

# EE 712: ELECTRICAL INSULATION IN HIGH VOLTAGE ENGINEERING (3-0-0: 3)

## Introduction

Introduction to electrical insulation system, classification and application of insulating materials. Properties of insulating materials, Maxwell's equation.

## Electrostatic Fields

Laplace & Poisson's equations, Electrostatic field boundary conditions, Electrostatic potential energy, properties of dielectrics. Electric field Stress Estimation and Control: electric field distribution in homogeneous and composite materials and electric field stress and electrode geometry. Introduction to numerical computation of electric field.

## Characteristics and Behaviour of Insulating Materials

Gaseous and vacuum insulation: uniform and non-uniform breakdown mechanism, air, SF<sub>6</sub>, vacuum. Liquid insulation: classification and characteristics of insulating oils, streaming electrification, conduction and breakdown mechanism. Solid insulation: classification and characteristics of solid insulation, breakdown mechanism. Composite insulation: classification and characteristics of composite insulation, breakdown mechanism, surface erosion and tracking, chemical and electro-chemical deterioration.

## Testing and Assessment of Insulation

Generation and measurement of high AC, DC and Impulse voltage. Standard test techniques. Non-destructive test techniques – measurement of resistivity, dielectric dissipation factor, partial discharge, DC conductivity measurement, AC loss and permittivity measurement; surface failure measurement; breakdown test; time and frequency domain spectroscopy. Digital measuring technique and evaluation procedure, application of sensors for assessment of power apparatus – Ultra-High-Frequency (UHF) sensors, fiber-optic sensors, space charge measurement. Physical and chemical diagnostic techniques – Dissolved Gas Analysis (DGA), Furan test.

## Insulation System in High Voltage Equipments

Cables: development of high voltage cables, cable parameters, ageing and fault, AC & DC cables. Transformer: transformer insulation, ageing and faults. Circuit breaker: circuit interruption, arc control and extinction. Outdoor insulators: design of external insulation, electrical characteristics. ZnO Surge arrester: basic properties, thermal performance, degradation and ageing.

## References:

1. N. H. Malik, A. A. Al-Arainy and M. I. Qureshi, "Electrical Insulation in Power System", Marcel Dekker Inc.
2. R. Arora and W. Mosch, "High Voltage and Electrical Insulation Engineering", Wiley-IEEE press
3. A. Haddad and D. F. Warne, "Advances in High Voltage Engineering", Institution of Engineering and Technology
4. R. E. James and Q. Su, "Condition Assessment of High Voltage Insulation in Power System Equipment", The Institution of Engineering and Technology
5. S. Chakravorti, D. Dey and B. Chatterjee, "Recent Trends in the Condition Monitoring of Transformers", Springer-Verlag
6. S. Chakravorti, "Electric Field Analysis", CRC Press (Taylor & Francis)