 – 45%

Examination Detail	
Midterm Exam	Yes/No: Yes Combine/Separate: Combined Duration: 03 hrs Preferred Date: Exam Specifications: Closed book, closed notes, 1 A4 double sided, hand written help sheet, calculators
Final Exam	Yes/No: Yes Combine/Separate: Combined Duration: 03 hrs Exam Specifications: Closed book, closed notes, 1 A4 double sided, hand written help sheet, calculators

COURSE OVERVIEW			
Week/ Lecture/ Module	Topics	Recommended Readings	Objectives/ Application
1.	Power System Overview with present and future grid structure and issues.	Bergen and Vittal: Chapter 1	
2.	AC Power flow in linear systems, Phasors, Complex Power	Bergen and Vittal: Chapter 2	
3.	1φ and Poly phase systems. 3φ circuits.	Bergen and Vittal: Chapter 2	
4.	System modeling – single line diagram and per unit system.	Bergen and Vittal: Chapter 5	
5.	Power quality and harmonics in Power Systems	Handout	
6.	Power quality and harmonics in Power	Handout	

	Systems…		
7.	Transmission line parameters: Overview and construction, Resistance and Conductance	Reading pack Bergen and Vittal: Chapter 3	
8.	Transmission line parameters: Series Impedance, Resistance	Reading Pack Bergen and Vittal: Chapter 3	
9.	Transmission line parameters: Inductance, Single phase and Three phase	Reading Pack Bergen and Vittal: Chapter 3	
10.	Transmission line parameters: Inductance continued, unsymmetrical spacing, bundled conductors, parallel circuits	Reading Pack Bergen and Vittal: Chapter 3	
11.	Transmission line parameters: Capacitance of two wire line, three phase line	Reading Pack Bergen and Vittal: Chapter 3	
12.	Transmission line parameters: Capacitance continued, unsymmetrical spacing, bundled conductors, parallel circuits	Reading Pack Bergen and Vittal: Chapter 3	
13.	Transmission line models: Short and medium transmission lines	Bergen and Vittal: Chapter 4	
14.	Transmission line models continued: Differential equations and solution	Bergen and Vittal: Chapter 4	
15.	**Midterm**		
16.	Transmission line models continued: Differential equations and solution	Bergen and Vittal: Chapter 4	
17.	Transmission line: maximum power flow, reactive compensation techniques, Transients	Bergen and Vittal: Chapter 4 Glover: Chapter 12.1 – 12.3	
18.	Y_{Bus}, reduction of nodes, Bus Impedance matrix in fault calculations	Reading Pack Bergen and Vittal: Chapter 9	
19.	Bus Impedance Matrix Equivalent Network, Generation of Z_{Bus}, Selection of circuit breaker	Reading Pack Bergen and Vittal: Chapter 9	
20.	Power Flow Analysis: Direct solution to linear algebraic equations. Gauss-Seidel method	Bergen and Vittal: Chapter 10 Hadi Saadat: Chapter 6	
21.	Power Flow Analysis – Solution of non-linear algebraic equations Newton-Raphson method	Bergen and Vittal: Chapter 10 Hadi Saadat: Ch 6	
22.	Power Control – System Modeling Application to single machine-Infinite Bus System	Bergen and Vittal: Chapter 11	
23.	Power Control – Multi generator case Division into Control Areas	Bergen and Vittal: Chapter 11	
24.	Economic Dispatch considerations	Bergen and Vittal: Chapter 11	
25.	Unbalanced System – Use of Symmetrical Components.	Bergen and Vittal: Chapter 12	

26.	Sequence Networks of Impedance, Lines, Generators and Transformers	Bergen and Vittal: Chapter 12	
27.	Symmetrical faults	Bergen and Vittal: Chapter 12	
28.	Introduction to Unsymmetrical faults	Bergen and Vittal: Chapter 12	

Textbook(s)/Supplementary Readings

Textbook:

Power System Analysis by Arthur R. Bergen and Vijay Vittal, Pearson Education Inc., 2008.
Reading pack uploaded on LMS

Supplementary Reading:

Power System Analysis by J. J. Grainger and W. D. Stevenson, Second Edition, McGraw Hill, 2003.
Power System Analysis and Design by J. D. Glover, M. S. Sarma and T. J Overbye, fourth edition, Thomson Learning, 2008.
Power System Analysis by Hadi Saadat, McGraw Hill, 2002