



EE 361 Electrical Power Systems
School of Electrical Engineering and Computer Science
Fall 2015

1 Course Overview

Title	EE 361 Electrical Power Systems
Credits	Three credit hours; required
Semester	Fall 2015
Instructor	Prof. Ali Mehrizi-Sani
Email	mehrizi@eecs.wsu.edu
Office	EME 35
Phone	(509) 335-6249
Fax	(509) 335-3818
Lecture Room	SLOA 233
Lecture Hours	Mondays, Wednesdays, Fridays from 9:10 AM to 10:00 AM
Course Website	http://eecs.wsu.edu/~mehrizi/ee361/2015F
Office Hours	<ul style="list-style-type: none">• Mondays 10:00-11:00; Wednesdays 10:00-10:30; Fridays 10:00-10:30; or• Email me for an appointment with “EE 361” in the subject line.
TA Name	Hooman Ghaffarzadeh
TA Email	hooman.ghaffarzadeh@wsu.edu
TA Office Hours	Tuesdays from 3:00 pm to 4:00 pm in SLOA 338
Catalog Description	Power system hardware; transformers, and electromechanical machinery; introduction to power system operation.
Longer Description	This is a gateway course for power engineering. This course discusses the basic components of a power system, e.g., three-phase circuits, different types of electric machines, transformers, and transmission lines. You see several applications and examples.



Please note: This course will use AMS recording facilities to capture videos of each lecture. Your voice and/or picture may also be captured. The recordings may be used for future offerings of this or similar courses. Any concerns about this should be communicated to the course instructor in writing, i.e., WSU email, by the end of the first week of classes. You can find the videos in Blackboard (learn.wsu.edu) under Tools and then Panopto content. (If needed, the server address is wsu.hosted.panopto.com.)

2 Required Background by Topic

You need to have taken the following courses. For each prerequisite, some of the topics that will be used in this course are listed. A general knowledge of other topics typically covered in the respective course is preferred.

Certified in major Electrical Engineering, Computer Science, or Computer Engineering.

EE 321 Electrical Circuits II (with C or better) Three-phase circuits; transformers; phasors.

EE 331 Electromagnetic Fields and Waves (with C or better) Field calculations; magnetic circuits.

3 Learning Outcomes

At the end of this course, you are expected to be able to

- Analyze a three-phase circuit;
- Analyze and solve problems related to electric motors;
- Compare different electric motors;
- Develop models for electricity transmission lines;
- Analyze single- and three-phase transformers.

4 Course Topics

The course topics include

- Power computations and review of circuit analysis [a, b, c]
- Three-phase circuits (§2) [a, b, c]
- Transformers (§3) [a, b, c]
- Per unit system (§3) [a, b, c]
- Fundamentals of rotating machines (§4) [a, b, c]
- Synchronous machines (§5 and §6) [a, b, c]
- Induction machines (§7) [a, b, c]
- DC machines (§8) [a, b, c]
- Transmission lines (§9) [a, b, c]
- Power system models (§10) [a, b, c, k, i]
- Power flow (§11) [a, b, c, e, k]
- Power system operation [a, e, f, h, i, j]

Below is the approximate course schedule (the text in crimson and green are hyperlinked). Important dates are also marked. Because of the necessary travel to showcase research/teaching efforts at WSU, we may have a few make-up classes in the evenings (marked below as EVE) at 5:30 PM, unless otherwise stated. The make-up classes will be held in the same classroom.

To download PSCAD simulation cases, click on the green link and then press Ctrl-S (Save) in your browser. Make sure the file is saved with an extension of .pscx, and not .pscx.txt.

