



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

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Department of Electrical and Electronics Engineering

QUESTION BANK

Course Name	:	SWITCH GEAR AND PROTECTION
Course Code	:	A70231
Class	:	IV B. Tech I Semester
Branch	:	Electrical and Electronics Engineering
Year	:	2018-2019
Course Faculty	:	P Shiva Kumar, Assistant Professor, EEE

OBJECTIVE:

“Switch Gear & Protection” subject gives general awareness of different Protective Equipments for Power Systems such as Relays, Circuit Breakers, and Isolators. It also explains about protective system- how it works and where it works? A different application of the relays for different elements of power system is also discussed in the subject.

S. No	Question	Blooms Taxonomy Level	Course Outcomes
UNIT - I			
CIRCUIT BREAKERS			
Part - A (Short Answer Questions)			
1	What is a circuit breaker? Explain its functions?	Remember	1
2	Discuss the arc phenomenon in a circuit breaker.	Understand	1
3	Define the following terms as applied to circuit breakers : (i) Arc voltage (ii) Re striking voltage (iii) Recovery voltage?	Understand	1
4	Discuss the phenomenon of current chopping?	Understand	1
5	What is resistance switching?	Understand	1
6	What the function of auto reclosures?	Remember	1
7	What is switchgear?	Understand	2
8	Define the term RRRV?	Understand	1
9	Discuss the advantages and disadvantages of oil circuit breakers.	Understand	2
10	Define the terms (i) symmetrical breaking current (ii) Asymmetrical breaking current (iii) making current	Understand	2
11	What are the advantages of SF6 circuit breaker?	Understand	2
12	What are the advantages and disadvantages of an Air blast circuit breaker?	Understand	2
13	What are the advantages and disadvantages of vacuum circuit breaker?	Understand	2
14	Why are circuit breakers designed to have a short-time rating?	Remember	1
15	List the types of air blast circuit breaker?	Understand	2
Part - B (Long Answer Questions)			
1	Discuss about various methods of arc extinction in a circuit breaker?	Understand	3
2	Explain the following terms as applied to circuit breakers : (i) Arc voltage (ii) Re striking voltage (iii) Recovery voltage	Remember	3
3	Write a short note on the rate of re-striking voltage indicating its importance in the arc extinction?	Remember	3
4	Discuss the phenomenon of. (i) Current chopping (ii) Capacitive current breaking	Understand	3
5	Discuss about the following (i) resistance switching (ii) circuit breaker ratings (iii) circuit interruption problems?	Remember	4
6	Write short notes on the following (i) resistance switching (ii) circuit breaker ratings	Understand	4

	(iii) circuit interruption problems?		
7	Derive an expression for restriking voltage in terms of system capacitance		4
8	What are the major duties that a circuit breaker is required to perform? Explain them clearly?	Understand	4
9	Describe briefly the action of an oil circuit breaker. How does oil help in arc extinction?	Remember	4
10	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	3
11	Explain briefly the following types of air-blast circuit breakers? (i) Axial- blast type (ii) Cross-blast type	Understand	3
12	Discuss the operating principle of SF6 circuit breaker.	Understand	3
13	Describe construction, operating principle and application of vacuum circuit breaker. For what voltage range is it recommended?	Remember	3
14	Compare the performance of sf6 gas with air when used for circuit breaking.	Remember	3
15	Discuss the constructional details and operation of a typical low-oil circuit breaker? What are its relative merits and demerits?	Understand	2
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	6
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	Remember	6
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	Remember	6
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	2
5	Explain the terms Recovery voltage, restriking voltage and RRRV. Derive an expression for the restriking voltage in terms of system capacitance and inductance	Remember	2
6	Discuss the recovery rate theory and energy balance theory of arc interruption in a circuit breaker	Understand	1
7	Write the differences between high resistance and low resistance methods	Remember	4
8	(a) Explain briefly about various Switch gear components. (b) Give the importance of ratings and specifications of Circuit Breaker	Understand	1
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	Remember	4
10	Describe the construction, principle of operation and application of sf6 circuit breaker. How does this breaker essentially differ from an air blast breaker	Understand	4
11	Discuss the properties of vacuum, arc phenomenon, and constructional details, working principle, merits and applications of vacuum circuit breakers.	Remember	4
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	4
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	4
14	With a neat block diagram, explain the construction, operating principles and merits of air blast circuit breaker.	Remember	4
15	Discuss how breaking capacity and making capacity of a circuit breaker are tested in a laboratory type testing stations.	Remember	4
UNIT - II ELECTROMAGNETIC AND STATIC RELAYS			

