		L	T	P	C
EE 0306	**SWITCHGEAR AND PROTECTION**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To introduce the students the different types of circuit breakers and protective relays for protecting power system equipments.

INSTURCTIONAL OBJECTIVES

At the end of course the students will be able to:

1. Gain knowledge on protective relays and circuit breakers.
2. Understand the concept of protection of generators, transformers and bus bars.
3. Gain knowledge in different types of microprocessor based relays.
4. Understand the concept of lightning and its protection.

PROTECTIVE RELAYS

Introduction to protective relaying-classification of relays – over current relays - directional over current relays - differential relays-distance relays - frequency relays-negative sequence relays - Introduction to static relays - comparison of electromagnetic and static relays, Bucholz Relay.

PROTECTION OF GENERATOR, TRANSFORMER AND BUSBAR

Generator protection-differential protection, balanced earth fault protection, restricted earth fault protection, stator inter-turn protection. Transformer protection-percentage differential protection-station bus zone protection-differential, fault bus protection- protection of transmission lines-time-graded, differential, distance protection.

CIRCUIT BREAKERS

Theory of arcing and arc quenching-RRRV-current chopping-capacitive current breaking-DC circuit breaking-switchgear-fault clearing and interruption of current-Breakers-classification of circuit breakers-construction and operation of circuit breakers-minimum oil circuit breaker-air-blast circuit breaker-vacuum circuit breaker-SF_6 circuit breaker-circuit breaker rating-circuit breaker testing.

FUSES & MICROPROCESSOR BASED RELAYS

Definitions-characteristics of fuses-types of fuses-low voltage fuses-HRC fuses-high voltage fuses
Introduction to Microprocessor based over current relays, impedance relays, Directional and reactance relay.

LIGHTNING AND ITS PROTECTION

Causes for over voltages-lightning-switching-insulation failure-arcing grounds-methods of protection-earthing screen-ground wires- peterson coil-surge arrestors-surge absorbers-neutral earthing -Insulation co-ordination.

TEXT BOOKS

1. Sunil.S.Rao, *Switchgear and Protection*, Khanna publishers, New Delhi, 1986.
2. Soni,Bhatnagar & Gupta, *A Course in Electrical Power*, Dhanpat Rai & Sons, New Delhi - 6, 1976.

REFERENCE BOOKS

1. Ravindranath.B. and Chander.M., *Power system protection and switchgear*, Wiley Eastern Ltd., 1996.

2. Wadhwa.C.L., *Electrical power systems*, New age international (P) Ltd., publishers, 1995.
3. Uppal, S. L. *Electrical Power*, Khanna Publishers, New Delhi, 1997.

EE 0306 - SWITCHGEAR AND PROTECTION (R)												
Course designed by		**Department of Electrical and Electronics Engineering**										
1	Student outcomes	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
		x							**x**			**x**
2	Category	General (G)	Basic Sciences (B)		Engineering Sciences and Technical Arts (E)			Professional Subjects (P)				
								x				
3	Broad area (for 'P'category	Electrical machines	Circuit and systems		Electronics			Power Systems		Intelligent systems		
		x	**x**					**x**				
4	Course Coordinator	Mrs.Suchitra										

LESSON PLAN

UNIT – I PROTECTIVE RELAYS

Introduction to protective relaying-classification of relays – over current relays - directional over current relays - differential relays-distance relays - frequency relays-negative sequence relays - Introduction to static relays - comparison of electromagnetic and static relays, Bucholz Relay.

Day	Topics to be covered	Text book	Chap.no & Page No.	Testing Methods	Instructional Objective	Student Outcome
1	Introduction to protective relaying	Book1: Su**nil**.S.Rao, Switchgear and Protection, Khanna publishers, New Delhi, 1986. Book2: Soni,Bhatnagar & Gupta, A Course in Electrical Power, Dhanpat Rai & Sons, New Delhi - 6, 1976.	Book1:C26,500-502 Book2:C8,656-658	Cycle test I and Model Exam	Gain knowledge on protective relays	a).An ability to apply knowledge of mathematics, science, and engineering. b) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
2	Classification of relays		Book1:C26,503 Book2:C8,658-661			
3	Over current relays		Book2:C8,663			
4	Directional over current relays		Book2:C8,666-669			
5	Differential relays-distance relays -		Book2:C8,679-684,670-675			
6	Frequency relays		Book1:C26,517			
7	Negative sequence relays -		Book2:C8,685-686			
8	Introduction to static relays -		Book2:C11,738			
9	Comparison of electromagnetic and static relays		Book2:C11,738-739			
10	Buchholz Relay		Book2:C9,715-716			

UNIT – II PROTECTION OF GENERATOR,TRANSFORMER AND BUSBAR

Generator protection-differential protection, balanced earth fault protection, restricted earth fault protection, stator inter-turn protection. Transformer protection-percentage differential protection-station bus zone protection-differential, fault bus protection- protection of transmission lines-time-graded, differential, distance protection.

