Ref No:
Ex/EE/PC/B/T/321/2022

B.E. ELECTRICAL ENGINEERING THIRD YEAR SECOND SEMESTER - 2022

SUBJECT: - POWER SYSTEM PERFORMANCE

Full Marks: 100

Time: Three hours

(50 marks for this part)

Use a separate Answer-Script for each part

No. of Questions		PART -I Answer any Three (Two marks reserved for well-organized answers)	Marks
1)	a)	Illustrate with proper phasor diagrams how, for a synchronous generator delivering constant power to an infinite bus, the variation of excitation results in change of power factor.	(6)
	b)	Why it is desirable to keep the system frequency within narrow bounds?	(4)
	c)	Justify the statement – 'Active power may flow from lower to higher potential but reactive power flows from higher to lower potential.'	(6)
2)	a)	Develop the expressions of active power and reactive power for a Cylindrical rotor synchronous generator. Sketch the power angle curve for this generator.	(8)
	b)	With the help of proper block diagram explain "supplementary control" in connection with Load frequency control.	(8)
3)	a)	Two generator rated 500 MVA and 800 MVA and governor regulations 4% and 5% respectively are operating in parallel supplying a common load 1000 MW. Determine the operating frequency and power delivered by the generators if the no-load frequency of both the generators is 50 Hz.	(8)
	b)	Show that the Transfer function of the Generator and load of a Power System may be represented as $\frac{K_P}{1+sT_P}$ for load-frequency control studies.	(8)
4)	a)	Explain the Equal Area Criterion for Transient Stability.	(6)
	b)	Justify the following statement: "Transient stability limit is less than steady state stability limit."	(2)
	c)	A loss free alternator supplies 50 MW to an infinite bus, the steady state limit of the system being 100 MW. Determine whether the alternator will remain in synchronism if the prime mover input is abruptly increased by 30 MW.	(8)
		(please turn over)	

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5)	a)	Draw the schematic diagram and explain the operation of static excitation systems. Also illustrate the term "ceiling voltage" in excitation systems.	(6+2)
	b)	Illustrate the following: **(any two)** (i) Methods of improving the steady-state stability of a power system. (ii) Use of Load compensators in excitation systems. (iii) Weak coupling between P-V and Q-δ in power system.	(4×2)

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B. E. Electrical Engg. 3rd Year, 2nd Semester Examination 2022

Power System Performance

Time: Three hours Full Marks: 100

(50 marks for each part)

Use separate answer script for each part.

PART II

Answer question no.6 and any two from the rest.

Figures in the margin indicate full marks

6. (a) A short transmission line having impedance of $100\angle 80^0$ ohm delivers a load of 60 MW at 0.85 p.f. lag at 132 kV. Draw receiving end power circle diagram with a scale of 1cm = 25MVA. Determine following from the receiving end power circle diagram 8
(i) the sending end voltage, (ii) the output of the VAR compensator connected at the receiving end so that the same load can be supplied with a sending end voltage of 132kV, (iii) the load angle in each of the above cases.

(b) What do you understand by the term 'Fault MVA' ? Four identical alternators each rated for 20MVA, 11kV having a sub-transient reactance of 16% are working in parallel. Calculate the fault level of the bus-bar ? 4

(c) What do you understand by economic operation of generation units in a power generating station? Deduce the condition of most economic loading of N no.s of alternators in a thermal power station. 6

7(a) Show that the value of equivalent p.u. series impedance of a transformer is independent of the side to which it is referred. 3

(b) Derive the expression for instantaneous fault current when there is a sudden three phase short circuit at the terminal of an alternator operating at no load. Sketch the fault current waveform and show the sub-transient, transient and steady state part in it. 6

(c) A load of 650 MW is to be shared by the three generators at a power plant. Determine the optimum distribution of the load assuming operating limits. The co-efficients of fuel cost characteristics of the generators as given below: 7

Generator No.	a (Rs/MW^{2}H)	b (Rs/MWH)	c (Rs/Hr)	P_{min} (MW)	P_{max} (MW)
1	0.025	22	300	50	300
2	0.024	20	300	50	300
3	0.022	18	300	50	250

8(a) Prove analytically that the locus of sending end complex power of any transmission line can be represented by a circle under certain conditions. State the conditions. 4

(b) There is a solid three phase fault at HT terminal of the motor transformer in the power system shown in Fig.1. Draw the reactance diagram of the network under faulted condition and calculate the fault current. 6

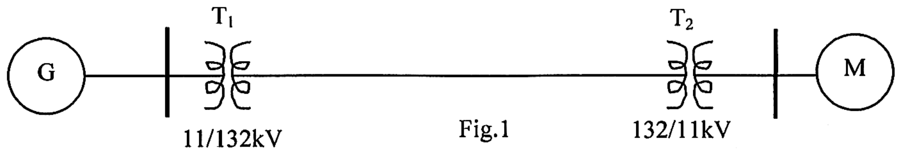

Fig.1

G: 60 MVA, 11kV, X= 20%, M: 50 MVA, 11kV , X=12%
T_1 and T_2 : 50MVA, 11/132kV, X=10%, Line: X= j85 ohm

(c) Draw a neat schematic diagram of a six-pulse bridge converter and explain its operation. Sketch the input and output voltage wave-forms when operating from a three phase sinusoidal ac source with a delay angle of α ($\alpha \leq 90^{\circ}$). 6

9 (a) Discuss how p.u value of impedance changes with change in base values. 3

(b) State the load flow problem and derive equations necessary for its solution. Explain why iterative process is required for load flow solution. 8

(c) Deduce expression for the output dc voltage of a six-pulse bridge converter in terms of ac rms voltage and α, where α is the firing angle. 5

10.(a) Derive the expression for voltage drop in a lossless transmission line in terms of receiving end complex power, receiving end voltage and line reactance. Explain when and why following compensations are employed a) shunt capacitive compensation b) shunt inductive compensation. 7

(b) Explain why the buses of a power system are classified in load flow study. Discuss about each category of bus. 7

(c) Write the expression for fuel cost function of a thermal power generator and justify it. 2