Part - A (Short Answer Questions)			
1	What is the difference between a fuse and a relay?	Remember	2
2	Define over current relay?	Understand	2
3	Why are differential relays more sensitive than over current relays?	Understand	2
4	Explain about balanced voltage relay?	Remember	2
5	What is protective relay?	Understand	2
6	Define pick-up value?	Understand	2
7	Define Plug-setting multiplier?	Remember	2
8	State the various applications of differential protection.	Remember	2
9	What are the essential qualities of a relay?	Remember	2
10	How the relays are basically classified?	Understand	2
11	Define Time-setting multiplier?	Understand	3
12	Define Current setting?	Remember	3
13	Explain about Translay relay?	Understand	3
14	Define current differential relay?	Understand	3
15	Write the comparisons between electromagnetic and static relays?	Remember	3
Part - B (Long Answer Questions)			
1	With the help of neat sketch explain the principle of operation of Differential Relays.	Understand	4
2	Distinguish between Over current relays, Directional relays and Differential Relays.		4
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	4
4	Explain the „Differential protection“. State the various applications of differential protection.	Remember	4
5	What are the different types of electromagnetic relays? Discuss their field of applications	Remember	4
6	What are the various types of over current relays? Discuss their area of application.	Remember	4
7	Describe the operating principle, constructional features and area of applications of reverse power or directional relay.	Understand	11
8	Describe the construction and principle of operation of an induction type directional over current relay.	Understand	11
9	Explain the working principle of distance relays.	Understand	11
10	Write a detailed note on differential relays.	Remember	11
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	11
12	Explain the following terms as applied to protective relaying : (i) Pick-up value (ii) Current setting	Understand	11
13	Explain with the help of neat diagram the construction and working of Induction type directional power relay.	Remember	11
14	Explain the construction and working of Translay relay	Understand	11
15	Explain the working principle of distance relays	Remember	11
Part - C (Analytical 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	Remember	11
2	What are the different inverse time characteristics of over Current relays? Mention how characteristics can be achieved In practice for an electromagnetic relay.	Remember	6
3	Write short notes on the following : (i) Percentage differential relays (ii) Definite distance relays (iii) Time-distance relays	Understand	6
4	Describe the construction and principle of operation of an induction type directional over current relay.	Understand	4
5	Explain with the help of neat diagram the construction and working of Non-directional induction type over current relay	Understand	4
6	Define and explain the following terms as applied to protective relaying :	Understand	4

	(i) Plug-setting multiplier (ii) Time-setting multiplier		
7	Derive the equation for torque developed in an induction relay.	Remember	4
8	(a) Draw the characteristics of a directional impedance relay on an R-X diagram Compare Static and Electromagnetic relay	Understand	4
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	Remember	6
10	Describe the operating principle, constructional features and area of applications of directional relay.	Understand	6
11	How do you implement directional feature in the over current relay?	Remember	6
12	Define the following terms and explain their significance in distance protection? (a) Reach of a distance relay. (b) Under reach	Understand	6
13	Draw and Explain the characteristics of a reactance relay	Remember	6
14	Draw and Explain the characteristics of a mho relay on an R-X diagram	Understand	6
15	Write the applications of impedance relay, reactance relay and mho relay	Remember	6
UNIT - III			
GENERATOR AND TRANSFORMER PROTECTION			
Part - A (Short Answer Questions)			
1	Why is overload protection not necessary for alternators?	Understand	5
2	List the types of stator winding faults in alternator?	Remember	5
3	Mention the most commonly used protection scheme for alternators.	Understand	5
4	What are the rotor faults in alternator?	Remember	5
5	Discuss Different generator faults?	Understand	5
6	Discuss abnormal conditions?	Remember	5
7	What is inter turn fault protection?	Understand	5
8	Discuss the protection employed against loss of excitation of an alternator.	Remember	5
9	(a) What do you understand by field suppression of an alternator? (b) How is it achieved?	Understand	5
10	Which type of relays is required for back-up protection of alternator?	Remember	5
11	Which type of relays are used in merz-price protection system for alternator	Understand	3
12	Discuss the different transformer faults.	Understand	3
13	What are the various protections usually recommended for power transformers?	Remember	3
14	Name the two basic requirements that are to be fulfilled by differential relay	Understand	3
15	What is magnetic inrush current?	Understand	1
16	What are the advantages of buchholtz relay Protection?	Remember	2
17	What is the principle of harmonic restraint relay?	Understand	3
18	What are the advantages of differential protection scheme?	Understand	3
19	What is the function of buchholtz relay?	Remember	3
20	Discuss Different generator faults?	Remember	3
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	3
2	What type of a protective scheme is employed for the protection of the field winding of the alternator against ground faults?	Understand	3
3	Draw the schematic of a Merz-price circulating method of protecting an alternator. Explain the operating principle	Remember	3
4	Discuss suitable protection schemes for internal and external fault protection of an alternator	Understand	3
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	3
6	Describe protection scheme of an alternator against inter-turn fault	Understand	3
7	Explain with a neat diagram the application of Merz-Price circulating current principle for the protection of alternator	Understand	3
8	Describe the construction and working of a Buchholz relay.	Remember	3
9	Describe the Merz-Price circulating current system for the protection of Transformers.	Understand	3
10	Write short notes on the following (i) combined leakage and overload protection for transformers	Understand	5

