III Year II Semester **L T P C**

Code: 20EE6318 **3 0 0 3**

POWER SYSTEM PROTECTION

Preamble: In order to supply power from generating end to receiving end several equipments are connected in the system. Protective devices are required and installed in the system to protect the equipment's and components against various operating conditions. Topics specified in this subject deal with various types of protective equipment's and their working principle and limitations etc.

Course Objectives

1. To Illustrate the basic principles and analyze the quenching mechanism of various types of circuit breakers.
2. To study the classification of operation and application of different types of electromagnetic protective relays.
3. To explain, apply and evaluate protective schemes for generator, transformers.
4. To impart knowledge of various protective schemes used for feeder and busbars.
5. To explain the principle and operation of different types of static and microprocessor relays. And to Understand different types of over voltages in a power system and analyze different protective schemes and insulation co–ordination.

Course Outcomes

1. Understand the principles of arc interruption for application to high voltage circuit breakers of air, oil, vacuum, SF6 gas type
2. Understand the working principle, operation and application of different types of electromagnetic protective relays.
3. Acquire knowledge of faults and protective schemes for high power generator and transformers
4. Ability to understand various types of protective schemes used for feeders and bus bar protection.
5. Explain the principle and operation of different types of static and microprocessor relays. And to Understand different types of over voltages in a power system and analyze different protective schemes and insulation co–ordination.

CO – PO & CO – PSO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	3	0	0	0	0	1	0	0	0	1	3	2	2
CO 2	3	2	3	0	0	0	0	1	0	0	0	1	3	2	2
CO 3	3	2	3	0	0	1	0	1	0	0	0	1	3	2	2
CO 4	3	2	3	0	0	1	0	1	0	0	0	1	3	2	2
CO5	3	2	3	0	2	1	0	1	0	0	0	1	3	2	2

1 – Weak, 2 – Moderate and 3 - Strong

Unit – I: Circuit Breakers **12 Hours**

Miniature Circuit Breaker(MCB)– Elementary principles of arc interruption– Restriking Voltage and Recovery voltages– Restriking phenomenon - RRRV– Average and Max. RRRV– Current chopping and Resistance switching– Introduction to oil circuit breakers– Description and operation of Air Blast– Vacuum and SF6 circuit breakers– CB ratings and specifications– Concept of Auto reclosing.

Unit – II: Electromagnetic Protection **12 Hours**

Relay connection – Balanced beam type attracted armature relay - induction disc and induction cup relays–Torque equation - Relays classification–Instantaneous– DMT and IDMT types– Applications of relays: Over current and under voltage relays– Directional relays– Differential relays and percentage differential relays– Universal torque equation– Distance relays: Impedance– Reactance– Mho and offset mho relays– Characteristics of distance relays and comparison.

Unit – III: Protection of Power System Components **12 Hours**

Generator Protection

Protection against Stator, Rotor faults and other abnormal conditions– restricted earth fault and inter turn fault protection– Numerical examples.

Transformer Protection

Percentage differential protection– Design of CT's ratio– Buchholz relay protection–Numerical examples.

Unit – IV: Feeder and Bus bar Protection **12 Hours**

Protection of lines**:** Over current Protection schemes – PSM,TMS - Numerical examples - Carrier current and three zone distance relay using impedance relays–Protection of bus bars by using Differential protection.

Unit – V: Static and Microprocessor based Relays and Protection against over voltage and grounding **12 Hours**

Static Relays: Introduction, Static Relay Components, Static Over current Relay, Static Distance Relay, Microprocessor based Over current, block diagram approach of Numerical relays.

Generation of over voltages in power systems– Protection against lightning over voltages– Valve type and zinc oxide lighting arresters– Insulation coordination– BIL– impulse ratio– Standard impulse test wave– volt-time characteristics– Grounded and ungrounded neutral systems–Effects of ungrounded neutral on system performance– Methods of neutral grounding**:** Solid–resistance– Reactance–Arcing grounds and grounding Practices.

Text Books:

1. Switchgear Protection and Power Systems – Sunil.S.Rao – Khanna Publications.
2. Power System Protection and Switchgear by Badari Ram and D.N Viswakarma, TMH Publications
3. Power system protection- Static Relays with microprocessor applications by T.S.MadhavaRao, TMH

Reference Books:

1. Fundamentals of Power System Protection by Paithankar and S.R.Bhide., PHI, 2003
2. Art & Science of Protective Relaying – by C R Mason, Wiley Eastern Ltd.
3. Power System Protection and Switchgear by Bhavesh A. Oza, Nirmal-Kumar C Nair, RasheshPrahladbhai Mehta, Vijay Hiralal Makwana – Tata McGraw Hill – 2011
4. Protection and Switch Gear by Bhavesh Bhalja, R.P. Maheshwari, NileshG.Chothani, Oxford University Press, 2013.