PROGRAMME : Diploma Programme in Electrical Engineering (EE)
COURSE : Switchgear and Protection (SGP) **COURSE CODE :** 21427

TEACHING AND EXAMINATION SCHEME:

Teaching Scheme					Examination Scheme							
Hrs / week				Credits	TH Paper Hrs.	Marks						
TH	TU	PR	HRS				TH	TEST	TH+TEST	PR	OR	TW	TOTAL
03	--	02	05	04	03	Max.	80	20	100	--	25	25	150
						Min.	32	--	40	--	10	10	--

1.0 RATIONALE:

In Today's world electrical power is a prime requirement of society and industry. Switchgear and protection ensures a lot about reliability and stability of the power system. In order to ensure continuity of power supply and maintain the power system, a student of Electrical Engineering should know the operational principles, selection and testing aspects of switchgear and protection system. This will be helpful for them in discharging their duties as a supervisor or a technician in substations, manufacturing industries & public service utilities.

2.0 COURSE OBJECTIVES:

The student will be able to,

1. Learn the principles, concepts and procedural aspects of switchgear and protection.
2. Identify the various components of switchgear and protection systems.
3. Know the specifications and select switchgear and protection system.
4. Identify the faults and carry out remedial measures.
5. Know the need of insulation co-ordination.

3.0 COURSE OUTCOMES:

The course content should be taught and learning imparted in such a manner that students are able to acquire required learning outcome in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

1. Identify various types of faults in power system.
2. Select suitable switchgears for different applications.
3. Test the performance of different protective relays.
4. Maintain the protection systems of alternators and transformers, transmission line, bus-Bar.
5. Protect power system against over voltages.

4.0 COURSE DETAILS:

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics	Hrs
Unit-I **Basics of Protection**	1a. Describe the functions of elements of the given protective system. 1b. Describe the various types of faults and abnormalities occurring in a power system. 1c. Explain the concept of the Backup protection. 1d. Calculate the short circuit currents for symmetrical faults.	1.1 Necessity, functions and components of protective system. 1.2 Normal and abnormal conditions. 1.3 Types of faults and their causes. 1.4 Protection zones and backup protection 1.5 Short circuit calculations (Symmetrical faults only) 1.6 Need of current limiting reactors and their arrangements.	06

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics	Hrs
	1e. Select suitable current limiting for given situation.		
Unit-II **Circuit Interrupting Devices**	2a. Describe protective system showing different circuit interrupting devices using a line diagram 2b. Explain arc formation, high resistance and zero current interruption. 2c. Explain the operation of isolators, HT and LT circuit breakers and HRC fuse. 2d. Explain the terms associated with fuse and circuit breaker. 2e. Select relevant Fuse, CB and MCCB for given application with justification. 2f. Explain Insulation co-ordination for given installation/Machine.	2.1 HRC fuses – construction, types, working, characteristics, selection and applications 2.2 Isolators- Vertical break, Horizontal break and Pantograph type 2.3 Arc formation process, methods of arc extinction, related terms 2.4 L.T.- Air circuit breakers (ACB), miniature circuit breakers (MCB), Moulded case circuit breakers (MCCB), Earth leakage circuit breaker (ELCB), Comparison of fuse and MCCB, working and applications. 2.5 H.T. Circuit breakers- Concept, Classification, Working, Construction, Specifications and Applications of Sulphur Hexa Fluoride (SF6), Vacuum circuit breaker 2.6 Ratings of HT circuit breakers 2.7 Insulation co-ordination	10
Unit-III **Protective Relays**	3a. Describe need for different types of relays. 3b. State the terms related to relays. 3c. Explain concept of over current and directional relays. 3d. Explain construction and working principle of various relays 3e. Explain setting of relays. 3f. Solve simple numerical on the PSM and TSM of relays.	3.1 Fundamental relay 3.2 Requirements - Selectivity, Speed, Sensitivity, Reliability, Simplicity, Economy 3.3 Basic relay terminology- Protective relay, relay time, Pick up, Reset current, current setting, Plug setting multiplier (PSM), Time setting multiplier (TSM).(Simple numerical on relay setting, PSM, TSM) 3.4 Protective relay, classification, Principle of working, construction and operation of electromagnetic induction relays (shaded pole, watt-hour meter), Thermal relay, Block diagram and working of static Over current relays 3.5 Over current relay-Time current characteristics 3.6 Microprocessor based over current relays: Block diagram, working and protection features 3.7 Distance relaying- Principle, operation of definite distance relays, Time Distance relay 3.8 Directional relay (watt-hour meter) need and operation with block diagram	10