	(ii) Earth fault protection for transformer		
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	Remember	5
12	What protective devices other than differential protection are used for the protection of a large transformer? Briefly describe them.	Understand	5
13	Explain with a neat circuit diagram the differential protection scheme used to protect star/delta transformers	Remember	5
14	Discuss the different transformer faults. What are the various protection schemes available for transformers?	Understand	5
15	What is the principle of harmonic restraint relay? Explain its applications?	Understand	5
Part – C (Analytical 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	Remember	6
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	Understand	6
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	Remember	6
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	6
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	Remember	6
6	Describe with a neat sketch the percentage differential protection of a modern alternator	Remember	6
7	Make a list faults, which may occur on a alternator. State the protections to be used for each of such faults	Understand	9
8	Discuss suitable protection scheme which are used for (i) rotor earth fault (ii) rotor open-circuit of a synchronous generator	Understand	9
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	9
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	9
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	9
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	Remember	14

	C.T. ratios on the high voltage side?		
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?	Understand	14
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	Remember	14
15	Explain the protective scheme for the transformer that takes care of magnetizing inrush current without effecting the sensitivity	Remember	14
UNIT - 1V			
FEEDER AND BUS-BAR PROTECTION AND GROUNDING: PROTECTION OF LINE			
Part - A (Short Answer Questions)			
1	How earth fault protection is achieved in case of feeder?	Remember	3
2	What are the protection scheme for the protection parallel feeder	Understand	3
3	Write the applications of Merz-Price protection scheme	Understand	3
4	What are the advantages of distance protection over other types of protection	Remember	3
5	Define backup protection?	Understand	3
6	Define differential protection?	Remember	3
7	How does linear coupler differ from ordinary CTs?	Understand	3
8	What do you mean by grounding or earthing?	Remember	5
9	What do you mean by equipment grounding?	Understand	5
10	Define neutral grounding?	Remember	5
11	What are the advantages of neutral grounding?	Understand	5
12	Define resonant grounding?	Remember	5
13	Where do we use grounding transformer?	Understand	5
14	In an overhead system, most of the faults are single line to ground. Why?	Remember	5
15	What are the factors causing arcing grounds?	Understand	5
Part - B (Long Answer Questions)			
1	Discuss the time-graded over current protection for (i) Radial feeders (ii) Parallel feeders (iii) Ring main system	Remember	3
2	Describe the differential pilot wire method of protection of feeders.	Understand	3
3	Explain the Translay protection scheme for feeders?	Remember	3
4	Discuss and compare briefly various bus-bar arrangement in a power system.	Remember	3
5	What are the different bus-bar arrangements possible in a substation? Discuss them briefly with application areas?	Remember	3
6	What is the necessity of bus-bar protection? How bus-bar protection scheme is stabilized?	Understand	3
7	Describe with neat line diagram the principle of operation of duplicate bus-bar system in a substation.	Remember	6
8	Write short notes on the following (i) Necessity of bus-bar protection? (ii) bus bar arrangement (iii) differential protection of bus bar	Understand	6
9	What is resistance grounding? What are its advantages and disadvantages?	Understand	6
10	Describe ungrounded or isolated neutral system. What are its disadvantages?	Remember	6
11	What do you mean by grounding or earthing? Explain it with an example?	Understand	6
12	What is solid grounding? What are its advantages and disadvantages?	Remember	6
13	Describe Arc suppression coil grounding	Remember	6
14	What is the importance of arc suppression coil grounding?	Understand	6
15	Discuss the advantages of (i) Grounding the neutral of the system (ii) keeping the neutral isolated	Understand	6
Part - C (Analytical Questions)			
1	Write short notes on the following : (i) Time graded protection of feeders (ii) Protection of parallel feeders	Understand	3
2	How earth fault protection is achieved in case of feeders.	Remember	3
3	How is the protection system graded with respect to the time of operation of relays for a radial feeder	Understand	3
4	Describe in detail the protection of parallel feeder and ring mains	Remember	3
5	Describe the principle of bus bar protection based on voltage differential systems.	Understand	3
6	How does it respond to saturation of CTs for external and internal faults?	Remember	3

