

Branch Name:	Electrical Engineering
Program Code:	ET109
Course Name:	Switchgear and Protection
Course Code:	1ET1090704
Pre-requisite Course:	Fundamental Knowledge of Electrical Power System is required.

Course Objectives:

1. The students will acquire the knowledge regarding the fundamentals of protection and switchgear.
2. Subject deals with the principles of electromagnetic relays and circuit breakers.
3. To explore the knowledge of different types of protective scheme for transmission line, generator, transformer and induction motor.
4. Students can also get knowledge of protective switchgears like CT and PT.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)								
Lecture	Tutorial	Practical	Credit	Theory				Practical				Total
				University Assessment		Continuous Assessment		University Assessment		Continuous Assessment		
				Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
4	-	-	4	28	70	12	30	-	-	-	-	100

Course Contents:

Sr. No.	Topic	Total Hours	Weightage (%)
1	Introduction to protective relaying, electromagnetic relays and numerical relay: Types of faults, abnormalities, functions of protective relay schemes, major components of power system, basic tripping circuit, zones of protection, requirements of protective systems, relay operating criteria, main and backup protection, relay pick up, reset or drop out, pick up/ drop off ratio, construction and working of induction disc and induction cup relays, block diagram of numerical relay advantages of numerical relaying.	04	06
2	Over current protection of transmission line: Introduction, describe need for different types of relays, thermal relays, over current relays, application of definite time & IDMT O.C. Relays for protection of feeder, directional protection, directional over current relay, limitations of O.C. Relays, describe the testing procedure of various relays.	04	07
3	Differential protection: Simple differential protection, zone of protection and actual behavior of	03	05

	simple differential protection, percentage differential protection, earth leakage protection.		
4	Transformer protection: Explain various protection scheme for transformer, Types of faults, over current protection, percentage differential protection, inrush phenomenon, high resistance ground faults in transformers, inter-turn faults, incipient faults, and over-fluxing phenomenon.	04	07
5	Distance protection of transmission line: Compare various protection scheme of transmission line, describe the criteria to selection the protection scheme, drawbacks of O.C. Protection, introduction to distance protection, types of distance relay, impedance, reactance, mho relay, performance of distance relay during normal load and power swing, effect of arc resistance on reach of distance relays, comparison of distance relays, distance protection of transmission line, reasons for inaccuracy of distance relay reach, three step protection, trip contact configuration, 3-step protection of double and fed lines.	08	15
6	Generator protection and Induction motor protection: Generator Protection: Various faults and abnormal operation conditions, stator and rotor faults, transverse differential protection, unbalanced loading, over speeding, loss of excitation, loss of prime mover. Induction Motor Protection: Various faults and abnormal operation conditions, protection of small induction motor, protection of large induction motor- thermal overload protection, short-circuit protection, negative phase sequence protection, earth fault and differential protection, under voltage protection.	10	20
7	Circuit interruption and circuit constant in relation to circuit breaking: Introduction, Physics of arc phenomena, Maintenance of the arc, Essential properties of arc, Arc interruption theories, Circuit breaker rating, Circuit constants & circuit conditions, Re-striking voltage, transient Characteristics of re-striking voltage, Interaction between the breaker & circuit, Current chopping, duties of switchgear.	07	13
8	Theory & practice of conventional circuit breaker and modern circuit breakers: Automatic switch, Air-break circuit breakers, Oil circuit breakers, Single and multi-break Construction, Air-blast circuit breaker, Performance of circuit breakers and system requirements, Modification of circuit breaker duty by shunt resistors, Power factor correction by series resistance, Comparative merits of different types of conventional circuit breakers, Modern trends, Vacuum circuit breakers, Sulphur hexafluoride (SF ₆) circuit breakers D.C. circuit breaker, auto-reclosing – definitions & features, 3-Phase versus 1-Phase auto-reclosing.	09	20
9	Protective current transformer and potential transformer: Magnetization curve of CT, Difference between measurement & protective CT, Factors to be consider while selecting a CT, CT errors, specifications of CT, specifications of PT, CVT.	04	07

Reference Books:

1. Fundamentals of Power System Protection – Y. G. Parithankar & S. R. Bhide, 2nd edition, PHI Publications, 2013.
2. Power system protection and switchgear by Oza, Nair, Mehta, 2001.
3. Power System Protection and Switchgear – B. Ravindranath and M. Chander, 2004.
4. Switchgear and Protection – S. S. Rao, Khanna publication, 1999.
5. Power System Protection – B. Ram, TMH Publication, 2005.

List of Open Source Software/learning website:

- <http://www.electrical-engineering-portal.com/>
- <http://nptel.iitm.ac.in/courses.php>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	To know the purposes of protection, in relation to major types of apparatus, protection principle, dangers and criteria.	1 Remembering
CLO2	Choose and justify a suitable protection system for a specified application.	3 Applying
CLO3	Analyze and compare specified protection systems.	4 Analyze
CLO4	Compare merits of various principles, relay hardware and interrupting devices.	4 Analyze
CLO5	Classify different type of circuit breakers based on performance & selection of circuit breaker can be made for a given application.	2 Understanding 3 Applying
CLO6	To understand the arc interruption theories and Re-striking voltage.	2 Understanding

Mapping of CLOs with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1	L		L			L		M					L			L
CLO2		M				M	L		M	L					M	
CLO3				L	L						L		M			
CLO4		M			H			H	L			L		L		M
CLO5	M		L	H			M					M		H	H	
CLO6		L			L					M	M		L			

H: High, M: Medium, L: Low