



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

TUTORIAL QUESTION BANK

Course Title	POWER SYSTEM PROTECTION				
Course Code	AEE014				
Programme	B.Tech				
Semester	VII	EEE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lectures	Tutorials	Credits	Laboratory	Credits
	3	1	4	3	2
Chief Coordinator	Mr. P Shivakumar, Assistant Professor, EEE				
Course Faculty	Mr. P Shivakumar, Assistant Professor, EEE				

COURSE OBJECTIVES:

The course should enable the students to:

The course should enable the students to:	
I	Understand types of various circuit breakers.
II	Classify relays into various types such as of electromagnetic, static and numerical relays.
III	Evaluate the performance of protection schemes of generator and transformer.
IV	Analyze the performance of feeder and bus-bar protection.
V	Discuss the protection schemes against over voltages.

COURSE OUTCOMES (COs):

CO 1	Understand the working of various types of circuit breakers and protective equipments of power systems.
CO 2	Understand the working of various protective relays.
CO 3	Discuss about various components of substation and understand protection of feeders and bus bars.
CO 4	Understand the various faults and protection methods for the Generators and Transformers.
CO 5	Understand the various protection schemes of power system against over voltages

COURSE LEARNING OUTCOMES (CLOs):

AEE014.01	Understand various types of faults in Power system.
AEE014.02	Apply the knowledge on different Protective Equipments of Power Systems.
AEE014.03	Understand concept of recovery and restriking voltages.
AEE014.04	Understand working of various protective systems.
AEE014.05	Compare the different type of circuit breakers performance based on which selection of circuit breaker can be made for a given application.
AEE014.06	Discuss the construction and working of Fuse and circuit breakers.
AEE014.07	Explain working of protective relays.
AEE014.08	Understand the concept of DMT, IDMT type relays.
AEE014.09	Understand layout of Substations.
AEE014.10	Understand layout of Substations, neutral earthling, testing of CB, CT and PT.
AEE014.11	Remember the faults and protection for the Feeders and Bus-Bars.
AEE014.12	Understand and justify a suitable protection system for a specified application.
AEE014.13	Understand the faults and protection for the Generators and Transformers.
AEE014.14	Understand Rotor, Stator Faults, inter turn faults and their protection.
AEE014.15	Understand the protection of power system against over voltages.

TUTORIAL QUESTION BANK

UNIT – I

CIRCUIT BREAKERS

Part - A(Short Answer Questions)

S No	QUESTION	Blooms taxonomy level	Course Outcomes	Course Learning Outcomes
1	What is a circuit breaker? Explain its functions?	Remember	CO1	AEE014.01
2	Discuss the arc phenomenon in a circuit breaker.	Remember	CO1	AEE014.02
3	Define the following terms as applied to circuit breakers : (i) Arc voltage (ii) Re striking voltage (iii) Recovery voltage?	Understand	CO1	AEE014.03
4	Explain the phenomenon of current chopping?	Remember	CO1	AEE014.03
5	What is resistance switching?	Remember	CO1	AEE014.01
6	What the function of auto is re closures?	Understand	CO1	AEE014.01
7	What is switchgear?	Remember	CO1	AEE014.01
8	Explain the term RRRV?	Understand	CO1	AEE014.01
9	Discuss the advantages and disadvantages of oil circuit breakers.	Remember	CO1	AEE014.06
10	Explain the terms (i) symmetrical breaking current (ii) Asymmetrical breaking current (iii) making current	Understand	CO1	AEE014.04
11	What are the advantages of SF6 circuit breaker?	Remember	CO1	AEE014.05
12	What are the advantages and disadvantages of an Air blast circuit breaker?	Remember	CO1	AEE014.05
13	What are the advantages and disadvantages of vacuum circuit breaker?	Understand	CO1	AEE014.01
14	Why are circuit breakers designed to have a short-time rating?	Remember	CO1	AEE014.04
15	What are the types of air blast circuit breaker?	Remember	CO1	AEE014.05

Part - B (Long Answer Questions)

