3303 Your Roll No. ....

B.Tech. (EE) / IV **J**

Paper EEE–405— POWER SYSTEM STABILITY

Time : 3 hours *Maximum Marks* : 70

(Write your Roll No. on the top immediately on receipt of this question paper.)

Answer five questions in all. Question No. 1 is compulsory. All questions carry equal marks.

1. Answer the following questions in brief (not more than 100 words):

   (*i*) A salient pole machine is more stable than a cylindrical rotor machine. Why?

   (*ii*) Why are present day generators less stable than the generators made few years ago?

   (*iii*) Define the inertia constants M and H. What is their relation?

   (*iv*) What do you understand by 'Infinite bus' in a Power System?

   (*v*) What is meant by steady state stability limit?

   (*vi*) Why is transient stability limit lower than steady state stability limit?

(*vii*) Why does equal area criterion give only absolute stability of Power System? 14

2. (*a*) Explain point-by-point method of solving swing equation. 7

(*b*) A 20 MVA, 50 Hz generator delivers 18 MW over a double circuit line to an infinite bus. The generator has K.E. of 3·0 MJ/MVA at rated speed. The generator transient reactance is $X_d' = 0 \cdot 35$ pu. Each transmission circuit has a reactance of 0·2 pu on a 20 MVA base. $|E'| = 1 \cdot 1$ pu and infinite bus voltage is $V = 1 \cdot 0 \angle 0°$. A three phase fault (short circuit) occurs at the mid-point of one of the transmission lines. Plot swing curve with fault cleared by simultaneous opening of breakers at both ends of the line at 6·25 cycles after occurrence of fault. 7

3. (*a*) Using equal area criterion, derive an expression for critical clearing angle for a system having a generator feeding a large system through a double circuit line. 7

(*b*) A 50 Hz, four pole turbogenerator rated 100 MVA, 11 kV has an inertia constant of 6·0 MJ/MVA. Determine:

(*i*) Stored energy in the rotor at synchronous speed.

(*ii*) If the mechanical input is suddenly raised to 100 MW for an electrical load of 70 MW, find rotor acceleration, neglecting mechanical and electrical losses.

(*iii*) If the acceleration calculated in part (*ii*) is maintained for 10 cycles, find the change in torque angle and rotor speed in revolutions per minute at the end of this period. 7

4. (*a*) What is 'Equal Area Criterion'? How is it derived from the swing equation? Explain the operation of a synchronous motor using this criterion when sudden increase in mechanical load on that motor occurs. 7

(*b*) A power deficient area receives 50 MW over a tie line from another area. The maximum steady state capacity of tie line is 120 MW. Find the allowable sudden load that can be switched on without loss of stability. 7

5. (*a*) What are the assumptions made during the stability analysis of a multimachine system? Derive the equation for a reduced admittance matrix. 7

(*b*) A generator is connected to an infinite bus through a double circuit line as shown in Fig. 1.

Suppose a 3-ϕ (three-phase) fault takes place at the mid point of one feeder and the breakers operate after same time. Determine the prefault, during fault and post fault reduced Y-matrices. 7

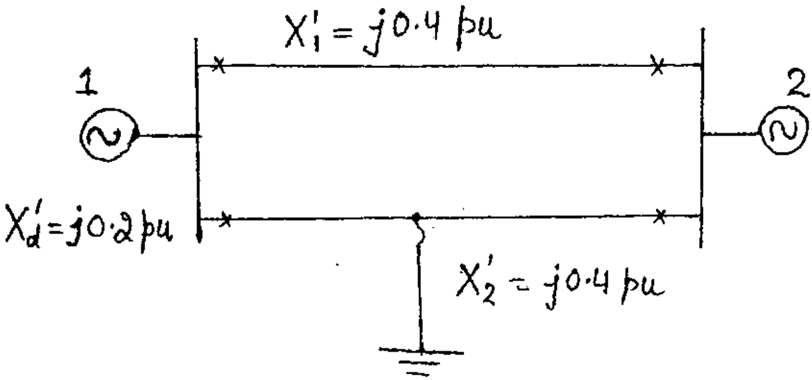

Fig. 1

6. (*a*) Express the swing equation in terms of state equations. Describe with the help of flow chart the Runge-Kutta method of solving swing equation for multimachine system. 7

(*b*) Consider a system having the following parameters:

$P_m = 3 \cdot 0$ p.u.; $r_1 P_m = 1 \cdot 2$ p.u.; $r_2 p_m = 2 \cdot 0$ p.u.

$H = 3 \cdot 0$; $f = 50$ Hz; $\Delta t = 0 \cdot 02$ sec.

$P_e = 1 \cdot 5$ p.u.

Determine the rotor angle and angular frequency at the end of 0·02 sec using Runge-Kutta method. 7

7. (*a*) What do you understand by MEL of generator? Derive an expression of the pull-out curve under steady state operation. 7

(*b*) Given a generator and a system with reactance of $X_d = 1 \cdot 5$ pu and $X_e = 0 \cdot 2$ pu both on 100 MVA base. Assume a generator terminal voltage of 0·96 pu. Determine the center and radius for the pull out curve and also the minimum permissible output VARs when the output power is zero. 7

8. (*a*) Can power be transferred if the reactance is zero (of transmission line)? Derive the equation required to justify this statement. Also show the condition for maximum power transfer. 7

(*b*) How can the transient stability of a system be improved? Discuss the traditional as well as new approaches to the problem. 7