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics	Hrs
		3.9 Operation of current and voltage Differential Relay	
Unit-IV **Protection of Alternator, Transformer, Motors, Bus-bar And Transmission Line**	4a. Describe the causes and remedies of the given faults in the specified machine. 4b. Explain with sketches the given protection schemes of given machine. 4c. Calculate percentage of winding protected for the specified alternator. 4d. Calculate CT ratio of specified transformer protection scheme. 4e. Explain the protection offered by Buchholz Relay. 4f. Describe the causes and remedies of the given faults in specified equipment. 4g. Explain With sketches the given protection scheme of the specified motor. 4h. Explain With sketches the given protection scheme of the given component of the power system.	**Alternator Protection** 4.1 Abnormalities and Faults 4.2 Differential protection (basic and modified) 4.3 Over current, earth fault, inter turn fault, negative phase sequence, over heating protection, field failure protection 4.4 Reverse power protections (Simple numerical on differential protection) **Transformer Protection** 4.5 Abnormalities and faults 4.6 Differential, over current, earth fault, over heating protection 4.7 Limitations of Differential protection 4.8 Buchholz relay: Construction, operation, merits and demerits. (Simple numerical on differential protection) **Motor Protection** 4.9 Abnormalities and faults 4.10 Short circuit protection, Overload protection, Single phase preventer **Bus bar and transmission line Protection** 4.11 Abnormalities and faults 4.12 Bus bar protection: Differential and Fault bus protection 4.13 Transmission line, over current, distance protection. Pilot wire protection	04 04 04 04
Unit-V **Over Voltage Protection & Neutral Earthing**	5a. State the causes of over voltage. 5b. Explain the operation and characteristics of Lightning Arrestor. 5c. State the importance of neutral earthing 5d. Explain the types of neutral earthing. 5e. Distinguish between the equipment and neutral earthing.	5.1 Causes of over voltages 5.2 Lighting phenomena and over voltage due to lightning 5.3 Protection of transmission line and substation from direct stroke 5.4 Protection against travelling waves 5.5 Introduction and importance 5.6 Types of neutral earthing 5.7 Difference between Equipment earthing and Neutral earthing	06
		TOTAL	**48**

5.0 SUGGESTED SPECIFICATION TABLE WITH MARKS (THEORY):

Unit No.	Unit Title	Distribution of Theory Marks			
		R Level	U Level	A and above Levels	Total Marks
I	Basics of Protection	04	04	02	10
II	Circuit Interrupting Devices	06	06	06	18
III	Protective Relays	06	06	06	18
IV	Protection of Alternator and Transformer, Protection of Motor, Bus-bar and Transmission Line.	04	06	08	18
V	Over Voltage Protection & Neutral Earthing	04	04	08	16
	TOTAL	**24**	**26**	**30**	**80**

Legends: R = Remembrance (Knowledge); U= Understanding; A= Application and above levels (Revised Bloom's taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

6.0 ASSIGNMENTS/TUTORIALS/PRACTICALS/TASKS:

The tutorial/practical/assignment/task should be properly designed and implemented with an attempt to develop different types of cognitive and practical skills **(Outcomes in cognitive, psychomotor and affective domain)** so that students are able to acquire the desired programme outcome/course outcome.

Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in the mapping matrix for this course. Faculty should ensure that students also acquire Programme Outcomes/Course Outcomes related to affective domain.

Sr. No.	Unit No.	Practical Exercises (Outcomes in Psychomotor Domain)	Approx. Hrs. Required
01	I	Prepare report on specifications of LT switchgear e.g. MCB, MCCB, ELCB, RCCB used in Electrical power system through market survey.	04
02	II	Demonstrate the operation of MCB/MCCB under the normal and abnormal condition.	02
03	II	Test fuse (Kit kat / HRC) by performing the load test.	02
04	II	Prepare report of protection schemes of alternator through visit	04
05	II	Observe constructional details of VCB and ACB, list out the parts and state their function, material used through visit/video/model.	02
06	II	To identify the components of different types of circuit breakers with their specifications (through visits / video / model).	02
07	III	Carry out plug and time setting (with PSM, TSM) of induction disc type electromagnetic relay.	02
08	IV	Prepare visit report on protection schemes of Transformer	04
09	V	Simulate transmission line protection by using the impedance relay/over current relay for various fault. (On transmission line protection simulation model).	04
10	V	Test the working of single phasing preventer for protection of three phase induction motor.	02
11	V	Demo of neutral earthing & its types in substations.	02
12	V	Comparative study of working of various surge diverters by market survey & literature survey.	02
		TOTAL	**32**

7.0 SUGGESTED STUDENT ACTIVITIES:

Other than the Classroom and laboratory learning, following are the suggested Student-related co-curricular activities. This can be undertaken to accelerate the attainment of the various outcomes in the course,

1. Collect from market the catalogues of MCB, MCCB, and ELCB (for specification).
2. Collect the information on switch gear components from nearby place
3. Trace the connection diagram of control circuit of CB.
4. Download the video of functioning of circuit breakers, Relays.
5. List different Manufactures of Switchgear equipment and list out the technical specifications of their equipment from their websites.
6. List out the earthing materials with specifications.
7. Observe the working of numerical relays through video/ visit.

