(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 2498 Roll No. | | | | | | | | | | |

B.Tech.

(SEM. VI) THEORY EXAMINATION 2010-11

POWER SYSTEM ANALYSIS

Time : 3 Hours *Total Marks : 100*

Note :- (1) Attempt **ALL** the questions.

(2) All questions carry equal marks.

1. Attempt any **THREE** parts :— $6^2/_3 \times 3 = 20$

(a) Draw an impedance diagram of power system with correct levelling of each section with transformer rating from generation to load point.

(b) For the three-phase power network shown in Fig. 1, the ratings of the various components are :

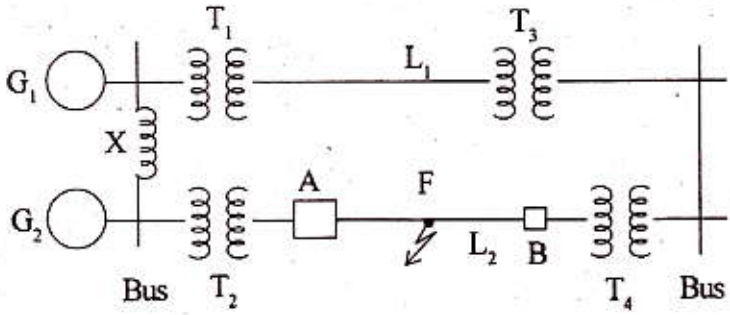

Fig. 1

Generators G_1 : 100 MVA, 0·30 pu reactance, Generator G_2 : 60 MVA, 0·18 pu reactance, Transforemrs (each) : 50 MVA, 0·10 pu reactance, Inductive reactor X : 0·20 pu on a base of 100 MVA, Lines (each) : 80 ohms (reactive); neglect resistance. With the network initially unloaded and a line voltage of 110 kV, a symmetrical short circuit occurs at mid point F of line L_2.

Calcualte the short circuit MVA to be interrupted by the circuit breakers A and B at the ends of the line. What would these values be, if the reactor X were eliminated ? Comment.

(c) Determine the symmetrical components of three voltages

$$V_a = 100\angle 0°,\ V_b = 200\angle 245°,\ V_c = 100\angle 105°\ V.$$

If the star connected load of 100 ohm each leg is connected, find the power consumed by 3-phase load.

(d) Derive an expression for maximum momentary current, if transient takes place on a transmission line, also draw the waveform of short circuit on a transmission line. Assume the conditions.

2. Attempt any **TWO** parts :— **10×2=20**

(a) Calculate :—

(i) the sub-transient fault current in each phase.

(ii) neutral fault current,

for the bolted line-to-ground fault from phase b to c to ground at bus 2 for the given Fig. 2. Neglect the Δ-Y transformer phase shifts.

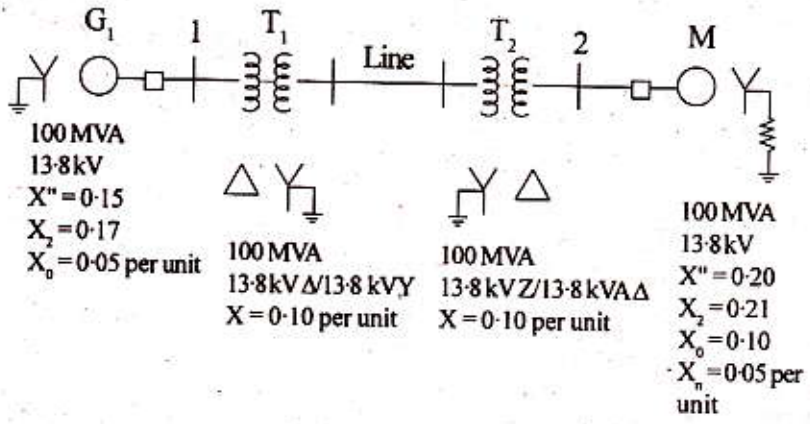

Fig. 2

(b) Develop the connection diagram of sequence networks for a single line-to-ground (LG) fault. Also find the expression for the fault current in terms of sequence currents in the fault conditions.

(c) Prove that for the transmission lines zero sequence impedance is much larger than the positive sequence impedance. Also discuss the effect of mutual inductances.

3. Attempt any **TWO** parts :— **10×2=20**

(a) Using the Gauss elimination, solve the following linear algebraic equations :

$$5x_1 - 2x_2 - 3x_3 = 4$$
$$-5x_1 + 7x_2 - 2x_3 = -10$$
$$-3x_1 - 3x_2 + 8x_3 = 6.$$

Find the three unknown x_1, x_2, x_3. Check your answers using Cramer's rule.

(b) Draw the flow chart algorithm for Newton-Raphson Load flow method. Also compare the Gauss-Siedel and Newton Raphson methods of load flow.

(c) For the network shown in Fig. 3, obtain the complex bus bar voltage at bus 2 at the end of the first iteration using the Gauss-Siedel method. Line impedances shown in figure are in pu. Given : Bus 1 is slack bus with $V_1 = 1{\cdot}0\angle 0°$

$$P_2 + Q_2 = -5{\cdot}96 + j1{\cdot}46$$
$$|V_3| = 1{\cdot}02$$

Assume :

$$V_3^0 = 1{\cdot}02\angle 0° \text{ and } V_2^0 = 1{\cdot}0\angle 0°.$$

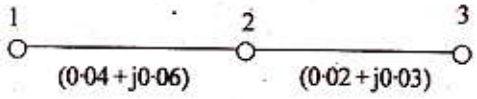

Fig. 3

4. Attempt any **TWO** parts :— **10×2=20**

(a) For improving the transient stability of power system, briefly discuss the following discrete supplementary control terms : (i) Dynamic Braking (ii) High Speed circuit breaker reclosing (iii) Independent control of excitation (iv) Series capacitor insertion (v) Generator Tripping.

(b) A three-phase, 60 Hz, 500 MVA, 13·8 kV, 4-pole steam turbine-generating unit has an H constant of 5·0 pu-s. Determine :—

(i) ω_{syn} and ω_{msyn};

(ii) the kinetic energy in joules stored in the rotating masses at synchronous speed;

(iii) the mechanical angular acceleration α_m and electrical angular acceleration α if the unit is operating at synchronous speed with an acceleration power of 500 MW.

(c) Discuss the effect of clearing time on the stability of power system, also derive the expression for critical clearing time and critical clearing angle.

5. Attempt any **TWO** parts :— **10×2=20**

(a) An overhead line with surge impedance 500 ohm bifurcates into two lines of surge impedance 500 ohm and 50 ohm, respectively. If a surge of 25 kV is incident on the overhead line, determine the magnitudes of voltage and current which enter the bifurcated lines.

(b) A unit-step voltage wave is travelling along a line of characteristic impedance Z_c. The line terminates in a shunt inductance L. Derive the expression for the voltage at the line and the inductance junction as a function of time.

(c) Derive an expression for travelling waves in overhead line; also mention interpretation from physical significance point of view.