UJ – 105

VI Semester B.E. (E & E) Degree Examination, June/July 2017
(2K11 Scheme)
EE602 : POWER SYSTEM ANALYSIS

Time : 3 Hours Max. Marks : 100

***Instruction** : Answer **any 5 full** questions choosing at least **2** from **each** Part.*

PART – A

1. a) What is per unit quantity ? Enumerate the advantages of per unit quantity. **5**

   b) Show that the p.u. impedance of a transformer is same on both primary and secondary sides. **5**

   c) The figure 1 (c) shows the diagram of a radial transmission system. A load of 60 MW at 0.9 p.f. Lag is tapped at 60 KV as shown. Determine the terminal voltage of the generator at bus 1. The ratings of transformers are

   T_1 = 3 phase, 50 Hz, 100 MVA, 11 K V Y – 220 KV Δ , X = 10 %

   T_2 = 3 phase, 50 Hz, 80 MVA, 220 KV Δ – 66 KV Y, X = 10 % **10**

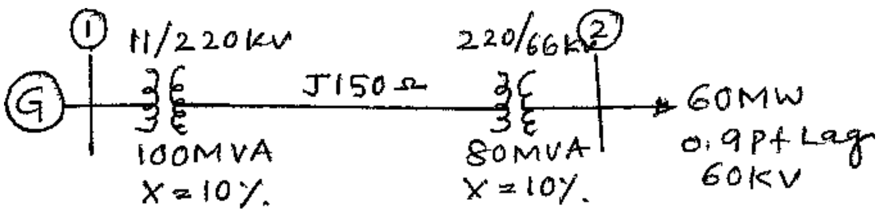

Fig. 1 (c)

2. a) Explain clearly the variation of current and impedance of an alternator when a 3 phase sudden short circuit occurs at its terminals. **10**

   b) A synchronous generator and motor are rated for 30000 KVA, 13.2 KV and both have subtransient reactance of 20 %. The line connecting them has a reactance of 10 % on the base of machine ratings. The motor is drawing 20000 KW at 0.8 p.f. leading. The terminal voltage of the motor is 12.8 KV. When a symmetrical three phase fault occurs at motor terminals. Find the subtransient current in generator, motor and at the fault point. **10**

P.T.O.

3. a) Obtain an expression for the three phase complex power in terms of symmetrical components. **10**

   b) A delta connected resistive load is connected across a balanced supply of 400 V as shown in figure 3 (b). Find the symmetrical components of line currents and delta currents. **10**

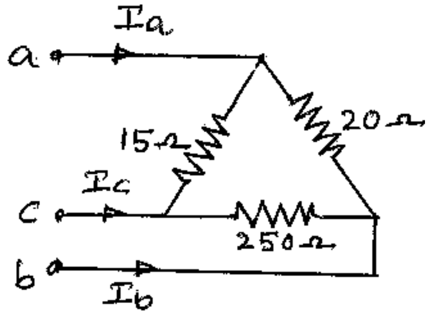

Fig. 3 (b)

4. a) Prove that in symmetrical system, currents of a given sequence produce voltage drops of the same sequence only. **10**

   b) Draw the positive, negative and zero sequence networks for the power system shown in figure 4 (b) choose a base of 50 MVA, 220 KV in the 50 Ω transmission lines and mark all the reactances in p.u. The ratings of the generators and transformers are

   Generator 1 : 25 MVA, 11 KV, $X'' = 20\ \%$

   Generator 2 : 25 MVA, 11 KV, $X'' = 20\ \%$

   Three phase transformer (each) = 20 MVA 11 Y/220 Y 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 reactances of each lines are 250 % of their positive sequence reactances. **10**

