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Question Paper Code : X 10399

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020

Fifth Semester

Electrical and Electronics Engineering

EE 8501 – POWER SYSTEM ANALYSIS

(Regulations 2017)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Give the representation of an off nominal transformer in power system.
2. Give the bus incidence matrix for the given power system.
3. State at least four applications of power flow studies in the planning and operation of electric power systems.
4. What is the need of slack bus for load flow analysis ?
5. Define Fault level of a bus in power system, give the expression in per unit.
6. What is the advantage of symmetrical components ?
7. The Z-bus method is very suitable for fault studies on large systems rather than Y bus. Why ?
8. Name the faults in which zero sequence currents are absent.
9. Define rotor angle stability.
10. State the significance of critical clearing time.

PART – B **(5×13=65 Marks)**

11. a) Fig. 1 shows a single-line diagram of a power system. The ratings of generators and transformers are :

Generator G_1 : 30 MVA, 6.6 kV, j0.2 pu

Generator G_2 : 15 MVA, 6.6 kV, j0.15 pu

Motor M_1 : 15 MVA, 6.6 kV, j0.15 pu

Transformer T_1 : 30 MVA, 6.6 Δ – 115 Y kV, j0.2 pu

Transformer T_2 : 15 MVA, 6.6 Δ – 115 Y kV, j0.1 pu

Transformer T_3 : 15 MVA, 6.6 Δ – 115 Y kV, j0.1 pu

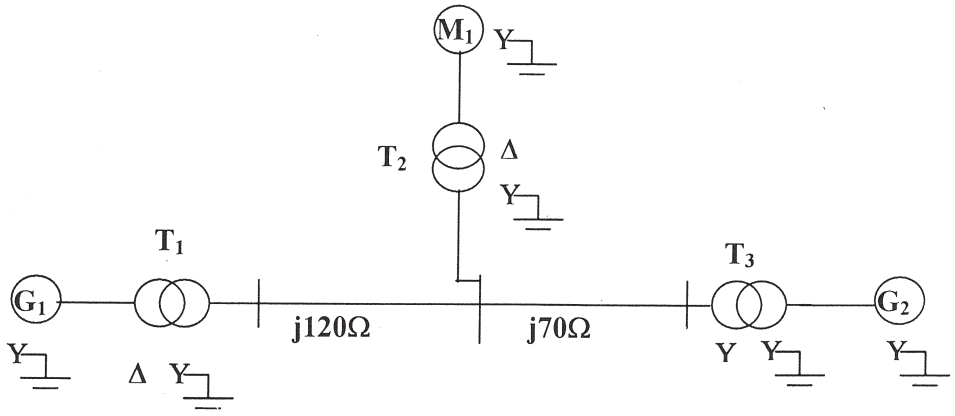

Fig. 1

Draw impedance diagram with all values in pu on a base of 30 MVA, 6.6 kV in the circuit of generator G_1. **(13)**

(OR)

b) i) Subtransient reactance of a 500 MVA, 18 kV generator is 0.25 pu on its ratings. It is connected to a network through a 20/400 kV transformer. Find out the subtransient reactance of the generator on a base of 100 MVA and 20 kV. **(4)**

ii) Derive the Π model for a transformer with off-nominal tap-ratio. **(9)**

12. a) Fig. 2 shows the one-line diagram of a simple three-bus power system with generation at bus 1. The line impedances are marked in per unit on a 100 MVA base. Find out the bus voltages after two iterations using Gauss-Seidel method. **(13)**

