

SWITCHGEAR AND PROTECTION

Preamble:

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

Learning objectives:

1. To provide the basic principles and operation of various types of circuit breakers.
2. To study the classification, operation and application of different types of electromagnetic protective relays.
3. To explain protective schemes, for generator and transformers.
4. To impart knowledge of various protective schemes used for feeders and bus bars.
5. To explain the principle and operation of different types of static relays.
6. To study different types of over voltages in a power system and principles of different protective schemes for insulation co-ordination.

UNIT-I

Circuit Breakers

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

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

Generator Protection

Protection of generators against stator faults– Rotor faults and abnormal conditions– restricted earth fault and inter turn fault protection– Numerical examples.

Transformer Protection

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

UNIT-IV

Feeder and Bus bar Protection

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 Digital Relays

Static relays: Static relay components– Static over current relays– Static distance relay– Micro processor based digital relays

UNIT-VI

Protection against over voltage and grounding

Generation of over voltages in power systems– Protection against lightning over voltages– Valve type and zinc oxide lightning 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.

Learning outcomes:

1. Able to understand the principles of arc interruption for application to high voltage circuit breakers of air, oil, vacuum, SF6 gas type.
2. Ability to understand the working principle and operation of different types of electromagnetic protective relays.
3. Students acquire knowledge of faults and protective schemes for high power generator and transformers.
4. Improves the ability to understand various types of protective schemes used for feeders and bus bar protection.
5. Able to understand different types of static relays and their applications.
6. Able to understand different types of over voltages and protective schemes required for insulation co-ordination.

Text books:

1. Power System Protection and Switchgear by Badari Ram and D.N Viswakarma, TMH Publications
2. Power system protection- Static Relays with microprocessor applications by T.S.Madhava Rao, 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. Protection and Switch Gear by Bhavesh Bhalja, R.P. Maheshwari, NileshG.Chothani, Oxford University Press, 2013.