

**ADVANCED POWER SYSTEM PROTECTION****Course Code:13EE2102****L P C****4 0 3****Pre requisites:** Switchgear and Protection.**Course Outcomes:**

At the end of the course, the student will be able to

- CO 1: Describe the classification of protective schemes, basic construction of static relays and different types of comparators
- CO 2: Describe and characterize different types of static over current and Distance relays.
- CO 3: Describe various types of pilot relaying schemes.
- CO 4: Describes the protection schemes of an AC machine and Bus zone for different faults.
- CO 5: Describe, implement and test on Numerical relaying algorithms' for a Micro Processor and DSP based protective relays.

**UNIT-I STATIC RELAYS:**

Basic construction of static relays, Classification of protective schemes, Comparison of Static relays with electromagnetic relays, Amplitude comparator, Phase comparator, Principle of Duality.

**AMPLITUDE AND PHASE COMPARATORS (2-INPUT):**

Rectifier bridge circulating and opposed Voltage type- Averaging - phase splitting type -Sampling type of amplitude Comparison. Block spike type-Phase splitting type-Transistor integrating type-Rectifier bridge type-Vector product type Phase comparison.

**UNIT-II****STATIC OVER CURRENT RELAYS:**

Instantaneous- Definite time – Inverse time- Directional- IDMT- Very inverse Time-Extremely inverse time over current relays. Time current characteristics of over current relays-applications.

**DISTANCE PROTECTION:**

Impedance Relay: operating principle- relay Characteristic-Protective Schemes-Static Impedance Relay- Static reactance relay- static MHO relay-effect of arc resistance, effect of power surges, effect of line length and source impedance on performance of distance relays-Quadrilateral relay – Elliptical relay - selection of distance relays.

**UNIT-III PILOT RELAYING SCHEMES:**

Wire pilot protection: circulating current scheme- balanced voltage scheme-translay scheme-half wave comparison scheme- Carrier current protection: phase comparison type-carrier aided distance protection-operational comparison of transfer trip and blocking schemes-optical fiber channels.

**UNIT-IV AC MACHINES AND BUS ZONE PROTECTION:**

Protection of Alternators: stator protection-rotor protection-over voltage protection-over speed protection-Transformer protection: earth faults in transformers-percentage differential protection-protection against magnetic inrush current-generator and transformer unit protection-Bus zone protection: differential current protection-high impedance relay scheme-frame leakage protection.

**UNIT-V****MICROPROCESSOR AND DSP BASED PROTECTIVE RELAYS:**

Numerical Protection: Introduction, numerical relay, Comparison of Numerical relays with static relays Data acquisition System, Numerical relaying algorithms- Mann-Morrison technique, differential equation technique, Discrete Fourier transform technique:

MP based: Introduction-over current relays-Impedance relay-Directional relay-Reactance relay.

DSP based: Digital signal processing –digital filtering in protection relays- – digital data transmission– relay hardware – relay algorithms. Concepts of modern coordinated control system.

**Text Books:**

1. Badri Ram & D.N.Vishwakarma, “*Power System Protection & Switchgear*”, 2<sup>nd</sup> edition, Tata McGraw – Hill, 2011(Unit-I to V)
2. The Electricity Training Association, “*Power System Protection*”, Vol1-4, The IEE, U.K., 1995. (Part of Unit-V).

**Reference Books:**

1. Madhava Rao T.S, “*Power System Protection, Static Relays with Microprocessor and Applications*”, 2<sup>nd</sup> edition, TMH, 2008.
2. Lewis Blackburn, J., “*Protective Relaying – Principles and Applications*”, Marcel Dekkar, INC, New York, 2006.
3. Stanley, H.Horowitz (ED), “*Protective relaying for power systems II*”, IEEE Press, 1992.
4. Warrington and Coll, “*Protective Relays*”. Vol I & II.