

NIRMA UNIVERSITY
Institute of Technology
B. Tech. in Electrical Engineering
Semester – V

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Course Code	2EEDE52
Course Title	High Voltage Engineering

Course Outcomes (COs):

At the end of the course, students will be able to-

1. illustrate the phenomenon of electrical breakdown in various dielectrics
2. make use of various high current and high voltage, generation and measurement techniques
3. select appropriate testing method for diagnostics of insulation
4. comprehend standards related to test technique and diagnostics

Syllabus:

Teaching Hours: 30

Unit-1: Electrical breakdown in gases

05

Electrostatic fields and field stress control, classical gas laws, Townsend first and second ionization coefficient, transition from non-self-sustained discharges to breakdown, Townsend mechanism, equation for current growth, the streamer or 'Kanal' mechanism of spark, the sparking voltage – Paschen's law, cathode processes - related to vacuum, breakdown in vacuum, the breakdown field strength (E_b), breakdown in non-uniform fields, breakdown under impulse voltages, experimental studies of time lags, lightning mechanism, Lightning transients and protection

Unit-2: Breakdown in solid and liquid dielectrics

05

Breakdown in solids - intrinsic breakdown, electromechanical breakdown, thermal breakdown, edge and erosion breakdown – treeing & tracking, composite dielectric breakdown, breakdown in liquids - electronic breakdown, suspended solid particle mechanism, bubble and cavity breakdown, models of dielectric breakdown, various breakdown theories, transformer oil purification

Unit-3: Generation of high voltages and current

06

Direct voltages, voltage doubler circuits, Cockcroft Walton circuit, electrostatic generators, alternating voltages, cascade transformers, series resonant circuits, Tesla coils, impulse voltages - impulse voltage generator circuits, operation and design, control systems, impulse current generation - circuits, operation and design

Unit-4: Measurement of high voltages and current

06

Peak voltage measurements by spark gaps - sphere gaps, uniform field gaps, rod gaps, electrostatic voltmeters, ammeter in series with high ohmic resistors and high ohmic resistor voltage dividers, generating voltmeters, the Chubb–Fortescue method, high voltage capacitors for measuring circuits, voltage dividing systems and impulse voltage measurements, effect of lead, impulse current measurement, Rogowski coil.

Unit-5: Non-destructive insulation test techniques**06**

Dynamic properties of dielectrics, modelling of dielectric properties, DC resistivity measurement, complex permittivity, dielectric loss (tan delta) and capacitance measurements, RIV measurement, SFRA technique - concept, procedure, inference, partial discharge (PD) concept, apparent charge, measurement circuits, concept of dissolved gas analysis (DGA) – key gas method, Duval’s triangle, relevant standards and guidelines.

UNIT-6: Design, Planning and Layout of High Voltage Laboratories**02**

High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, shielding and grounding of high voltage laboratories

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Laboratory Work:

This shall consist of at least 10 laboratory experiments based on the syllabus.

Relevant standards, cases related to BIL, transformer derating, insulation failure etc. be covered.

Suggested Readings:

1. Kuffel, Zaengl and Kuffel, High Voltage Engineering Fundamentals, Newnes Publications.
2. Sivaji Chakravorti, Debangshu Dey, Biswendu Chatterjee, Recent Trends in the Condition Monitoring of Transformers, Springer.
3. Wadhwa C L, High Voltage Engineering, New Age Publications.
4. Alston L L, High Voltage Technology, Oxford University Press.
5. Naidu M S and Kamraju V, High Voltage Engineering, Tata McGraw Hill Publications.
6. Abdul Salem M A, Anis H, et al., High Voltage Engineering - Theory and Practice, Marcel Dekker.
7. Begamudre R D, High Voltage Engineering Problems and Solutions, New Age International Publishers.
8. Dieter Kind, High Voltage Test Technique, Newnes Publisher.
9. Recent technical literature, journal articles

L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. academic year 2020-21 and onwards