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10EE61

Sixth Semester B.E. Degree Examination, July/August 2022
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 same when referred to either its primary side or secondary side. **(04 Marks)**

b. A three winding transformer has rating as follows :
Primary : Y – connected, 6.6 KV, 15 MVA
Secondary : Y – connected, 33 KV, 10 MVA
Tertiary : Δ - connected, 2.2 KV, 7.5 MVA
Leakage impedance measured from primary side as $Z_{ps} = j0.232\Omega$, $Z_{pt} = j0.29\Omega$ and on secondary side $Z_{st} = j8.7\Omega$. Find the star connected equivalent on base of 15MVA, 6.6 kV in the primary circuit. Neglect resistance. **(08 Marks)**

c. A 300 MVA, 20kV , 3 ϕ generator has a subtransient reactance of 20%. The generator supplies two synchronous motors through a 64km transmission line having transformers at both ends a shown in Fig. Q1(c). T_1 is a 3ϕ transformer and T_2 is made of three single phase transformer of rating 100 MVA, 127/13.2 KV, 10% reactance. Series reactance of the transmission line is 0.5Ω/km. Draw the reactance diagram with all the reactances marked in per unit. Select the generator rating as base values. **(08 Marks)**

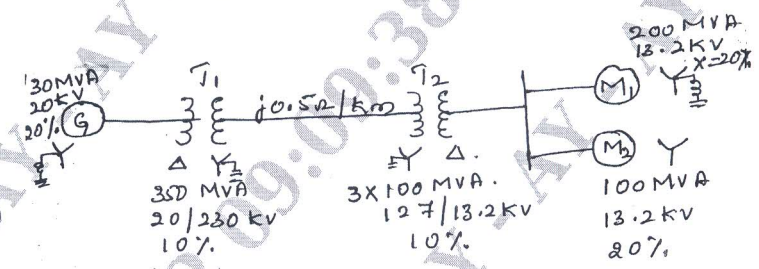

Fig. Q1(c)

2 a. Explain in detail the transients on a transmission line. **(10 Marks)**

b. Two generators are connected in parallel to LV side of a side of 3ϕ Δ-Y transformer. The rating of the machine are Generator G_1 : 50 MVA , 13.8 KV , $X''_d = 25\%$.
Generator G_2 : 25 MVA , 13.8 KV , $X''_d = 25\%$.
Transformer T : 75 MVA , 13.8 Δ - 69 Y KV, X = 10%.
Before the fault occurs, the voltage on HV side of the transformer is 66KV. The transformer is unloaded and there is no circulating current between the generators. Find the subtransient current in each generator when a 3ϕ fault occurs on the high voltage side of the transformer. **(10 Marks)**

3 a. Shat that the symmetrical component transformation is power invariant. **(06 Marks)**

b. In a 3 ϕ system $I_{a_1} = 100\angle 30$ A , $I_{b_2} = 40\angle 90$ A , $I_{a_0} = 10\angle -30$ A. Find the line currents. **(06 Marks)**

c. A balanced delta connected load is connected to a 3ϕ symmetrical supply. The line currents are each 10A in magnitude. If fuse in one of the lines blows out, determine the sequences components of line current. **(08 Marks)**

4 a. Show that in a 3 ϕ balanced system positive sequence components alone exists. **(04 Marks)**

b. Draw the positive, negative and zero sequence reactance diagram of the power system shown in Fig. Q4(b). **(06 Marks)**

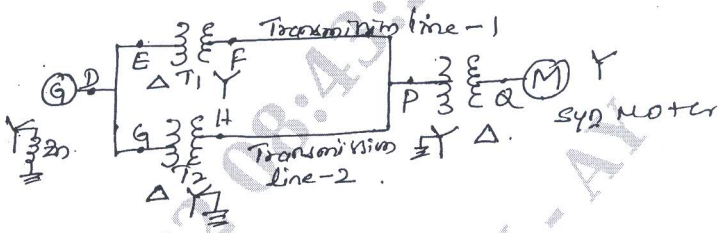

Fig. Q4(b)

c. Determine the positive, negative and zero sequence networks for the system shown in Fig. Q4(c). Assume zero sequence reactance for the generator and synchronous motors as 0.06 p.u. Current limiting reactors of 2.5Ω are connected in neutral of the generator and motor number 2. The zero sequence reactance of the transmission line is j300Ω. Take Base MVA 25 MVA , Base KV = 11KV. **(10 Marks)**

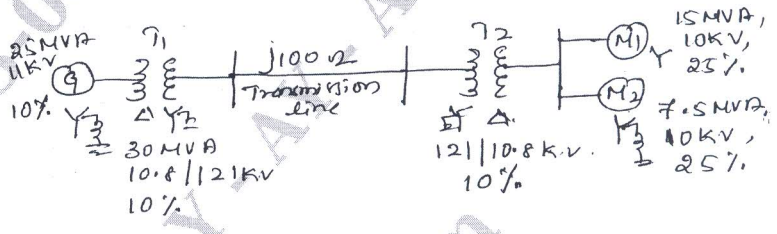

Fig. Q4(c)

PART – B

5 a. Derive an expression for a fault current if line to line fault occurs through fault impedance Z_f. In the power system show the connection of sequence network to represent the fault. **(10 Marks)**

b. A 3 ϕ 50 MVA, 11KV, star connected neutral solidly grounded generator operating on an land at rated voltage gave the following sustained fault current for the faults specified. Three phase fault – 2000A ; Line to line fault – 1800 A ; line to ground fault – 2200A. Determine the three sequence reactance in ohms and p.u. **(10 Marks)**

6 a. A single line to ground faults occurs at the terminal of an unloaded generator. Derive an expression for the fault current. Draw the connection of Sequence Network. **(08 Marks)**

b. A double line to ground fault on lines b and c at point p in the circuit whose one line diagram is shown in Fig. Q6(b). Find the subtransient current in phase b of Machine 1. Neglect prefault current. Assume that Machine 2 is a synchronous motor operating at rated voltage. Both machines are rated 1,250 KVA, 600V, at UPf with reactance of X" = 10% and X_0 = 4%. Each 3 ϕ transformer is rated 1,250 KA, 600 Δ - 4, 160 Y volts, with leakage reactance of 5%. The reactance of the transmission line are $X_1 = X_2$ = 15% and X_0 = 50% on a base of 1250 KVA and 4.16KV. **(12 Marks)**

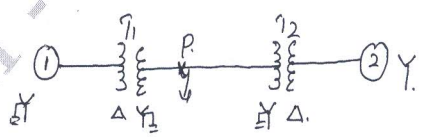

Fig. Q6(b)

7 a. Explain Steady State Stability and Transient Stability as applicable to a power system. **(06 Marks)**

b. Derive an expression for Swing equation of a synchronous machine with usual notation. **(06 Marks)**

c. Find the SSSL (Steady State Stability Limit) of a system consisting of a generator of equivalent reactance 0.5 p.u. Connected to an infinite bus through a series reactance of 1 p.u. The terminal voltage of the generator is held at 1.2 p.u and voltage of the infinite bus is 1.0 p.u. **(08 Marks)**

8 Write short notes on the following :
a. Equal Area Criteria.
b. Methods of improving transient stability.
c. M and H constants.
d. Un – balanced operation of 3ϕ I.M. **(20 Marks)**

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