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10EE61

Sixth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Power System Analysis and Stability

Time: 3 hrs. Max. Marks:100

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

PART - A

1 a. Show that the per – unit impedance of a transformer is the same when referred to either its primary side or secondary side. **(04 Marks)**

b. Explain the procedure of drawing per - unit reactance diagram from single line diagram. **(04 Marks)**

c. The one line diagram of an unloaded power system is shown in fig. Q1(c). Reactances of the three sections of transmission line are shown on the diagram. Draw the P.U. impedance diagram. Choose a base of 50MVA, 13.8 kV in the circuit of generator G_1.

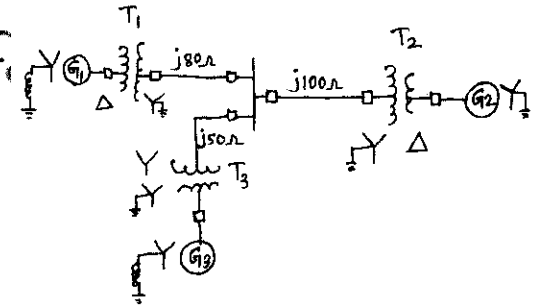


Fig.Q1(c)

The generators and transformers are rated as follows :
G_1 : 20MVA, 13.8kV , X" = 0.2 P.U ; G_2 : 30 MVA, 18kV, X" = 0.2 P.U ;
G_3 : 30MVA, 20 kV, X" = 0.2 P.U ; T_1 : 25MVA, 220Y/13.8Δ kV, X = 10%
T_2 : Three single phase units each rated 10MVA, 127/18 kV, X = 10%.
T_3 : 35 MVA, 220Y/22 Y kV, X = 10%. **(12 Marks)**

2 a. With the help of oscillogram of short – circuit current of a synchronous generator , operating on no load, distinguish between sub – transient, transient and steady state reactances. Also show that $X_d'' < X_d' < X_d$ with equivalent circuit diagrams. **(08 Marks)**

b. For the radial network shown in fig. Q2(b), a three phase fault occurs at 'F'. determine the fault current. Choose a base of 100MVA for the entire system and a base kV of 33kV in the overhead line. **(12 Marks)**

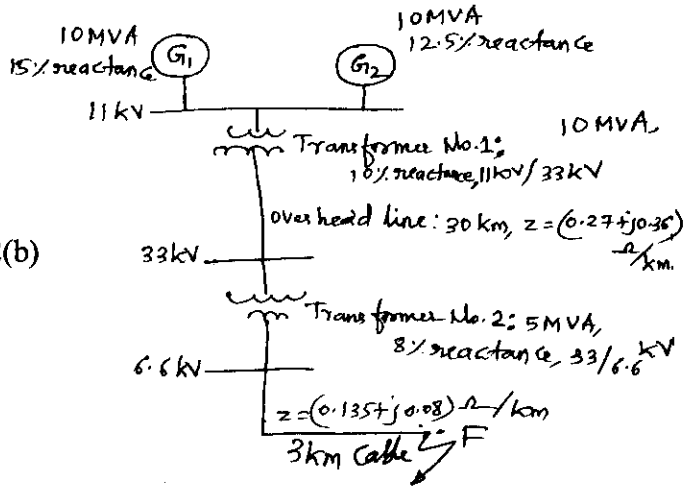


Fig.Q2(b)

3 a. Derive an expression for symmetrical components in terms of phase voltages. **(06 Marks)**

