[06 – 4113]

IV/IV B.E. DEGREE EXAMINATION.

First Semester

Electrical and Electronics Engineering

POWER SYSTEM ANALYSIS AND STABILITY

(Effective from the admitted batch of 2004–2005)

Time : Three hours Maximum : 70 marks

Answer question No. 1 and any FOUR from the rest.

All questions carry equal marks.

1. (a) Obtain the value of the per unit impedance when the 3-phase base quantities are given.

(b) Mention any two reasons in favour of N-R method compared to G-S method of load flow solution.

(c) Define the following terms clearly w.r.to a synchronous machine.

(i) Quadrature axis transient reactance

(ii) Quadrature axis subtransient reactance.

(d) Determine the zero sequence component voltage of the unbalanced 3-phase voltages as given below for the A, B, C phase sequence.

$V_A = 200\angle 0°$ volts ; $V_B = 200\angle 230°$ volts and $V_C = 200\angle 100°$ volts

(e) Define : Steady state stability and transient stability of power systems.

(f) Show that L – L fault, $I_{a0} = 0$ and $I_{a1} = -I_{a2}$. Mention the reason for $I_{a0} = 0$ in this type of fault.

(g) (i) Define single-line diagram w.r.to a power system.

(ii) Write the swing equation.

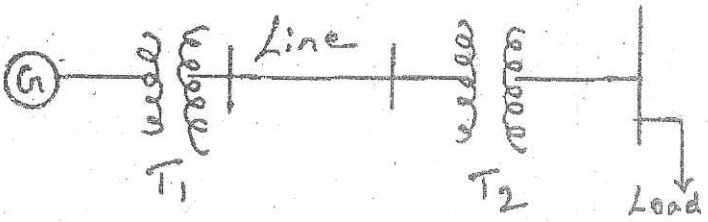
2. (a) Prove that for a transformer, the p.u. value of impedance will be the same when referred to either side of the transformer.

(b) Obtain the p.u. impedance diagram of the power system shown in the figure below. Choose the base quantities as 15 MVA and 33 kV.

Transformers T_1 and T_2 : 15 MVA, 33/11 kV, $X = 15\Omega$ referred to HV.

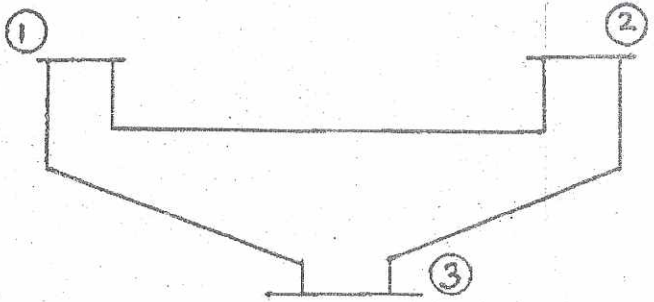
Transmission line : 20 ohms/phase

Load : 40 mW, 6.6. kV, 0.85 lagging p.f.



3. (a) Develop the load equations and explain Gauss-Seidal method of solving them for a 5-bus system. Use flow chart.

(b) Obtain the Bus-impedance matrix for the 3-bus system shown in the figure below.



$Z_{1-2} = 0.008 + j\ 0.24$; $Z_{13} = 0.002 + j\ 0.06$

$Z_{23} = 0.06 + j0.18$.

All are p.u. values.

4. (a) Compare G-S, N-R and fast decoupled load flow methods with respect to

   (i) Number of equations

   (ii) Memory and

   (iii) Time for iteration.

   (b) In a 2-bus power system with bus 1 as slack bus with $V_1 = 1.02\angle 0^\circ$ p.u and $P_2 = 3.0$ p.u; $Q_2 = 0.8$ p.u and $Z_2 = 0.025 + j0.045$ p.u. Using G – S method, determine V_2 after two iterations.

5. (a) Describe the various types of current limiting reactors used in power systems.

   (b) Two 50 MVA, 50 Hz, 11 kV alternators with subtransient reactance $X^{11} = 0.1$ p.u and a transformer of 40 MVA, 11/66 kV and reactance of 0.08 p.u are connected to a bus A. Another generator rated 60 MVA, 11 kV with a reactance of 0.12 p.u is connected to bus B. Both A and B are interconnected through a reactor of 80 MVA, 20% reactance. If a 3-phase fault occurs on the H.V. side of the transformer, calculate the current fed into the fault and fault MVA.

6. (a) A line-to-line fault occurs at the terminals of an unloaded synchronous generator. Derive the interconnection of sequence networks and expressions for the pre-fault currents in the machine.

(b) A 20 MVA, 11 kV, Star connected generator has positive, negative and zero sequence reactances of 25%, 35% and 100% respectively. The neutral is earthed through a reactance of 8%. When the generator is unloaded, a double line to ground fault occurs in phases b and c. Calculate the fault currents in all the three phases. Assume the voltage generated to be 11 kV phase sequence is abc.

7. (a) Derive the swing equation of a synchronous machine. The steady state limit of a power system is 100 mW. A generator with constant excitation is supplying 50 mW to the system. Estimate the maximum possible sudden increase in generator output without causing instability.

(b) Mention various methods of which transient stability can be improved.

8. Write short notes on the following :

(a) Data received for load flow studies

(b) Critical clearing time

(c) Phase shift in delta/star transformers.