Ref No:

Ex/EE/T/323/2019

B.E. ELECTRICAL ENGINEERING THIRD YEAR SECOND SEMESTER - 2019

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)	With proper explanation state the factor on which the limit of over-excitation and under-excitation of synchronous generators depends.	(8)
	c)	Explain the term "Infinite bus".	(2)
2)	a)	Discuss how the surplus power in the power system can be accounted and develop the corresponding expressions. Assume ΔP_G = Increased Generator Power Output & ΔP_D = Change in Load and $\Delta P_G > \Delta P_D$.	(8)
	b)	Develop the expressions of active power and reactive power for a Cylindrical rotor synchronous generator. Sketch the power angle curve for this generator.	(8)
3)	a)	Develop the expression determining the steady state frequency deviation of an isolated power system and assuming a free governor operation. It may also be assumed that the speed governor and the turbine are represented by 1st order transfer functions.	(8)
	b)	Two alternators rated at 200 MW and 300 MW respectively are supplying power to a network. Both the generators are loaded at 50 % of their individual full rated capacity and the system frequency is 50Hz. The load on the system decreases by 150 MW and the frequency rises by 0.5 Hz. Compute the droop of each generator in actual and per unit values. Assume that the load is decreased on each generator in proportion to their individual rating.	(6)
	c)	Justify the following statement: "Transient stability limit is less than steady state stability limit."	(2)

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4)	a)	A 50 Hz, three-phase synchronous generator delivers 0.8 p.u. power to an infinite busbar through a network of negligible resistance. A fault occurs which reduces the maximum transferable power to 0.50 p.u from 1.5 p.u. at post fault condition and after the clearance of the fault maximum transferable power is 1.20 p.u. Determine the critical angle using the equal area criterion.	(10)
	b)	Explain the function of Volt/Hz limiter and AC & DC regulators in connection with the excitation system of an alternator.	(6)
5)	a)	Illustrate with proper diagram the brushless excitation system. Also explain the term "ceiling voltage" in connection to an excitation system.	(8)
	b)	Illustrate the following: (**any two**) i) Methods of improving the steady-state stability of a power system. ii) Use of fast governor action for improving the transient stability of the power system. iii) Use of Load compensators in excitation systems.	(4×2)

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B. E. ELECTRICAL ENGG. 3RD YEAR, 2ND EXAMINATION 2019

POWER SYSTEM PERFORMANCE

Time: Three hours Full Marks: 100

(50 marks for each part)

Use separate answer script for each part.

PART II

Answer any three questions

Question no. 6 carries 18 marks

Figures in the margin indicate full marks

6. (a) Prove analytically that the locus of sending end complex power of a transmission line can be represented by a circle under certain conditions. Select suitable axes and draw a sketch of sending end complex power based on above derivation. (7)

(b) The parameters of a three bus system are as under: (7)

Line no.	From bus - to bus	Line impedance (p.u.)	Line charging admittance (p.u.)
1	1-2	0.01 + j0.18	j0.002
2	2-3	0.025 + j0.2	j0.003
3	1-3	0.01 + j0.15	j0.001

Compute the elements bus admittance matrix. Also compute the modified elements of the bus admittance matrix when a capacitor of j0.1 p.u. susceptance is connected at bus2.

(c) Explain why reactive power compensating devices are installed in HVDC power station. (4)

7(a) Draw the reactance diagram of the network shown in Fig.1 with a common base MVA of 60. (6)

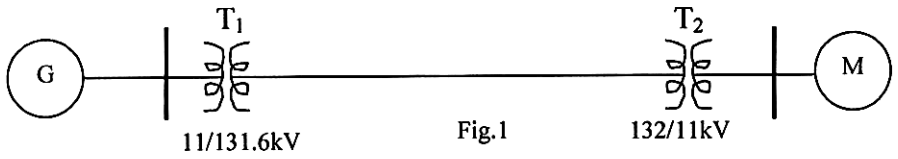

Fig.1

G: 50 MVA, 10kV , X= 25%, M: 30 MVA, 11kV , X=15%
T_1 and T_2 : 60MVA, X=10%, Line: X= (10+j85) ohm

(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 wave-form indicating its sub-transient, transient and steady state part. (6)

(c) Deduce the condition of most economic loading of N no.s of alternators in a thermal power station. (4)

8(a) What do you understand by the term 'PV bus'? (2)

(b) Draw a neat schematic diagram of a six-pulse bridge converter. Sketch the input and output voltage wave-forms when operating from a three phase sinusoidal ac source with a delay angle of α ($\alpha \leq 90^{\circ}$). Deduce expression for the output dc voltage in terms of ac rms voltage and α. (8)

(c) A three phase over-head line has circuit constants A= 0.98 $\angle 1^{0}$ and B= 210 $\angle 86^{0}$ ohm. The voltages at the sending and receiving end are held constant at 225 kV and 220 kV respectively. Select a suitable scale and draw the receiving end power circle diagram. Compute graphically (i) the maximum power that might be delivered over the line (ii) the operating load angle when line is supplying a load of 50 MW at 0.85 power factor lag at the receiving end. (6)

9 (a) Discuss the role of OLTC transformer in improvement of bus voltage in a power system. (4)

The parameters of a three bus power system are as under: (7)

Line no.	From bus - to bus	Line impedance (p.u.)	Half line charging admittance (p.u.)
1	1-2	0.01 + j0.08	j0.001
2	1-3	0.01 + j0.08	j0.001
3	2-3	0.01 + j0.08	j0.001

The final bus voltages of bus 1, 2 and 3 after convergence of Gauss Seidal method of load flow analysis are obtained as $1.02\angle 0^{0}$ p.u., $1\angle -2^{0}$ p.u., and $1.01\angle 1^{0}$ p.u. respectively. Bus 1 is the slack bus. Compute slack bus power.

(b) The incremental fuel costs of two generating units 1 and 2 of a power station are given by the following expressions: (5)
$dC_1/dP_1 = 0.3P_1 + 10$ and $dC_2/dP_2 = 0.25P_2 + 30$, where C is in Rupees and P is in MW. Compute economic load schedule of the generators if the total load to be supplied is 150 MW. Also calculate the saving in fuel cost in comparison to equal distribution of load among the generators.

10. Discuss about the following (6+5+5)

Improvement of transmission line loadability

Sub-transient, transient and steady fault in power system.

Monopolar HVDC link.