SWITCHGEAR AND PROTECTION

COURSE CODE: 15EE1116 **L T P C**
3 0 0 3

Pre-requisites: *Basic Networks, Electrical Machines-1 & II, Power transmission Engineering*

COURSE OUTCOMES:
At the end of the course the student shall be able to

CO1:	Describe and determine the rating of the different types of circuit breakers
CO2:	Describe the construction and working principle of various types of electromagnetic relays.
CO3:	Determine the characteristics of distance relay for transmission line protection.
CO4:	Use different protection schemes for protecting various components of power systems.
CO5:	Describe and determine different cause for over voltages in power system and can implement protective scheme overcome those problems.

UNIT-I (10 LECTURES)

CIRCUIT BREAKERS:
Principle of operation – RRRV – Current chopping- Circuit Breaker ratings and specifications, Testing of Circuit Breakers

Constructional features and selection of LT breakers (Miniature circuit breakers/Metal clad circuit breakers/Earth leakage circuit breaker) and HT breakers (Air blast circuit breaker-Oil circuit breakers-SF_6 CB-Vacuum Circuit Breakers)

UNIT-II (10 LECTURES)

PROTECTIVE RELAYS-I:
Principle of Operation and Construction of Attracted armature, Balanced Beam, induction Disc and Induction Cup relays. Relays Classification - Instantaneous, DMT and IDMT types - Application of relays - Over current, under voltage, Directional, Differential and Percentage Differential.

UNIT-III (10 LECTURES)

PROTECTIVE RELAYS-II:
Universal Torque Equation - Distance relays - Impedance, Reactance and Mho and Off-Set Mho relays, Characteristics of Distance Relays and Comparison - Static Relays - Static Relays versus Electromagnetic Relays - Microprocessor Based relays - impedance, directional, reactance, Mho & offset Mho and mathematical expression for distance relay.

UNIT-IV (10 LECTURES)

PROTECTION OF GENERATOR, TRANSFORMER, FEEDERS AND BUSBARS:
Protection of Generators against Stator faults, Rotor faults, and Abnormal Conditions - Restricted Earth Fault - Numerical Problems on % Winding Unprotected.

Percentage Differential Protection of transformers - Numerical Problems on Design of CT's Ratio - BUCHHOLTZ Relay Protection

Protection of transmission Lines - Over Current, Carrier Current and Three-zone Distance Relay Protection using Impedance Relays - Translay Relay.

Protection of Bus bars – Differential protection

UNIT-V (10 LECTURES)

GROUNDING TECHNIQUES AND OVER VOLATGE PROTECTION:
Grounded and Ungrounded Neutral Systems- Effects of Ungrounded Neutral on system performance- Methods of Neutral Grounding - Arcing Grounds and Grounding Practices.

Protection against Over Voltages- Volt-Time Characteristics- Valve type and Zinc-Oxide Lighting Arresters - Insulation Coordination-BIL, Impulse Ratio, Standard Impulse Test Wave

TEXT BOOKS:

1. Sunil S Rao, *"Switchgear Protection and Power Systems"*, Khanna Publishers, New Delhi, 11th Edition reprint 3rd Edition, 2008

REFERENCES:

1. Badri Ram, Viswakarma.D.N. *"Power System Protection and Switchgear"*,MGH Publications, 2nd Edition 2011. .
2. B.L. Soni, Gupta, Bhatnagar, Chakrabarthy, *"A Text book on Power System Engineering"*, DhanpatRai & Co, 2008.
3. C R Mason, *"Art& Science of Protective Relaying"*, Wiley Eastern Ltd