



BONAM VENKATA CHALAMAYYA INSTITUTE OF TECHNOLOGY & SCIENCE
(An Autonomous Institution)
Amalapuram-533201, Dr. B.R. Ambedkar Konaseema DT, Andhra Pradesh.
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
(Accredited by NBA)

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|------------------------------|-----------------------------------|----------|----------|----------|----------|
| III Year II Semester | SWITCHGEAR AND PROTECTION | L | T | P | C |
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| Course Code: 23EE6D03 | (PROFESSIONAL ELECTIVE-II) | | | | |

Pre-requisite:

Basic concepts of Electrical Machines and Power Systems.

Course Objectives:

- To explain the working principles and applications of circuit breakers in power systems, including MCBs, oil, SF₆, and vacuum breakers.
- To provide an understanding of electromagnetic protection mechanisms, particularly relays used in fault detection and system protection (overcurrent, under-voltage, directional, differential).
- To analyze protection techniques for generators and transformers, including fault protection schemes like percentage differential protection and Buchholz relays.
- To explore feeder and busbar protection methods using advanced relay systems such as distance and static relays.
- To study over-voltage protection systems including lightning arresters and neutral grounding methods to safeguard the power system.

Course Outcomes: At the end of the course, student will be able to

- CO1: Understand and describe the operation of circuit breakers, including their ratings, principles of arc interruption, and types.
- CO2: Analyze relay-based protection systems, identifying and explaining their roles in overcurrent, undervoltage, and fault detection.
- CO3: Design protection schemes for generators and transformers, addressing faults like restricted earth faults and inter-turn faults.
- CO4: Implement feeder and busbar protection using advanced relays such as distance, impedance, and static relays.
- CO5: Evaluate over-voltage protection strategies, including the use of lightning arresters, and understand various neutral grounding techniques.

UNIT – I**Circuit Breakers**

Components of a Protection System– Elementary principles of arc interruption– Restriking Voltage and Recovery voltages– Restriking phenomenon - RRRV– Average and Max. RRRV– Current chopping and Resistance switching– Concept of oil circuit breakers– Description and operation of Air Blast– Vacuum, SF₆ circuit breakers and RCCB– Circuit Breaker ratings and specifications– Concept of Auto reclosing.

UNIT – II**Electromagnetic Protection**

Relay connection – Balanced beam type attracted armature relay - induction disc and



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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

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

UNIT – IV

Feeder and Bus bar Protection & Static Relays:

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. Static relays: Introduction – Classification of Static Relays – Basic Components of Static Relays.

UNIT – V

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. 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. Power System Protection and Switchgear by Badri Ram and D.N Viswakarma - Tata McGraw Hill Publications - 3rd edition - 2022.
2. Power system protection- Static Relays with microprocessor applications by T.S.Madhava Rao - Tata McGraw Hill - 2nd edition.

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.

Online Learning Resources:

1. <https://archive.nptel.ac.in/courses/108/107/108107167>
2. <https://archive.nptel.ac.in/courses/108/105/108105167>