BE – 106

VI Semester B.E. (E & E) Degree Examination, December 2016
(2K11) (Semester Scheme)
EE – 602 : POWER SYSTEM ANALYSIS

Time : 3 Hours Max. Marks : 100

Instruction : *Answer **any five** questions by choosing at least **two** questions from **each** Part.*

PART – A

1. a) What are the advantages of per-unit system ? **5**

   b) Explain how transmission line and load are modelled for power system analysis. **5**

   c) Figure 1(c) shows a system. Draw a single line diagram and insert the reactances in per unit on 20 MVA, 6.6 KV base in the circuit of generator G_1. The data is

   G_1 : 10 MVA, 6.6 KV, j0.1 μc

   G_2 : 20MVA, 11.5 KV, j0.1μc

   T_1 : 10 MVA, 3ϕ, 6.6/115 KV, j0.15μc

   T_2 : Three single phase units, each of 10 MVA, 75/7.5 KV, j0.1μc **10**

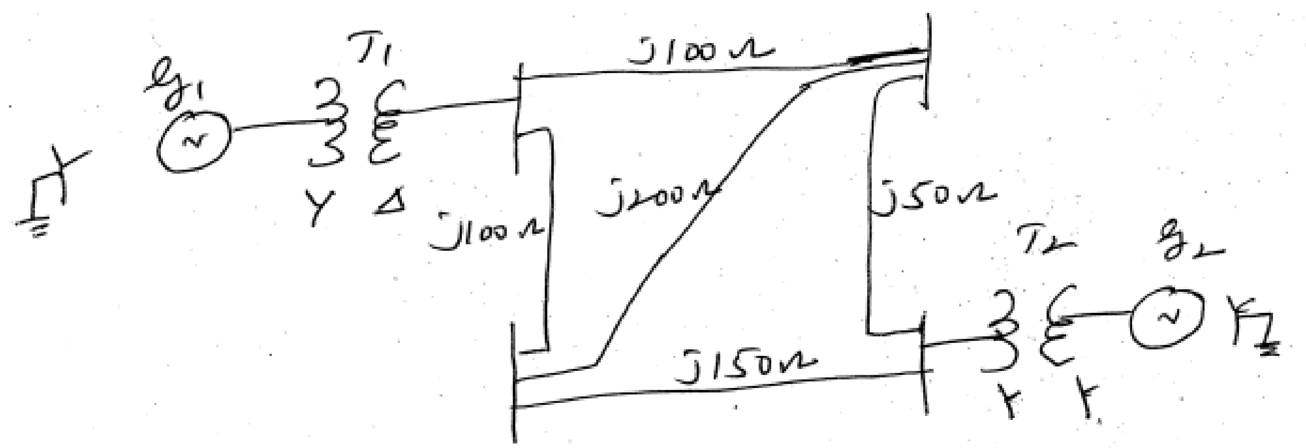

fig. 1 (c)

P.T.O.

2. a) A 3ϕ, 3 winding Y – Y – Δ transformer is rated as under

   Primary 132 KV, 30 MVA

   Secondary 11 KV, 20 MVA

   Tertiary 6.6 KV, 10 MVA

   The results of S.C. tests are as under secondary short circuited, tertiary open circuited, primary excited X = 7% on 132 KV, 30 MVA base secondary open circuited, tertiary short circuited, primary excited. X = 9%, on 132 KV, 30 MVA base tertiary short circuited Primary open circuited, secondary excited X = 4% on 11 KV, 20 MVA base. Find X_1, X_2, X_3 in per unit neglect resistances. **6**

   b) Explain clearly the variation of current and impedance of an alternator when a 3-phase, sudden short circuit takes place at its terminals. **6**

   c) Explain the variation of current and voltage on a overhead line when one end of the line is

   i) Short circuited and

   ii) Open circuited and at the other end a source of constant emf V is switched in. **(4+4=8)**

3. a) Prove that the zero sequence impedance of the neutral impedance z_n is equal to $3z_n$. **4**

   b) A 3 phase delta connected generator supplies an unbalanced load, the three line currents being $I_a = 30A$, $I_b = 40A$ and $I_c = 50A$. The phase sequence is acb. Determine the sequence components of the line and the phase currents. **8**

   c) Prove that

   $(I_a)^2 + (I_b)^2 + (I_c)^2 = 3\{(I_{a1})^2 + (I_{a2})^2 + (I_{a0})^2\}$ **8**

4. a) Clearly explain what you mean by the three sequence networks of a synchronous generator. **6**

   b) A single phase resistive load of 50 KVA is connected across lines ab of a balanced supply of 6 KV. Compute symmetrical components of the line currents. **8**

   c) A set of 3ϕ unbalanced voltages is applied to a star connected load, $z_s = 4+j12\,\Omega$, and $t_m = j2\,\Omega$. The load and source neutrals are solidly grounded. The phase to neutral source voltages are given by

$$[V_P] = \begin{bmatrix} 100\angle 25^\circ \text{ V} \\ 50\angle -155^\circ \text{ V} \\ 40\angle 100^\circ \text{ V} \end{bmatrix}$$

Determine :

i) sequence impedances

ii) symmetrical components of voltage. **6**

PART – B

5. a) Derive expressions for fault inherent and terminal voltages when :

i) L – L fault and

ii) L – L – G fault occurs at the terminals of an unloaded generator – show how the sequence networks are connected to represent the faults. **(6+6)**

b) A 3ϕ synchronous generator with generated line-to-line voltage of $200 \times \sqrt{3}$ volts is subjected to single line to ground fault of the various sequence impedances are $Z_1 = j_2\Omega$, $Z_2 = j0.5\Omega$ and $Z_0 = j0.25\Omega$. Determine the fault current and the terminal phase and line voltages. The generator neutral grounded. **8**

6. a) For the network shown in figure 6(a) determine the fault current when L-G fault takes place at point P. Assume base of 30 MVA, and 13.8 kv in generator circuit.

