

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2005.

Sixth Semester

Electrical and Electronics Engineering

EE 339 — POWER SYSTEM ANALYSIS

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write the equation for per unit impedance.
2. Represent a short transmission line of 3 phase into its equivalent single phase circuit.
3. Draw the zero sequence network diagram of a delta-delta connected transformer.
4. Draw the zero sequence equivalent network diagram for a 3 phase star connected alternator with reactance earthing.
5. Write the swing equation used for stability analysis of power system.
6. Write any two advantages of per-unit representation.
7. Write any two assumptions made to simplify the transient stability problems.
8. What are the reactances used in the analysis of symmetrical faults on the synchronous machines as its equivalent reactances?
9. What is slack bus in power flow analysis?
10. What are the constraints to be satisfied to solve load flow equations for a given bus load configuration?

PART B — (5 × 16 = 80 marks)

11. (i) What are the step by step procedures to be followed to find the per-unit impedance diagram of a power system? (4)
(ii) Obtain the reactance diagram of the power system given below :

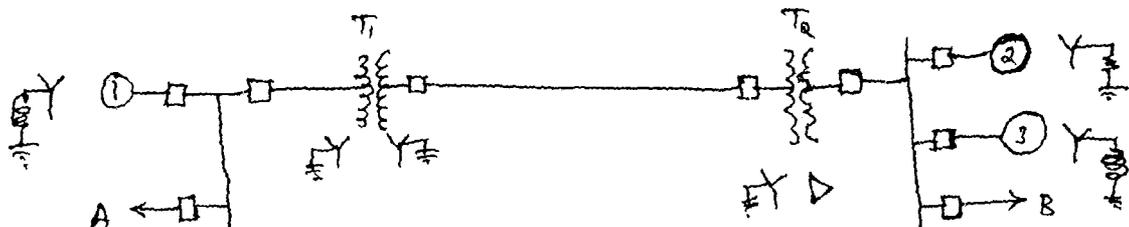


Fig. 1 one-line representation of a simple power system :

Generator No. 1 : 30 MVA, 10.5 kV, $X'' = 1.6$ ohms

Generator No. 2 : 15 MVA, 6.6 kV, $X'' = 1.2$ ohms

Generator No. 3 : 25 MVA, 6.6 kV, $X'' = 0.56$ ohms

Transformer T_1 (3 phase) : 15 MVA, 33/11 kV, $X = 15.2$ ohms per phase on high voltage side

Transformer T_2 (3 phase) : 15 MVA, 33/6.2 kV, $X = 16$ ohm per phase on high voltage side

Transmission line : 20.5 ohms/phase

Load A : 15 MW, 11 kV, 0.9 lagging p.f.

Load B : 40 MW, 6.6 kV, 0.85 lagging p.f. (12)

12. (a) The parameters of a 4-bus system are as under :

Bus code	Line impedance (pu)	Charging admittance (pu)
1-2	$0.2 + j 0.8$	$j 0.02$
2-3	$0.3 + j 0.9$	$j 0.03$
2-4	$0.25 + j 1.0$	$j 0.04$
3-4	$0.2 + j 0.8$	$j 0.02$
1-3	$0.1 + j 0.4$	$j 0.01$

Draw the network and find bus admittance matrix. (16)

Or

- (b) A three phase power of 700 MW is to be transmitted to a substation located 315 km from the source of power. For a preliminary line design assume the following parameters :

$$V_s = 1.0 \text{ p.u.}, V_R = 0.9 \text{ p.u.}, \lambda = 5000 \text{ km}; z_c = 320 \Omega, \text{ and } \delta = 36.87^\circ.$$

- (i) Based on the practical line loadability equation, determine a nominal voltage level for the transmission line.
- (ii) For the transmission voltage level obtained in (i), Calculate the theoretical maximum power that can be transferred by the transmission line. (8 + 8)

- 13 (a) A 25,000 KVA, 13.8 kV generator with $X''_d = 15\%$ is connected through a transformer to a bus which supplies four identical motors as shown in Fig. 2. The subtransient reactance X''_d of each motor is 20% on a base of 5000 KVA, 6.9 kV. The three-phase rating of the transformer is 25000 KVA, 13.8/6.9 kV, with a leakage reactance of 10%. The bus voltage at the motors is 6.9 kV when a three-phase fault occurs at point P. For the fault specified, determine (i) the subtransient current in the fault, (ii) the subtransient current in breaker A and (iii) the symmetrical short-circuit interrupting current in the fault and in breaker A. (16)

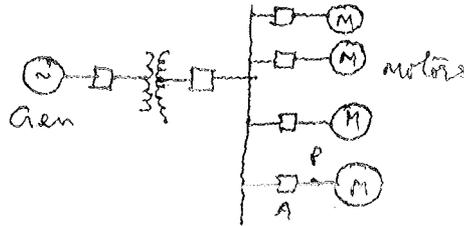


Fig. 2 one line diagram for the problem 13 (a).

