Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NEED501	High Voltage Engineering	3	0	0	3

Course Objective

- This syllabus has been designed with an eye on power engineering, and the topics considered are intricately related to power-engineering applications in general and dielectric engineering in particular. The topics are based on recent research publications and power utility requirements. The syllabus is designed so that a student gets necessary mathematical foundation while gaining advanced knowledge in the field of High voltage engineering. All the topics have been selected in such a way that the reader gets an idea of how these theories are useful in real life. However, strong fundamental knowledge about power system protection is the prerequisite for the course.

Learning Outcomes

Upon successful completion of this course, students will:

- Appreciate the limitations of conventional design procedure and develop the necessary knowledge required for numerical field computation.
- Develop an appreciation of the recent requirements and real-life problems faced by the utility providers.
- Gain the necessary mathematical foundation while gaining advanced knowledge in the field of High voltage engineering.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Numerical computation electric fields: Graphical Method, Finite Difference Method (FDM), Integral method of field computation, fictitious point, line and ring charges, Finite element method of field computation, minimum field energy and basic potential equation at nodes, field computation in lossy dielectrics; conformal transformation for two-dimensional fields, elliptic cylinders bundle conductors, Mechanical forces in HV systems, Charge Simulation Method- introduction; modelling using COMSOL/ANSYS	3L	Basics of Electromagnetic field theory. Fundamentals of Resistive and capacitive fields
2	Generation of High/Test Voltages and its measurement: Alternating Voltages - Transformers in cascade, the series resonant circuit, Transient voltages, Impulse Generator, Tripping and synchronization with oscilloscope, Direct Voltages - Voltage Doublers and Cascade Circuits, Electrostatic Generators. Electrostatic Voltmeters, Sphere gaps, Uniform field gap, Ammeter in series with High Impedance, Potential Dividers; Peak voltmeters, instrument transformers; Voltage divider, HV Electrode	8L	Advantages of Numerical field computation
3	Breakdown of insulation: Different mechanism of breakdown of gaseous, liquid and solid dielectrics; HV equipment insulation design and stress controlling devices. Analysis of voltage distribution in transformer winding and bushings.	7L	Knowledge about Finite Element Method and its application in HV equipment
4	Space Charge in dielectrics, Conduction Process in solid dielectrics, Ionic Conduction, electronic conduction, charge injection mechanisms in solid dielectrics, Treeing and Tracking, Conduction in dielectric liquids	6L	Knowledge about the different mechanisms responsible for conduction in dielectrics
5	Introduction to nanomaterials and Nanocomposites- classification of nanofillers, carbon and non-carbon based nanofillers - Properties of nanomaterials- role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, conductivity, and enhanced catalytic activity in the macroscopic state. Preparation, characterization and applications of SiO2, TiO2, ZrO2, Al2O3 composites, Applications of nano filled materials for outdoor and indoor equipment.	6L	Basics of Nanomaterials and nanocomposites and their potential in HV industry
6	Partial Discharge Measurement and analysis: Electrical method of PD measurement, PD inception and Extinction in closed cavity; Partial breakdown corona & EMI electromagnetic interference.	6L	Basics of Nanomaterials and nanocomposites and their potential in HV industry
7	Insulation Response measurement and analysis: Time and Frequency domain dielectric response; insulation condition determination using noninvasive electrical testing; Remaining Life Analysis-Life Estimation Based on Thermal Modeling; Aging Acceleration and Hot-Spot Factor; Probabilistic Approach Towards Life Estimation; Application of Statistical analysis in HV; Application of Optimization techniques in Contour optimization.	6L	Knowledge about. partial discharge – detection, analysis and impact on real-life equipment
	Total Contact Hours	**42L**	

Text Books:

1. E. Kuffel, W.S. Zaengl, J. Kuffel , "High Voltage Engineering: Fundamentals", Elsevier, 2nd Ed.
2. D. Razevig "High Voltage Engineering", Khanna publication

Reference Books:

1. Farouk A.M. Rizk, Gian N Trinh "High Voltage Engineering", CRC Press
2. Andreas Kuchler "High Voltage Engineering", Springer Verlag.
3. S. Chakravorti "Electric Field Analysis", CRC Press