



**SREENIVASA INSTITUTE of TECHNOLOGY and MANAGEMENT
STUDIES (autonomous)**

SWITCH GEAR AND PROTECTION

Question bank

III - B.TECH / I - SEMESTER

regulation: R20

Compiled by

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Pre-requisites: Co A Course on Electrical Power Generation and Transmission

COURSE EDUCATIONAL OBJECTIVES:

1. Provide the basic principles and operation of various types of circuit breakers.
2. Study the classification, operation of different types of Electromagnetic Protective Relays.
3. Instruct the ideas on protective schemes, for generator and transformers.
4. Impart knowledge of various protective schemes used for feeders and bus bars.
5. Instruct the ideas on the principle and operation of different types of static relays.

UNIT -1: CIRCUIT BREAKERS

Elementary principles of arc interruption –Restriking voltage & Recovery voltage – Rate of rise of recovery voltage – Numerical problems – Resistance switching – Current chopping - interruption of capacitive current's Specifications and Ratings – Auto reclosures - Types of Circuit Breakers – Air blast– Air break– Minimum oil- SF6 and Vacuum circuit breakers - Comparative merits of different circuit breakers – Testing of circuit breakers.

UNIT -2: RELAYS

Basic Requirements of Relays – Primary and Backup protection – Construction details of attracted armature – Balanced beam – Induction type and differential relays – Universal Torque equation – Characteristics of over current, Direction and distance relays. Static Relays – Types – Comparators – Amplitude and Phase comparators - Microprocessor based relays – Block diagram for over current (Definite, Inverse and IDMT) and Distance Relays and their Flow Charts.

UNIT -3: GENERATOR PROTECTION AND TRANSFORMER PROTECTION

Protection of generators against Stator faults – Rotor faults and Abnormal Conditions - Restricted Earth fault and Inter-turn fault Protection - Numerical Problems on % Winding Unprotected - Protection of transformers – Percentage Differential Protection – Numerical Problem on Design of CT Ratios – Buchholz relay Protection.

**UNIT -4: PROTECTION OF FEEDER AND TRANSMISSION LINES**

Principles and need for protective schemes –nature and causes of faults- Types of faults
 -Zones of protection and essential qualities of protection – Protection schemes-
 Protection of Feeder (Radial & Ring main) using over current Relays - Protection of
 Transmission line- 3 Zone protections are using Distance Relays. Carrier current
 protection-Protection of Bus bars.

UNIT -5: PROTECTION AGAINST OVER VOLTAGES AND EARTHING

Protection Against Over Voltages -Generation of Over Voltages in Power Systems–
 Protection against Lightning Over Voltages –Valve type and Zinc– Oxide Lighting
 Arresters - Insulation Coordination –BIL. Power system Earthing –Method of
 Neutral Earthing.

Course Outcomes:

On successful completion of the course, students will be able to		POs related to COs
CO1	Understand the principles of arc interruption for application to high voltage circuit breakers of air, oil, vacuum, SF6 gas type.	PO1 & PSO1
CO2	Understand the working principle and operation of different types of electromagnetic protective relays.	PO1 & PSO1
CO3	Acquire knowledge of faults and protective schemes for high power generator and transformers.	PO1, PO2, PO3, PO4 & PSO1
CO4	Improves the ability to understand various types of protective schemes used for feeders and bus bar protection.	PO1, PO2, PO3, PO4 & PSO1
CO5	Understand different types of static relays and their applications.	PO1 & PSO1

TEXT BOOKS:

1. Sunil S Rao “Switchgear and Protection”, Khanna Publishers - New Delhi, 10/e 2009
2. Badri Ram and D.N Viswakarma “Power System Protection and Switchgear”, Tata McGraw – Hill Education Pvt. Ltd. Noida, 1/e 2007 ,
3. J. B. Gupta “Switch Gear Protection”, S. K. Kataria and Sons – New Delhi, 1/e 2009.

REFERENCE BOOKS:

1. M.L.Soni, P.V.Gupta, V.S.Bhatnagar and A. Chakrabarti “A Text Book on Power System Engineering”, Dhanpat Rai and Co – New Delhi, 1/e 1998
2. Y. G. Paithankar and S. R. Bhide “Fundamentals of Power System Protection”, PHI Learning Pvt Ltd – New Delhi, 2/e 2010,



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(Autonomous)

DEPARTMENT of ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

SWITCH GEAR AND PROTECTION

20EEE354B

3. B. Ravindranath, M. Chander "Power System Protection & Switch Gear" New Age International Pvt .Ltd – New Delhi, 1/e 1977 (Reprint 2005)
4. U. A. Bakshi and M. V. Bakshi "Protection & Switch Gear" Technical Publications – Pune, 4/e 2009.

