USN

10EE61

Sixth Semester B.E. Degree Examination, June/July 2014

Power System Analysis and Stability

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. 2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Draw the impedance diagram for the power system shown in Fig.Q1(a) and mark on it the per unit impedances calculated on a base of 50 MVA, 13 kV in the circuit of generator 1.

Power system component	Rating
Generator G_1	25 MVA, 13 kV, $X_d'' = 0.15$ PU
Generator G_2	35 MVA, 22 kV, $X_d'' = 0.12$ PU
Transformer T_1	30 MVA, 220Y/13.84 kV X = 10%
Transformer T_2	40 MVA, 220/20 kV X = 12%
Transformer T_3	Bank of 1ϕ Transformers, each rated 10 MVA, 127/18 kV X = 8%
Load, L_A	3+j1 Ω
Load, L_B	4+j2 Ω
Transmission Line TL_1	j60 Ω
Transmission Line TL_2	j90 Ω

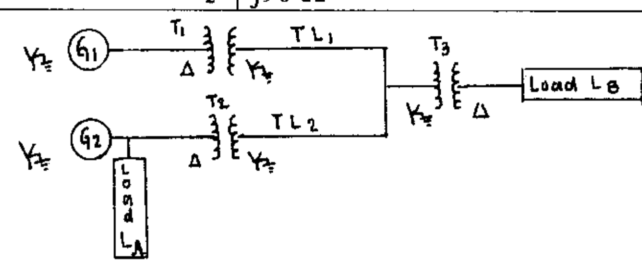


Fig.Q1(a) **(12 Marks)**

b. Write in matrix form, the node equations necessary to solve for the voltages of numbered buses as shown in Fig.Q1(b). All the impedances are marked in per unit. The emf's shown are $E_a = 1.5\angle 0°$, $E_b = 1.5\angle -36.87°$ and $E_c = 1.5\angle 0°$. **(08 Marks)**

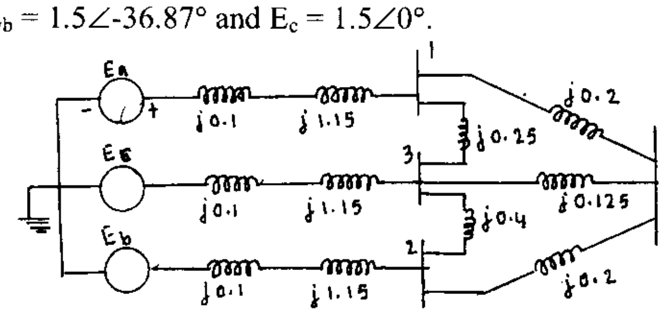


Fig.Q1(b)

2 a. Explain in detail the transients on a transmission line. **(08 Marks)**

b. For the radial network shown in Fig.Q2(a), a 3 phase fault occurs at F. Determine the fault current and line voltage at 11 kV bus under fault condition. Select a base of 100 MVA, 11 kV on generator side. **(12 Marks)**

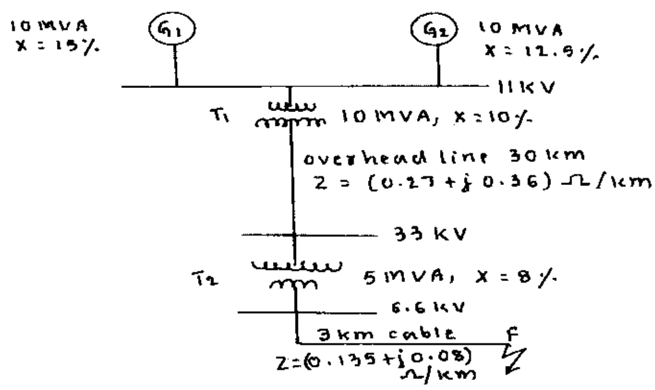


Fig.Q2(a)

3 a. Prove that a balanced set of 3-phase voltages will have only positive sequence components of voltages only. **(06 Marks)**

b. A delta connected balanced resistive load is connected across an unbalanced 3-phase supply as shown in Fig.Q3(b). With currents in lines A and B specified, find the symmetrical components of line currents. Also, find the symmetrical components of delta currents (phase currents). **(14 Marks)**

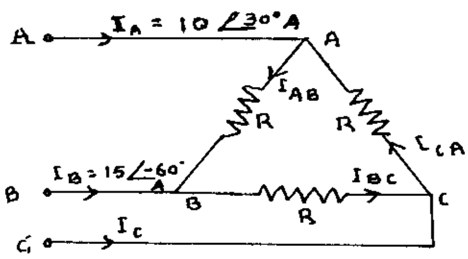
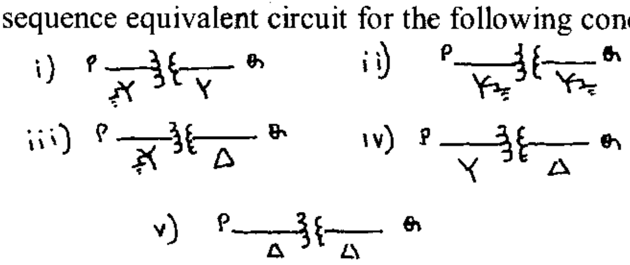


