USN

10EE61

Sixth Semester B.E. Degree Examination, June/July 2023
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 reactance of two winding transformer will remain same when referred to primary as well as secondary. **(05 Marks)**

b. Explain the importance of impedance and reactance diagram for the analysis of a power system. **(05 Marks)**

c. A 90MVA, 11KV, 3phase generator has a reactance of 25%. The generator supplies two motors through transformers and transmission line as show in Fig Q1(c). The transformer T_1 is a 3 phase transformer 100MVA, 10/132KV, 6% reactance, Transformer T_2 is a bank of three single phase units each rated at 30MVA, 66/10kV with 5% reactance. The motors are rated at 50MVA and 40 MVA both 10KV and 20% reactance. Taking the generator rating as base draw the per unit reactance diagram. The reactance of the line is 100 ohms.

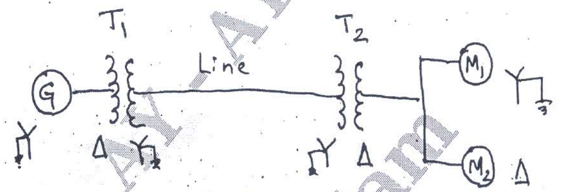

Fig Q1(c) **(10 Marks)**

2 a. With the help of oscillograms of short circuit current of a synchronous generator explain why $x''_d < x'_d < x_d$. **(08 Marks)**

b. An 11KV, 100MVA alternator having a subtransient reactance of 0.25PU is supplying a 50MVA motor having subtransient reactance of 0.2PU through a transmission line. The line reactance is 0.05PU on 100MVA base. The motor is drawing 40MW at 0.8pf leading with a terminal voltage of 10.95kV, when a 3 phase fault occurs at the terminals of the generator. Calculate the total current in the generator and motor under fault condition. **(12 Marks)**

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

b. What are symmetrical components and how are they useful in power system analysis. **(04 Marks)**

c. A delta connected resistive load is connected across a balanced supply of 415V. $R_{ab} = 20\Omega$, $R_{bc} = 250\Omega$, $R_{ca} = 15\Omega$. Find the symmetrical components of line current and delta currents. **(08 Marks)**

4 a. Explain the phase shift of symmetrical components in Y - Δ transformers. **(10 Marks)**

b. For the power system shown in Fig Q4(b) obtain the positive sequence, negative sequence and zero sequence network.

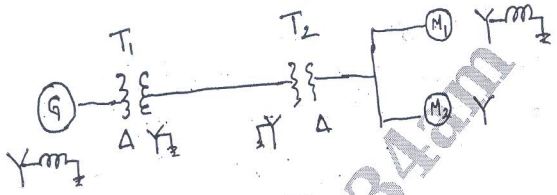

Fig Q4(b)

G : 300MVA, 20KV, $x''_d = 15\%$, $x_0 = 5\%$, $z_n = 0.4\Omega$

M_1 : 2.00MVA, 13.2KV, $x''_d = 20\%$, $x_0 = 5\%$, $z_n = 0.5\Omega$

M_2 : 100MVA, 13.2KV, $x''_d = 20\%$, $x_0 = 5\%$

T_1 : 230/20KV, 300MVA, x = 10%

T_2 = 3 × 100MVA, 132/13.2KV, 100MVA, x = 10%

Transmission line 100 Km, reactance = 0.5Ω/km, $z_0 = 3z_1$. **(10 Marks)**

PART – B

5 a. A double line to ground fault through fault impedance Z_f occurs at the terminal of an unloaded generator. Derive the expression for the fault currents. Also draw the connection of sequence networks. **(10 Marks)**

b. A generator of negligible resistance having 1PU voltage behind transient reactance is subjected to following faults

Type of fault	Resulting fault current in PU
3 phase	3.33
L – L	2.23
L – G	3.01

Calculate the PU value of three sequence reactances. **(10 Marks)**

6 a. Discuss briefly the open conductor faults in power system. **(06 Marks)**

b. Briefly explain how sequence impedances of synchronous generator are measured. **(06 Marks)**

c. A 3 phase generator rated 15MVA, 13.2KV has a solidly grounded neutral. Its positive, negative and zero sequence networks are 40%, 30% and 5% respectively.

i) Find the value of reactance to be connected in the neutral circuit so that fault current for a single line to ground fault (zero fault impedance) does not exceed rated line current

ii) Find the value of resistance to be connected in the neutral circuit to serve the same purpose. **(08 Marks)**

7 a. Distinguish between i) Steady state stability ii) Dynamic stability iii) Transient stability. **(06 Marks)**

b. Derive the swing equation of a synchronous machine starting from the laws of Mechanics. **(08 Marks)**

c. A 50Hz, 4 pole alternators rated 150MVA, 11KV has an inertia constant of 9MJ/MVA. Find: i) stored energy at synchronous speed ii) The rotor acceleration if the input mechanical power is increased to 100MW when the electrical load is 75MW iii) The speed at the end of 10 cycles if the acceleration is assumed constant at the initial value. **(06 Marks)**

8 a. Analyze the performance of a 3 phase inductions motor when unbalanced voltages are applied to it. **(10 Marks)**

b. A 500HP, 2200V, 60Hz, wound rotor induction motor has unbalanced input voltages of 2200V, 2000V and 1600V. $R_1 = 0.2\Omega/\text{ph}$, $R'_2 = 0.25\Omega/\text{ph}$, $x_1 = x'_2 = 0.6\Omega/\text{ph}$. Neglect friction and windage loss. Determine the net torque at S = 0.04. **(10 Marks)**

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