Week	Topic	Reading and Notes
W1 Aug. 24	M Overview of the course and policies	M Slides
	W Review of circuit concepts	W L^AT_EX resources (Gettig something out of L^AT_EX ; L^AT_EX Wikibook ; The Art of L^AT_EX ; A (not so) Short Introduction to L^AT_EX ; T_EX StackExchange ; TikZ graphics in L^AT_EX)
	F Review of diagnostic exam; circuit concepts	F Sample diagnostic exam
W2 Aug. 31	M Real and reactive power	M
	W Average power; 3Φ circuits	W
	F 3Φ circuits; Y connection	F
W3 Sept. 7	M No class—Labor Day (Holiday)	M Homework 1
	W Δ connection; Power calculations	W
	F Solving 3Φ circuits	F

W4 Sept. 14	M	Transformers	M	Homework 2
	W	Model of transformers	W	Homework 1 due Homework 1 Solution
	F	Efficiency η and voltage regulation	F	
	O	Open-circuit and short-circuit tests	O	Make-up for Nov. 9; on Wednesday
W5 Sept. 21	M	Autotransformers	M	Homework 3 Exam One Coverage; Transformers
	W	Midterm Exam 1	W	Homework 2 due Homework 2 Solution
	F	Three-phase transformers; pu system	F	Exam 1 Exam 1 Solution
W6 Sept. 28	M	Midterm solution; pu system	M	Homework 4
	W	pu system for 3ph; considerations	W	Homework 3 due Homework 3 Solution
	F	Fundamentals of electric machines	F	How to make a simple DC motor
W7 Oct. 5	M	Rotating magnetic field in an AC machine; poles	M	Homework 5 Rotating magnetic field animation
	W	Equivalent model of an SM; phasor diagram	W	Homework 4 due Homework 4 Solution
	F	No class—Talk: Guadalajara, Mexico	F	
	O	Synchronous machines	O	Make-up for Oct. 9; on Mon, 5pm, SLOA 38
W8 Oct. 12	M	OC and SC tests on an SM	M	Homework 6
	W	Capability curve	W	Homework 5 due Homework 5 Solution
	F	Examples	F	Solved examples for transformers and SMs
W9 Oct. 19	M	Synchronous motors	M	Homework 7
	W	Power factor correction	W	Homework 6 due Homework 6 Solution
	F	Parallel operation of synchronous generators	F	
W10 Oct. 26	M	Physics of induction motors	M	Homework 8 Exam 2 Coverage
	W	Equivalent circuit	W	Homework 7 due Homework 7 Solution
	F	Power and torque	F	
W11 Nov. 2	M	Midterm Exam 2	M	Homework 9 Exam 2 Exam 2 Solution
	W	Tests on an IM	W	
	F	DC motors	F	Homework 8 due Homework 8 Solution
	O	Example; torque-speed characteristics	O	Make-up for Nov. 16; on Wed, 5:30, SLOA 233
W12 Nov. 9	M	No class—IECON (Japan)	M	Homework 10
	W	No class—Veterans Day (Holiday)	W	
	F	Shunt DC machines	F	Homework 9 due Homework 9 Solution
W13 Nov. 16	M	Examples	M	Solved example problems for DC machines and induction machines
	W	No class—WSU Operations Suspended	W	
	F	Series and compound DC machines	F	Homework 10 due Homework 10 Solution
Nov. 23	Thanksgiving Vacation			

W15 Nov. 30	M Compound machines example; Transmission lines	M	Homework 11	Exam 3 Coverage
	W T-line models	W		
	F Midterm Exam 3	F	Exam 3	Exam 3 Solution
W16 Dec. 7	M Power flow studies; Y_{bus}	M		
	W Power flow studies	W		
	F Review	F	Homework 11 due	Final Exam Coverage Solved problem on DC machines
			Homework 11 Solution	
Final	Final Exam, ¹ Tuesday, Dec. 15, 2015 8:00 AM to 10:00 AM	M	Exam Final	Exam Final Solution

¹<http://www.registrar.wsu.edu/Registrar/Content/FinalExams20157.pdf>

5 Textbook

The required textbook is

- S. J. Chapman, *Electric Machinery and Power System Fundamentals*. New York: McGraw-Hill, 2001, ISBN 0072291354.