1	Explain the various methods of arc extinction in a circuit breaker?	Understand	CO1	AEE014.03
2	Explain the following terms as applied to circuit breakers : (i) Arc voltage(ii) Re striking voltage (iii) Recovery voltage	Understand	CO1	AEE014.04
3	Write a short note on the rate of re-striking voltage indicating its importance in the arc extinction?	Remember	CO1	AEE014.01
4	Discuss the phenomenon of (i) Current chopping (ii) Capacitive current breaking	Understand	CO1	AEE014.02
5	Write short notes on the following (i) resistance switching (ii) circuit breaker ratings (iii) circuit interruption problems?	Remember	CO1	AEE014.06
6	Write short notes on the following (i) resistance switching (ii) circuit breaker ratings (iii) circuit interruption problems?	Understand	CO1	AEE014.01
7	Derive an expression for restriking voltage in terms of system capacitance	Remember	CO1	AEE014.03
8	What are the major duties that a circuit breaker is required to perform? Explain them clearly?	Understand	CO1	AEE014.02
10	Describe briefly the action of an oil circuit breaker. How does oil help in arc extinction?	Understand	CO1	AEE014.04
11	Discuss the principle of operation of an air-blast circuit breaker. What are the advantages and disadvantages of using air as the arc quenching medium?	Remember	CO1	AEE014.05
12	Explain briefly the following types of air-blast circuit breakers? (i) Axial- blast type (ii) Cross-blast type	Remember	CO1	AEE014.05
13	Describe construction, operating principle and application of vacuum circuit breaker. For what voltage range is it recommended?	Remember	CO1	AEE014.01

14	Compare the performance of sf6 gas with air when used for circuit breaking.	Remember	CO1	AEE014.05
15	Discuss the constructional details and operation of a typical low-oil circuit breaker? What are its relative merits and demerits?	Understand	CO1	AEE014.06
Part - C (Problem Solving and Critical Thinking Questions)				
1	An air-blast circuit breaker is designed to interrupt a transformer magnetizing current of 11 A (r.m.s.) chops the current at an instantaneous value of 7 A. If the values of L and C in the circuit are 35.2 H and 0.0023 μ F, find the value of voltage that appears across the contacts of the breaker. Assume that all the inductive energy is transferred to the capacitance	Understand	CO1	AEE014.05
2	A circuit breaker is rated as 1500 A, 1000 MVA, 33 kV, 3-second, 3-phase oil circuit breaker. Find (i) rated normal current (ii) breaking capacity (iii) rated symmetrical breaking current (iv) rated making current (v) short-time rating (vi) rated service voltage	Understand	CO1	AEE014.04
3	In a short circuit test on a circuit breaker, the following readings were obtained on single frequency transient : a. Time to reach the peak re-striking voltage, 50 μ sec b. The peak re-striking voltage, 100 kV c. Determine the average RRRV and frequency of oscillations	Understand	CO1	AEE014.03
4	In a power system the r.m.s voltage is 38.1kV, L is 10mH and C is 0.02 μ F. determine a) restriking voltage across the circuit breaker b) frequency of restriking voltage transient c) average rate of restriking voltage up to peak restriking voltage and d) maximum RRRV	Understand	CO1	AEE014.05
5	Explain the terms Recovery voltage, restriking voltage and RRRV. Derive an expression for the restriking voltage in terms of system capacitance and inductance	Understand	CO1	AEE014.05
6	Discuss the recovery rate theory and energy balance theory of arc interruption in a circuit breaker	Remember	CO1	AEE014.04
7	Write the differences between high resistance and low resistance methods	Understand	CO1	AEE014.06
8	(a) Explain briefly about various Switch gear components. (b) Give the importance of ratings and specifications of Circuit Breaker	Remember	CO1	AEE014.05
9	A circuit breaker is rated at 1500 A, 2000 MVA, 33 kV, 3 sec, 3-phase oil circuit breaker. Determine (i) the rated normal current (ii) breaking current (iii) making current (iv) short time rating current	Understand	CO1	AEE014.01
10	Describe the construction, principle of operation and application of sf6 circuit breaker. How does this breaker essentially differ from an air blast breaker	Remember	CO1	AEE014.05
11	Explain the properties of vacuum, arc phenomenon, and constructional details, working principle, merits and applications of vacuum circuit breakers.	Understand	CO1	AEE014.05
12	With a neat diagram, discuss the constructional details and operational Features of a typical minimum oil circuit breaker. Also state its advantages and disadvantages over others	Remember	CO1	AEE014.05
13	A 50 Hz, 3 phase alternator has rated voltage 12 kV, connected to circuit breaker, inductive reactance 5 ohms/phase, C= 3 μ F. Determine maximum RRRV, peak restriking voltage and frequency of oscillations.	Understand	CO1	AEE014.06
14	With a neat block diagram, explain the construction, operating principles and merits of air blast circuit breaker.	Remember	CO1	AEE014.05
15	Discuss how breaking capacity and making capacity of a circuit breaker are tested in a laboratory type testing stations.	Understand	CO1	AEE014.03
UNIT - II				
SINGLE PHASE AND THREE PHASE CONTROLLED RECTIFIERS				
Part – A (Short Answer Questions)				

