NEW SCHEME

EE61

USN

Sixth Semester B.E. Degree Examination, July/August 2005

Electrical & Electronics Engineering

Power System Analysis & Stability

Time: 3 hrs.] [Max.Marks : 100

Note: ***Answer any FIVE full questions.***

1. (a) Explain the advantages of per unit system. **(6 Marks)**

   (b) Draw the impedance diagram for the power system shown in fig.Q. 1.b and mark on it the per unit impedances calculated on a base of 50 MVA, 13KV in the circuit of generator G_1

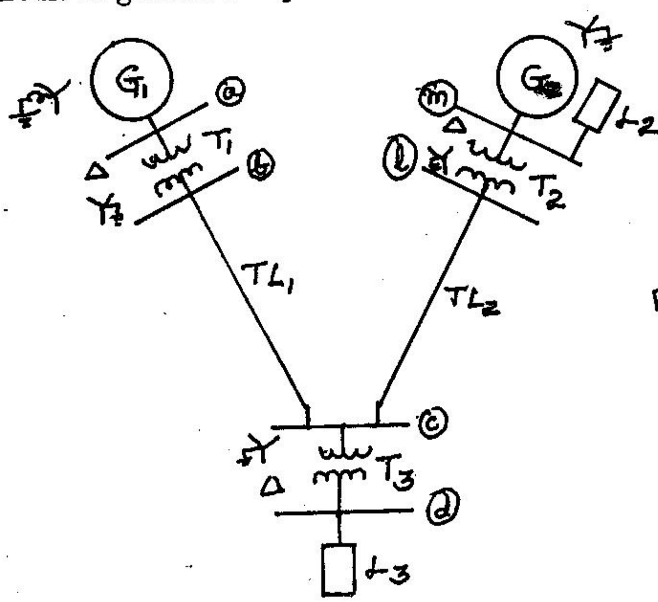


Fig Q1b.

Power system component	Rating
Generator G_1	$25MVA,\ 13KV, X''_d = 0.15Pu$
Transformer T_1	$30MVA,\ 220Y/13.8\triangle KV,\ X = 10\%$
Transmission line TL_1	$j60$ ohms
Transformer T_3	Bank of 1Φ transformers,
	each rated $10MVA,\ 127/18KV,\ X = 8\%$
Load L_3	$4 + j2$ ohms
Transmission Line TL_2	$j90$ ohms
Transformer T_2	$40MVA,\ 220/20KV,\ X = 12\%$
Generator G_2	$35MVA,\ 22\ KV, X''_d = 0.12Pu$
Load L_2	$3 + j1$ Ohms

(14 Marks)

2. (a) Explain why $x_d'' < x_d' < x_d$ for a synchronous m/c. (8 Marks)

(b) In a power system, a generator G is connected to two motors M_1 & M_2 in parallel, through a transformer T_1 at the sending end and a transformer T_2 at the receiving end connected through a transmission line TL. If a solid 3Φ symmetrical fault occurs between M_2 & the 3 cycle circuit breaker connected to that motor, determine the interrupting current of the circuit breaker. The ratings and Pu impedances on the respective ratings for the different components of the power system are as follows :

$G: 50MVA,\ 11KV, x_d'' = j0.09Pu$; $M_1 \& M_2$; $25MVA, 11KV, x_d'' = j0.04Pu$, $x_d' = j0.06Pu$,

$T_1: 75MVA,\ 11/66KV,\ X = 12\%$
$T_2: 60MVA,\ 11/66KV,\ X = 12\%$:
$TL: j7$ ohm

Prefault currents : $M_1 - 15MW$, Unity PF, $10.45KV$
$M_2 - 18MW$, $0.6PF\ lag$, $10.45KV$

Choose a base of 50 MVA, 11 KV in the generator circuit. (12 Marks)

3. (a) In the circuit shown in fig Q 3a, i) find the potential of the neutral of the load with that of the source ii) Find the symmetrical components of load currents.

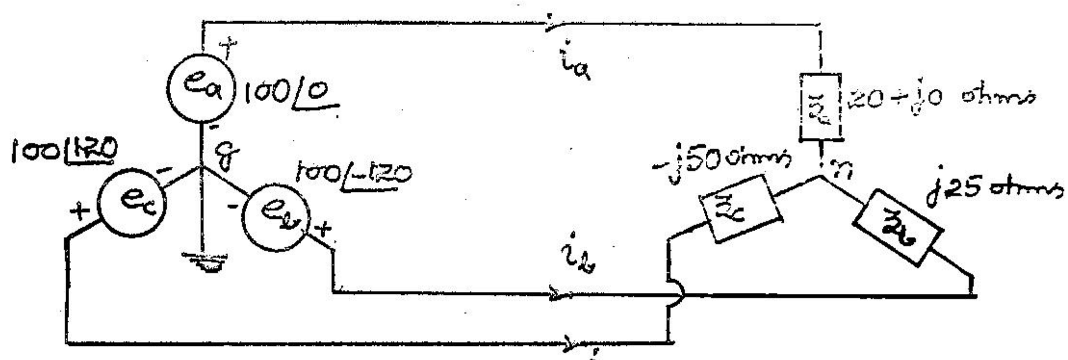


Fig Q3a

(14 Marks)

