

COURSE TITLE	HIGH VOLTAGE ENGINEERING
COURSE CODE	01EE1507
COURSE CREDITS	3

Objective:

- 1 Conceptualize the idea of high voltage and its safety measures involved. Analyze the breakdown mechanism of solids, liquids, and gases. Understanding of Measurement and generation of direct, alternating, and impulse high voltage signals. Measure the dielectric loss and partial discharge involved in non-destructive high voltage tests.

Course Outcomes: After completion of this course, student will be able to:

- 1 Calculate the electric field distribution using computational numerical methods.
- 2 Investigate the factors that influence the electrical breakdown phenomenon in different dielectric mediums.
- 3 Determine various parameters for high voltage generation and measurement circuits.
- 4 Illustrate various testing methods to test high voltage electrical equipment.

Pre-requisite of course:Field Theory

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	0	50	30	20	0	0

Contents : Unit	Topics	Contact Hours
1	Electrostatic fields, control and Analysis Electrical field, Uniform and non uniform Electrical field, numerical method for Electrical field computation: Finite difference Method (FDM), Finite Element Method (FEM), charge simulation method (CSM), Introduction to FEMM tool to compute electric field	4
2	Breakdown in Gases dielectric Ionization of Gases by different phenomenon like electron collision, photo-ionization, thermal ionization, Townsend mechanism and its first and second ionization coefficient, equation for current growth, Streamer theory for breakdown in gases or Kanal mechanism of spark, Paschen's law, breakdown in non-uniform fields and corona discharges, vacuum and its breakdown mechanisms	7

Contents : Unit	Topics	Contact Hours
3	Breakdown in Solid and liquid dielectrics Simple and Composite solid insulating materials, factor affecting dielectric strength, Breakdown in solids - intrinsic breakdown, electromechanical breakdown, thermal breakdown, breakdown due to treeing & tracking and internal discharge, breakdown in composite dielectric, solid dielectric used in practice, Classification and characteristics of liquid dielectrics, Fundamentals of insulating oils, breakdown in pure and commercial liquids, various breakdown mechanism like suspended solid particle mechanism, bubble and cavity breakdown mechanism and stressed oil volume mechanism	10
4	Generation of High Voltages Need for Generation of high voltages, different forms of high voltages, Generation of high d.c. voltages using, half and full wave rectifier circuits, voltage doubler and cascade circuits, van de graaff generator and electrostatic generator, Generation of high a.c. voltages using cascade transformers, series resonant circuits, Characteristics parameters of impulse voltages, single stage impulse generator circuits, multistage impulse generation or Marx circuit	8
5	Measurement of High Voltages Measurement of direct voltage by resistor potential divider and, Generating voltmeter, Measurement of alternating and impulse voltages by series capacitor voltmeter, CVT, resistor potential divider, Peak reading voltmeter or the Chubb–Fortescue method, sphere gap, uniform field gap, potential divider	6
6	Non-Destructive High Voltage Tests DC resistivity measurement, dielectric loss (tan delta) and capacitance measurements, dielectric loss measurement by Schering bridge, partial discharges measurements, Digital PD instruments. Frequency response analysis (FRA), concept of dissolved gas analysis (DGA) and its measurement techniques like Duval's triangle and relevant standards and guidelines	7
Total Hours		42

Textbook :

- 1 High Voltage Engineering, Naidu M. S. and Kamaraju V, Tata McGraw- Hill Publishing, 2009
- 2 High Voltage Engineering, Wadhwa C.L., New Age publishers, New Delhi, 2010
- 3 High Voltage Engineering Fundamentals, E. Kuffel, W.S. Zaengl and J. Kuffel, Newnes, 2000

References:

- 1 High Voltage Engineering, Problems and Solutions, High Voltage Engineering, Problems and Solutions, Rakosh Das Begamudre, New Age International Publishers, New Delhi, 2010

References:

- High Voltage Test Techniques, High Voltage Test Techniques, Dieter Kind, Kurt Feser, Newnes, 2001
- High Voltage Engineering : Theory and Practice, High Voltage Engineering : Theory and Practice, Mohammad Khalifa, M. Dekker, 1989
- High Voltage Engineering and Testing, High Voltage Engineering and Testing, Hugh M. Ryan, Institution of Engineering and Technology, 2012

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
20.00	30.00	25.00	15.00	10.00	0.00

Instructional Method:

- The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, case studies etc.
- The internal evaluation will be done on the basis of continuous evaluation of students in the class-room.
- Students will use supplementary resources such as online videos.

Supplementary Resources:

- <https://archive.nptel.ac.in/courses/108/104/108104048/>
- http://www.ndl.iitkgp.ac.in/he_document/nptel/IN__N__1_E_E__12391_H_V_E__14240_14241