An errata is available at <http://www.mhhe.com/engcs/electrical/chapman/power/graphics/errata.pdf>. A supplementary errata is available at http://www3.nd.edu/~sauer/power/Xtras/errata_sup.pdf.

6 Evaluation

Your performance in this course will be assessed based on the components shown below. Failure to complete assigned work or to take a test results in a zero for that portion of your grade, unless you have a compelling reason because of an emergency, which has to be discussed with me and approved by me in advance. I will not consider ANY request at the end of the semester to convert a failing grade to a passing grade or to otherwise change a grade. The grading scheme is subject to change. Grades will no be curved; you are assessed on what you know, not what others know.

Diagnostic Test (5%; required) Scoring 100% on the diagnostic test (DT) is paramount to passing this course. DT is designed to test your basic math and electrical engineering skills (examples include phasor notation, complex math, KVL/KCL, real and reactive power, and circuit concepts). You will either get 0 or 100 (i.e., full grade) on the diagnostic exam. You have four opportunities to take the DT: 1) **Thursday, Aug. 27**, 2) **Friday, Aug. 28**, 3) **Thursday, Sept. 3**, and 4) **Friday, Sept. 4** all from 4:10 to 4:40 in SLOA 9. Anyone who does not pass the diagnostic test can withdraw from the course without it showing on their transcript if done by the appropriate deadline (please see WSU academic calendar).

Assignments (15%) Nine to eleven assignments. Each assignment is usually assigned on a Monday and is due at the beginning of the Wednesday of the week after. You can discuss assignments with your fellow students, but the assignment you hand in must be your own work. Assignments not submitted in class can be submitted before 12:00 pm in my office if you receive my approval in advance. Assignments submitted between 12:00 pm and midnight are subject to a 15% grade reduction. No assignment after the due date will be accepted as I usually post solutions as soon as possible. Assignments will significantly help you in preparing for tests and final exam.

Letter	Range
A	[95, 100]
A–	[90, 95)
B+	[85, 90)
B	[80, 85)
B–	[75, 80)
C+	[70, 75)
C	[65, 70)
C–	[60, 65)
D	[55, 60)
F	[0, 55)

Midterm Exams (40%) Fifty-minute midterm exams during lecture. The first midterm is on **Wednesday, Sept. 23, 2015**, the second on **Monday, Nov. 2, 2015**, and the third on **Friday, Dec. 4, 2015**. The dates and number of midterm exams may change in unforeseen circumstances.

Final Exam (40%) Two-hour comprehensive exam on **Tuesday, Dec. 15, 2015**.

Class Participation (0%) But class attendance is required. Class participation may help you when in the boundary of letter grades.

7 Academic Integrity

I encourage you to work with classmates on assignments. However, each student must turn in original work. No copying will be accepted. Students who violate WSU's Standards of Conduct for Students will receive an F as a final grade in this course, will not have the option to withdraw from the course and will be reported to the Office Student Standards and Accountability. Cheating is defined in the Standards for Student Conduct WAC 504-26-010 (3). It is strongly suggested that you read and understand these definitions. Please also see <http://academicintegrity.wsu.edu>.

8 Students with Disabilities

Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center (Washington Building 217; (509) 335-3417; Access.Center@wsu.edu) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center. For more information, see <http://accesscenter.wsu.edu>.

9 Safety and Emergency Notification

Washington State University is committed to enhancing the safety of the students, faculty, staff, and visitors. It is highly recommended that you review the Campus Safety Plan (<http://safetyplan.wsu.edu>) and visit the Office of Emergency Management web site (<http://oem.wsu.edu>) for a comprehensive listing of

university policies, procedures, statistics, and information related to campus safety, emergency management, and the health and welfare of the campus community.

10 Disclaimer

Information contained in this document may and will change as required during the semester. Such changes will be communicated to you via email, in class, and/or on the website. Please make sure you attend all lectures to stay up-to-date. Most course material, e.g., assignments, grades, and extra readings, will be communicated through the website. I encourage you to discuss any difficulties you may have in this course with me or with your TA.