Fig.Q3(b)

4 a. Draw the zero sequence equivalent circuit for the following conditions of transformer:



(10 Marks)

b. Draw the positive, negative and zero sequence networks for the power system shown in Fig.Q4(b). Choose a base of 50 MVA, 220 kV in the 50 Ω transmission lines. Mark all the reactances in p.u. The ratings of the generators and transformers are

Gen G_1 : 25 MVA, 11 kV, X″ = 20%

Gen G_2 : 25 MVA, 11 kV, X″ = 20%

Three phase transformers (each): 20 MVA, 11Y/220Y kV, X = 15%

The negative sequence reactance of each synchronous machine is equal to its subtransient reactance. The zero sequence reactance of each machine is 8%. Assume that zero sequence reactance of lines are 250% of their positive reactances. **(10 Marks)**

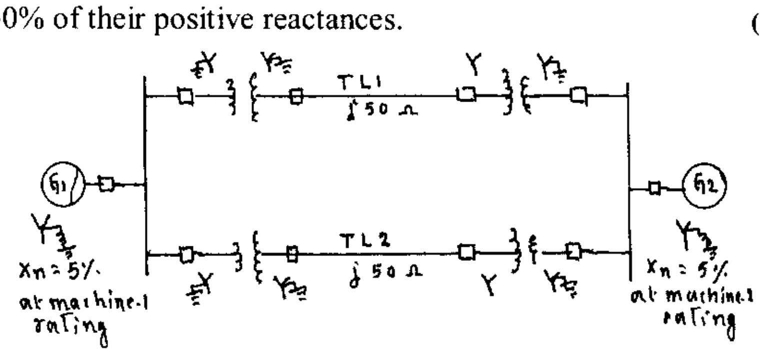


Fig.Q4(b)

PART – B

5 a. Draw the interconnected sequence networks for the following cases:
(i) L-G fault through fault impedance z_f
(ii) L-L fault through fault impedance z_f
(iii) L-L-G fault through fault impedance z_f
clearly indicating positive, negative and zero sequence impedance, symmetrical components of voltages and currents. Also, write the expressions for fault current in the above three cases. **(12 Marks)**

b. A three phase generator with line-to-line voltages of 400 V is subjected to L-L-G fault. If Z_1=j2 Ω, Z_2=j0.5 Ω and Z_0=j0.25 Ω. Determine the symmetrical components of currents and fault current. **(08 Marks)**

6 a. Derive an expression for fault current in case of line-to-ground fault on an unloaded generator. **(10 Marks)**

b. Draw the sequence networks for the system shown in Fig.Q6(b). Determine the fault current if a line-to-line fault occurs at point F. The p.u. reactances all referred to the same base are as follows. Both the generators are generating 1.0 p.u.

Component	X_0	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

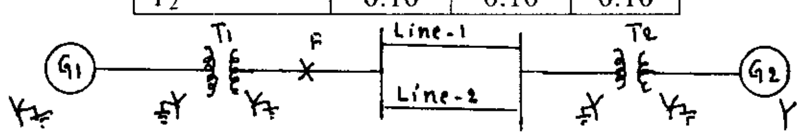


Fig.Q6(b) **(10 Marks)**

7 a. A turbo generator, 6 pole, 50 Hz of capacity 80 MW working at 0.8 p.f. has an inertia of 10 MJ/MVA.
i) Calculate the energy stored in the rotor at synchronous speed.
ii) Find rotor acceleration if the mechanical input is suddenly raised to 75 MW for an electrical load of 60 MW.
iii) Supposing the above acceleration is maintained for a duration of 6 cycles, calculate the change in torque angle and rotor speed at the end of 6 cycles. **(10 Marks)**

b. Explain the equal area criterion when there is sudden loss of one of the parallel lines. **(10 Marks)**

8 a. A load free alternator supplies 50 MW to an infinite bus, the steady state stability being 100 MW, determine if the alternator will remain stable if the input to alternator is abruptly increased by 40 MW. **(08 Marks)**

b. Write short notes on any three of the following :
i) Analysis if three phase induction motor with unbalanced voltage
ii) Methods of improving steady state stability
iii) Impedance and reactance diagram
iv) Swing curve
v) Selection of circuit breakers. **(12 Marks)**

* * * * *