Ref:Ex/EE/PC/B/T/321/2024

B. E. ELECTRICAL ENGINEERING 3RD YEAR, 2ND SEMESTER EXAMINATION 2024

POWER SYSTEM PERFORMANCE

Time: Three hours Full Marks: 100

(50 marks for each part)
Use separate answer script for each part.

PART I
Figures in the margin indicate full marks

Group-A
Answer any two questions out of three

1. The resistance and reactance of a three phase short transmission line are 6Ω and 18Ω respectively. Using power circle diagram determine the load supplied by the line at 132kV and 0.8 pf lagging when the sending end voltage is 150kV. Also determine the rating of the synchronous phase modifier which can improve the power factor to 0.95 lagging if the receiving end voltage and load are constant. (10)

2. (a) Explain how series compensation can increase the power transmission capability of the line. What will happen if 100% series compensation is made in a power transmission line? (3+2)

   (b) Discuss the role of on load tap changing transformer in voltage control. (5)

3. (a) What are the advantages of per unit system? Justify that the per unit equivalent impedance of a two winding transformer is the same whether calculation is made from low voltage side or high voltage side. (3+3)

   (b) Show that the reactive power transferred over a line does not depend on the power angle but on the difference between the sending end and receiving end voltage. (4)

Group-B
Answer any two questions out of three

4. (a) What do you understand by short circuit capacity of a system? How can the load current be taken into account in fault calculations? (2+3)

   (b) A three phase 15 MVA, 10kV alternator has internal reactance of 6%. Determine the external reactance to be connected in series with the alternator so that the short circuit current does not exceed 6 times the full load current. (5)

[Turn over

5. The per unit admittances of a power system network are indicated in the diagram below. Bus 1 is the slack bus with V = 1.02 pu and consider bus 2 as load bus. The generation and load power of bus 2 in per unit are (0.25 + j 0.15) and (0.5 + j0.25) respectively. The load power of bus 3 in per unit is (0.6 + j0.3). Determine bus admittance matrix and find voltages at bus 2 and 3 after first iteration using Gauss Seidel method. Assume acceleration factor as 1.4. (10)

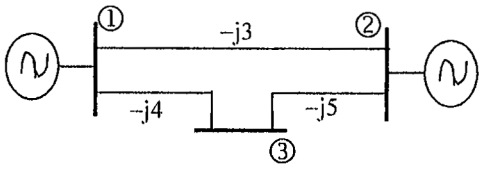

Fig..1

6. (a) Why load flow study is performed? Explain the importance of slack bus in load flow study. (2+3)

(b) A three phase 10kV transmission line has resistance of 1Ω and reactance of 4 Ω and is connected to the generating station bus bar through a 5MVA transformer of reactance 6%. In the generating station there is a generator of 10MVA having reactance of 12%. Determine the short circuit MVA if symmetrical fault occurs at the load end of the transmission line. (5)

Group-C
Answer any one question out of two

7. (a) Write short note on HVDC link. (5)

(b) Compare the insulation level of a bipolar HVDC system with three phase ac system for same power transmission, same power loss and same conductor size. (5)

8. a) What is breakeven distance in connection with HVDC transmission? (3)

b) A load of 450 MW is to be shared by the three generators, rated at 150, 175 and 170 MW at a power plant. Determine the optimum distribution of the load among the generators. Assume operating cost of the three generators in Rs/MWh to be as follows: (7)

$C_1 = 100 + 0.18P_1 + 0.01P_1^2$, $C_2 = 150 + 0.15P_2 + 0.014P_2^2$,

$C_3 = 200 + 0.16\,P_3 + 0.012P_3^2$

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SUBJECT: - POWER SYSTEM PERFORMANCE

Time: Three hours (**50** marks for this part) Full Marks: 100

Use a separate Answer-Script for each part

No. of Questions		PART -II Answer ONE question from EACH OF THE FOLLOWING GROUPS. Figures in the margin indicate full marks	Marks
		GROUP- A [CO 4, K3]	
1)	a)	Illustrate the following statements: i. "It is crucial to maintain the System Frequency within a narrow range." ii. "Active power may flow from lower to higher potential but reactive power flows from higher to lower potential." iii. "The reactive power output of an alternator can be controlled by controlling excitation."	(3×5= 15)
	b)	Illustrate the factor on which the limit of under-excitation of synchronous generators depends.	(3)
	c)	Illustrate "Infinite Bus". Explain its characteristics.	(4)
2)	a)	Draw the phasor diagrams for a cylindrical rotor synchronous generator and from the phasor diagram deduce the expression for the active power and the reactive power for this generator. Also, draw the power angle curve for this generator.	(8)
	b)	Illustrate with the help of a schematic diagram, the operation of the Speed Governor. Also, illustrate with proper discussion how the surplus power in the power system can be accounted for and develop the corresponding expressions. Assume ΔP_G = Increased Generator Power Output & ΔP_D= Change in Load and $\Delta P_G > \Delta P_D$.	(6+8=14)
		GROUP- B [CO 5, K3]	
3)	a)	50 Hz, 4-pole turbogenerator rated 100 MVA, 11KV,has an inertia constant of 4 MJ/ MVA. If the electrical power output suddenly reduces from 80 MW to 60 MW, find acceleration neglecting losses. If the accelerationis maintained for 10 cycles, find the change in torqueangle and rotor speed in r.p.m. at the end of this period.	(8)
	b)	Illustrate the swing equation for a synchronous generator.	(6)

(please turn over)

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	c)	Illustrate "power system stability" concerning a power system. In this regard, illustrate the necessity of power system stability studies.	(3+3=6)
4)	a)	A loss-free generator supplies 30 MW to an infinite bus, the steady-state limit of the system being 100 MW. Determine whether the generator will remain synchronized if the prime mover input is abruptly increased by 50 MW.	(8)
	b)	Illustrate the term 'critical clearing angle.' An alternator is delivering 1.0 p.u. power to an infinite bus through parallel transmission lines each having a reactance of 0.5 p.u. The internal e.m.f. of the alternator is 1.10 p.u and its transient reactance is 0.3 p.u. A sudden three-phase short circuit occurs at the midpoint of one of the lines and is subsequently cleared by opening the circuit breakers at both ends of the line. Determine the critical clearing angle.	(12)
		GROUP- C [CO 6, K3]	
5)		Illustrate the operations of the following (use proper diagrams wherever needed): **(any one)** (i) Volt/Hz limiter and AC & DC regulators in the excitation system of an alternator. (ii) Static Excitation Systems. (iii) Field Controlled Alternator-rectifier Excitation system.	(8)