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06EE61

Sixth Semester B.E. Degree Examination, Dec.09/Jan.10
Power System Analysis and Stability

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

Part – A

1 a. Show that the per unit impedance of a transformer is the same, whether computed from primary or secondary side, so long as the voltage bases on the two sides are in the ratio of transformation. **(08 Marks)**

b. The one line diagram of an unloaded power system is shown in figure Q1 (b). Choose a base of 30 MVA, 6.9 KV in G1 circuit. Draw the reactance diagram. If a fault involving ground occurs at point 'E', determine the Thevenin's reactance of the network viewed from E.

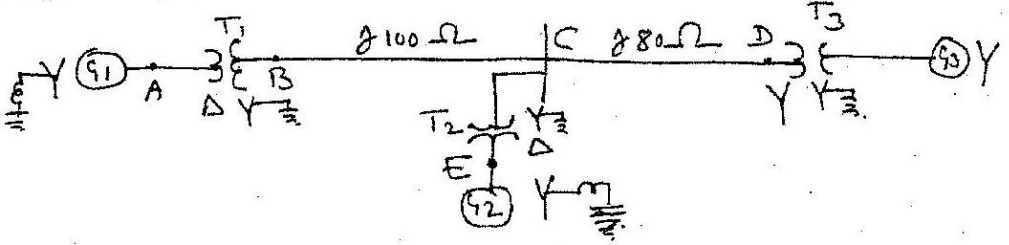

Fig. Q1 (b)

G_1 : 20 MVA, 6.9 KV, $x'' = 0.15$ pu
G_2 : 10 MVA, 6.9 KV, $x'' = 0.15$ pu
G_3 : 30 MVA, 13.8 KV, $x'' = 0.15$ pu
T_1 : 25 MVA, 6.9 Δ/115 Y KV, $x = 0.1$ pu
T_2 : 12.5 MVA, 6.9 Δ/115 Y KV, $x = 0.1$ pu
T_3 : single phase units each rated 10 MVA, 7.5/75 KV, $x = 0.1$ pu **(12 Marks)**

2 a. With the help of oscillograms of short circuit current, of a synchronous generator, operating on no load, distinguish between sub-transient, transient and steady state periods. Also write the corresponding equivalent circuits, which are used in computing x''_d , x'_d and x_d. **(08 Marks)**

b. A synchronous generator and motor are rated 30 MVA, 13.2 KV and both have $x''_d = 20\%$. 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 PF leading at a T.V. of 12.8 KV, when a symmetrical 3 phase fault occurs at the motor terminals. Find the sub-transient current in the generator motor and fault using the internal voltages of the machines. Verify the value of sub-transient current in the fault. **(12 Marks)**

3 a. Show that the symmetrical component transformation is power invariant. **(08 Marks)**

b. The current flowing to the Δ connected load through line 'a' is 10 A. Line 'c' is open. Find the symmetrical components of the line currents. **(04 Marks)**

c. Three identical resistors are star connected. The magnitude of the voltages at the terminals are $V_{ab} = 2000$ V, $V_{bc} = 2900$ V and $V_{ca} = 2500$ V. Determine the sequence components of the line to neutral voltages of phase 'a'. **(08 Marks)**

4 a. The sequence components of the line to neutral voltages of a 3 phase system are, $Va_1 = 100\angle 0°V$, $Vb_2 = (10 - J15)V$, $Vc_0 = J15V$

Determine line to neutral voltages. **(08 Marks)**

b. Show that +ve and –ve sequence voltages and currents undergo a phase shift, in passing through Y-Δ transformer and the phases shift is dependent on labeling of terminals. **(12 Marks)**

Part – B

5 a. A single L-G fault occurs on phase 'a' of an unloaded synchronous generator. Derive an expression for the fault current and for the post fault line to line voltages. Also prove that the equivalent circuit under fault conditions comprises of +ve, -ve and zero sequence networks in series. **(10 Marks)**

b. Two 11 KV, 30 MVA, 3 phase star connected synchronous generators operate in parallel, x_1, x_2 and x_3 of each being 0.2, 0.18 and 0.12 pu respectively. The star point of one of the generators is isolated and that of the other is earthed through a 3 Ω resistor. A single LG fault occurs at the terminals of one of the generators. Calculate the fault current, current in grounding resistor and voltage across the grounding resistor. **(10 Marks)**

6 a. A synchronous generator has its neutral grounded through a reactance x_n. Zero sequence reactance of the generator is larger than the +ve and –ve sequence reactances.

i) Show that if the neutral is grounded solidly, single LG fault current would be more than the 3 phase fault current.

ii) Obtain expression for x_n such that single LG fault current is less than the 3 phase fault current. **(10 Marks)**

b. A synchronous generator has an O.C. voltage of 1.1 pu behind its transient reactance. The magnitude of fault currents for different types of faults at its terminals are 3 phase fault 5 pu, LL fault 4.55 pu and LG fault 3.3 pu. Calculate per unit values of the sequence reactances of the generator. **(10 Marks)**

7 a. Define inertia constants M and H for a synchronous machine. How are they related to each other? **(04 Marks)**

b. What are the assumptions made in stability studies? How do you justify them? **(06 Marks)**

c. A synchronous motor is receiving 25% of the power, it is capable of receiving from an infinite bus. If the load on the motor is doubled, calculate the maximum value of δ during the swing of the motor around the new equilibrium position. **(10 Marks)**

8 a. Distinguish between steady state stability limit and transient stability limit. **(04 Marks)**

b. Explain point-by-point solution of the swing equation. **(06 Marks)**

c. An ac generator is delivering 50% of the maximum power which it can deliver to an infinite bus. Due to a sudden short circuit, the reactance between the generator and infinite bus increases to 325% of the value before the fault. The maximum power that can be delivered after clearance of the fault is 75% of the original maximum value. Determine the critical clearing angle, to maintain the stability of the system. **(10 Marks)**

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