

EE 431
Fall 2019

ELECTRICAL POWER DISTRIBUTION SYSTEMS, 3 hr. cr.

INSTRUCTOR: Dr. Sarika Khushalani Solanki, 241 Advanced Engineering Research Building
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OFFICE HOURS: TR 12:15-1:15

CLASS TIME: TR 11:00-12:15 Class Location: ESB E211

PREREQUISITE: Electromechanical Energy Conversion & Energy Systems (EE 335)

TEXT:

Power System Analysis and Design, 4th Edition by Mulukutla Sarma and Duncan Glover
Distribution System Modeling and Analysis by W. H. Kersting, CRC Press, 2nd edition

Objective: To acquaint the students with load characteristics, subtransmission and distribution substations; primary and secondary distribution; secondary network systems; distribution transformers, voltage regulation and application of capacitors; voltage fluctuations; protective device coordination.

In Summary: The course is not easy and has lot of mathematical equations, formulations and calculations. It is expected that students can do complex calculations and have good trigonometric knowledge. The course requires the students to revise the material after it has been taught and work on homework and project as the material is covered in the class and not wait for last for all the work. Regular working on inclass problems, homeworks, quizzes, lectures will help excel in the class.

Expected Learning Outcomes:

- Be able to calculate load factor, diversity factor and loss factor.
- Be able to calculate voltage along the feeder using allocated load method.
- Be able to calculate instantaneous and balanced power in three phase balanced circuits
- Have a good understanding of design consideration of substations, primary, and secondary systems.
- Be able to calculate voltages and currents for single-phase and three-phase transformers.
- Have a good understanding of voltage regulation issues in distribution power system.
- Be able to design overcurrent and overvoltage protections for a distribution feeder.
- Introduction to software like MATLAB for power calculations

- I. Introduction to Distribution System
 - A. The Distribution System
 - B. Distribution Substations
 - C. Radial Feeders
 - D. Distribution Feeder Map
 - E. Distribution Feeder Electrical Characteristics

- II. The Nature of Loads
 - A. Individual Customer Load
 - B. Distribution Transformer Loading
 - C. Feeder Load
 - D. Voltage Drop Calculations

- III. Distribution Transformers
 - A. The Ideal Transformer
 - B. Equivalent Circuits for Practical Transformers
 - C. The Per-Unit System
 - D. Three-Phase Transformer Connections and Phase Shift
 - E. Per-Unit Equivalent Circuits of Balanced Three-Phase Two-Winding Transformers
 - F. Three-Winding Transformers

- IV. Symmetrical Faults
 - A. Series R-L Circuit Transients
 - B. Three-Phase Short Circuit
 - C. Power System Three-Phase Short Circuits
 - D. Bus Impedance Matrix
 - E. Circuit Breaker and Fuse Selection

- V. Introduction to Power World
 - A. Making one line diagrams
 - B. Simulating for Power Flow
 - C. Simulating for Fault Analysis

- VI. Symmetrical Components
 - A. Definition of Symmetrical Components
 - B. Sequence Networks of Impedance Loads
 - C. Sequence Networks of Series Impedances
 - D. Sequence Networks of Three-Phase Lines
 - E. Sequence Networks of Rotating Machines
 - F. Per-Unit Sequence Models of Three-Phase Two-Winding Transformers
 - G. Per-Unit Sequence Models of Three-Phase Three-Winding Transformers
 - H. Power in Sequence Networks

- VII. Unsymmetrical Faults
 - A. System Representation
 - B. Single Line-to-Ground Faults
 - C. Line-to-Line Fault
 - D. Double Line-to-Ground Fault
 - E. Sequence Bus Impedance Matrices

- VIII. System Protection (If time permits)
 - A. Overcurrent Relays
 - B. Reclosers and Fuses

GRADE POLICY:

Exam 1	20%	90 – 100 = A
Exam 2	20%	75 – 89 = B
Homework	10%	60 – 74 = C
Project	10%	50 – 59 = D
Quizzes	10%	<50 = F
Final Exam	30%	
TOTAL	100%	

There will be curving at instructor’s discretion. Changes in syllabus are at the discretion of the instructor.

Class Policy:

Class Attendance: Attendance at lecture is expected. If you miss a class, you are responsible for all assignments and material covered. You are required to participate in all class discussions. If you attended the lectures and did not understand any material, see the instructor before the next lecture. You will be required to answer questions or discuss your solutions in class or on black board. The textbook will be used as a reference. You must maintain good class notes and should review all past materials covered before attending a class.

