Ref No:

Ex/EE/T/323/2017

B.E ELECTRICAL ENGINEERING EXAMINATION, 2017

(3^{rd} year, 2^{nd} Semester)

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)	Why the system voltage has to be kept constant?	(4)
	b)	What is an infinite bus? Explain its characteristics.	(3)
	c)	Derive the power angle curve for a salient pole synchronous generator	(6)
	d)	What are the limits of over-excitation for synchronous generator?	(3)
2.	a)	Explain the "Equal Area Criterion for Transient Stability".	(8)
	b)	A 50 Hz, 100 MVA four pole, synchronous generator has an inertia constant of 3.5 s and is supplying 0.16 p.u. power on a system base of 500 MVA. The input to the generator is increased to 0.18 p.u. Determine (i) the kinetic energy stored in the moving parts of the generator and (ii) the initial accleration of the generator.	(5)
	c)	Explain why power system faults may lead to transient stablity problem.	(3)
3.	a)	Two alternators rated at 300 MW and 500 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 200 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)
	b)	Draw a neat schematic representing the speed governor system. Also derive the block diagram representing this system.	(10)
4.	a)	A double circuit transmission line connects a generator to a large power network. The power corresponding to the limit of steady –state stability of each of the circuits is 400 MW. The line is transmitting 300 MW when one of the circuits is suddenly switched out. Determine	(8)

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		whether the generator is likely to remain in synchronism.	
	b)	With a neat diagram explain the operation of brushless excitation system.	(8)
5.	a)	Explain the function of Over excitation and Under excitation limiters and power system stabilizers in connection with an excitation system. Also explain the term "field flashing".	(6)
	b)	Explain how fast acting excitation control improves Transient Stability of a power system.	(6)
	c)	What do you understand by the term "Load Damping" with respect to a power system?	(2)
	d)	Explain why steady state stability limit is always greater than transient stability limit.	(2)

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B. E. ELECTRICAL ENGG. 3rd Year, 2nd Semester Examination 2017

Power System Performance

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PART II

Answer **any three** questions.

Two marks allotted for neat and well organised answer

Figures in the margin indicate full marks

6. (a) Derive an expression for the complex power at the sending end of a transmission line in terms of the voltages at its two ends and the transmission line parameters. Assuming that the magnitude of the voltages at the two ends of the line to remain fixed, show that the locus of the complex power at the sending end would be a circle. Write down the expressions for its radius and coordinates of the centre. What will be the effect on locus diagram if the voltages at the two ends vary? (8)

(b) A three phase over-head transmission line has circuit constants $A= 0.95\angle 2^0$ and $B= 50\angle 88^0$ ohm. The voltages at the sending and receiving end are held constant. The line delivers at the receiving end a load of 40 MW at 66 kV and 0.85 power factor lag. Draw the receiving end power circle diagram with a scale of 1cm=20MVA. Find graphically (i) the sending end voltage, (ii) operating load angle and iii) 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 70 kV. (8)

7(a) Derive static load flow equations. Explain how the buses of a power system are classified in load flow study. Why is the concept of slack bus needed in load flow study? How is it chosen? (4+4+4)

(b) Two buses of a power system are connected through a transmission line of series impedance of 0.01+j0.15 p.u. and shunt susceptance of j0.002 p.u.. Calculate the elements of the bus admittance matrix of the power system rounded up to three decimal places. (4)

8(a) Write and explain general form of fuel cost function of alternator of a steam power plant. Justify the presence of constant term in the fuel cost function. Why economic load scheduling is necessary? (3+2+3)

(b) A load of 300 MW is to be shared by the three generators, rated at 120, 125 and 100 MW at a power plant. Determine the optimum distribution of the load and incremental production cost. Assume operating cost of the three generators in Rs/MWh to be as follows for generators 1, 2 and 3 respectively. (8)

$C_1 = 100 + 0.25P_1 + 0.001P_1^2$, $C_2 = 150 + 0.16P_2 + 0.002P_2^2$,

$C_3 = 200 + 0.1\ P_1 + 0.001P_3^2$

[Turn over

9 (a) Derive equation for modification of the per unit impedance due to change in MVA and kV base values. (4)

(b) A 5 kVA, 1.1 kV/220 V single phase transformer, has impedances $z_1 = (1+j10)\ \Omega$ and $z_2 = (0.1 + j\ 0.5)\ \Omega$ respectively for the primary and secondary windings. Determine the per unit impedance of the transformer based on its own rating. (4)

(c) A three phase metallic short circuit occurs in the transmission line at a distance of 30 km from generator G_2 in the system shown in Fig.1. Draw reactance diagram under faulted condition. Determine the fault current and the share of each generator. State your assumptions, if any. (8)

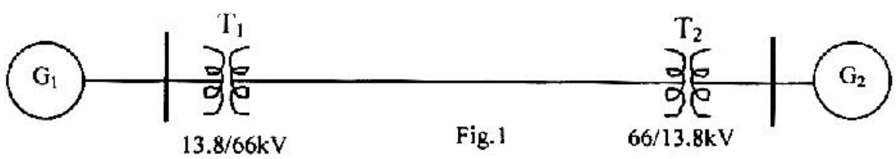

Fig.1

G_1: 21 MVA, 13.8 kV , X= 30%, G_2: 21 MVA, 13.8 kV , X= 30%,
T_1 and T_2 : 7MVA, 13.8/66kV, X=8%,
Line: 50 km long, z= (0.02+j0.5) ohm/km/phase

10(a) Draw a neat schematic diagram of a six-pulse bridge converter. Sketch the input and output voltage waveforms when operating with a delay angle of α ($\alpha \leq 90^\circ$) and fed from a three phase sinusoidal ac source. Deduce expression for the output dc voltage in terms of ac rms voltage and α. What happens when α is made larger than 90°? (10)

(b) Discuss the functions of the following components in a HVDC station (6)

i) Smoothening reactor
ii) AC and DC Filter
iii) Reactive power compensator