

**B.E. ELECTRICAL ENGINEERING
FOURTH YEAR
FIRST SEMESTER EXAM 2024**

POWER SYSTEM PROTECTION AND SWITCHGEAR

Time: Three Hours

Full Marks: 100

(50 marks for each part)

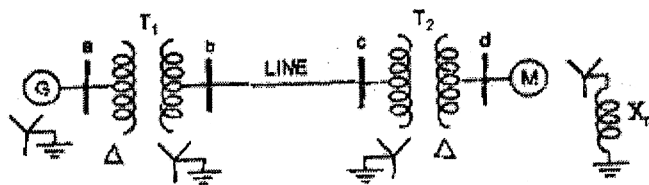
Use a separate Answer-Script for each Part

PART-I

Group A

Answer *any two* questions from Group A.

1. a) A star connected alternator is connected to a power system through a step up transformer followed by a high voltage transmission line. Explain whether a solid single line to ground fault or a three phase fault is more severe if it occurs at the i) generator terminal ii) far end of transmission line. 5
 b) Show that the sequence impedances of transmission lines are uncoupled even when mutual impedances exist between the phases. 5
2. The positive, negative and zero sequence reactances of 100MVA, 13.8 kV generator G in per unit as shown in the figure are 0.15, 0.17 and 0.05 respectively. The positive, negative and zero sequence reactances of 100MVA, 13.8 kV motor M in per unit are 0.2, 0.21 and 0.1 respectively. The motor neutral is grounded through a reactance of 0.05 pu. The rating of both the transformers is 120MVA, 13.8kV/ 138kV with per unit reactance of 0.12. The positive and negative reactance of the line is 20 ohm and the zero sequence reactance is 60 ohm. Consider 100MVA base. 10
 a) Draw the sequence networks.
 b) Determine the fault current in per unit for a line to line fault at bus b.



[Turn over

3. a) With the help of necessary derivation represent a single line to ground fault using sequence networks. 6
- b) A 30 MVA, 11kV generator has $Z_1 = Z_2 = j0.2$ pu, $Z_0 = j0.05$ pu. A line to line fault occurs on the terminals of the generator. Determine the line currents under fault condition. 4

Group B

Answer *any three* questions from Group B.

4. a) Explain with suitable diagram why severe voltage oscillations may occur while a circuit breaker de-energizes a long transmission line which is open circuited at the receiving end. 7
- b) Explain why current interruption is easier in ac circuit breaker than in dc circuit breaker. 3
5. a) 'Autoreclosing is not always beneficial' - Explain. 5
- b) What do you understand by diffused arc and constricted arc in vacuum circuit breaker? Explain with suitable diagram. 5
6. a) Explain the difference between self blast oil circuit breaker and forced blast oil circuit breaker. 4
- b) What are the limitations of SF₆ circuit breakers? 3
- c) Mention the factors that influence the arc extinction process in a circuit breaker. 3
7. a) Discuss the effect of current symmetry on recovery voltage. 3
- b) Explain with necessary derivation the benefits of resistance switching in circuit breakers. 7

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PART II

Figures in the margin indicate full marks

Group –A																
Answer any three questions from Group-A																
1.	Explain the main features of relaying. Explain their interdependency. What do you understand by local backup and remote backup schemes of relaying? Discuss about basic elements of protective relaying.	(4+2+4) =10														
2.	Explain the advantage possessed by IDMTL relay over the inverse characteristic of overcurrent relay. Also, explain how the pickup current and time delay of an IDMTL overcurrent relay are selected. Explain PMS and TMS in connection to an IDMTL overcurrent relay. Explain why the disc of an induction-type overcurrent relay is made spiral-shaped or holes are cut into it. (IDMTL, PMS, and TMS have their usual meanings.)	(2+2+4+2) =10														
3.	Explain the factors on which the reach of the overcurrent relay depends. Also, explain that for a three-phase fault in a balanced transmission line, only the positive sequence network is excited and the apparent impedance seen by the distance relay is xZ_1 , x being the distance on the line from the source end where the 3-phase fault occurs.	(4+6) =10														
4.	Explain the universal torque equation. In this regard explain impedance relay and reactance relay. Also, explain, among the mentioned distance relays, which relay is least affected by arc resistance.	(2+6+2) =10														
5.	a) Determine the time of operation of an IDMTL relay rating 5A, 2.2sec, and having a plug setting PS= 125% , and TMS=0.6. It is connected to a supply circuit through a C.T of 400/5 ratio. The fault current is 4000A. The relay characteristics is shown below: <table border="1"><tr><td>PSM</td><td>2</td><td>4</td><td>6</td><td>8</td><td>12</td><td>20</td></tr><tr><td>Time</td><td>10</td><td>5.53</td><td>3.84</td><td>3.4</td><td>2.63</td><td>2.1</td></tr></table> b) Explain why the plug settings for an earth fault relay vary between 10% to around 70% ?	PSM	2	4	6	8	12	20	Time	10	5.53	3.84	3.4	2.63	2.1	(6+4) =10
PSM	2	4	6	8	12	20										
Time	10	5.53	3.84	3.4	2.63	2.1										
Group –B																
Answer any two questions from Group-B																
6.	Discuss protection scheme for alternator for (a) stator winding inter-turn fault (b) field ground fault.	(10)														
7.	Discuss about carrier inter-tripping scheme used for transmission line protection.	(10)														
8.	Draw a protection scheme for three phase transformer winding protection and explain it.	(10)														
9.	What is restricted earth fault protection? Explain this protection scheme with a suitable diagram.	(10)														