High Voltage Engineering (3-0-2)

Sub Code : EE7C02 **CIE: 50% Marks**

Hrs/Week : 3+0+2 **SEE: 50% Marks**

SEE HOURS: 3 hours **Marks: 100**

Course Outcomes

On successful completion of the course students will be able to:

1. Discuss the fundamental concept of High Voltage engineering and breakdown mechanisms of various dielectrics.
2. Describe the principles of generating different forms of High voltage.
3. Analyze the different methods of High Voltage measurements and Testing techniques of HV insulation. 4. Demonstrate generation of High voltages and breakdown studies.

MODULE 1: Introduction: Introduction to HV technology, need for generating high voltages in laboratory, Electrode configuration, Classification of HV insulating media.

Breakdown phenomena in Liquid Dielectrics: Pure and commercial liquids, properties, Suspended particle theory, Cavity breakdown theory, and Stressed oil volume theory.

07 Hours

SLE: Degree of Uniformity

MODULE 2: Breakdown Phenomena in Gaseous and Solid Dielectrics: Gaseous dielectrics: primary and secondary ionization processes. Criteria for Breakdown and Limitations of Townsend's theory. Streamer's theory, breakdown in non-uniform fields. Corona discharges. Electronegative gases. Breakdown in solid dielectrics: Intrinsic Breakdown, thermal breakdown, Breakdown due to internal discharges.

08 Hours

SLE: Panchen's law, Time lags of Breakdown.

MODULE 3: Generation of HVAC and HVDC Voltage: HV transformer; Need for cascade connection and working of cascaded transformers. Series resonant circuit- principle of operation and advantages. Tesla coil. Cock roft- Walton voltage multiplier. Calculation of voltage regulation, ripple and optimum number of stages for minimum voltage drop.

08 Hours

SLE: Parallel resonant circuit, HVDC- voltage doubler circuit.

MODULE 4: Generation of Impulse Voltage and Current: Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator- expression for Output impulse voltage. Multistage impulse generator, working of Marx circuit. Components and rating of multistage impulse generator. Triggering of impulse generator by Trigetron gap, Generation of high impulse current.

07 Hours

SLE: Generation of switching impulse voltage.

MODULE 5: Measurement and Testing Techniques of High Voltages: Electrostatic voltmeter principle, construction and limitation. Chubb and Fortescue method for HVAC measurement. Generating voltmeter- Principle, construction. Standard sphere gap measurements of high voltages. Factors affecting the measurements. Potential dividers-capacitance dividers, Mixed RC potential dividers. Partial discharges and its measurements, dielectric testing of insulators.

09 Hours

SLE: Definitions of terminologies related to breakdown.

List of High Voltage Engineering Laboratory Experiments

1. Breakdown strength of transformer oil using oil-testing unit.
2. Field mapping using electrolytic tank for coaxial cable /capacitor/transmission Line Conductors models.
3. Generation and measurement of Lightning Impulse Voltage.
4. Power frequency AC Test Source
5. Generation of Critical Flashover of a Sphere Gap using Impulse Voltage Generator.
6. Voltage doubler and Cockroft Walton voltage multiplier circuit

Textbooks:

1. M.S.Naidu and Kamaraju, **"High Voltage Engineering",** 3rd edition, THM, 2007.
2. C.L.Wadhwa**, "High Voltage Engineering"**, New Age International Private limited, 1995.

Reference Books:

1. E. Kuffel and W.S. Zaengl**, "High Voltage Engineering Fundamentals",** 2nd edition, Elsevier publication, 2000.

Protection Lab (0-0-2)

Sub Code : EE7L02 **CIE: 50% Marks**
Hrs/Week : 0+0+2 **SEE: 50% Marks**
SET Hrs : 2 **Max. Marks: 50**

Course Outcomes

On successful completion of the course, the students will be able to:

1. Draw the operating characteristics of Fuse and Overvoltage/Undervoltage/Over current Relays, Distance, Differential and Negative sequence Relays.
2. Demonstrate the performance characteristics of Feeder, Generator and Motor protection schemes.

List of experiments:

1. Operating characteristics of static over-voltage relay and static under-voltage relay
2. Current-time characteristics of Fuse.
3. Operating characteristics of microprocessor based over-current relay.
4. Operating characteristics of microprocessor based over/under voltage relay
5. Study the performance of Negative sequence relay.
6. Operating Characteristics microprocessor-based Distance Relay.
7. Operating Characteristics Numerical based Differential Relay.
8. Simulation study of Feeder protection schemes of Radial feeder
9. Simulation study of Motor protection schemes
10. Simulation study of Generator protection schemes

d) Commissioning Tests: IR Value, CB open and close time, CT, PT ratio tests relay primary and secondary injection.

08 Hours

SLE: Study of current relay co-ordination

Textbooks:

1. Ramesh. L, Chakrasali, **"Testing & Commissioning of Electrical Equipment"**, Elite Publishers, Mangalore.
2. S. Rao **,"Testing & commissioning of Electrical Equipment",** Khanna Publishers.

Reference Books:

1. M. P. Krishan Pillai, **"Power Station and Substation Practice",** ISBN: 81-8014-116-0 Standard Publishers Distributors, NAI SAPRK, DELHI-110006.
2. **BIS Standards**

Hand Books: Transformers–BHEL Handbook, Switchgear - J&P Handbook.

List of High Voltage Engineering Laboratory Experiments

1. Breakdown strength of transformer oil using oil-testing unit.
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3. Generation and measurement of Lightning Impulse Voltage.
4. Power frequency AC Test Source
5. Generation of Critical Flashover of a Sphere Gap using Impulse Voltage Generator.
6. Voltage doubler and Cockroft Walton voltage multiplier circuit