REFERENCE WEBSITE LINK:

<https://nptel.ac.in/courses/108/107/108107167/>

CO-PO MAPPING:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	1	1	1	-	-	-	-	-	-	-	-	2	-
CO4	3	1	1	1	-	-	-	-	-	-	-	-	2	3
CO5	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO*	3	1	1	1	-	-	-	-	-	-	-	-	2	3

QUESTION BANK

Question No.	Questions	PO Attainment
UNIT – 1: CIRCUIT BREAKERS		
PART-A (Two Marks Questions)		
1	What is circuit breaker?	PO1
2	Define arc interruption?	PO1
3	What are various rating of a circuit breaker?	PO1
4	Define Restriking voltage & Recovery voltage?	PO1
5	What are the advantages of oil as arc quenching medium ?	PO1
6	Name and state briefly two theories of reducing of arc in a circuit breaker?	PO1
7	What are the various methods of arc extinction?	PO1
8	Explain the necessity of resistance switching?	PO1
9	What is rupturing capacity?	PO1
10	Write the difference between the fuse and circuit breaker?	PO1
11	Write short notes on Current Chopping?	PO1
12	Write short notes on interruption of capacitive current?	PO1
13	What are the difference between Restriking voltage & Recovery voltage?	PO1
14	A circuit breaker is rated as 1500A,1000MVA,3second,3phase oil circuit breaker. Find rated making current.	PO1
15	What are the advantages of oil as arc quenching medium ?	PO1



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DEPARTMENT of ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

SWITCH GEAR AND PROTECTION

20EEE354B

16	List the advantages of Oil circuit breaker?	PO1
17	What are the merits and demerits of minimum oil circuit breaker?	PO1
18	What are the Limitations of Bulk oil circuit breaker?	PO1
19	List the Types of Air blast Circuit Breaker?	PO1
20	What are the characteristics of SF6 gas?	PO1
PART-B (Ten Marks Questions)		
1	Explain terms : 1. Restriking voltage 2.Recovery voltage 3. Rate of rise of recovery voltage 4. Arc Voltage?	PO1, PO2
2	Derive expressions for Restriking voltage and RRRV?	PO1, PO2, PO4
3	Write short notes on : (i)Current chopping (ii)Interruption of capacitive current.	PO1, PO2
4	In a system having 220kv, the line to ground capacitance 0.018 micro farad, inductance 4.5H. Find the voltage appearing across the pole of the circuit breaker if a magnetizing current of 8.5A instantaneous is interrupted. Calculate also the value of resistance to be used across the contacts to eliminate the restriking voltage?	PO1, PO2, PO4
5	Discuss the principle of arc interruption in an i)Oil circuit breaker and ii)air blast circuit breaker	PO1, PO2, PO4
6	Describe construction, operation principle of SF6 circuit breaker?	PO1, PO2, PO4
7	Describe construction, operation principle of Vacuum circuit breaker?	PO1, PO2, PO4
8	Describe construction, operation principle of Minimum Oil Circuit Breaker?	PO1, PO2, PO4
9	Explain with the help of a neat sketch, construction and working of air blast circuit breaker?	PO1, PO2, PO4
10	What are the different methods of testing of circuit breaker ? Discuss their merits and demerits?	PO1, PO2, PO4

Question No.	Questions	PO Attainment
UNIT – 2: RELAYS		
PART-A (Two Marks Questions)		
1	What is protective relay?	PO1
2	Define resetting time of a relay?	PO1
3	What are the over and under current relays?	PO1
4	What are the features of directional relay?	PO1
5	What is the back up protection available for an alternator?	PO1
6	What is primary protection?	PO1
7	List the types of comparators?	PO1
8	Difference between Amplitude and phase comparator?	PO1
9	What is static relay?	PO1
10	Mention any two applications of differential relay?	PO1
11	What is the principal of operation of impedance relay?	PO1



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(Autonomous)

DEPARTMENT of ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

SWITCH GEAR AND PROTECTION

20EEE354B

12	State the applications of static relay?	PO1
13	List the advantages of static relay?	PO1
14	What are the uses of Buchholz relay?	PO1, PO2
15	What are the limitations of Buchholz relay?	PO1
16	List types of distance relay ?	PO1, PO2
17	What is Mho relay and Reactance relay	PO1
18	What are the merits and demerits of Merz price scheme?	PO1
19	What is inverse time relay?	PO1
20	Difference between inverse time and definite time relay?	PO1

