EL 6631 – Electrical Transmission and Distribution Systems

Objective: At the end of the term the participants will have a deeper understanding of electrical power transmission and distribution systems beyond an introductory course in power. The students will be able to rate and compute the parameters of the major components of the system: lines, cables, transformers, circuit breakers, capacitors and grounding systems. The participants will understand the principles of protection for short-circuit, lightning strikes and some internal transients.

Outline: Introduction to T&D systems. Choice of voltage and frequency. Radial and meshed networks. Aerial lines: construction, parameters and thermal rating. Cables: installations, impedance and thermal rating. Transformers and reactors: types, connections, insulation class, inrush currents and parallel operation. Capacitors: construction and application to transmission, distribution and industrial systems. Introduction to steady state system analysis: load-flow and short-circuit. Lightning. Grounding systems. Characteristics of loads: customer classes, voltage sensitivity, duty cycle, and load growth. Modern grids: nano-, micro-, mini-, smart- and super-grid.

Textbook: Electrical Transmission and Distribution Reference Book, **Electric Systems Technology Institute,** ABB Power T&D Company Inc., 1997.

Reference Books:

1. Turan Gonen, "Title: Electric Power Distribution System Engineering", CRC; 2 edition, December 14, 2007. ISBN-10: 142006200X, ISBN-13: 978-1420062007.
2. William H. Kersting, "Distribution System Modeling and Analysis", CRC; 2 edition, November 15, 2006. ISBN-10: 084935806X , ISBN-13: 978-0849358067.
3. James J. Burke, "Power Distribution Engineering", CRC; 1 edition, June 29, 1994, ISBN-10: 0824792378, ISBN-13: 978-0824792374.
4. Thomas Allen Short, "Electric Power Distribution Equipment and Systems", CRC; 1 edition, November 29, 2005, ISBN-10: 0849395763, ISBN-13: 978-0849395765.
5. Colin Bayliss and Brian Hardy, "Transmission and Distribution Electrical Engineering", ELSEVIER – NEWNES, December, 2006, ISBN-13: 978-0-7506-6673-2, ISBN-10: 0-7506-6673-0.

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Grading:

Homework	Weekly	10%
Midterm exam	October/29/2009	30%
Project	December/10/2009	30%
Final Exam	December/17/2009	30%

Pre-requisites: EL 5613 – Introduction to Electric Power Systems

Weekly Lecture Schedule

9/10 - Lecture 1. Introduction to T&D Systems. History of Electric Systems. Choice of Voltage and Frequency. Generation, Transmission and Distribution. Substations, Feeders and Networks. Radial Networks. Secondary (Automatic) Networks. Distribution Systems around the World.

9/17 - Lecture 2. Aerial (Overhead) Lines. Conductors and Towers. Calculation of Impedance and Admittance. Thermal Rating. Skin and Corona Effects.

9/24 - Lecture 3. Cables. Types of Cables and Installations. Calculation of Impedance and Admittance. Operation of Cables in Parallel.

10/1 - Lecture 4. Thermal Rating of Cables. NEC. Neher-McGrath Method. IEC and IEEE Standards.

10/8 - Lecture 5. Transformers and Reactors. Types, Construction and Installations. Insulation Class and Connections. Thermal Rating. Inrush Currents and Ferroresonance. Parallel Operation

10/15 - Lecture 6. Thermal Rating of Transformers. Cyclic and Dynamic Loading. IEEE Standards. Thermal Loss of Life.

10/29 - Week 8. ***Mid-Term Exam***

11/5 - Lecture 7. Capacitors. Construction . Application of Capacitors in Transmission, Distribution and Industrial Systems. Shut Capacitors (Voltage Control and Power Factor Correction). Series Capacitors (Line Reactance Compensation). Rating. Capacitor Switching and Operating Problems with Capacitors (Inrush Currents).

11/12 - Lecture 8. Protection. Circuit Breakers. Types and Construction. Arc Extinction. Rating and Selection. Introduction to Relaying. Fuses. Introduction to Protection Coordination.

11/19 - Lecture 9. Lightning. Characteristics. Surge Arresters. Basic Insulation Level. Insulation Coordination.

11/24 - Lecture 10. Grounding Systems. Ground and Neutral. Touch and Step Potentials. Petersen Coil. Resonant Grounding.

11/26 – No classes (Thanksgiving) –This class is moved to Tuesday 11/24.

12/3 - Lecture 11. Characteristics of Loads. Customer Classes and Categories. Voltage Sensitivity of Loads. Constant Power. Constant Current. Constant Impedance. ZIP Coefficients. Load Curves and Duty Cycle. Coincidental and Non-coincidental Loads. Load Growth.

12/10 - Lecture 12. Optimization. Loss Minimization. System Reconfiguration. Capacitor Switching. (Energy) Conservation Voltage Reduction. Introduction to System Restoration.

12/10 - Lecture 13. Modern Grids. Distribution Automation. Distributed Generation. Grid 2030. Nano Grid. Micro Grid. Mini Grid. Smart Grid. Super Grid. The Issues.

12/17 - Week 15. Final exam or presentation of projects.