

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

PAPER ID : 2498

Roll No.

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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 :— $6\frac{2}{3} \times 3 = 20$
- (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 :

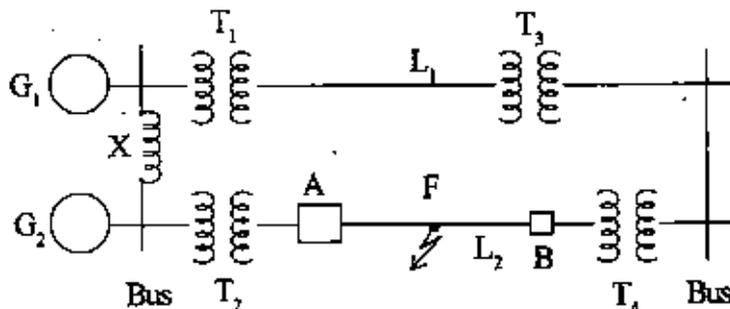


Fig. 1

Generators G_1 : 100 MVA, 0.30 pu reactance, Generator G_2 : 60 MVA, 0.18 pu reactance, Transformers (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 .

Calculate 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

$$V_a = 100 \angle 0^\circ, V_b = 200 \angle 245^\circ, V_c = 100 \angle 105^\circ \text{ V.}$$

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.

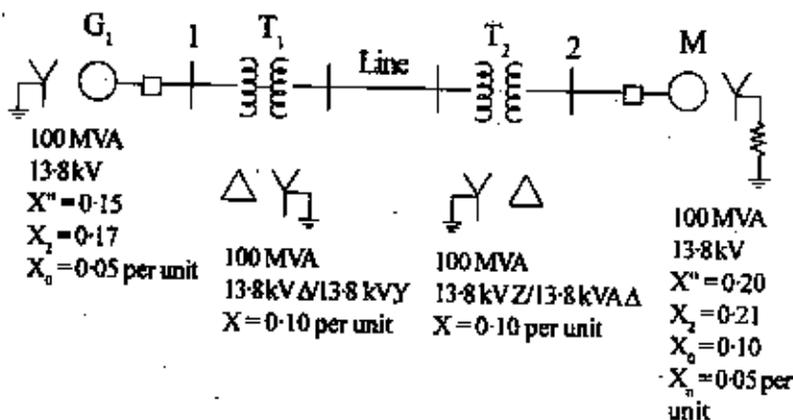


Fig. 2

- (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 $V_1 = 1.0 \angle 0^\circ$.

$$P_2 + Q_2 = -5.96 + j1.46$$

$$|V_3| = 1.02$$

Assume :

$$V_1^0 = 1.02 \angle 0^\circ \text{ and } V_2^0 = 1.0 \angle 0^\circ.$$

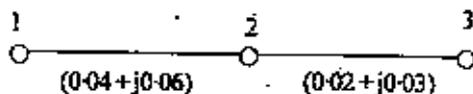


Fig. 3

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 :—
- ω_{syn} and ω_{max} ;
 - the kinetic energy in joules stored in the rotating masses at synchronous speed;
 - 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.