2002 SCHEME

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EE61

Sixth Semester B.E. Degree Examination, May/June 2010
Power System Analysis and Stability

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. What are the advantages of per unit? Explain how the per unit impedance value on a given base are changed to p.u. impedance value on a new base value. **(08 Marks)**

b. Figure Q1 (b) shows a one line diagram of a unloaded three phase generator power system with inter connection between generators by means of three transformers and a transmission line with two sections with their impedances marked on the diagram. The voltages of the generators and transformers are given below:

Generator	MVA	Line KV	Reactance in p.u.
1	25	6.6	0.2
2	15	6.6	0.15
3	30	13.2	0.15

Transformer 1: 30 MVA, 6.6Δ-115YKV, x = 0.10 p.u.
Transformer 2: 15 MVA, 6.6Δ-115YKV, x = 0.10 p.u.
Transformer 3: Single phase unit each 10 MVA, 6.9/69 KV, x = 0.10 p.u.
Draw reactance diagram mentioning all the reactances in p.u. Selecting 30 MVA, 6.6 KV in the circuit of generator 1. **(12 Marks)**

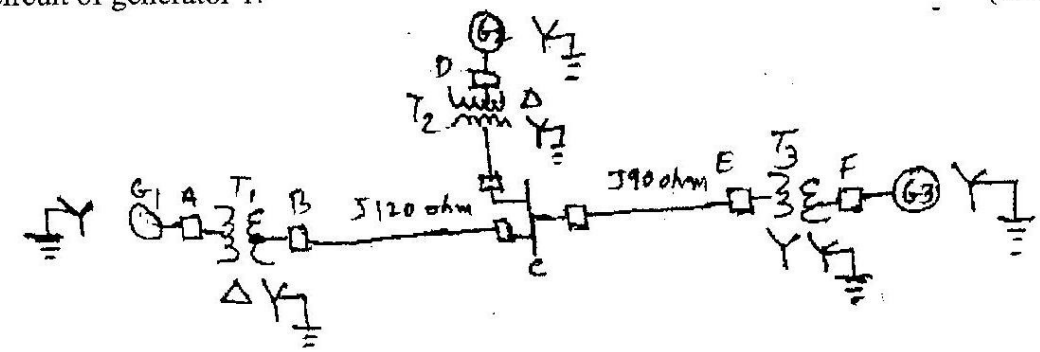

Fig. Q1 (b)

2 a. Draw the typical wave form for the armature current in one of the phases of a previously unloaded 3-phase synchronous generator subjected to sudden symmetric 3-phase short circuit at its terminals and explain its salient features. How are x''_d, x'_d and x_d determined from this wave form? **(08 Marks)**

b. An alternator and a synchronous motor are rated 30 MVA, 13.2 KV and both have sub transient reactances of 20%. The line connecting them has a reactance of 10% on the base of the machine ratings. The motor is drawing 20 MW at 0.8 power factor leading and a terminal voltage of 12.8 KV. When a symmetrical three phase fault occurs at the motor terminals, find the sub transient current in the alternator motor and fault by using the internal voltages of the machines. **(12 Marks)**

3 a. What are symmetrical components and their significance? Obtain the equations for three phase power in terms of their symmetrical components. **(08 Marks)**

3 b A delta connected balanced resistive load is connected across an unbalanced 3-phase supply as shown in figure Q3 (b). Currents in lines A and B are specified. Find the symmetrical components of line currents. Also find the symmetrical components of delta currents. Comment. **(12 Marks)**

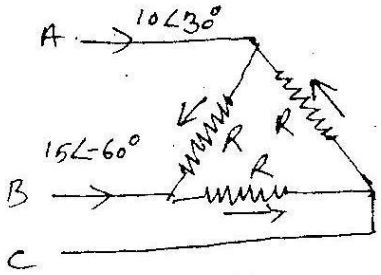

Fig. Q3 (b)

4 a. The HV winding of a 3-phase transformer is star connected and the LV winding is delta connected. Establish the relation between positive sequence voltages and currents on the delta side with corresponding variables on the star side. Voltages refer to line to neutral voltages and currents refer to line currents. State the convention used regarding labeling the transformer terminals. **(10 Marks)**

b. A 25 MVA, 11 KV three phase generator has a sub-transient reactance of 20%. The generator supplies two motors over a transmission line with transformers at both ends as in figure Q4 (b). The motors have rated inputs of 15 and 7.5 MVA, both 10 KV with 25%, sub-transient reactance. The three phase transformers are both rated 30 MVA, 10.8/121 KV, connection Δ-Y with leakage reactance of 10% each. The series reactance of the line is 100 Ω. Draw the positive and negative sequence network of the system with the reactance's marked in p.u. Assume that the negative sequence reactance's of each machine is equal to its sub-transient reactance. Select generator rating as base in the generator circuit. **(05 Marks)**