1	What is the difference between a fuse and a relay?	Remember	CO2	AEE014.03
2	Define over current relay?	Understand	CO2	AEE014.03
3	Why are differential relays more sensitive than over current relays?	Remember	CO2	AEE014.03
4	Explain about balanced voltage relay?	Remember	CO2	AEE014.03
5	What is protective relay?	Understand	CO2	AEE014.03
6	Define pick-up value?	Remember	CO2	AEE014.03
7	Define Plug-setting multiplier?	Remember	CO2	AEE014.03
8	State the various applications of differential protection.	Understand	CO2	AEE014.03
9	What are the essential qualities of a relay?	Remember	CO2	AEE014.03
10	How the relays are basically classified?	Remember	CO2	AEE014.03
11	Define Time-setting multiplier?	Understand	CO2	AEE014.03
12	Define Current setting?	Remember	CO2	AEE014.03
13	Explain about Tran slay relay?	Understand	CO2	AEE014.03
14	Define current differential relay?	Understand	CO2	AEE014.03
15	Write the comparisons between electromagnetic and static relays?	Remember	CO2	AEE014.03
Part - B (Long Answer Questions)				
1	With the help of neat sketch explain the principle of operation of Differential relays.	Understand	CO2	AEE014.07
2	Distinguish between Over current relays, Directional relays and Differential relays.	Remember	CO2	AEE014.08
3	Determine the time of operation of a 4-ampere, 3-second over current relay having a current setting of 125% and a time setting multiplier of 0.4 connected to supply circuit through a 200/5 current transformer when the circuit carries a fault current of 2000 A.	Understand	CO2	AEE014.07
4	Explain the „Differential protection“. State the various applications of differential protection.	Remember	CO2	AEE014.08
5	What are the different types of electromagnetic relays? Discuss their field of applications.	Understand	CO2	AEE014.07
6	What are the various types of over current relays? Discuss their area of application.	Remember	CO2	AEE014.08
7	Describe the operating principle, constructional features and area of applications of reverse power or directional relay.	Remember	CO2	AEE014.07
8	Describe the construction and principle of operation of an induction type directional over current relay.	Understand	CO2	AEE014.08
9	Explain the working principle of distance relays.	Remember	CO2	AEE014.07
10	Write a detailed note on differential relays.	Understand	CO2	AEE014.08
11	A relay is connected to 200/5 ratio current transformer with current setting of 120%. Calculate the Plug Setting Multiplier when circuit carries a fault current of 2000A.	Understand	CO2	AEE014.07
12	Explain the following terms as applied to protective relaying : (i) Pick-up value (ii) Current setting	Remember	CO2	AEE014.08
13	Explain with the help of neat diagram the construction and working of Induction type directional power relay.	Understand	CO2	AEE014.07
14	Explain the construction and working of Tran slay relay.	Remember	CO2	AEE014.08
15	Explain the working principle of distance relays.	Understand	CO2	AEE014.07
Part - C (Problem Solving and Critical Thinking Questions)				

