Ref : Ex/EE/PC/B/T/321/2023

B. E. ELECTRICAL ENGG. 3RD YEAR, 2ND SEMESTER EXAMINATION 2023

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. (a) What are the major advantages of static VAR system? (3)

b) A three phase line has sending and receiving end voltages of 240kV and 220kV respectively. The generalized constants are: A=D=(0.99+j0.0132), B=(24.75+j165) ohm and C= (0.000044 + 0.0011) mho. (7)
Draw the receiving end power circle diagram and from the diagram determine the active and reactive power received when the angle between the sending and receiving end voltage phasors is 30°.

2. (a) Derive necessary equations to justify that power can be transmitted over a line even when the magnitudes of sending and receiving end voltages are equal. (5)

(b) b) What do you understand by loadability of a transmission line? Derive the relation between magnitude of power transfer and surge impedance loading of the line. (2+3)

3. A 50MVA, 15kV three phase generator having sub-transient reactance of 0.2 p.u. supplies two motors through a transmission line. The transmission line having series impedance of (25+j75) ohms has transformers at both ends. The rating of sending end transformer is 50MVA, 11/132kV with leakage reactance of 0.1 p.u. The receiving end transformer consists of three single phase transformers connected as a single unit with star connection in the high voltage side and delta in the motor side. The rating of each transformer is 20MVA, 33/76kV with leakage reactance of 0.12 p.u. The motors have rated inputs of 30MVA and 20MVA, both 30kV with 0.15 p.u. sub-transient reactance. Draw the impedance diagram showing detailed calculations. Assume generator rating as the base in the generator circuit. (10)

Group-B
Answer any two questions out of three

4. (a) What are current limiting reactors? In what positions they are placed in a power system network? (5)

(b) Explain with suitable diagram what you understand by doubling effect in connection with short circuit fault at the terminals of an unloaded transmission line. (5)

[Turn over

5. (a) What do you understand by transient, sub-transient and steady state conditions? (3)

(b) b) A three phase 10kV transmission line has resistance of 1 ohms and reactance of 4 ohms and is connected to the generating station bus bar through a 5MVA transformer of reactance 6%. The other end of the transmission line is connected to load. In the generating station there is a generator of 10MVA having reactance of 12%. Determine the short circuit MVA if symmetrical fault occurs (i) at the high voltage terminals of the transformer (ii) at the load end of the transmission line. (7)

6. (a) Why is load flow study necessary? (3)

(b) Why acceleration factor is used in Gauss Seidel method for load flow studies? (2)

(c) The line impedances of a three bus system are shown below: (5)

Line (bus to bus)	Impedance (p.u.)
1-2	0.06+j0.18
1-3	0.03+j0.09
2-3	0.08+j0.24

Determine the bus admittance matrix considering shunt admittance of each line as of j0.02 p.u.

Group-C
Answer any one question out of two

7. (a) Explain why dc transmission is superior to ac transmission for long distances. (3)

(b) What are the limitations of HVDC transmission? (3)

(c) Describe the role of converter transformer and smoothing reactor in HVDC converter station. (4)

8. a) Deduce the condition for most economic loading of alternators in a power plant. Discuss the steps to be taken if the power output as obtained from the above condition exceeds the generation limits of a generator. (5)

b) A load of 300 MW is to be shared by the three generators, rated at 120, 125 and 125 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: (5)
$C_1 = 100 + 0.2P_1 + 0.01P_1^2$, $C_2 = 150 + 0.12P_2 + 0.015P_2^2$, $C_3 = 200 + 0.14\,P_3 + 0.012P_3^2$

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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) i)	Illustrate and justify the following statements: "System Frequency has to be kept within narrow bounds."	(3×5= 15)
	ii)	"System Voltage has to be kept constant".	
	iii)	"Dynamics of load frequency control is unaffected by the transients in excitation control."	
	b)	Illustrate the factor on which the limit of over-excitation of synchronous generators depends.	(3)
	c)	Illustrate "Synchronous Condenser".	(4)
2)	a)	Draw the phasor diagrams for a salient pole rotor synchronous generator and from the phasor diagram deduce the expression for active power and reactive power for this generator. Also draw the power angle curve for this generator.	(10)
	b)	A 100 MW generator is supplying power to a network when the frequency drops by 0.1 Hz. (a) If the network is infinite, (i) What will be the effect of drop in frequency have on the power changer setting? (ii) How can the turbine generator output be decreased by 10 MW? (b) If the network is finite, what is the increase in the turbine power if the power changer setting remains unchanged? Assume that the speed governor has a droop of 0.04 per unit and the system frequency is 50 Hz.	(8)
	c)	Illustrate "Load Damping" and its effect on system frequency.	(4)
		GROUP- B [CO 5, K3]	
3)	a)	Illustrate the difference between steady state stability and transient stability of a power system. In this regard also explain why steady state stability limit is always greater than transient stability limit. Also explain the term synchronizing power coefficient.	(2+2+2 =6)

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	b)	A 30 MVA, 15KV, 4 pole, 50Hz turbo-alternator has an inertia constant of 10 KW-sec/KVA. i) Compute the kinetic energy stored by the rotor at synchronous speed. ii) If the input power and the output power are 25 MW and 20 MW respectively, find the acceleration in degrees per sec^2 and in rpm per sec.	(8)
	c)	Illustrate why power system faults may lead to transient stability problem.	(3)
	d)	Illustrate the necessity of power system stability studies.	(3)
4)	a)	Illustrate with relevant diagrams the Equal Area Criterion for Transient Stability.	(8)
	b)	Illustrate how the transient stability of a power system can be improved by the following: (i) reducing the fault clearance time (ii) effective use of voltage regulators.	(8)
	c)	Illustrate the terms "coherent swing" and "non-coherent swing" with regard to synchronous machines.	(4)
		GROUP- C [CO 6, K3]	
5)		Illustrate with relevant diagrams the operations of the following: (**any one**) (i) Brushless Excitation Systems. (ii) Static Excitation Systems. (iii) Field Controlled Alternator-rectifier Excitation system.	(8)