Day	Topics to be covered	Text book	Chap.no & Page No.	Testing Methods	Instructional Objective	Student Outcome
11	Generator protection	Book1: Su**nil**.S.Rao,				a) an ability to

12	differential protection, balanced earth fault protection	Switchgear and Protection, Khanna publishers, New Delhi, 1986.	Book1: C33,614-632 Book2: C9,691-704	Cycle test I and Model Exam	Understand the concept of protection of generators, transformers and bus bars.	apply knowledge of mathematics, science, and engineering. (b) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
13	restricted earth fault protection					
14	Stator inter-turn protection.					
15	Transformer protection-percentage differential protection		Book1: C26,593-608 Book2: C9,704-713			
16	station bus zone protection-differential ,fault bus protection	Book2: Soni,Bhatnagar & Gupta, A Course in Electrical Power, Dhanpat Rai & Sons, New Delhi - 6, 1976.	Book1:C30,550-561 Book2:C10,719-734			
17	protection of transmission lines					
18	time-graded and differential protection					
19	Distance protection.					

UNIT – III CIRCUIT BREAKERS

Theory of arcing and arc quenching-RRRV-current chopping-capacitive current breaking-DC circuit breaking-switchgear-fault clearing and interruption of current-Breakers-classification of circuit breakers-construction and operation of circuit breakers-minimum oil circuit breaker-air-blast circuit breaker-vacuum circuit breaker-SF_6 circuit breaker-circuit breaker rating-circuit breaker testing.

Day	Topics to be covered	Text book	Chap.no & Page No.	Testing Methods	Instructional Objective	Student Outcome
20.	Theory of arcing and arc quenching	Book1: Su**nil**.S.Rao, Switchgear and Protection, Khanna publishers, New Delhi, 1986.	Book2:C6, 593-604	Cycle Test II Model Exam	Gain knowledge on circuit breakers.	a).An ability to apply knowledge of mathematics, science, and engineering. (b) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
21.	current chopping-capacitive current breaking and Problems On RRRV.					
22.	DC circuit breaking-switchgear					
23.	fault clearing and interruption of current-Breakers					
24.	classification of circuit breakers-construction and operation of circuit breakers-minimum oil circuit breaker		Book2:C6, 608-615 Book1:C8, 131-137			
25.	air-blast circuit breaker-		Book1:C6, 89-93 Book2:C6, 616-619			

26.	vacuum circuit breaker	Book2: Soni,Bhatnagar & Gupta, *A Course in Electrical Power*, Dhanpat Rai & Sons, New Delhi - 6, 1976.	Book1:C9, 138-153 Book2:C6, 628-630			
27.	SF_6 circuit breaker-		Book1:C7, 97-121 Book2:C6, 626-628			
28.	circuit breaker rating-		Book1:C3,61-65 Book2:C6, 619-622			
29.	circuit breaker testing.		Book2:C6, 630-632			

UNIT _ IV FUSES & MICROPROCESSOR BASED RELAYS

Definitions-characteristics of fuses-types of fuses-low voltage fuses-HRC fuses-high voltage fuses
Introduction to Microprocessor based over current relays, impedance relays, Directional and reactance relay.

Day	Topics to be covered	Text book	Chap.no & Page No.	Testing Methods	Instructional Objective	Student Outcome
30.	Definitions-characteristics of fuses	Book1: Sunil.S.Rao, Switchgear and Protection, Khanna publishers, New Delhi, 1986. Book2: Soni,Bhatnagar & Gupta, A Course in Electrical Power, Dhanpat Rai & Sons, New Delhi - 6, 1976.	Book1:C14, 218 Book2:C5, 582-584	Cycle Test II and Model Exam	Gain knowledge in different types of microprocessor based relays.	a)An ability to apply knowledge of mathematics, science, and engineering. (b) the broad education necessary to understand the impact of engineering solutions in a global perspective. (c) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
31.	types of fuses		Book1:C14, 218 Book2:C5, 585-588			
32.	low voltage fuses					
33.	fuses-high voltage fuses		Book1:C14, 219-224 Book2:C5, 589-590			
34.	Introduction to Microprocessor based over current relays		Book1:C43B, 834-838			
35.	Introduction to Microprocessor based Impedance relays					
36.	Introduction to Microprocessor based Directional Relays					
37.	Introduction to Microprocessor based Reactance relays					

UNIT - V LIGHTNING AND ITS PROTECTION

Causes for over voltages-lightning-switching-insulation failure-arcing grounds-methods of protection- earthing screen-ground wires-Peterson coil-surge arrestors-surge absorbers-neutral earthing -Insulation co-ordination.

Day	Topics to be covered	Text book	Chap.no & Page No.	Testing Methods	Instructional Objective	Student Outcome
38.	Introduction to Lightning	Book1: Su**nil**.S.Rao, Switchgear and Protection, Khanna publishers, New Delhi, 1986. Book2: Soni,Bhatnagar & Gupta, A Course in Electrical Power, Dhanpat Rai & Sons, New Delhi - 6, 1976.	Book1:C18A, 340-359 C18B 360-373 Book2:C12, 759-777, C14,798-801	Model Exam	Understand the concept of lightning and its protection.	(a).An ability to apply knowledge of mathematics, science, and engineering. (b) the broad education necessary to understand the impact of engineering solutions in a global perspective. (c) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
39.	Causes for over voltages					
40.	lightning-switching					
41.	Insulation failure, Arcing grounds					
42.	methods of protection					
43.	Earthing screen-ground wires					
44.	Peterson coil-surge arrestors-surge absorbers-					
45.	Neutral earthing - Insulation co-ordination.					

REFERENCE BOOKS

1. Ravindranath.B. and Chander.M., *Power system protection and switchgear*, Wiley Eastern Ltd., 1996.
2. Wadhwa.C.L., *Electrical power systems*, New age international (P) Ltd., publishers, 1995.
3. Uppal, S. L. *Electrical Power*, Khanna Publishers, New Delhi, 1997.