SWITCHGEAR & PROTECTION

Course Code	20EE3601	Year	III	Semester(s)	II
Course Category	Professional Core	Branch	EEE	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Circuit Theory
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** the operation of switchgear equipment and Protective relays and the grounding practices **(L2)**
CO2	**Apply** electromagnetic principles in switchgear equipment and in protective relays. **(L3)**
CO3	**Apply** protective relays for Protection of electrical equipment and grounding practices for Protection against Over Voltages. **(L3)**
CO4	**Analyze** switchgear equipment, protective relays and protection of various electrical equipment. **(L4)**
CO5	**Examine** various grounding practices and Protection against Over Voltages in the power system. **(L4)**
CO6	**Ability** to understand the concepts of switchgear devices, protective relays, protection of power system components, various grounding practices, Protection against Over Voltages and submit a report.

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					1							3	3
CO3	3												3	3
CO4		3											3	3
CO5		2				1							3	3
CO6	3	3						3	3	3			3	3

SYLLABUS		
Unit No.	**Contents**	**Mapped CO**
I	**Circuit Breakers** Circuit Breakers: Elementary principles of arc interruption, Restriking voltage and Recovery voltages - Restriking phenomenon, average and max. RRRV, numerical problems - current chopping and resistance switching – CB ratings and specifications, auto reclosures - Numerical Problems. Types of circuit breakers: Minimum oil circuit breakers, Air blast circuit breakers, Vacuum and SF6 circuit breakers.	CO1,CO2 CO4,CO6

II	**Fundamentals of Protective Relaying** Fundamental principles of protective relaying, protection against other abnormal conditions, functional characteristics of protective relaying, evaluation of protectiverelaying. Principle of operation and construction of attracted armature, balanced beam, induction disc and induction cup relays. Introduction to static relays and Numerical relays. Comparison of electromagnetic, static and numerical relays.	CO1, CO3 CO4, CO6
III	**Application of Relays** Universal torque equation, over current relay, direction relays, differential relays and percentage differential relays. Relays Classification: Instantaneous, DMT, IDMT types and under voltage relays. Distance relays: impedance, reactance, mho. Characteristics of distance relays and comparison-Electromagnetic only.	CO1, CO3 CO4, CO6
IV	**Generator, Transformer and Bus bar Protection** Protection of generators against stator faults, rotor faults, and abnormal conditions. Restricted earth fault and inter-turn fault protection. Numerical Problems on percentage winding unprotected. Protection of transformers: Percentage differential protection, Buchholtz relay protection. Protection of Lines: Over current, three-zone distance relay protectionusing impedance relays. Protection of bus bars – differential protection	CO1,CO2, CO3,CO4, CO6
V	**Protection Against Over Voltages** Grounded and ungrounded neutral systems.- Effects of ungrounded neutral on system performance. Methods of neutral grounding: solid, resistance, reactance - arcing grounds and grounding practices. Protection of transmission lines, stations and substations against direct lightning strokes.	CO1,CO2, CO5, CO6

Learning Resources
Text Books
1. Sunil S Rao , “Switchgear Protection and Power Systems” , Khanna Publishers, 1st edition, 2002 2. Badari Ram, D N Viswakarma, “Power System Protection and Switchgear” , TMH Publications, 2nd edition, 2014
Reference Books
1. Paithankar and S.R.Bhide, “Fundamentals of Power system protection” , Prentice Hall of India Pvt. Ltd., 2nd edition, 2003 2. Ravindranth. B and Chander, “Power System Protection and Switch Gear”, New Age International (P) Ltd., 2nd edition, 2014. 3. Ravindra P. Singh, “Switch Gear and Power system Protection”, Prentice Hall of India Pvt. Ltd., 2nd edition, 2014 4. J.B.Gupta, “Switchgear and Protection” , S.Chand publications, 2nd edition, 2013
Web Links 1. https://nptel.ac.in/courses/108101039 2. https://nptel.ac.in/courses/108107167