Or

- (b) Two synchronous machines are connected through three-phase transformers to the transmission line as given below in Fig. 3. The ratings and reactances of the machines and transformers are

Machines 1 and 2 : 100 MVA, 20 KV; $X''_d = X_1 = X_2 = 20\%$

$X_0 = 4\%$; $X_n = 5\%$.

Transformers T_1 and T_2 : 100 MVA, 20 Y/345 Y kV; $X = 8\%$

Both transformers are solidly grounded on two sides. On a chosen base of 100 MVA, 345 kV in the transmission line circuit the line reactances are $X_1 = X_2 = 15\%$ and $X_0 = 50\%$. The system is operating at nominal voltage without pre-fault currents when a bolted ($Z_f = 0$) single line-to-ground fault occurs on phase A at bus (3). Using the bus impedance matrix for each of the three sequence networks, determine the subtransient current to ground at the fault.

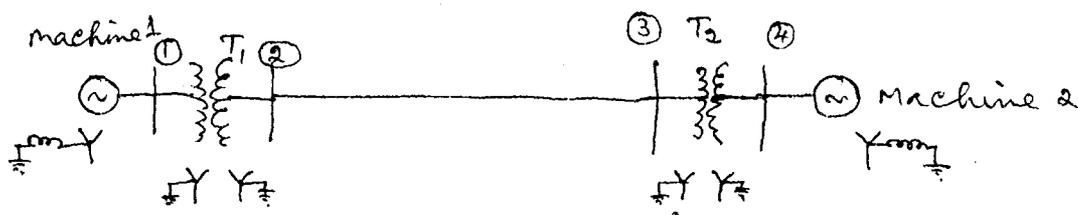


Fig. 3

14. (a) Determine Z_{bus} for the network shown below in Fig. 4 where the impedances labeled 1 through 6 are shown in per unit. Preserve all buses. (16)

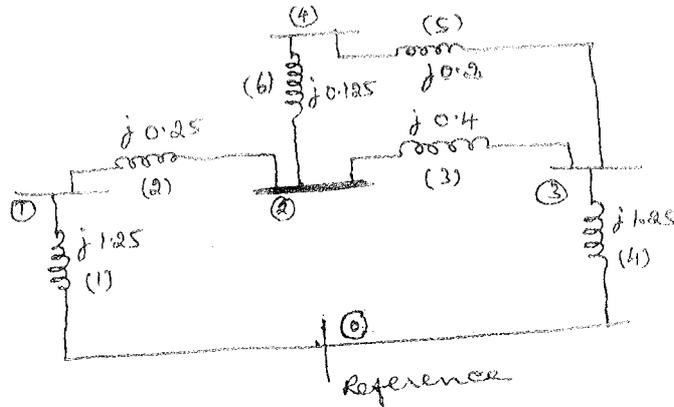


Fig. 4

Fig. 4 Branch impedances are in p.u. and branch numbers are in parentheses.

Or

- (b) Explain the step by step computational procedure for the Gauss-Seidel method of load flow studies. (16)
15. (a) Derive Swing equation used for stability studies in power system. (16)

Or

- (b) In the system shown in Fig. 5 a three phase static capacitive reactor of reactance 1 p.u. per phase is connected through a switch at motor bus bar. Calculate the limit of steady state power with and without reactor switch closed. Recalculate the power limit with capacitance reactor replaced by an inductive reactor of the same value.

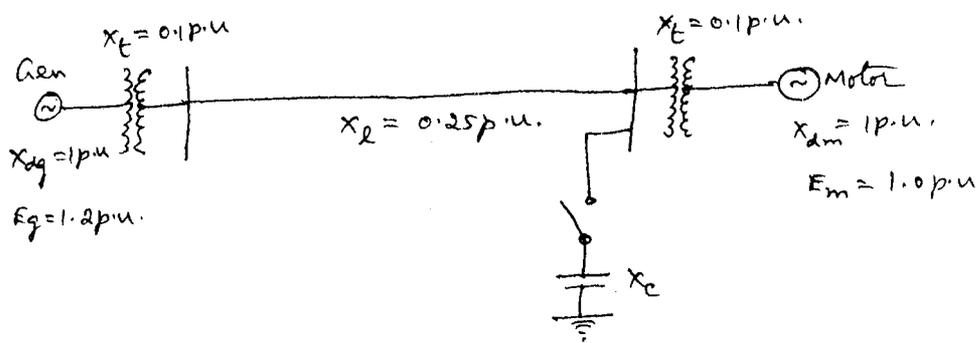


Fig. 5

Assume the internal voltage of the generator to be 1.2 p.u. and that of the motor to be 1.0 p.u. (16)