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10EE61

Sixth Semester B.E. Degree Examination, July/August 2021
Power System Analysis & Stability

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. With the help of a typical electric power system, explain
(i) One line diagram.
(ii) Impedance diagram.
(iii) Reactance diagram. **(06 Marks)**

b. What is per unit? List advantages of per unit system. **(04 Marks)**

c. Draw the impedance diagram of power system shown in Fig.Q1 (c). Mark all impedance values in per unit on a base of 50 MVA, 138 kV in the 40 Ω transmission line.
Generator G_1 : 20 MVA, 13.2 KV, X″ = 15%
Generator G_2 : 20 MVA, 13.2 KV, X″ = 15%
Motor M : 30 MVA, 6.9 KV, X″ = 20%
Three phase Y-Y Transformer : 20 MVA, 13.8/138 KV, X = 10%
Three phase Y-Δ Transformer : 15 MVA, 6.9/138 KV, X = 10%

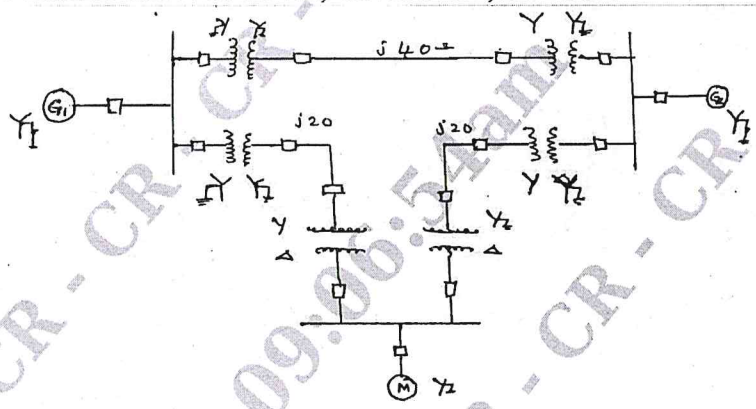

Fig. Q1 (c) **(10 Marks)**

2 a. With circuit model, explain direct axis subtransient, transient and synchronous reactance. **(06 Marks)**

b. Generators G_1 and G_2 are identical and rated 11 KV, 20 MVA and have a transient reactance of 0.25 pu at own MVA base. The transformers T_1 and T_2 are also identical and are rated 11/65 KV, 5 MVA and have a reactance of 0.06 pu to their own MVA base. A 50 km long transmission line is connected between the two generators. Calculate the three phase fault current when fault occurs at the middle of the line as shown in Fig. Q2 (b). **(14 Marks)**

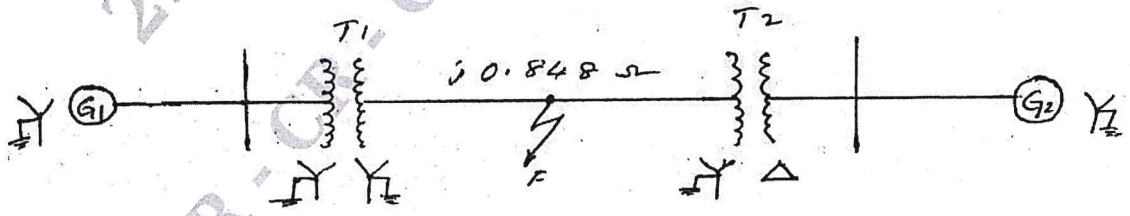

Fig. Q2 (b)

3 a. What is symmetrical components? Explain. **(06 Marks)**

b. In a three phase system, $Ia_1 = 100\angle 30^\circ$ A, $Ib_2 = 40\angle 90^\circ$ A and $Ic_0 = 10\angle -30^\circ$ A. Find the line currents. **(08 Marks)**

c. The sequence components of the phase voltage are $Va_1 = 200\angle 30^\circ$, $Va_2 = 60\angle 60^\circ$ and $Va_0 = 20\angle -30^0$ V. The line currents are $Ia_1 = 20\angle 10^\circ$, $Ia_2 = 5\angle 20^\circ$ and $Ia_0 = 3\angle -10^\circ$ A. Determine the 3 phase power in KVA and per unit if the base power is 10 KVA. **(06 Marks)**

4 a. Draw the zero sequence network for various types of transformer connections. **(06 Marks)**

b. The one line diagram of a power system is shown in Fig. Q4 (b). The ratings of the devices are as follows:

G_1 and G_2 : 104 MVA, 11.8 KV, $X_1 = X_2 = 0.2$ pu, $X_0 = 0.1$ p.u.

T_1 and T_2 : 125 MVA, 11Y-220Y KV, $X_1 = X_2 = X_0 = 0.12$ pu

T_3 and T_4 : 120 MVA, 230Y-6.9 Y KV, $X_1 = X_2 = X_0 = 0.12$ pu

M_1 : 175 MVA, 6.6 KV, $X_1 = X_2 = 0.3$ pu, $X_0 = 0.15$ pu

M_2 : 50 MVA, 6.9 KV, $X_1 = X_2 = 0.3$ pu, $X_0 = 0.1$ pu

Transmission line reactances :$X_1 = X_2 = 30\ \Omega$, $X_0 = 60\ \Omega$

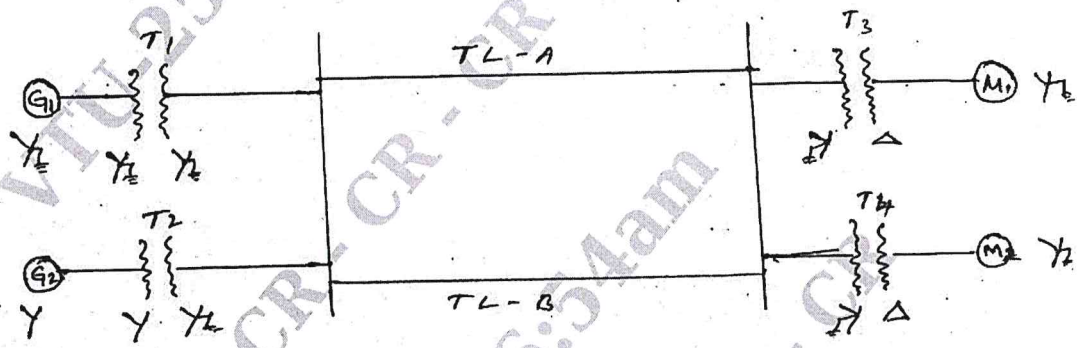

Fig. Q4 (b)