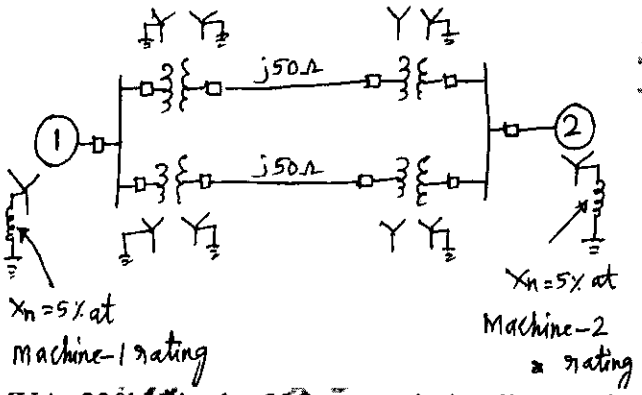
b. In a 3 – ϕ system, $I_{a_1} = 100\angle 30^0$ A , $I_{b_2} = 40\angle 90^0$ A and $I_{c_0} = 10\angle -30^0$ A. Find the line currents. **(06 Marks)**

c. Explain the phase – shift of symmetrical components in Y - Δ transformers considering voltage relations with vector diagrams. **(08 Marks)**

4 a. What are sequence impedances and sequence networks? Draw the zero sequence networks for different combinations of 3 – ϕ transformer bank. **(08 Marks)**

b. Draw the positive, negative and zero sequence networks for the power system shown in fig. Q4(b).

Fig.Q4(b)



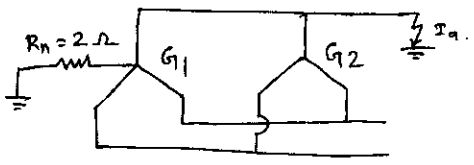
Choose a base of 50MVA, 220kV in the 50Ω transmission lines and mark all reactances in P.U. The ratings of the generators and transformers are :
Generator 1 : 25MVA, 11kV, X" = 20% ; Generator 2 : 25 MVA, 11kV, X" = 20%.
Three phase transformers (each) : 20MVA, 11Y / 220Y kV, X = 15%. The negative sequence reactance of each synchronous machine is equal to the subtransient reactance. The zero sequence reactance of each machine is 8%. Assume that the zero sequence reactance of lines are 250% of their positive sequence reactances. **(12 Marks)**

PART - B

5 a. A double line to ground fault occurs at the terminals of an unloaded generator. Derive an expression for fault current. Draw the connections of sequence networks. **(10 Marks)**

b. Two 11kV, 20MVA, 3 – ϕ, star connected generators operate in parallel as shown in fig. Q5(b), the positive, negative and zero sequence reactances of each being respectively, j0.18, j0.15, j0.10PU. The star point of one of the generators is isolated and that of the other is earthed through a 2 Ω resistor. A single line to ground fault occurs at the terminals of one of the generators. Estimate i) the fault current ii) current in the grounding resistor iii) the voltage across grounding resistor. **(10 Marks)**

Fig.Q5(b)



6 a. Derive an expression for fault current if L – L fault occurs through a fault impedance Z_f in a power system. Show the connections of sequence network to represent the fault. **(08 Marks)**

b. A 3 – ϕ, 50 MVA, 11kV, star connected neutral solidly grounded generator operating on no load at rated voltage gave the following sustained fault current for the faults specified. Three phase fault = 2000A ; Line – to – line fault = 1800A ; Line – to – ground fault = 2200A. Determine the three sequence reactances in ohms and P.U. **(12 Marks)**

7 a. Define : i) steady state stability ii) Transient stability. **(04 Marks)**

b. Derive the swing equation of a synchronous machine with usual notations. **(08 Marks)**

c. A 50Hz, 4 pole turbo generator rated 100MVA, 11kV has an inertia constant of 8MJ/MVA.

i) Find the stored energy in the rotor at synchronous speed.

ii) If the mechanical input is suddenly raised to 80MW for an electrical load of 50MW, find rotor acceleration, neglecting mechanical and electrical losses.

iii) If the acceleration calculated in part (ii) is maintained for 10 cycles, find the change in torque angle and rotor speed in revolutions per minute at the end of this period. **(08 Marks)**

8 Write short notes on the following :

a. Methods of improving transient stability.

b. Series type faults.

c. Equal area criteria.

d. Un – balanced operation of 3 – Q induction motor. **(20 Marks)**

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