7	Describe earth fault protection of sectionalized bus bar	Understand	3
8	Discuss why duplicate bus-bar system is used? With a neat sketch develop the duplicate bus-bar system	Remember	3
9	Explain the phenomenon of “arcing grounds” on overhead transmission lines.	Understand	3
10	How does neutral earthing oppose arcing ground currents?	Understand	3
11	Explain with diagrams : the phase to earth voltage rise in un faulted lines during a single phase to earth fault in a 3-phase system without (a) neutral earthing, (b) the situation with neutral earthing	Remember	15
12	A transmission line has capacitance of 0.1 μ f per phase. Determine the inductance of Peterson coil to neutralize the effect of capacitance of (i) complete length of line (ii) 97% of the line (iii) 90% length of line .The supply frequency is 50HZ	Understand	15
13	A 132kv,50hz,3-phase, 100km long transmission line has a capacitance of 0.012 μ f per km per phase. Determine the inductive reactance and KVA rating of the arc suppression coil suitable for the line to eliminating arcing ground phenomenon.	Understand	15
14	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.	Understand	15
15	A 50 Hz overhead line has line to earth capacitance of 1.2 μ F. It is desired to use earth fault neutralizer. Determine the reactance to neutralize the capacitance of (i) 100% of the length of the line (ii) 90% of the length of the line and (iii) 80% of the length of the line	Understand	15

UNIT - V

PROTECTION AGAINST OVER VOLTAGES

Part - A (Short Answer Questions)

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

Part - B (Long Answer Questions)

1	What is a voltage surge? Draw a typical lightning voltage surge..	Understand	6
2	Discuss the causes of over voltages.	Remember	6
3	What is lightning? Describe the mechanism of lightning discharge.	Understand	6
4	Describe the various types of lightning stroke.	Understand	6
5	How do earthing screen and ground wires provide protection against direct lightning strokes?	Remember	6
6	What is a surge diverter? What is the basic principle of operation of a surge diverter?	Understand	6
7	Write short notes on the following surge diverters a. Rod gap diverter b. Horn gap diverter	Remember	6
8	Write short notes on the following surge diverters a. Expulsion type diverter b. Multigap type diverter	Understand	6
9	Discuss the construction, principle and working of a valve type arrester	Remember	13
10	What is a surge absorber? Write a short note on Ferranti surge absorber	Remember	13
11	Name different types of lightening arresters used now-a-days in protecting equipment and overhead line	Remember	13
12	Explain How do ground wires protect the overhead lines against direct lightening	Remember	13

	strokes?		
13	What is a horn-gap arrester? Explain how its works	Remember	13
14	What are the causes of over-voltages arising on a power system?	Remember	13
15	Write short notes on the following (i) Causes of over voltages ii) Lightning phenomenon	Understand	13
Part – C (Analytical Questions)			
1	Why is it necessary to protect the lines and other equipment of power system against over voltages?	Remember	14
2	How can the magnitude of over voltages due to direct and indirect lightning strokes on overhead lines be calculated?	Understand	14
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?	Remember	14
4	Explain the term over voltage factor, protective ratio, protective angle, protective zone and coupling factor?	Understand	14
5	Discuss the phenomenon of lightning stroke. How can wave set up by such a stroke be represented.	Remember	14
6	What is the purpose of inserting a resistance between horn gap arrester and the Line.	Understand	14
7	What is the function of a surge absorber? In what way is it different from lightning arrester.	Remember	14
8	Explain clearly why lightening arresters are used.	Understand	14
9	Write short notes on the following switching surges Lightning phenomenon.	Understand	14
10	Explain how a substation and the equipment in the substation are protected from lightening strokes.	Remember	14
11	Explain the operation of Valve type Lighting Arresters.	Remember	14
12	Explain the operation of Zinc-Oxide Lighting Arresters.	Remember	14
13	Discuss about Volt-Time Characteristics.	Understand	6
14	Explain the following: (i) Insulation Coordination (ii) Impulse Ratio.	Remember	6
15	Explain the Adverse effects of Over Voltages?	Remember	6

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