WEST VIRGINIA UNIVERSITY                    COLLEGE OF ENGINEERING
LANE DEPARTMENT OF COMPUTER SCIENCE AND ELECTRICAL ENGINEERING

EE 431
Fall 2014

ELECTRICAL POWER DISTRIBUTION SYSTEMS, 3 hr. cr.

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| INSTRUCTOR: | Dr. Sarika Khushalani Solanki, 835 Engineering Sciences Building |
| | Phone: 293-9142 |
| | Email: skhushalanisolanki@mail.wvu.edu |
| OFFICE HOURS: | TR   2:00-3:00  PM |
| CLASS TIME: | TR     12:30-01:45 PM        Class Location: ESB-E 201 |

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

TEXT:

Power System Analysis and Design, 4$^{th}$ Edition by Mulukutla Sarma and Duncan Glover

Electric Power Distribution System Engineering by Turan, Gonen, CRC Press, 2$^{nd}$ edition

Distribution System Modeling and Analysis by W. H. Kersting, CRC Press, 2$^{nd}$ 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.

**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

III.     Balanced Three Phase Circuits
    A.      Balanced Source
    B.      Balanced Load
    C.      Power in balanced three phase circuits


IV.     Subtransmission and Distribution Substations
    A.      Distribution-Substation Design-One Line Diagrams
    B.      Distribution-Substation Design-Physical Arrangement

V.      Primary and Secondary Distribution
    A.      Primary System
    B.      Secondary System
    C.      Secondary Banking
    D.      RUD Systems

VI.     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

VII.    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

VIII.   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

IX.     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

X.      System Protection

      A.      Overcurrent Relays
      B.      Reclosers and Fuses

GRADE POLICY:

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|---|---|---|---|
| Exam 1 | 20% | 90 – 100 | = A |
| Exam 2 | 20% | 75 – 89 | = B |
| Homework | 15% | 60 – 74 | = C |
| Quizzes | 15% | 50 – 59 | = D |
| Final Exam | 30% | <50 | = F |
| TOTAL | 100% | | |

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

General: 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: Problems may be assigned in class to test your understanding of the material covered in class and provide immediate feedback to the whole class. If homework is assigned, it will be graded and feedback will be provided. 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 student 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.

Tentative Exam Dates:
Exam 1: September 24-28
Exam 2: November 12-16
Final Exam: University Calendar

Exams are designed to test your application of the knowledge learned. It may not be based on homework assignments and in-class problems. One page front and back with formulas and tables with no solved problems is allowed. The final exam is comprehensive. 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. 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: Instructor is welcome to suggestions. Any suggestion 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

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.