Sixth Semester B.E. Degree Examination, June-July 2009
Power System Analysis and Stability

e: 3 hrs. Max. Marks:100

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

PART – A

a. Define per unit quantity. Mention the advantage of p.u. system. **(04 Marks)**

b. Show that per unit impedance of a transformer remains same whether it is referred to H. V. or L. V. side. **(04 Marks)**

c. A 15 MVA, .5 kV, 3 - ϕ generator has a sub transient reactance of 20%. It is connected through a Δ – Y transformer to a high voltage transmission line having a total series reactance of 70Ω. The load end of the line has Y – Y step down transformer. Both transformer banks are composed of single phase transformers connected for 3 – phase operation. Each of three transformers composing 3 - ϕ bank is rated 6667 kV, 10/100 kV, with a reactance of 10%. The load represented as impedance, is drawing 10 MVA at 12.5 kV and 0.8 p.f. lagging. Draw the single line diagram of the power network. Choose a base of 10 MVA, 12.5 kV in the load circuit and determine the reactance diagram. Determine also the voltage at the terminals of the generator. **(12 Marks)**

a. For the network shown in Fig. Q2(a), form the admittance matrix. The values are marked in p.u. **(08 Marks)**

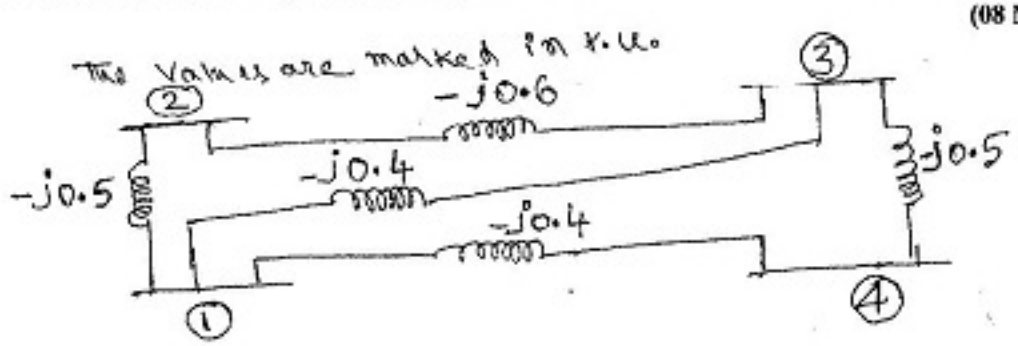

Fig. Q2(a)

b. A 25 MVA, 13.2 kV synchronous generator is connected to a synchronous motor of same rating. Both have a sub-transient reactance of 15%. The line connecting them has reactance of 10% on the machine base. The motor is drawing a power of 18 MW at 0.8 pf lead, at 12.9 kV, when a short circuit occurs at its terminals. Find the sub-transient currents in the motor, generator and at fault points. **(12 Marks)**

a. Determine the symmetrical components of the asymmetrical phasors below :

$$V3\phi = \begin{vmatrix} 100 & \angle 250 \\ 50 & \angle -1550 \\ 40 & \angle 100 \end{vmatrix}.$$ **(06 Marks)**

b. Show that the symmetrical component tr. sformation is power invariant. **(06 Marks)**

c. Discuss on the phase shift of currents or voltages in Y – Δ transformers. **(08 Marks)**

4 a. Obtain an expression for the fault current for a LG fault at the terminals of an unloaded generator, through a fault impedance Z_f. **(08 Marks)**

b. The single line diagram is shown in Fig. Q4(b). Draw the sequence networks. Mark all reactances in p.u. on a base of 50 MVA, 13.8 kV in circuit of generator 1. The neutrals of generators 1 and 3 are connected to ground through reactors having a reactance of 6% on the machine base. Each generator has a negative sequence reactance of 20% and zero sequence reactance of 5% on its own rating. The zero sequence reactance of the transmission lines are 2.5 times the positive sequence reactance. The other ratings are given below.

G_1 : 20 MVA, 13.8 kV, $X_d'' = 0.2$ p.u. G_2 = 30 MVA, 20 kV, $X_d'' = 0.2$ p.u G_3 = 30 MVA, 20 kV, $X_d'' = 0.2$ p.u, T_1 : 25 MVA, 220 Y /13.8 Δ kV, T_2 = 1 - ϕ units, each rated 10 MVA, 132/22 kV, X = 10%, T_3 = 35 MVA, 220 Y/22 Y kV. X = 10%. **(12 Marks)**

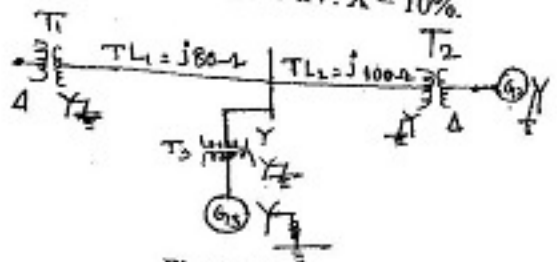

Fig. Q4(b)

5 A 30 MVA, 13.8 kV, 3 - ϕ alternator has, a sub transient reactance of 15% and negative and zero sequence reactance of 15% and 5% respectively. The alternator supplies two motors over a transmission line having transformers at both ends as shown in Fig. Q5. On the one line diagram. The motors have rated inputs of 20 MVA, and 10 MVA. Both 12.5 kV with 20% sub-transient reactance and negative and zero sequence reactions are 20% and 5% respectively. Current limiting reactors of 2.0 Ω each are in the neutral, of the alternator and the larger motor. The 3 - ϕ transformers are both rated 35 MVA, 13.2 Δ – 115 Y kV, with leakage reactance of 10%. Series reactance of the line is 80 Ω. The zero sequence reactance of the line is 200 Ω. Determine the fault current when i) L – G fault ii) L – L fault and iii) L-L-G fault takes place at point P. assume V_{pf} = kV. **(20 Marks)**

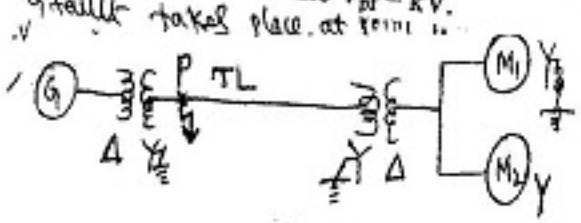

Fig. Q5

6 a. A Double line to ground fault occurs at the terminals of an loaded generator. Derive an expression for the fault currents, draw the connection of sequence networks. **(10 Marks)**

b. Derive expression for fault current if L – L fault occurs through a fault impedance Z_f in a power system. Show the connections of sequence networks to represent the fault. **(10 Marks)**

7 a. Derive the power angle equation of a salient pole synchronous machine connected to an infinite bus. Draw the power angle curve. **(10 Marks)**

b. A turbo generator, 6 pole 50 Hz of capacity 80 MW working at 0.8 pf has an inertia of 10 MJ/ MVA. I) Calculate the energy stored in the later at synchronous speed ii)Find rotor acceleration if the mechanical input is suddenly raised to 75 MW for an electrical load of 60 MW. iii)Supposing the above acceleration is maintained for a duration of 6 cycles, calculate the change in torque angle and the rotor speed at the end of 6 cycles. **(10 Marks)**

8 Write short notes on : a. Methods of improving transient stability b. Selection of circuit breakers c. Solution of swing equation d. Series type of faults. **(20 Marks)**

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