(b) Derive an expression for complex power in terms of symmetrical components. (6 Marks)

4. (a) With the help of relevant vector diagrams for voltages and currents, establish the phase shift of symmetrical components in $Y - \Delta$ transformers. Assume the HT side to be star connected and the LT side to be Δ connected. (14 Marks)

(b) List the types of short circuit faults at the terminals of a previously unloaded 3Φ synchronous generator in the increasing order of severity, and briefly justify. (6 Marks)

5. (a) Explain why

i) + ve & – ve sequence synchronous reactances are not equal for a synchronous generator.

ii) Zero seq reactance of a synchronous generator is practically same as the armature leakage reactance

iii) Zero sequence reactance of a transmission line is higher than its +ve or -ve sequence reactance. (12 Marks)

(b) Draw the + ve, - ve & zero sequence networks for the power system shown in the fig Q. 5.b

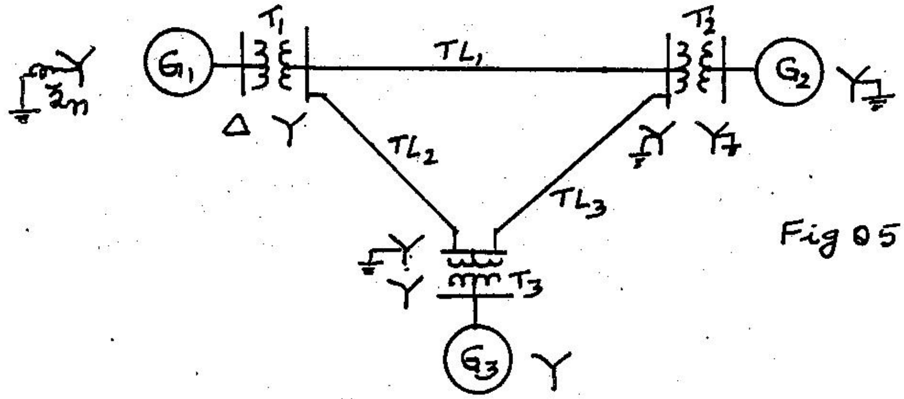


Fig Q5b

Impedance data in Pu on a common base :

Power system component	Impedance		
	+ ve sequence	- ve sequence	Zero sequence
G_1, G_2, G_3	j 0.12	j 0.08	j0.03
T_1, T_2, T_3	j 0.1	j 0.1	j0.1
TL_1, TL_2, TL_3	j0.08	j0.08	j0.12

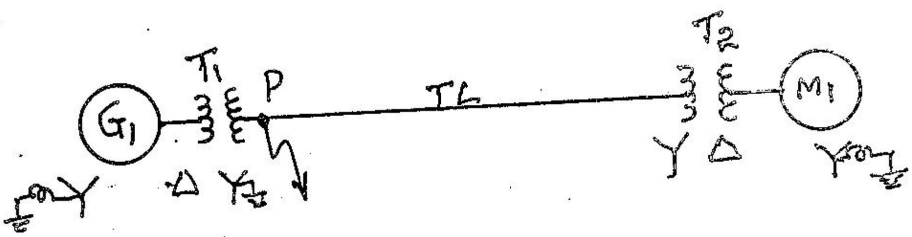
Pu impedance z_n in the neutral of $G_1 : j0.02\ Pu$ **(8 Marks)**

6. (a) Establish the interconnection of sequence networks for i) Single line open conductor fault ii) Double line open conductor fault. **(8 Marks)**

(b) The data for the power system shown in fig Q 6.b is as follows :

G_1, M_1 : $100MVA, 20KV,\ X'' = X_2 = 20\%,\ X_0 = 4\%$
$T_1,\ T_2$: $100MVA, 345Y/20\triangle\ KV,\ X = 8\%$

Transmission line : $X_1 = X_2 = 15\%,\ X_0 = 20\%$ on a base of $100MVA,\ 34.5KV$. A DLGF occurs at P through a fault impedance of $j0.02Pu$ (on a base of $100MVA,\ 345KV$). Find current in the line 'a' of the generator G_1. Ignore prefault current. Assume fault on lines b & c.



(12 Marks)

7. (a) Bring out the difference between steady state stability and transient stability and derive the swing equation for a synchronous machine connected to infinite bus. **(10 Marks)**

(b) Explain the difference between the inertia constants M & H. Establish the relation between them. What is the unique advantage of using H instead of M in stability studies? (10 Marks)

8. (a) Given $P_1 = P_{max}\ sin\delta$; $P_2 = \gamma_2 P_{max}\ sin\delta$; $P_3 = \gamma_3\ P_{max}\ sin\delta$ as the power angle equations respectively for the prefault, during the fault and post fault conditions, derive an expression for the critical clearing angle if $P_1 = P_0$ before the occurence of fault. (10 Marks)

(b) In a two m/c system a generator is delivering a power of $0.5Pu$ and its power angle equation is given by $P_1 = 1.5sin\delta$. Due to a fault the power angle equation changes to $P_2 = 0.7sin\ \delta$. If the fault is sustained, investigate the stability of the generator. (10 Marks)

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