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Printed Pages : 7 **EN – 601**

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

PAPER ID : 2029 Roll No.

B. Tech.

(SEM. VI) EXAMINATION, 2006-07

POWER SYSTEM ANALYSIS

Time : 3 Hours] *[Total Marks : **100***

Note : *(1)* *Answer **all** questions.*

(2) In case of numerical problems assume data wherever not provided.

(3) Be precise in your answer.

1 Attempt any **three** parts of the following : $6\frac{2}{3} \times 3 = 20$

(a) What do you understand by single line and reactance diagram of a power system? Explain. Discuss the per unit system of analysing power system problems and its advantages.

(b) A 100 MVA, 33 kV, 3-phase generator has a subtransient reactance of 15%. The generator is connected to the motors through a transmission line and transformers as shown in Fig 1 (b). The motors have rated inputs of 30 MVA, 20 MVA and 50 MVA at 30 kV with 20% subtransient reactance.

The three-phase transformers are rated at 110 MVA, 32 kV Δ/110 kV γ with leakage reactance 8%. The line has a reactance of 50 ohms. Selecting the generator rating as the base quantities in the generator circuit, determine the base quantities in other parts of the system and evaluate the corresponding p.u. values.

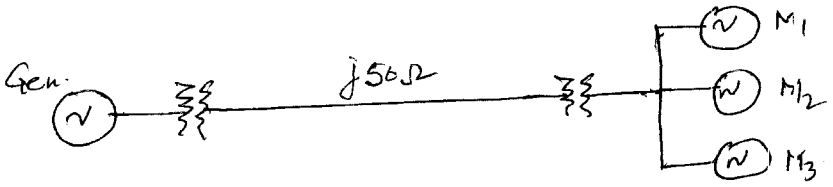

Fig. 1 (b)

(c) What are current limiting reactors? Discuss their locational aspects and advantages.

(d) Explain clearly the variation of current and impedance of an alternator when a 3-phase sudden short circuit takes place at its terminals.

(e) The line to ground voltages on the high voltage side of a transformer are V_a = 100 kV, V_b = 33kV and V_c = 38 kV on phases *a, b* and *c* respectively. The voltage of phase a leads that of phase *b* by 100° and lags that of phase *c* by 176.5°. Determine the symmetrical components of voltage phasor V_a.

2 Attempt any **two** parts of the following : **10×2=20**

(a) (i) Show that the zero sequence impedance of a 3-phase, star connected load with neutral grounded through an impedance Z_w is three times the Z_n.

(ii) Draw the zero sequence networks for the transformers of the following connections:

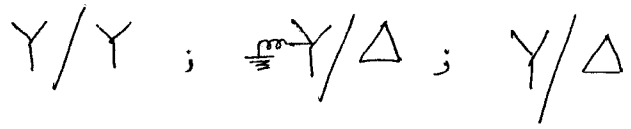

Fig. 2

(b) An unloaded synchronous generator, whose neutral is grounded through a reactance X_n, has balanced emfs and sequence reactances X_1, X_2 and X_o such that

$X_1 = X_2 > X_o$

(i) Draw the sequence networks of the generator as seen from the terminals.

(ii) Derive expression for fault current for a solid line-to-ground fault on phase *a*.

(iii) Show that, if the neutral grounded solidly, the LG fault current would be more than that of three-phase fault current.

(c) Determine the line-to-line to ground (L-L-G) fault current when the fault occurs at point F in the system shown in Fig 2(c). Both the generators are generating power at 1.0 p.u. voltage.

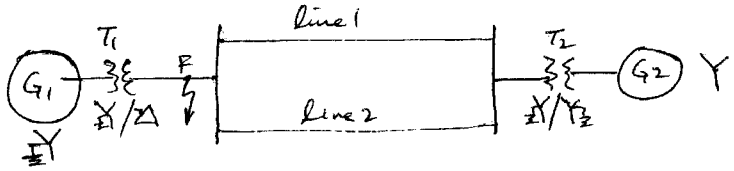

Fig. 3

The per unit reactances, all referred to the same base, are given in the following table:

	X_o	X_1	X_2
G_1	0.05	0.30	0.20
G_2	0.03	0.25	0.15
Line 1	0.70	0.30	0.30
Line 2	0.70	0.30	0.30
T_1	0.12	0.12	0.12
T_2	0.10	0.10	0.10

3 Attempt any **two** parts of the following : **10×2=20**

(a) Why is load flow study essential for a power system?

Formulate the mathematical model in polar form for a power system using Newton-Raphson method.

(b) (i) Discuss the procedure for representing a tap changing transformer in the formation of system matrix $[Y_{BUS}]$ for load flow study.

(ii) Explain the procedure for calculating line flows and line losses.

(c) For the network shown in figure 3(c), obtain the complex bus bar voltage at bus 2 at the end of first iteration. Use Gauss-Siedal method. Line impedances shown in figure are in p.u.

Given : Bus 1 in black bus with $V_1 = 1.00^o$

$P_2 + j\ Q_2 = -5.96 + j\ 1.46$ and $|V_3| = 1.02$

Assume : $V_3^\circ = 1.02 \angle 0^\circ$ *and* $V_2^\circ = 1 \angle 0^\circ$

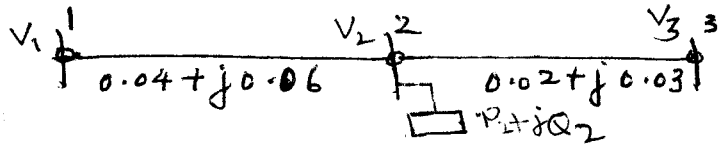

Fig. 3

4 Attempt any **two** parts of the following : **10×2=20**

(a) (i) Derive the swing equation of a synchronous machine connected to an infinite bus.

(ii) Deduce the condition of equal area criterion for transient stability analysis.

(b) (i) Using equal area criterion, discuss about the transient stability of a power system when sudden loss of one of parallel lines occurs in the system.

(ii) Explain the point by point solution technique of swing equation for transient stability study.

(c) Name various factors which affect the stability of a system. Discuss the role of automatic voltage regulator in improving transient stability.

5 Attempt any **three** parts of the following : $6\frac{2}{3} \times 3 = 20$

(a) Starting from the first principles show that surges behave as travelling waves.

(b) Why the indoor transformers are usually connected to the overhead lines through short length of cables? Explain.

(c) Discuss the reflection and refraction of a travelling wave drawing the Bewlay's Lattice diagram. Take a suitable example for explanation.

(d) A d.c. voltage source of unit voltage is switched on to a lossless transmission line with surge impedance Z_S terminated at far end by a lumped resistance R. The ratio $R/Z_s = 3$. The line length is 150 km. Draw the Bewley's Lattice diagram for the voltage and current.

(e) Discuss the behaviour of a travelling wave when it reaches :

(i) short circuited transmission line and

(ii) line terminated with an inductance.
