EE 413: High Voltage Engineering (3-0-2:4)

Introduction
Generation and Transmission of Electrical Energy, Voltage Stresses, Testing Voltages such as power frequency voltage, Impulse voltage, DC voltage, Electric field distribution, Gas, Liquid & Solid as Insulator, Application of Insulating materials.

Breakdown in Gaseous, Liquid and Solid Insulators
Mechanism of breakdown of gases –Townsend's criteria, Streamer theory;Paschen's Law, Penning effect, Corona discharges, Post breakdown phenomena, Vacuum Insulation breakdown mechanism.Breakdown mechanism in pure and commercial Liquid dielectrics.Mechanism of breakdown in homogeneous and composite solid dielectrics.

Generation of High Voltage and current
High DC voltage – Rectifier circuit, Voltage doubler circuit, Cockroft-Walton Voltage Multiplier Circuit, Electrostatic Generator.High AC voltage – Cascaded Transformer, Series Resonant circuit.High Impulse voltage and current – Impulse generator circuit, Marx circuit, Impulse current generator.

Measurement of High Voltage and Current
High DC voltage – series resistance micro-ammeter, resistance potential divider, sphere gap.High AC voltage– series impedance ammeter, potential divider (resistance and capacitance type), potential transformer (CVT), Electrostatic Voltmeter, Sphere Gap, Chubb-Fortesque method.High Impulse voltage – Voltage divider (resistive or capacitive type), peak voltmeters, sphere gap.High current– resistive shunt with miliammeter, Hall effect generators, resistive shunts, rogowski coil.

Electric field Stress Estimation and Control
Electric field distribution and breakdown strength of insulating material, Electric field in composite or multidielectric and homogeneous materials, Electric field stress control and optimisation of electrode geometry, Numerical methods

Non-Destructive Insulation Test Techniques
Measurement of DC resistivity, Measurement of Dielectric constant and loss factor – Schering bridge, Transformer ratio arm bridge, Partial Discharge Measurement

Overvoltage Phenomenon and Insulation Coordination
Overvoltage due to lightning, Overvoltage due to switching surge, faults or other abnormalities, Methods of Protection against HV surge, Insulation coordination in HV apparatus.

Laboratory Testing of High Voltage Apparatus
Standard test procedures, Laboratory test procedures, Testing of – Insulators, Bushings, Circuit breakers, Isolators, Transformer, Cables, surge diverters.

List of Experiments
1. Study of generation and measurement of High Voltages (a) AC, (b) DC, (c) Impulse.
2. Estimation of degree of uniformity of electric field and breakdown studies of air gaps under different electrode configuration,(a) Plane – Plane, (b) Point – Plane, (c) Sphere – Sphere, (d) Point – Point.
3. Study of breakdown characteristics and estimation of dielectric strength in solid and liquid dielectrics using different electrode configuration.
4. Estimation of string efficiency and flashover study of suspension type porcelain/ceramic insulators under (a) Dry and (b) Wet condition.

5. Study of Impulse generator and estimation of Critical Impulse Flashover Voltages on suspension type Insulator with (a) Positive Impulse (b) Negative Impulse voltage
6. Measurement of dielectric loss and dissipation factor in liquid and solid dielectrics using schering bridge.
7. Measurement of volume and surface conductivity or resistivity of liquid and solid dielectrics using 3 – electrode configuration.
8. Study of Partial discharge phenomena in air using (a) Needle – Plane geometry, (b) Co-axial cylindrical field.
9. Measurement of Partial Discharge in(a) Transformer, (b) Cables.
10. Study of travelling waves on transmission line due to lightning and switching over voltages.

Text Books:

1. M. S. Naidu & V. Kamaraju, “High Voltage Engineering”, Tata McGraw Hill Education
2. C.L. Wadhwa, “High Voltage Engineering”, New Age International Publishers

References:

1. E. Kuffel, W. S. Zaengl& J. Kuffel, “High Voltage Engineering - Fundamentals”, Newnes Publisher
2. R. Arora & W. Mosch, “High voltage inslation Engineering”, New Age International Publishers
3. A. Haddad & D.F. Warne, “Advances in High Voltage Engineering”, Institution of Engineering and Technology