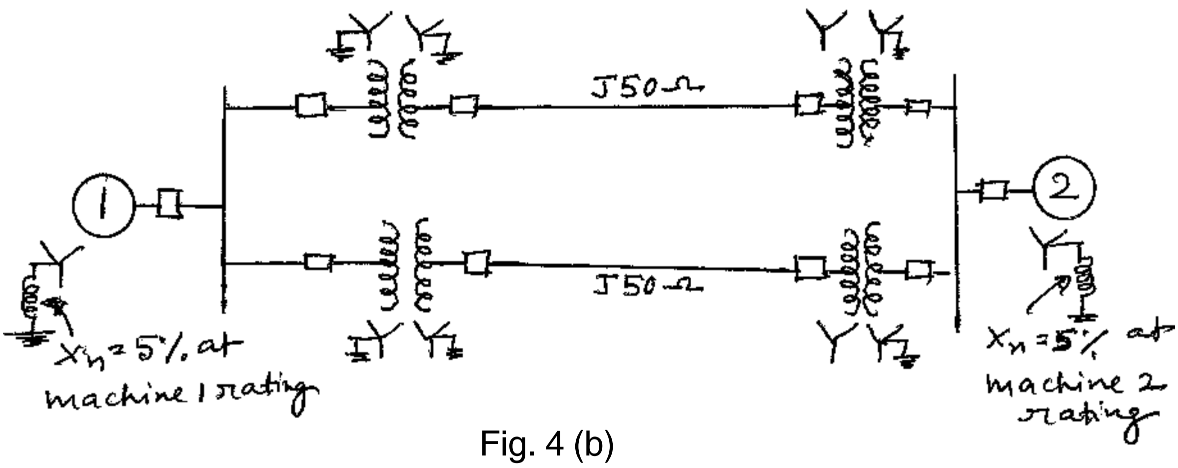

Fig. 4 (b)

PART – B

5. a) A single line to ground fault occurs at the terminals of an unloaded generator through a fault impedance Z_F. Assume that the neutral of the is grounded through a reactance Z_n. Derive the expression for fault current. Draw the connection of sequence networks to represent the fault. **10**

b) A three phase generator with line to line voltages of 400 V is subjected to double line to ground fault. If $Z_1 = J\,2\Omega$, $Z_2 = J\,0.5\Omega$ and $Z_0 = J\,0.25\Omega$. Determine the fault current and terminal voltages. **10**

6. a) For i) one conductor open fault and

ii) two conductor open fault

Obtain expressions for currents and show the connections of sequence networks to represent the faults. **8**

b) A synchronous motor is receiving 10 MW of power at 0.8 pf lag at 6 KV. Double line to ground fault takes place at the middle point of the transmission line as shown in figure 6 (b). Find the fault current.

The ratings of the generator, motor and transformer are as follows.

Generator : 20 MVA, 11 KV, $X_1 = 0.2$ PU, $X_2 = 0.1$ PU, $X_0 = 0.1$ PU

Transformer T_1 : 18 MVA, 11.5 Y/34.5 KV, X = 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

Consider the base values of 20 MVA, 11 KV on the generator side. **12**

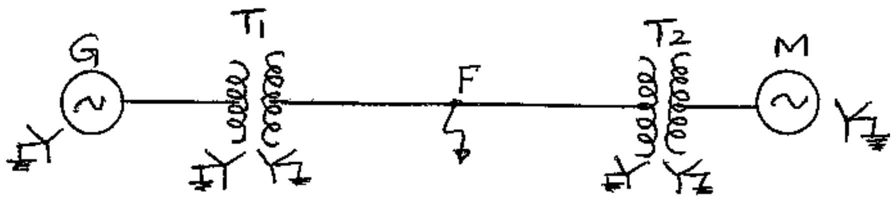

Fig. 6 (b)

7. a) Derive swing equation for a synchronous machine. **10**

   b) A turbogenerator 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) Suppose the above acceleration is maintained for a duration of 6 cycles, calculate the change in torque angle and rotor speed at the end of 6 cycles. **10**

8. a) Explain the complete block diagram representation of load frequency control of an isolated power system. **12**

   b) Two generators rated 200 MW and 400 MW are operating in parallel. The droop characteristics of their governors are 4 % and 5 % respectively from no load to full load. Assuming that the generators are operating at 50 Hz at no load, how would a load of 600 MW be shared between them ? What will be the system frequency at this load ? Assume free governor operation. **8**