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10EE61

Sixth Semester B.E. Degree Examination, June/July 2019

Power System Analysis and Stability

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Missing data, if any, may be suitably assumed.***

PART – A

1 a. For the given one line diagram shown in Fig.Q1(a), draw impedance diagram and reactance diagram.

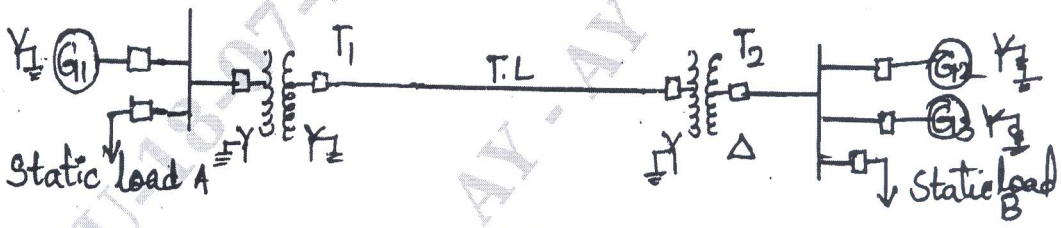

Fig.Q1(a) **(05 Marks)**

b. List any five advantages of PU system. **(05 Marks)**

c. The one line diagram of an unloaded power system is shown in Fig.Q1(c). Reactances of the 2 sections of the transmission line are shown on the diagram. The generator and transformer are rated as follows:
Gen 1 : 20 MVA, 13.8 KV, X″ = 0.2 pu
Gen 2 : 30 MVA, 18 KV, X″ = 0.2 pu
Gen 3 : 30 MVA, 20 KV, X″ = 0.2 pu
Tr : T_1 : 25 MVA, 220 KV/13.8, X″ = 0.1 pu
Tr : T_2 : 1-ϕ units each rated 10 MVA, 127/18 KV, X = 10%
Tr : T_3 : 35 MVA, 220 Y/22Y KV, X = 10%.
Draw the impedance diagram with all reactances marked in pu. Choose a base of 50 MVA, 13.8 KV.

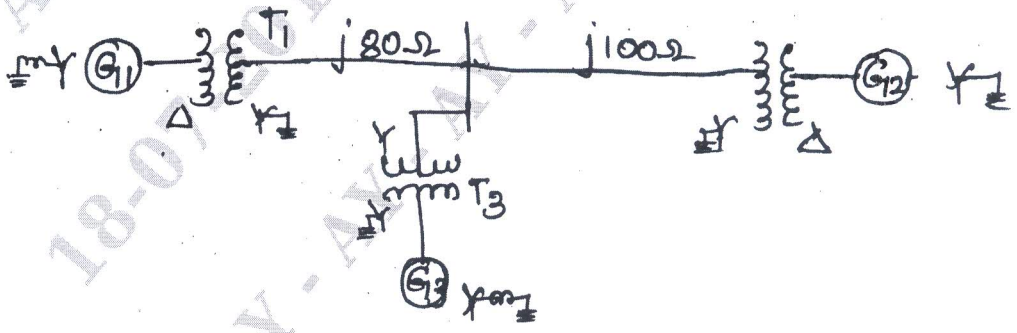

Fig.Q1(c) **(10 Marks)**

2 a. Draw the oscillogram of the short circuit current of a synchronous machine and obtain the expressions for X_d, X'_d, X''_d with the help of suitable equivalent circuits and hence show that $X''_d < X'_d < X_d$. **(10 Marks)**

b. Two generators are connected in parallel to the L.V. side of 3-ϕ Δ-Y transformer as shown in Fig.Q2(b). Ratings of Gen.1 is 50,000 KVA, 13.8 KV and that of Gen 2 is 25000 KVA, 13.8 KV and each generator has subtransiential reactance of 25%. The transformer is rated 75000 KVA, 13.8 Δ-69YKv, with a reactance of 10%. Before the fault occurs, the voltage on the H.T. tr: is 66 KV. The tr: is unloaded and there is no circulating current between the generator. Find the subtransiential current in each gen in pu, when a 3-ϕ S.C occurs on the H.T. side of tr:. Select a base in H.T. circuit.