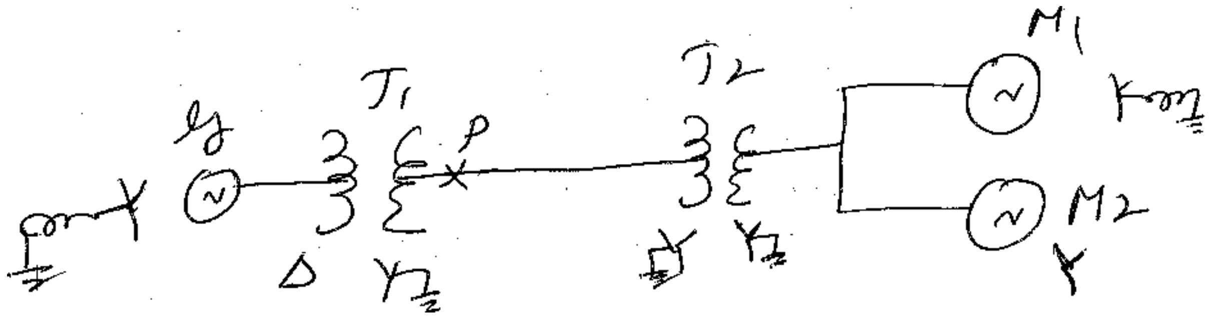

fig. 6 (a)

G : 30 MVA, 13.8 KV, $X_1 = X_2 = 15\%$, $X_0 = 5\%$

$T_1 = T_2$: 35MVA, 13.2/115 KV, X = 10%

M_1 : 20 MVA, 12.5 KV, $X_1 = X_2 = 20\%$, $X_0 = 5\%$

M_2 : 10 MVA, 12.5 KV, $X_1 = X_2 = 20\%$, $X_0 = 5\%$

Current limiting reactors of $j2\Omega$ each are in the neutral of the alternator and M1. series reactance of the line is 80Ω. The zero sequence reactance of the line is 200Ω. **14**

b) Explain open conductor faults in power systems. **6**

7. a) Starting from final principles, derive the rising equation of synchronous machine. **6**

   b) Draw diagrams to illustrate the application of equal area criterion to study transient stability for the following cases.

      i) a sudden increase in input of the generator

      ii) a fault on one of the parallel circuits of a two circuit line feeding an infinite bus. The fault is very close to the sending end bus and is subsequently cleared by the opening of faulted line.

   Mark the accelerating and decelerating area in each case. **6**

   c) Fig. 7(c) shows a simple system. Find the maximum steady state power transfer

      i) When capacitor is connected

      ii) When capacitor is replaced by an inductor of the same value. All the reactances are to a common base. **8**

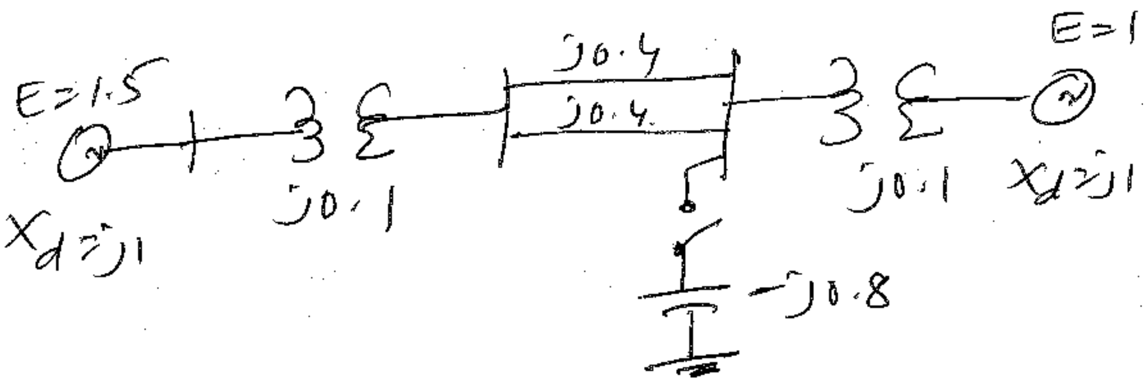

fig. 7 (c)

8. a) Obtain the mathematical model of an isolated power system load frequency controller. **12**

   b) Two generators rated 350 MW and 650 MW are operating in parallel. The droop characteristics of their governors are 5% and 4% from no load to full load. If the nominal frequency is 60 Hz at no load, how would a load of 1000 MW be shared between them ? What is the system frequency ? **8**