1	Determine the time of operation of a 5-ampere, 3-second over current relay having a current setting of 125% and a time setting multiplier of 0.6 connected to supply circuit through a 400/5 current transformer when the circuit carries a fault current of 4000 A.	Understand	CO2	AEE014.08
2	What are the different inverse time characteristics of over Current relays? Mention how characteristics can be achieved In practice foran electromagnetic relay.	Understand	CO2	AEE014.07
3	Writes short notes on the following : (i)Percentage differential relays (ii) Definite distance relays (iii)Time-distance relays	Remember	CO2	AEE014.07
4	Describe the construction and principle of operation of an induction type directional over current relay.	Understand	CO2	AEE014.08
5	Explain with the help of neat diagram the construction and working of Non-directional induction type over current relay	Remember	CO2	AEE014.07
6	Define and explain the following terms as applied to protective relaying : (i) Plug-setting multiplier (ii)Time-setting multiplier	Understand	CO2	AEE014.08
7	Derive the equation for torque developed in an induction relay.	Remember	CO2	AEE014.08
8	(a) Draw the characteristics of a directional impedance relay on an R-X diagram (b) Compare Static and Electromagnetic relay	Understand	CO2	AEE014.07
9	A relay is connected to 400/5 ratio current transformer with current setting of 150%. Calculate the Plug Setting Multiplier when circuit carries a fault current of 4000A	Understand	CO2	AEE014.08
10	Describe the operating principle, constructional features and area of applications of directional relay.	Remember	CO2	AEE014.07
11	How do you implement directional feature in the over current relay?	Understand	CO2	AEE014.08
12	Define the following terms and explain their significance in distance protection? (a) Reachof a distance relay. (b) Under reach	Remember	CO2	AEE014.07
13	Draw and Explain the characteristics of a reactance relay.	Understand	CO2	AEE014.07
14	Draw and Explain the characteristics of a mho relay on an R-X diagram .	Understand	CO2	AEE014.08
15	Write the applications of impedance relay, reactance relay and mho relay.	Remember	CO2	AEE014.07

UNIT – III

SUBSTATIONS AND PROTECTION OF FEEDER / BUS BAR

Part – A (Short Answer Questions)

1	Define a substation and what its need is in a power system.	Remember	CO3	AEE014.09
2	Classify substation according to a) service requirements b) constructional features.	Understand	CO3	AEE014.09
3	Compare outdoor and indoor substation.	Remember	CO3	AEE014.09
4	What are the advantages of the following equipment in a substation a) bus bars b) Insulators c) circuit breakers d) isolating switches.	Understand	CO3	AEE014.09
5	Discuss about a) Power transformer b) potential transformer c) current transformer.	Remember	CO3	AEE014.10
6	What are the advantages of gas insulated substations over air insulators?	Understand	CO3	AEE014.09
7	Compare air insulated substation and gas insulated substations?	Remember	CO3	AEE014.09
8	Explain the maintenance schedule of gas insulated substation	Understand	CO3	AEE014.09
9	Why do we use isolators on both sides of circuit breakers?	Remember	CO3	AEE014.10
10	Write advantages of gas insulated substation	Understand	CO3	AEE014.09