PART-B (Ten Marks Questions)

1	What are the different types of electromagnetic relay ? Discuss their field of applications?	PO1, PO2, PO4
2	What are the various types of over current relays?	PO1, PO2, PO4
3	Describe the operating principle , constructional features of reverse directional relay?	PO1, PO2, PO4
4	Describe the operating principle , constructional features of induction type directional over current relay?	PO1, PO2, PO4
5	Explain the working principle of distance relay?	PO1, PO2, PO4
6	Explain the Amplitude and phase comparators?	PO1, PO2, PO4
7	What is definite and inverse time relay ?	PO1, PO2, PO4
8	Write a detailed note on differential relays?	PO1, PO2, PO4
9	Explain with neat sketches and their R-X diagrams for the following distance relays. (i) impedance relay (ii) Mho relay (iii) reactance relay	PO1, PO2, PO4
10	Draw the block diagram and explain Microprocessor based relay?	PO1, PO2, PO4

Question No.	Questions	PO Attainment
UNIT – 3: GENERATOR PROTECTION AND TRANSFORMER PROTECTION		
PART-A (Two Marks Questions)		
1	What is Differential protection ?	PO1
2	How do you protect generator against stator faults?	PO1
3	Difference between Differential and Over current protections?	PO1
4	What are the common types of Generator faults?	PO1
5	For what type of faults does differential protection provided?	PO1
6	What is advantage of using percentage differential relay protection?	PO1
7	Why over current not necessary for Modern Generators?	PO1
8	What is the limitation of merz price protection?	PO1
9	Mention different types of faults occurs in generator	PO1
10	What types of relay is used for loss of excitation of an alternator?	PO1
11	Discuss the earth fault protection for Transformer?	PO1, PO2
12	Explain internal faults inside the transformer?	PO1



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(Autonomous)

DEPARTMENT of ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

SWITCH GEAR AND PROTECTION

20EEE354B

13	What are the various schemes available in Transformer?	PO1, PO2
14	Discuss the different types of transformer faults?	PO1, PO2
15	What is the limitation of Buchholtz relay protection?	PO1
16	Write short note on Buchholtz relay protection?	PO1
17	What are the causes of over speed in alternator?	PO1
18	Enumerate the relaying schemes ?	PO1
19	Discuss the Percentage Differential Protection?	PO1
20	What is Inter-turn fault Protection and Restricted earth fault ?	PO, PO2
PART-B (Ten Marks Questions)		
1	Explain the Protection of generators against Stator faults?	PO1, PO2, PO4
2	Difference between Stator fault and Rotor fault in alternator?	PO1, PO2, PO4
3	Explain in detail about Restricted earth fault and Inter-turn fault Protection?	PO1, PO2, PO4
4	What are the causes of over speed in alternators are protected from it?	PO1, PO2, PO4
5	Calculate the required value of neutral resistance for a 3-phase 11KV alternator so as to protect 70% of the winding against earth-fault by a relay with pick-up current of 1 A. The neutral CT has a ratio of 250/5.	PO1, PO2, PO4
6	Explain the different Protections of Transformer?	PO1, PO2, PO4
7	Draw and explain the Percentage Differential protection of Transformer?	PO1, PO2, PO4
8	Explain Construction and working of Buchholtz relay?	PO1, PO2, PO4
9	(i) Discuss the earth fault protection for Transformer? (ii) Explain internal faults inside the transformer?	PO1, PO2, PO4
10	A 3- phase transformer rated for 33KV/6.6KV is connected star-delta and the protecting current transformer on the low voltage side have a ratio of 100/5. Determine the ratio of the current transformer on HV side?	PO1, PO2, PO4

Question No.	Questions	PO Attainment
UNIT – 4: PROTECTION OF FEEDER AND TRANSMISSION LINES		
PART-A (Two Marks Questions)		
1	Explain nature and causes of faults?	PO1
2	What is the need for bus bar protection?	PO1
3	What is differential protection?	PO1
4	Discuss requirement of line protection?	PO1, PO2
5	State the types of faults in power system ?	PO1, PO2
6	Define pickup current?	PO1, PO2
7	What is the commonly used protection for 3phase feeders?	PO1, PO2
8	Discuss the importance of bus bar protection?	PO1, PO2
9	Write short note on Fault bus protection?	PO1
10	Write short note on Translay scheme?	PO1
11	What are the various methods of over voltage protection of over head	PO1



