Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-Vth Examination December 2010

Subject code: 150902

Subject Name: Power System Analysis and Simulation

Date: 15 /12 /2010 **Time: 03.00 pm - 05.30 pm**

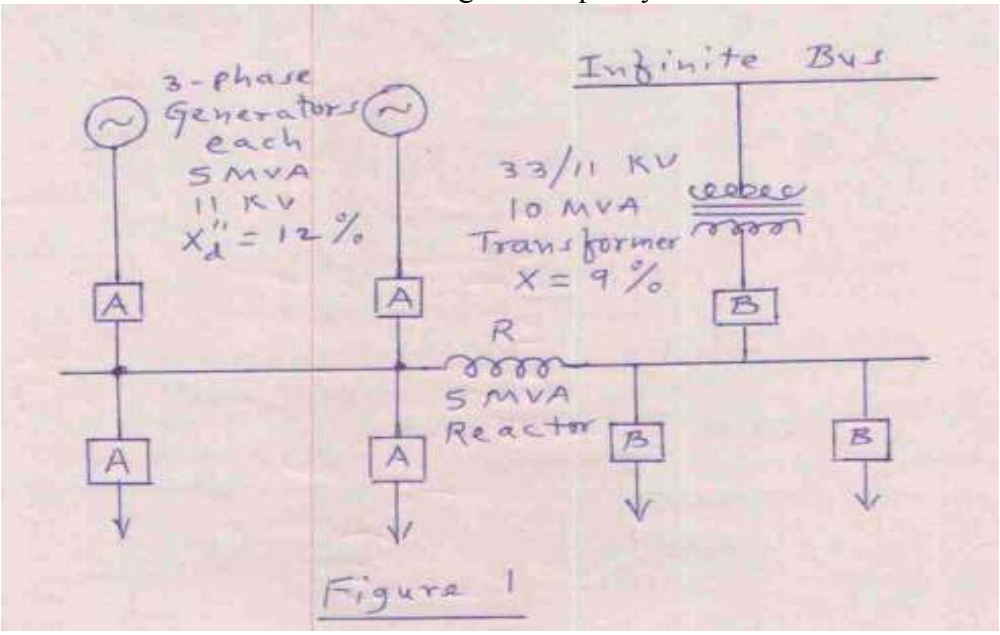
Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Using appropriate interconnection of sequence networks, derive the equation for a line to line fault in a power system with a fault impedance of Z_f. **07**

(b) Figure 1 shows a single-line diagram of power system network. The breaking capacity of breakers *A* is 100 *MVA*. Find out the per unit value of reactor *R*. Also find out the breaking capacity of breakers B. **07**



Q.2 **(a)** Figure 2 shows a power system network. Draw positive, negative and zero sequence networks. The system data is as under:

Equipment	MVA Rating	Voltage Rating	X_1	X_2	X_0
Gen. G_1	100	11 kV	0.25 p.u.	0.25 p.u	0.05 p.u.
Gen. G_2	100	11 kV	0.2 p.u.	0.2 p.u	0.05 p.u.
Transformer T_1	100	11/220 kV	0.06 p.u.	0.06 p.u	0.06 p.u.
Transformer T_2	100	11/220 kV	0.07 p.u.	0.07 p.u	0.07 p.u.
Line 1	100	220 kV	48.4 Ω	48.4 Ω	145.2 Ω
Line 2	100	220 kV	48.4 Ω	48.4 Ω	145.2 Ω