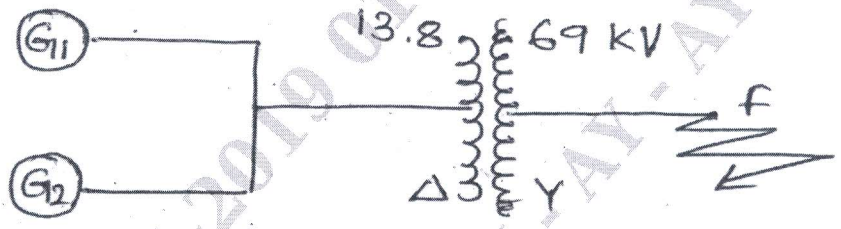

Fig.Q2(b) **(10 Marks)**

3 a. Prove that a balanced set of 3-ϕ voltages will have only positive sequence components of voltages. **(06 Marks)**

b. One conductor of a 3-ϕ line is open. The current flowing to the Δ-connected load through line 'a' is 10A. With the current in line 'a' as reference and assuming that line 's' is open, find the symmetrical components of the line currents. **(07 Marks)**

c. Obtain the relation between sequence components of phase and line currents in delta connected systems. **(07 Marks)**

4 a. For the following configurations of a 3-ϕ transformer, draw the winding connection and zero sequence network. **(08 Marks)**

i) Y - Δ ii) Δ - Δ iii) Y - Y iv) Y - Δ

b. In a 3-ϕ, 4 wire system, the sequence voltages and currents are,

$V_{a_1} = 0.9\angle 10^\circ$ pu; $V_{a_2} = 0.25\angle 110^\circ$ pu; $V_{a_0} = 0.12\angle 300^\circ$ pu

$I_{a_1} = 0.75\angle 25^\circ$ pu; $I_{a_2} = 0.15\angle 170^\circ$ pu; $I_{a_0} = 0.1\angle 330^\circ$ pu

Find the complex power in pu. If the neutral gets disconnected, find the new power. **(08 Marks)**

c. Draw a zero sequence network for the given one line diagram shown in Fig.Q4(c).

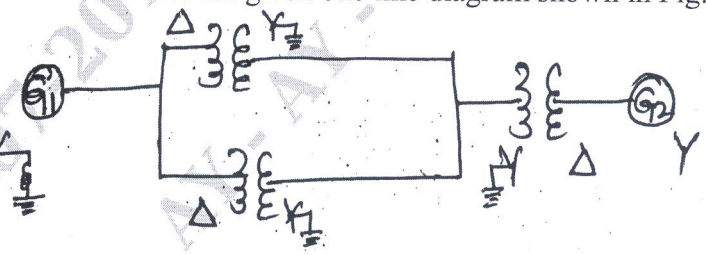

Fig.Q4(c) **(04 Marks)**

PART – B

5 a. Show that, the fault current in an unloaded generator is zero, if the neutral is not grounded in the case of LLG fault, with suitable circuit diagram and sequence networks, after deriving the expression for fault current. **(10 Marks)**

b. A 3-ϕ generator with line to line voltages of 400 V is subjected to an LLG fault. If $Z_1 = j2\Omega$, $Z_2 = j0.5\Omega$ and $Z_0 = j0.25\Omega$, determine the fault current and terminal voltages. **(10 Marks)**

6 a. Derive an expression for fault currents in case of series type of faults. **(06 Marks)**

b. The following data may be assumed for the network shown in Fig.Q6(b).
Generator : 50 MVA, 11 KV, $X_1 = 80\%$, $X_2 = 50\%$, $X_0 = 20\%$
Transformer : 40 MVA, 11-110 KV, $X_1 = X_2 = X_0 = 6\%$
If a L-L-G fault occurs at 'f', find the current flowing in the conductor at 'f'.

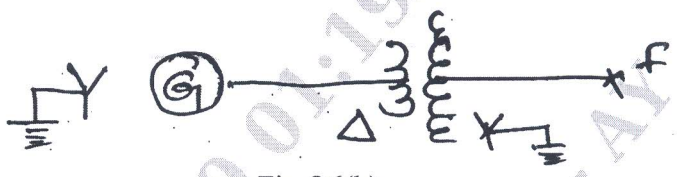

Fig.Q6(b) **(10 Marks)**

c. Identify the type of fault:
i) Positive, negative and zero sequence components currents are equal
ii) The fault current is not affected by neutral grounding.
iii) In the absence of neutral grounding, the fault current is zero.
iv) The positive sequence component of voltage at the point of fault is zero. **(04 Marks)**

7 a. Define:
i) Stability as applied to power system studies
ii) Infinite bus **(04 Marks)**

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

c. A turbo generator, 6 pole, 50 Hz of capacity 80 MW working at 0.8 p.f. has an inertia of 10 MJ/MVA.
i) Calculate the energy stored in the rotor at synchronous speed.
ii) Find rotor acceleration if the mechanical input is suddenly raised to 75 MW for an electrical load of 60 MW. **(06 Marks)**

8 a. Bring out the difference between power angle curve and swing curve. What information can we get from these curves? **(06 Marks)**

b. Write a note on equal area criterion. **(06 Marks)**

c. Find the expressions for power developed and torque developed when an unbalanced supply voltage is given to 3-ϕ induction motor. **(08 Marks)**

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