Homework Assignments: The homework assignments are to assist students in understanding the material better. Please do your own work. There will be a quiz on the homework on the day it is due. Homework assignments should be done on individual bases and in case of questions students should not expect complete or full steps for solving assignments. There may be many assignments and also may be at short notice. It is expected from students that some material should be understood using your ability and also homework assignments may not exactly replicate the in-class problems or material covered. It is at instructor’s discretion to provide homework solution from the best solution received from the student or a drafted solution. Frequency of assignments may increase towards the end of the course. Homework problems will include problems from material covered in last class so students should make sure they start working on problems for material already covered in classes before.

Exams: Exams are designed to test your application of the knowledge learned. The questions will be more complex and challenging. All exams are closed book and closed notes. One page front and back with formulas and tables with no solved problems is allowed. If the one page sheet violates these requirements points will be deducted and penalty will be given based on instructor’s discretion. The final exam is comprehensive. It may not be based on homework assignments and in-class problems.

Exam Dates: The dates for exams shown in the syllabus are tentative. They will be finalized in class. In case you miss a class, make sure you stay in touch with important announcements.

Make-up Exam: As a general policy, make-up exams will not be given. If there is an extenuating circumstance, you must contact your instructor before the exam and seek approval for granting a make-up exam. Usually the make-up will be a comprehensive exam to accommodate all students.

Class Learning Environment: Cell phones must be turned off during class. Do not talk in class or read newspapers or do homework assignments from other classes. These activities disturb students and it is important to respect their right to a good learning environment in class.

Plagiarism: Plagiarism will be severely penalized and may result in an F grade for the course or receive no credit for a specific exam. Students are expected to exhibit the same level of professionalism and integrity that will distinguish them in their professional careers. Both the student who copied the work and the student who allowed the work to be copied will be penalized. Consequences and procedures for dealing with cases of academic dishonesty are outlined in the WVU Student Code of Rights and Responsibilities.

Students with Disability: If you have a disability and anticipate needing any type of accommodation in order to participate in this class, please advise your instructor and make appropriate arrangements with Disability Services (304-293-6700). The student should notify the instructor during the first week of class regarding the accommodation needed.

Inclass Problems: Problems may be assigned in class to test your understanding of the material covered in class and provide immediate feedback to the whole class. The instructor will be assisting on inclass problems but the student has to do majority of the work. If the student is found reluctant in working on inclass problems or misses classes and hence inclass problems, points will be deducted from overall grade based on instructor discretion. The instructor believes in experiential/ hands-on learning through inclass problems and will follow a mix of both experiential and didactic learning.

Grading: Grading will be fair by all means. When papers are graded it may not be in the scope of the space to explain why it is incorrect. Questions regarding grading may be asked during office hours. Grades after the second exam will be indicated to students and they should ask the instructor if they have any performance question.

Review: Every student is different and one set of teaching style may work for some but may not work for others. To find a good balance and enhance the teaching effectiveness and learning in this course instructor is welcome to suggestions. Any suggestion/constructive criticism that can lead to instructor's teaching effectiveness can be put on a paper and can be slid under the office door. (Regarding less student learning, fast instructor pace, class presentation, tests, organization, exams, grading, project)

Extra Classes: Additional classes outside regular hours will be scheduled if classes are cancelled either due to national holiday, emergency or instructor commitments to professional travel.

Tentative Exam Dates:

Exam 1: September 23-27

Exam 2: November 11-15

Project: November 18

Final Exam: University Calendar

Academic Integrity Statement:

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I will enforce rigorous standards of academic integrity in all aspects and assignments of this course. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the Student Conduct Code at <http://www.arc.wvu.edu/admissions/integrity.html>. Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me before the assignment is due to discuss the matter.

Attendance Policy:

Consistent with WVU guidelines, students absent from regularly scheduled examinations because of authorized University activities will have the opportunity to take them at an alternate time. Make-up exams for absences due to any other reason will be at the discretion of the instructor.

Social Justice Statement:

The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me during the first week of class and make appropriate arrangements with the Office of Disability Services (293-6700). For more information on West Virginia University's Diversity, Equity, and Inclusion initiatives, please see <http://diversity.wvu.edu>. If you feel that you are being treated inappropriately or unfairly in any way, please feel free to bring your concerns to my attention. Please be assured that doing so will not prejudice the grading process. In return, I expect you to behave professionally and ethically. Grades will be based on performance, but will be lowered for unethical or unprofessional conduct.

The syllabus and its contents may be changed at instructor's discretion at any time in the semester.