11	Where and Why Gas Insulated Substations are Used	Remember	CO3	AEE014.09
13	How earth fault protection is achieved in case of feeder?	Remember	CO3	AEE014.11
14	What are the protection scheme for the protection parallel feeder.	Understand	CO3	AEE014.12
15	What is the Merz-Price voltage protection scheme.	Remember	CO3	AEE014.12
16	What are the advantages of distance protection over other types of protection.	Remember	CO3	AEE014.11
17	What is backup protection of bus bars?	Understand	CO3	AEE014.12
18	What is differential protection of bus bars?	Understand	CO3	AEE014.11
19	How does linear coupler differ from ordinary CTs?	Remember	CO3	AEE014.11
20	What do you mean by grounding or earthing?	Remember	CO3	AEE014.12
21	What do you mean by equipment grounding?	Understand	CO3	AEE014.11
22	What is neutral grounding?	Remember	CO3	AEE014.12
23	What are the advantages of neutral grounding?	Understand	CO3	AEE014.11
24	What is resonant grounding?	Remember	CO3	AEE014.12
25	Where do we use grounding transformer?	Understand	CO3	AEE014.11
Part – B (Long Answer Questions)				
1	(a)What are the various electrical quantities measured and monitored in a sub-station? (b) Write short notes on accessories of a gas insulated substation.	Understand	CO3	AEE014.09
2	Draw the single line diagram, show the location of substation equipment's for the following bus bar arrangements. I) Single bus bar and ii) Main and transfer bus bar.	Remember	CO3	AEE014.10
3	How can substations are Classified according to constructional features?	Remember	CO3	AEE014.09
4	(a)Explain an indoor substation layout by drawing key diagram showing all equipment. (b) Draw single line diagram of gas insulated substation indicating different equipment.	Understand	CO3	AEE014.09
5	Draw single line diagram of gas insulated substation indicating different equipment.	Remember	CO3	AEE014.10
6	Write Short notes on Maintenance of gas insulated substation	Understand	CO3	AEE014.09
7	a) Where Gas Insulated Substation is preferred b) What are the Comparisons of Gas Insulated Substation over Air Insulated.	Remember	CO3	AEE014.09
8	What are the Merits and Demerits of SF6 Gas Insulated Substation.	Understand	CO3	AEE014.09
9	Where and Why Gas Insulated Substations are Used.	Remember	CO3	AEE014.10
10	Describe following corresponding to gas insulated substation i) Current transformer ii. Earth switch.	Remember	CO3	AEE014.09
9	What are the different bus-bar arrangements possible in a substation? Discuss them briefly with application areas?	Remember	CO3	AEE014.11
10	What is the necessity of bus-bar protection? How bus-bar protection scheme is stabilized?	Understand	CO3	AEE014.12
11	Describe with neat line diagram the principle of operation of duplicate bus-bar system in a substation.	Remember	CO3	AEE014.11
12	Discuss and compare briefly various bus-bar arrangement in a power system.	Understand	CO3	AEE014.11

13	Write short notes on the following (i) Necessity of bus-bar protection? (ii) bus bar arrangement (iii) differential protection of bus bar	Remember	CO3	AEE014.12
14	What is resistance grounding? What are its advantages and disadvantages?	Understand	CO3	AEE014.11
15	Describe ungrounded or isolated neutral system. What are its disadvantages?	Understand	CO3	AEE014.12
16	What do you mean by grounding or earthing? Explain it with an example?	Understand	CO3	AEE014.11
17	What is solid grounding? What are its advantages and disadvantages?	Remember	CO3	AEE014.12
Part - C (Problem Solving and Critical Thinking Questions)				
1	What are the Classification Of Air Insulated sub Stations a) According to service requirement b) According to construction.	Understand	CO3	AEE014.09
2	Define a substation and what its need is in a power system.	Remember	CO3	AEE014.10
3	Compare outdoor and indoor substation.	Understand	CO3	AEE014.09
4	What are the advantages of the following equipment in a substation a) bus bars b) Insulators c) circuit breakers d) isolating switches?	Remember	CO3	AEE014.10
5	What are the advantages of the following equipment in a substation a) Power transformer b) potential transformer c) current transformer.	Understand	CO3	AEE014.10
6	What are the advantages of gas insulated substations over air insulators?	Remember	CO3	AEE014.09
7	What are the Comparisons of Gas Insulated Substation over Air Insulated.	Understand	CO3	AEE014.10
8	Explain the maintenance schedule of gas insulated substation.	Remember	CO3	AEE014.10
9	What are the Merits and Demerits of SF ₆ Gas Insulated Substation?	Remember	CO3	AEE014.09
10	Write short notes on main parts of gas insulated substation.	Understand	CO3	AEE014.10
11	Write short notes on the following : (i) Time graded protection of feeders (ii) Protection of parallel feeders.	Understand	CO3	AEE014.11
12	How earth fault protection is achieved in case of feeders.	Understand	CO3	AEE014.12
13	How is the protection system graded with respect to the time of operation of relays for a radial feeder.	Remember	CO3	AEE014.11
14	Describe in detail the protection of parallel feeder and ring mains.	Understand	CO3	AEE014.11
15	Describe the principle of bus bar protection based on voltage differential systems.	Remember	CO3	AEE014.12
16	How does it respond to saturation of CTs for external and internal faults?	Understand	CO3	AEE014.11
17	Describe earth fault protection of sectionalized bus bar	Remember	CO3	AEE014.12
18	Discuss why duplicate bus-bar system is used? With a neat sketch develop the duplicate bus-bar system	Understand	CO3	AEE014.11
19	Explain the phenomenon of “arcing grounds” on overhead transmission lines.	Remember	CO3	AEE014.12
20	How does neutral earthing oppose arcing ground currents?	Understand	CO3	AEE014.11
21	A 230 kV, 3-phase, 50 Hz, 200 km transmission line has a capacitance to earth phase. Calculate the inductance and kVA rating of the Peterson coil used for system.	Remember	CO3	AEE014.12