8.0 SPECIAL INSTRUCTIONAL STRATEGIES (If any):

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course,

1. Show video demonstration on working of circuit interrupting devices.
2. Arrange a visit to switchgear manufacturing industry/substation to understand the working of switchgear components.
3. Arrange expert seminar of industry person in the area of modern switchgear technology.

9.0 LEARNING RESOURCES:

A) Books:

Sr.No.	Title of Book	Author	Publication
01	Switch Gear and Protection	Sunil S. Rao.	Khanna Publications, New Delhi.
02	A Text Book on Electrical Power System	Soni, Gupta & Bhatnagar.	Dhanpat Rai & Sons, New
03	A Text Book of Electrical Power	Uppal S. L.	Khanna Publication, New Delhi
04	Power System Protection and Switchgear	Badriram & Vishwakarma P. N.	TMH, New Delhi. 2015 ISBN:978-07-107774-X
05	Principles of Power System	Mehta V. K. :	S. Chand & Co., New Delhi ISBN:978-81-21-92-496-2
06	Switchgear and Power System Protection	Singh R. P.	PHI Learning, New Delhi. ISBN: 978-93-5014-372-8.
07	Switchgear and Protection	Gupta J. B.	S. K. Katariya Publication, New Delhi

B) Learning Websites:

1. www.nptel.videos.in/electrical engineering/relays
2. www.youtube.com/switchgears
3. www.cselectric.co.in
4. www.abb.co.in/ProductGuide
5. www.schneider-electric.co.in
6. www.en.wikipedia.org

C) Major Equipment/ Instrument with Broad Specifications:

1. Switchgear testing kit.
2. Power System Simulator (with Induction disc type over current, earth fault Relay.)
3. Different types of MCB, MCCB and ELCB, Fuses.
4. Feeder Protection Simulation experimental unit (Including Transmission line model, protective relay, CT PT Indicators with control switches)
5. Three phase 440V, 50 Hz, 1460 rpm Squirrel cage induction motors with single phasing preventer unit.

10.0 MAPPING MATRIX OF PO's, CO's and PSO's:

Course Outcomes	Programme Outcomes (PO's)							Programme Specific Outcomes (PSO's)		
	1	2	3	4	5	6	7	1	2	3
CO1	--	M	--	--	--	--	--	H	--	M
CO2	--	--	H	--	--	M	M	--	--	M
CO3	--	--	--	H	--	--	--	--	H	M
CO4	--	--	--	--	H	--	L	--	--	M
CO5	--	--	--	--	H	--	L	--	--	M

H: High Relationship, M: Medium Relationship, L: Low Relationship.

11.0 SUGGESTED QUESTION PAPER PROFILE:

Unit No	CO	Marks per Unit	1.35 Times marks	Question Number Wise Marks						Actual Distribution of Marks
				01	02	03	04	05	06	
I	CO1	10	14	04	04	08	--	--	--	16
II	CO2	18	24	08	04	04	04	--	04	24
III	CO3	18	24	08	08	04	04	--	--	24
IV	CO4	18	24	04	--	--	04	08	04	24
V	CO5	16	22	04	--	--	--	08	08	20
	TOTAL	**80**	**108***	**28**	**16**	**16**	**16**	**16**	**16**	**108**

a) Suggested Bitwise Distribution:

Unit No.	I							II							III							IV							V							Total
CO	1							2							3							4							5							
Marks per Unit	10							18							18							18							16							80
1.35 Times marks	16							24							24							24							20							108
Bits	a	b	c	d	e	f	g	a	b	c	d	e	f	g	a	b	c	d	e	f	g	a	b	c	d	e	f	g	a	b	c	d	e	f	g	Total
CO	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	5	5	
Q1	4	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4	28
Q2	4	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
Q3	4	4	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
Q4	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-	-	16
Q5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	4	4	-	-	-	16
Q6	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	4	4	-	-	-	16
Sub Total	16							24							24							24							20							108
TOTAL																																				108