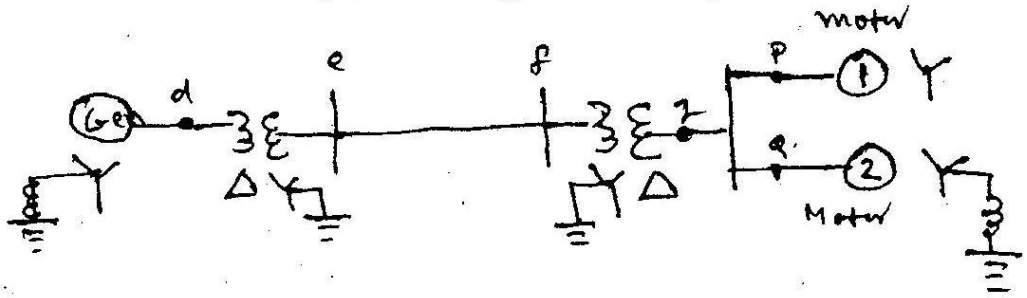

Fig. Q4 (b)

c. Draw the zero-sequence network for the system described in Fig. Q4 (b). Assume zero sequence reactances for the generator and motors of 0.06 p.u. Current limiting reactors of 2.5 Ω each are connected in the neutral of the generator and motor no. 2. The zero sequence reactance of the transmission line is 300 ohms. **(05 Marks)**

5 a. Derive an expression for the fault current in a single line to ground fault at the terminals of an unloaded alternator and draw the interconnection of sequence network. **(10 Marks)**

b. A 20 MVA, 13.8 KV generator has a direct-axis sub transient reactance of 0.25 p.u. The negative and zero sequence reactances are respectively 0.35 and 0.10 per unit. The neutral of the generator is solidly grounded. Determine the sub transient current in the generator and line to line voltages for sub transient conditions when a line to line fault occurs at the terminal of the generator. Assume that the generator is unloaded and operating at rated terminal voltage when the fault occurs. Neglect resistance. **(10 Marks)**

6 a. Obtain the inter connection of sequence networks for the following types of open conductor faults on power systems: i) One conductor open. ii) Two conductors open. **(08 Marks)**

b. The power system shown in figure Q6 (b) has a dead short circuit at the mid-point of the transmission line. Find the short circuit current for, i) Single line toground fault ii) a double line to line fault and iii) a double line to ground fault. Assume machine Z is a motor operating at its rated voltage. Neglect prefault current. The reactances are given in p.u. on the same base. **(12 Marks)**

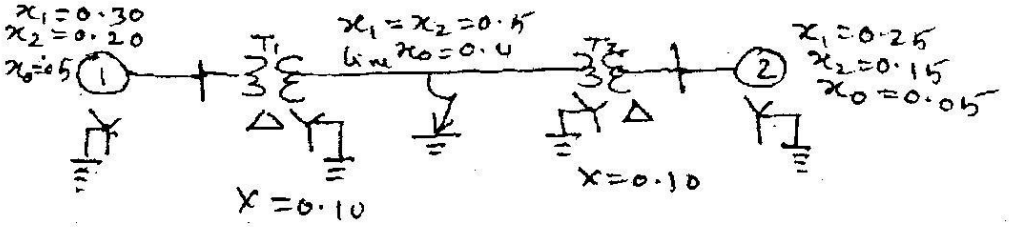

Fig. Q6 (b)

7 a. Derive power angle equation of a salient pole machine and explain. **(06 Marks)**

b. What is swing equation? Derive the same for a synchronous generator connected to infinite bus. **(06 Marks)**

c. A synchronous generator of reactance 1.20 p.u. is connected to an infinite bus bar ($|V| = 1.0$p.u.) through transformers and a line of total reactance of 0.60 p.u. The generator no load voltage is 1.20 p.u. and its inertia constant is H = 4 MW-S/MVA. The resistance and machine damping may be assumed negligible. Calculate the frequency of natural oscillations if the generator is loaded to i) 50% and ii) 80% of its maximum limit. **(08 Marks)**

8 a. Derive the expression for critical clearing angle when the fault occurs on one of the double circuit lines. Explain the importance of critical clearing angle and critical clearing time. **(10 Marks)**

b. Find the critical clearing angle for the system shown in figure Q8 (b) for a three phase fault at point P (mid point of the line). Assume generator is delivering 1 p.u. power under pre-fault condition. **(10 Marks)**

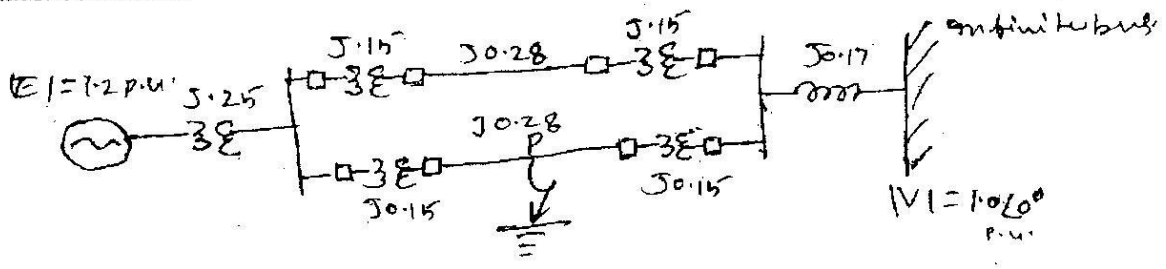

Fig. Q8 (b)

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