UNIT-IV

GENERATOR AND TRANSFORMER PROTECTION

Part – A (Short Answer Questions)

1	Why is overload protection not necessary for alternators?	Remember	CO4	AEE014.13
3	What are the types of stator winding faults in alternator?	Understand	CO4	AEE014.14
4	Mention the most commonly used protection scheme for alternators.	Understand	CO4	AEE014.14
5	What are the rotor faults in alternator?	Remember	CO4	AEE014.13
6	Discuss Different generator faults?	Understand	CO4	AEE014.14
7	Discuss abnormal conditions?	Remember	CO4	AEE014.13
8	What is inter turn fault protection?	Remember	CO4	AEE014.14
9	Discuss the protection employed against loss of excitation of an alternator.	Understand	CO4	AEE014.13
10	(a) What do you understand by field suppression of an alternator? (b) How is it achieved?	Understand	CO4	AEE014.14
11	What type of relays is required for back-up protection of alternator?	Remember	CO4	AEE014.13
12	Which type of relays are used in merz-price protection system for alternator	Understand	CO4	AEE014.14
13	Discuss the different transformer faults.	Remember	CO4	AEE014.13
14	What are the various protections usually recommended for power transformers?	Understand	CO4	AEE014.13
15	Name the two basic requirements that are to be fulfilled by differential relay	Understand	CO4	AEE014.14
16	What is magnetic inrush current?	Remember	CO4	AEE014.14
17	What are the advantages of buchholtz relay Protection?	Remember	CO4	AEE014.13
18	What is the principle of harmonic restraint relay?	Understand	CO4	AEE014.14
19	What are the advantages of differential protection scheme?	Remember	CO4	AEE014.14
20	What is the function of buchholtz relay?	Understand	CO4	AEE014.13

Part – B (Long Answer Questions)

1	What type of a protective device is used for the protection of an alternator against overheating of its (i) stator (ii) rotor? Discuss them in brief.	Remember	CO4	AEE014.14
2	What type of a protective scheme is employed for the protection of the field winding of the alternator against ground faults?	Remember	CO4	AEE014.13
3	Draw the schematic of a Merz-price circulating method of protecting an alternator .Explain the operating principle.	Understand	CO4	AEE014.14
4	Discuss suitable protection schemes for internal and external fault protection of an alternator protection of an alternator	Remember	CO4	AEE014.13
5	Write short notes on the following (i) Generator faults (ii)protection of alternator(iii)over-load protection of alternator(iv)self balanced protection.	Understand	CO4	AEE014.13
6	Describe protection scheme of an alternator against inter-turn fault.	Remember	CO4	AEE014.14
7	Explain with a neat diagram the application of Merz-Price circulating current principle for the protection of alternator.	Understand	CO4	AEE014.14
8	Describe the construction and working of a Buchholz relay.	Remember	CO4	AEE014.13
9	Describe the Merz-Price circulating current system for the protection of transformers.	Understand	CO4	AEE014.13
10	Write short notes on the following (i) combined leakage and overload protection for transformers (ii) Earth fault protection for transformer	Remember	CO4	AEE014.13

