

Branch Name:	Electrical Engineering
Program Code:	ET109
Course Name:	Power System Protection and Switchgear
Course Code:	2ET1090702T
Pre-requisite Course:	--

Course Objectives:

1. Understand the need, philosophy and principles of power system and switchgear protection.
2. Acquire skill to design specific protection schemes require for each part of a power system.
3. Understand the different relays and its characteristics & applications.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								Total (Marks)
					Theory (Marks)				Practical (Marks)				
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	3	-	-	3	24	60	16	40	-	-	-	-	100

Course Contents:

Sr. No.	Topic	Total Hours	Weightage (%)
1	Introduction and Components of a Protection System: Principles of Power System Protection, Introduction to switchgear, Essential features, Switchgear equipment, Types of protection.	04	10
2	Protective Devices: Fuse, Characteristics of fuse Elements and materials, Important terms, Types of fuses, isolator, Types of Circuit Breakers, Methods of arc extinction, restricting voltage, Recovery voltage, HVDC circuit breaker, Interruption of small inductive current and capacitive current, Problems of circuit interruption, Resistance switching, Circuit breaker ratings, Testing of CB.	08	15
3	Faults and Over-Current Protection: Review of Fault Analysis, Requirements of protective relaying, Basic relays, Relay timing, pick up current, Current setting, P.S.M., T.S.M., Calculation of relay operating time, Induction type over current, Directional power relay, Instantaneous over current relay, Definite time over current relay, Inverse definite minimum time over current relay, Application of over current relay, Over current relay co-ordination., Scheme used in practice, Directional protection.	09	20
4	Different Relays, its Characteristics and Applications: Distance relays, Stepped distance characteristics, Reach of distance relay, Time distance impedance relays, Effect of Power Swings and arc resistance on Distance Relaying, selection of relay for transmission line, Differential relays, Current differential relays, Voltage balance differential relay, Transbay System, Pilot protection system, Types of pilot communications, Carrier current protection, Under-frequency, Under voltage and df/dt relays, Out-of-step protection.	09	20
5	Apparatus Protection Schemes: Alternator protection, Transformer protection, Earth fault or leakage protection, Different bus bar protection scheme.	06	15
6	Digital Protection and Modelling of Protection Schemes: Digital relay, Merits and demerits, Block diagram, Digital over current relay, Digital earth fault relay, CT/PT modelling and standards, Relay Testing, Phasor Measurement Units and Wide Area Measurement Systems (WAMS) based protection.	09	20

Text Books:

1. Principle of Power System - V.K. Mehta and Rohit Mehta, S. Chand Publishers, 4th edition, 2015.
2. Power System Protection and Switchgear- Badri Ram and D.N. Vishwakarma, TMH publishing company, 2011.

Reference Books:

1. Protection and Switchgear- Bhavesh Bhalja, R. P. Maheshwari and N. G. Chothani, Oxford University Press, New Delhi, 2nd Edition, 2018.
2. Power System Protection and Switchgear- B. Ravindranath and M. Chander, New age International, 2nd edition, 2011.
3. Switchgear and Protection- Sunil S Rao, Khanna Publishers, 10th edition.
4. Power System Protection and Switchgear- Bhuvnesh Oza, Nirmalkumar Nair, Rashesh Mehta and Vijay Makwana, Tata McGraw Hill Education Private Limited, 2012.

ICT/ MOOCS:

1. <https://nptel.ac.in/courses/108101039>
2. <https://nptel.ac.in/courses/108107167>
3. <https://nptel.ac.in/courses/108105167>

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

CLO	Description	Bloom's Taxonomy Level
CLO1	Understand the significance of power system and switchgear protection.	2 Understanding
CLO2	Explore the fundamentals of different protective devices.	1 Remembering
CLO3	Identify the components, types, and features of the protection scheme for different apparatus and system.	4 Analyzing
CLO4	Acquire skill to design specific protection schemes require for each part of a power system.	5 Evaluating
CLO5	Understand the basic principles of digital protection and WAMS.	2 Understanding

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PS O1	PS O2	PS O3	PS O4
CLO1	H	M	M	L	L	M	H		L	L	L	H	L			L
CLO2	H	M	M	H	L	H	H		L	L	M	H	L			
CLO3	H	M	H	M	M	M	M	L			L	H	M	L	L	M
CLO4	H	H	H	H	M	H	H	L	M	L	H	M	M	H	L	
CLO5	H	M	M	H	H	M	M				L	L	L			H

H: High, M: Medium, L: Low