SWITCHGEAR AND PROTECTION

Course Code: 13EE1119

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Pre requisites: Electrical Machines and Power Transmission Engineering

Course Educational Objectives:

- To discuss the need for the protection and various protection schemes.
- To study different relays characteristics
- To understand the method of circuit breaking, arcing phenomena – various arc theories - capacitive and inductive breaking

Course Outcomes:

- Students acquire knowledge in the field of power system protection, circuit breakers and relays.
- Students will gain ability to design the relevant protection systems for the main elements of a power system.

UNIT-I (12 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 (12 Lectures)

PROTECTIVE RELAYS-I:

Electromagnetic Relays: 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 (12 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 verses Electromagnetic Relays. Microprocessor Based Relays: impedance, directional, reactance, Mho & offset Mho and mathematical expression for distance relay.

UNIT-IV (12 Lectures)

PROTECTION OF GENERATORS, TRANSFORMERS, FEEDERS AND BUS BARS:

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 (12 Lectures)

GROUNDING TECHNIQUES & OVER VOLTAGE PROTECTIONS:

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. C R Mason, *"Art& Science of Protective Relaying"*, Wiley Eastern Ltd.

2. 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"*, TMH Publications, 2nd Edition 2011.
2. T. S. MadhavRao, "*Power System Protection Static relays with Microprocessor Applications"*, TMH Publication, 2nd Edition, 2006.
3. C.L. Wadhwa, *"Electrical Power Systems"*, New Age International (P) Limited, Publishers, 5th Edition, 2009.
4. B.L. Soni, Gupta, Bhatnagar, Chakrabarthy, *"A Text book on Power System Engineering"*, DhanpatRai & Co, 2008.
5. Warrington and Coll, *"Protective Relays"*, Vol I & II.