11	Describe the protection scheme for internal faults in a three phase delta/star connected power transformer. Draw a neat sketch and explain clearly why the CTs are to be connected in a particular fashion only.	Understand	CO4	AEE014.14
12	What protective devices other than differential protection are used for the protection of a large transformer? Briefly describe them .	Remember	CO4	AEE014.14
13	Explain with a neat circuit diagram the differential protection scheme used to protect star/delta transformers.	Understand	CO4	AEE014.13
14	Discuss the different transformer faults. What are the various protection schemes available for transformers?	Understand	CO4	AEE014.14
15	What is the principle of harmonic restraint relay? Explain its applications?	Remember	CO4	AEE014.13
Part - C (Problem Solving and Critical Thinking Questions)				
1	A star-connected, 3-phase, 10-MVA, 6.6 kV alternator has a per phase reactance of 10%. It is protected by Merz-Price circulating-current principle which is set to operate for fault currents not less than 175 A. Calculate the value of earthing resistance to be provided in order to ensure that only 10% of the alternator winding remains unprotected.	Understand	CO4	AEE014.13
2	A star-connected, 3-phase, 10 MVA, 6.6 kV alternator is protected by Merz-Price circulating-current principle using 1000/5 amperes current transformers. The star point of the alternator is earthed through a resistance of 7.5Ω . If the minimum operating current for the relay is 0.5 A, calculate the percentage of each phase of the stator winding which is unprotected against earth-faults when the machine is operating at normal voltage.	Remember	CO4	AEE014.14
3	A 10 MVA, 11 kV, 3-phase star-connected alternator is protected by the Merz- Price balance-current system, which operates when the out-of-balance current exceeds 20% of full-load current. Determine what portion of the alternating winding is unprotected if the star point is earthed through resistance of 9Ω . The reactance of the alternator is 2Ω .	Understand	CO4	AEE014.13
4	A star-connected, 3-phase, 10 MVA, 6.6 kV alternator is protected by circulating current protection, the star point being earthed via a resistance r. Estimate the value of earthing resistor if 85% of the stator winding is protected against earth faults. Assume an earth fault setting of 20%. Neglect the impedance of the alternator winding.	Remember	CO4	AEE014.14
5	A 3-phase, 20 MVA, 11kV star connected alternator is protected by Merz-Price circulating current system. The star point is earthed through a resistance of 5 ohms. If the CTs have a ratio of 1000/5 and the relay is set to operate when there is an out of balance current of 1.5 A, calculate : (i) the percentage of each phase of the stator winding which is unprotected. (ii) the minimum value of earthing resistance to protect 90% of the winding.	Understand	CO4	AEE014.13
6	Describe with a neat sketch the percentage differential protection of a modern alternator.	Remember	CO4	AEE014.13
7	Make a list faults , which may occur on a alternator .State the protections to be used for each of such faults.	Understand	CO4	AEE014.14
8	Discuss suitable protection scheme which are used for (i) rotor earth fault (ii) rotor open-circuit of a synchronous generator.	Remember	CO4	AEE014.14
9	A 3-phase transformer of 220/11,000 line volts is connected in star/delta. The protective transformers on 220 V side have a current ratio of 600/5. What should be the CT ratio on 11,000 V side?	Understand	CO4	AEE014.13

10	A 3-phase transformer having line-voltage ratio of 0.4 kV/11kV is connected in star-delta and protective transformers on the 400 V side have a current ratio of 500/5. What must be the ratio of the protective transformers on the 11 kV side?	Remember	CO4	AEE014.13
11	A 3-phase, 33/6.6 kV, star/delta connected transformer is protected by Merz-Price circulating current system. If the CTs on the low-voltage side have a ratio of 300/5, determine the ratio of CTs on the high voltage side	Understand	CO4	AEE014.14
12	A 3-phase, 200 kVA, 11/0.4 kV transformer is connected as delta/star. The protective transformers on the 0.4 kV side have turn ratio of 500/5. What will be the C.T. ratios on the high voltage side?	Understand	CO4	AEE014.14
13	A 3-phase transformer of 220/11,000 line volts is connected in star-delta. The protective transformers on 220v side have a current ratio of 600/5. What should CT ratio 11,000v side?	Remember	CO4	AEE014.13
14	Write short notes on the following : (a) Combined leakage and over load protection (b) Biased differential protection (c) Restricted earth- fault protection for power transformer.	Understand	CO4	AEE014.13
15	Explain the protective scheme for the transformer that takes care of magnetizing inrush current without effecting the sensitivity.	Remember	CO4	AEE014.14

UNIT-V

PROTECTION AGAINST OVER VOLTAGES

Part - A (Short Answer Questions)