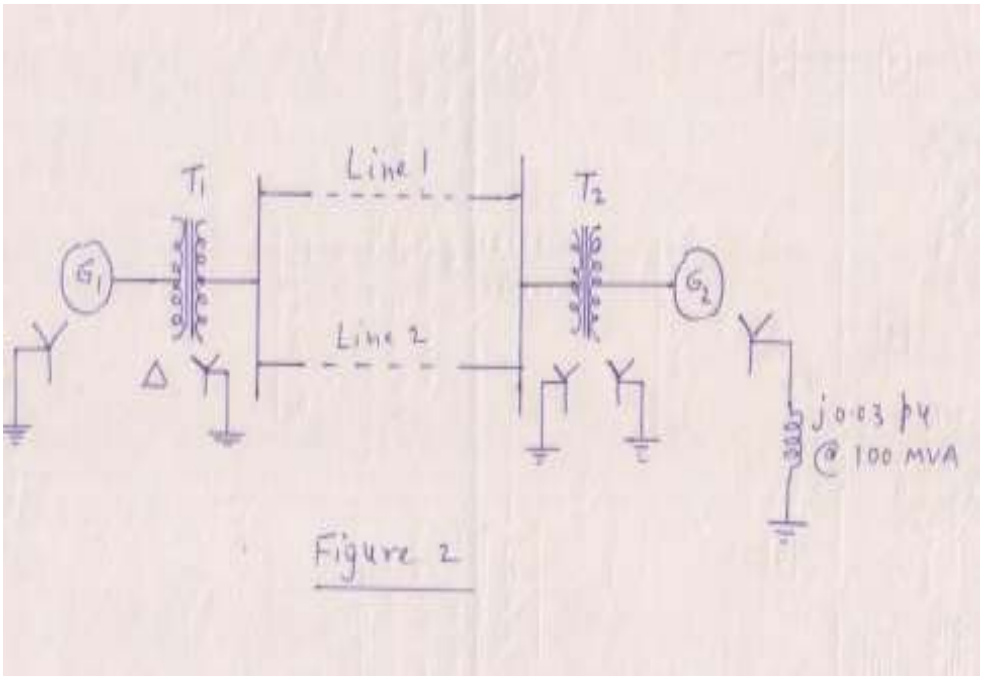


Figure 2

(b) Two 25 MVA, 11 kV generators are connected to a common busbar which supplies a feeder. The star-point of one of the generators is grounded through a resistance of 1 Ω, while that of the other generator is isolated. A line-to-ground fault occurs at the far end of the feeder. Determine: (i) the fault current and (ii) the voltage to ground of healthy phases of the feeder at the fault point. The sequence impedances of each generator are and feeder are given below: **07**

	Each Generator (p.u.)	Feeder (Ω/ph.)
X_1	j 0.2	j 0.4
X_2	j 0.15	j 0.4
X_0	j 0.08	j 0.8

Assume fault impedance to be zero.

OR

(b) A 25 MVA, 11 kV generator has $X_d^{"}$ = 0.2 p.u., X_2 = 0.3 p.u. and X_0 = 0.1 p.u.. The neutral of the generator is solidly grounded. Determine the sub-transient current in the generator and the line-to-line voltages for sub-transient condition when a Y-B-G fault occurs at the generator terminals. Assume pre-fault currents and fault-resistance to be zero. **07**

Q.3 **(a)** From first principles, derive the A, B, C and D constants of a long transmission line. **07**

(b) A long line with A = D = $0.9\angle 1.5°$ and B = $150\angle 65°$ has at the load end, a transformer having a series impedance Z_T = $100\angle 67°$. The load voltage and current are V_L and I_L. Obtain expressions for V_S and I_S in the form: **07**

$$\begin{bmatrix} V_S \\ I_S \end{bmatrix} = \begin{bmatrix} A' & B' \\ C' & D' \end{bmatrix} \begin{bmatrix} V_L \\ I_L \end{bmatrix}$$ and evaluate these constants.

OR

Q.3 **(a)** Prove that the active and reactive powers transmitted to load over a long line are given by $P_R = \frac{V_S V_R}{X} Sin\delta$ and **07**

$Q_R = \frac{V_S V_R}{X} Cos\delta - \frac{V_R^2}{X}$.

