

SWITCHGEAR AND PROTECTION

Course Code	23EE4601A	Year	III	Semester	II
Course Category	Professional Elective-II	Branch	EEE	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	EM, PS
Continuous Internal Evaluation:	30	Semester End Evaluation:	70	Total Marks:	100

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand working of circuit breakers, Protective relays and the grounding practices (L2).
CO2	Apply electromagnetic principles in switchgear equipment, protective relays and grounding techniques. (L3)
CO3	Analyze the characteristics of circuit breaker, protective relay schemes and grounding techniques. (L4)
CO4	Examine the protection of transformer, generator, transmission lines, bus bar, motors etc.(L4)
CO5	Prepare a report on circuit breakers, protective relay schemes and grounding techniques

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2	3											2	3	2
CO3		3										2	3	2
CO4		3	2			1						2	3	2
CO5									3	3			3	2

SYLLABUS		
Unit No.	Contents	Mapped CO
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– Concept of oil circuit breakers– Description and operation of Air Blast– Vacuum and SF ₆ circuit breakers– Circuit Breaker ratings and specifications– Concept of Auto reclosing.	CO1 CO2 CO3 CO5

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.	CO1 CO2 CO3 CO5
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.	CO1 CO2 CO4 CO5
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.	CO1 CO2 CO4 CO5
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.	CO1 CO2 CO3 CO5

Learning Resources	
Text Books:	
1. Power System Protection and Switchgear by Badri Ram and D.N Viswakarma - Tata McGraw Hill Publications - 2 nd edition - 2011. 2. Power system protection- Static Relays with microprocessor applications by T.S.Madhava Rao - Tata McGraw Hill - 2 nd edition.	
Reference Books:	
5. Fundamentals of Power System Protection by Paithankar and S.R.Bhide. - PHI - 2003. 6. Art & Science of Protective Relaying – by C R Mason - Wiley Eastern Ltd. 7. Switchgear Protection and Power Systems by Sunil S Rao - Khanna Publishers, 1st edition, 2002 8. Switch Gear and Power system Protection by Ravindra P. Singh, - Prentice Hall of India Pvt. Ltd., 2nd edition, 2014 9. Switchgear and Protection by J.B.Gupta- S.Chand publications, 2nd edition, 2013	
E-Resources:	
1. https://archive.nptel.ac.in/courses/108/107/108107167 2. https://archive.nptel.ac.in/courses/108/105/108105167	