1	What is a voltage surge?	Remember	CO5	AEE014.15
2	What are the causes of over voltages?	Understand	CO5	AEE014.15
3	What is lightning?	Remember	CO5	AEE014.15
4	What are the harmful effects of lightning?	Remember	CO5	AEE014.15
5	What are the types of lightning stroke?	Understand	CO5	AEE014.15
6	What is a surge diverter?	Understand	CO5	AEE014.15
7	What is a surge absorber?	Understand	CO5	AEE014.15
8	Where will you use a surge absorber?	Remember	CO5	AEE014.15
9	Why is lightning accompanied by a thunder?	Remember	CO5	AEE014.15
10	What is the principle of a valve type arrester?	Remember	CO5	AEE014.15
11	Explain the operation of Expulsion type diverter?	Remember	CO5	AEE014.15
12	Explain the operation of Multi gap type diverter?	Remember	CO5	AEE014.15
13	What is Rod gap diverter?	Understand	CO5	AEE014.15
14	What is Horn gap diverter?	Understand	CO5	AEE014.15
15	What is the function of lightning Arrester?	Remember	CO5	AEE014.15

Part - B (Long Answer Questions)

1	What is a voltage surge? Draw a typical lightning voltage surge..	Remember	CO5	AEE014.15
2	Discuss the causes of over voltages.	Understand	CO5	AEE014.15
3	What is lightning? Describe the mechanism of lightning discharge.	Understand	CO5	AEE014.15
4	Describe the various types of lightning stroke.	Understand	CO5	AEE014.15
5	How do earthing screen and ground wires provide protection against direct lightning strokes?	Remember	CO5	AEE014.15
6	What is a surge diverter? What is the basic principle of operation of a surge diverter?	Remember	CO5	AEE014.15

7	Write short notes on the following surge diverters a. Rod gap diverter b. Horn gap diverter	Remember	CO5	AEE014.15
8	Write short notes on the following surge diverters a. Expulsion type diverter b. Multigap type diverter	Remember	CO5	AEE014.15
9	Discuss the construction, principle and working of a valve type arrester	Understand	CO5	AEE014.15
10	What is a surge absorber? Write a short note on Ferranti surge absorber	Understand	CO5	AEE014.15
11	Name different types of lightning arresters used now-a-days in protecting equipment and overhead line	Understand	CO5	AEE014.15
12	Explain How do ground wires protect the overhead lines against direct lightning strokes?	Understand	CO5	AEE014.15
13	What is a horn-gap arrester? Explain how its works.	Understand	CO5	AEE014.15
14	What are the causes of over-voltages arising on a power system?	Remember	CO5	AEE014.15
15	Write short notes on the following (i) Causes of over voltages (ii) Lightning phenomenon.	Remember	CO5	AEE014.15
Part - C (Problem Solving and Critical Thinking Questions)				
1	Why is it necessary to protect the lines and other equipment of power system against over voltages?	Understand	CO5	AEE014.15
2	How can the magnitude of over voltages due to direct and indirect lightning strokes on overhead lines be calculated?	Understand	CO5	AEE014.15
3	What is a ground wire? What are the requirements to be satisfied by ground wires to provide efficient protection to lines against direct lightning strokes?	Understand	CO5	AEE014.15
4	Explain the term over voltage factor, protective ratio, protective angle, protective zone and coupling factor?	Remember	CO5	AEE014.15
5	Discuss the phenomenon of lightning stroke. How can wave set up by such a stroke be represented.	Understand	CO5	AEE014.15
6	What is the purpose of inserting a resistance between horn gap arrester and the line.	Remember	CO5	AEE014.15
7	What is the function of a surge absorber? In what way is it different from lightning arrester.	Understand	CO5	AEE014.15
8	Explain clearly why lightning arresters are used.	Remember	CO5	AEE014.15
9	Write short notes on the following switching surges Lightning phenomenon.	Understand	CO5	AEE014.15
10	Explain how a substation and the equipment in the substation are protected from lightning strokes.	Remember	CO5	AEE014.15
11	Explain the operation of Valve type Lighting Arresters	Understand	CO5	AEE014.15
12	Explain the operation of Zinc-Oxide Lighting Arresters	Understand	CO5	AEE014.15
13	Discuss about Volt-Time Characteristics	Remember	CO5	AEE014.15
14	Explain the following: (i) Insulation Coordination (ii) Impulse Ratio	Understand	CO5	AEE014.15
15	Explain the Adverse effects of Over Voltages?	Remember	CO5	AEE014.15

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