(b) A short 230 kV transmission line with a reactance of 18 Ω/ph supplies a load at 0.85 p.f. lag. For a line current of 1000 A, the receiving and sending end voltages are to be maintained at 230 kV. Calculate: (i) rating of synchronous capacitor required (ii) load current (iii) load MVA. Neglect power drawn by the capacitor. **07**

Q.4 **(a)** Discuss the advantages of per unit computations. **07**

(b) Figure 3 shows a three phase generator rated 300 MVA, 23 kV. It supplies a system load of 240 MVA, 0.9 p.f. lag at 230 kV through a 330 MVA, 23/230 kV DY step-up transformer of leakage reactance 11 %. Neglecting magnetizing current and choosing base values at the load as 100 MVA and 230 kV, find currents I_A, I_B and I_C supplied to the load in p.u. with V_A (voltage of h.v. side for A phase) as reference. Also determine currents I_a, I_b and I_c supplied by the generator and generator terminal voltage. **07**

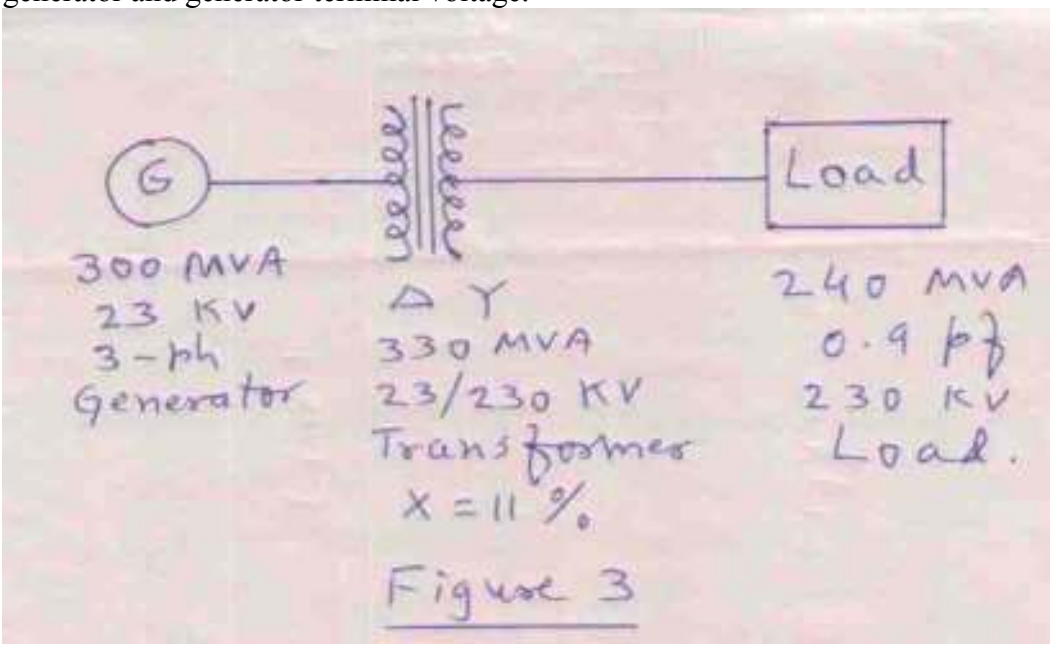


Figure 3

OR

Q.4 **(a)** What are the factors and conditions affecting corona loss? Explain them briefly. **07**

(b) Find the disruptive critical voltage for a 3-ph line consisting of 21 mm diameter conductors spaced in a 6 m delta configuration. Take temperature as 25° C, pressure as 73 cm of Hg and surface factor 0.85. What should be the voltage of transmission? **07**

Q.5 **(a)** Explain different systems of neutral grounding and compare them. **07**

(b) Starting from the first principles, show that surges behave as travelling waves. Find expressions for surge impedance and wave velocity. **07**

OR

Q.5 **(a)** Draw the waveforms for fault current for a 3-phase fault on alternator terminals. Explain the sub-transient, transient and steady state reactance. What is their significance in fault calculations? **07**

(b) Justify the following statement: **07**

"For a fault at alternator terminals, a single line to ground fault is generally more severe than a 3-ph fault whereas for faults on transmission lines, a 3-ph fault is more severe than other faults."

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