Draw the sequence impedance diagram in pu on a base of 200 MVA, 220 KV in the transmission lines. **(14 Marks)**

5 a. Derive an expression for fault current for Line-to-Line fault on an unloaded generator. **(10 Marks)**

b. Two 11 KV, 20 MVA, 3 phase, 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, j0.10 p.u. The star point of one of the generator 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 ground resistor, (iii) The voltage across the ground resistor. **(10 Marks)**

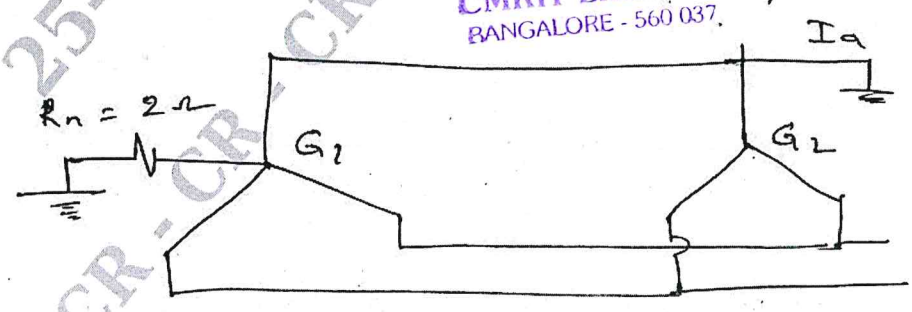

Fig. Q5 (b)

6 a. Derive an expression for fault current when double line to ground fault occurs in a power system. **(08 Marks)**

b. A synchronous motor is receiving 10 MW of power at 0.8 pf lag at 6 KV. An LG fault takes place at the middle point of the transmission line as shown in Fig. Q6 (b). Find the fault current. The ratings of the generator motor and transformer are as under:
Generator : 20 MVA, 11 KV, $X_1 = 0.2$ pu, $X_2 = 0.1$ pu, $X_0 = 0.1$ pu
Transmission line = $X_1 = X_2 = 5\ \Omega$, $X_0 = 10\ \Omega$
Transformer T_2 : 15 MVA, 6.9 Y-34.5 Y KV, X = 0.1 Pu
Motor : 15 MVA, 6.9 KV, $X_1 = 0.2$ pu, $X_2 = X_0 = 0.1$ Pu **(12 Marks)**

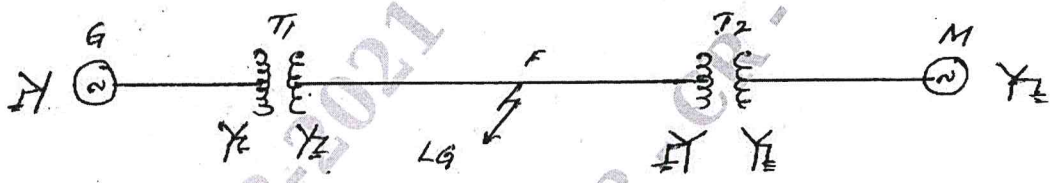

Fig. Q6 (b)

7 a. What is stability? Explain in brief the steady state stability, transient stability and Rotor angle stability. **(07 Marks)**

b. Find the critical clearing angle for the system shown in Fig. Q7 (b) for a 3 phase fault at point 'P'. The generator is delivering 1.0 pu power under prefault condition.

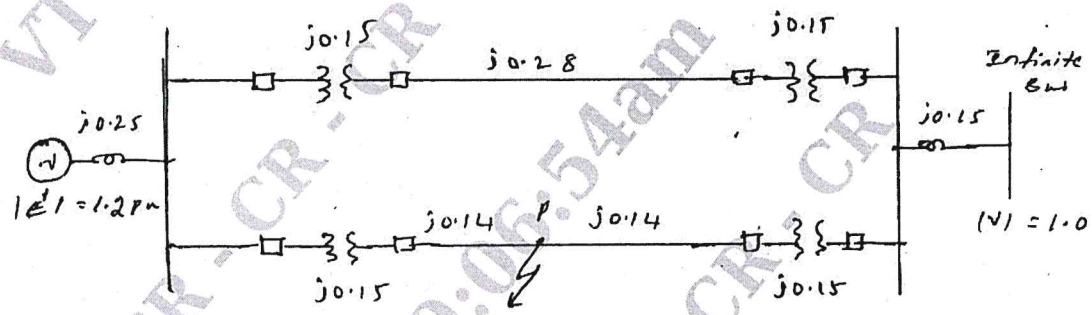

Fig. Q7 (b) **(13 Marks)**

8 a. 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 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.

(iii) Supposing the above acceleration is maintained for duration of 6 cycles.
Calculate the change in torque angle and the rotor speed of the end of 6 cycles. **(10 Marks)**

b. Explain working of three phase induction motor with unbalanced supply voltage. **(10 Marks)**

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