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QUESTION BANK

SWITCH GEAR AND PROTECTION

20EEE354B

	transmission line?	
12	What are the various schemes of bus bar protection?	PO1
13	Write short note on Radial feeder system?	PO1
14	Write short note on Ring main feeder system?	PO1
15	Write short note on parallel feeder?	PO1
16	What are the requirements of protection of transmission line?	PO1
17	List various methods for protection of feeders?	PO1
18	Explain over current protection of feeders?	PO1
19	Draw the three zone distance protection in transmission line ?	PO1
20	What is current graded system ?	PO1, PO2
PART-B (Ten Marks Questions)		
1	Elaborate on various methods for protection of feeders?	PO1, PO2, PO4
2	What is the importance of bus-bar protection? What are the requirements of protection of line?	PO1, PO2, PO4
3	Explain in detail about time graded and current graded system?	PO1, PO2, PO4
4	Explain the construction and principle of operation of a trans lay relay applied to a single phase system?	PO1, PO2, PO4
5	Describe in detail the protection of parallel , ring , radial feeders?	PO1, PO2, PO4
6	Draw the schematic diagram of over current protection of bus bars with relevant connection diagram?	PO1, PO2, PO4
7	Explain over current protection of feeders. How is the protection system graded with respect to the time of operation of relays for a radial feeder?	PO1, PO2, PO3
8	With neat diagram explain the Three zone distance protection in 3-phase transmission line?	PO1, PO2, PO4
9	Explain in detail about the Merz price voltage balanced system with a neat single line diagram?	PO1, PO2
10	(i)Discuss the importance of bus bar protection? (ii)What is back-up protection of busbar?	PO1, PO2, PO4

Question No.	Questions	PO Attainment
UNIT – 5: PROTECTION AGAINST OVER VOLTAGES AND EARTHING		
PART-A (Two Marks Questions)		
1	Write causes of over voltages in power system network?	PO1, PO2
2	What is meant by voltage surge?	PO1, PO2
3	What are the requirements of a good lightning arrester?	PO1, PO2
4	Describe the phenomenon of lighting ?	PO1, PO2
5	What are the various methods of over voltage protection of over head transmission system?	PO1
6	List out types of lightning arrester?	PO1, PO2
7	List out different types of grounding ?	PO1
8	Explain Reactance Grounding ?	PO1
9	What are the functions of grounding in power system?	PO1



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QUESTION BANK

SWITCH GEAR AND PROTECTION

20EEE354B

10	What are the advantages of neutral grounding?	PO1
11	Why earth wire provided in over head transmission line?	PO1
12	Draw neat sketch valve type lightning arrester?	PO1
13	Draw neat sketch Rod type lightning arrester?	PO1
14	Draw neat sketch Zinc-Oxide type lightning arrester?	PO1
15	What is horn gap arrester?	PO1
16	What is equipment grounding?	PO1
17	What is system grounding ?	PO1
18	Explain about insulation coordination?	PO1, PO2
19	Explain the need for a lightning arrester?	PO1
20	List various types of surge obsorbers?	PO1
<u>PART-B (Ten Marks Questions)</u>		
1	(i)Describe the phenomenon of lighting ? (ii)Explain the working of valve type lightning arrester?	PO1, PO2, PO4
2	Write short notes on the following : (i)Causes of over voltages in power system? (ii)Basic impulse level and its significance?	PO1, PO2, PO4
3	What is lighting? Describe the mechanism of lighting discharge by drawing suitable diagram?	PO1, PO2, PO4
4	Explain various types of lighting arresters ? Explain with neat sketch ,the working Zinc-oxide lightning arrester?	PO1, PO2, PO4
5	Explain and sketch neat diagram of Valve type lightning arrester?	PO1, PO2, PO4
6	Discuss and compare the various methods of neutral earthing explain?	PO1, PO2, PO4
7	Briefly explain the various methods of neutral over voltage protection of over head transmission line?	PO1, PO2, PO4
8	What is horn gap arrester? Explain how it works?	PO1, PO2, PO4
9	Discuss advantages and disadvantages of over head ground wires?	PO1, PO2, PO4
10	Draw neat sketch and explain resistance and reactance grounding ?	PO1, PO2, PO4

ALL THE BEST