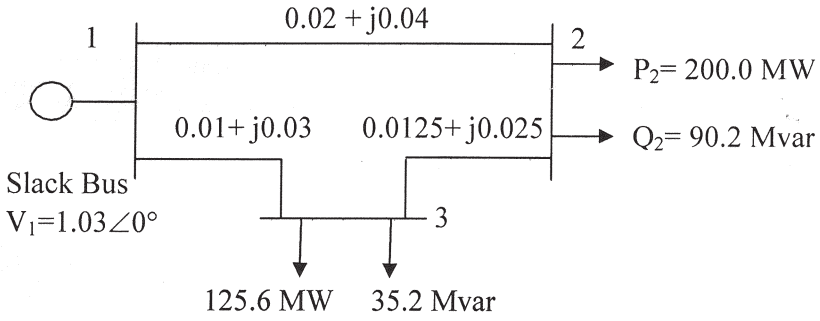

Fig. 2

(OR)

b) A sample system is described in Fig. 3. The line data, bus data and load flow results are given Table 1 and 2. Compute the following :

i) Slack bus power. **(4)**

ii) Reactive Power Generation from G2. **(3)**

iii) Line flows. **(3)**

iv) Line losses. **(3)**

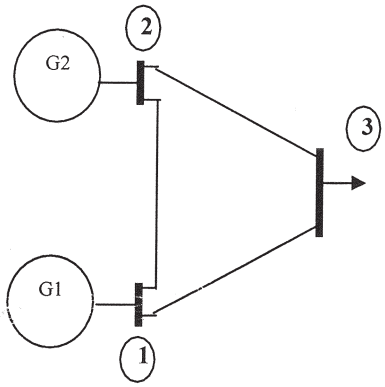

Fig. 3

Table 1 Line Data

Line	Admittance	Half line charging admittance
1-2	1.47 – j5.88	j0.15
1-3	2.94 – j11.77	j0.07
2-3	2.75 – j9.17	j0.04

Table 2 Bus Data and Load Data

Bus	Bus voltage	Generation		Load	
		MW	MVAR	MW	MVAR
1	1.04∠0°	--	--	0	0
2	1.02∠–3.09°	100	-	50	20
3	0.93∠–7.01°	0	0	250	150

13. a) A synchronous generator and motor are rated 30000 kVA, 13.2 kV and both have subtransient reactances of 20%. The line connecting them has a reactance of 10% on the base of the machine ratings. The motor is drawing 20000 kW at 0.8 p.f. leading and a terminal voltage of 12.8 kV when a symmetrical three-phase fault occurs at the motor terminals. Find the subtransient currents in the generator, the motor, and the fault by using the internal voltages of the machines. **(13)**

(OR)

b) Deduce the Z bus building algorithm. Illustrate the step by step procedure of Z bus formulation. **(13)**

14. a) Derive the relationship for fault currents in terms of symmetrical components when there is a line-to-line (L-L) fault between phase b and c. Also draw a diagram showing interconnection of sequence networks for L-L fault. **(13)**

(OR)

b) A single line to ground fault (phase a) occurs in a transmission system at transformer T1 star terminal. Draw the sequence network. Find current fed to fault.

Given :

Rating of generator is 1200 kVA, 600 V with $X' = X_2 = 10\%$, $.X_0 = 5\%$

Rating of each machine is 600 kVA, 600 V with $X' = X_2 = 12\%$, $.X_0 = 6\%$

Each transformer is rated 1200 MVA, 600 V on delta side and 3.3 kV on star side, with leakage reactance of 5%.

Reactance of the transmission line is $X_1 = 10\%$, $X_2 = 10\%$, $X_0 = 20\%$. **(13)**

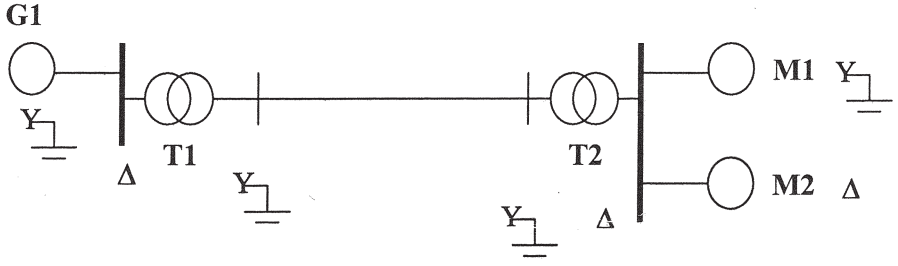

Fig. 4

15. a) What is Equal Area Criterion ? Using equal area criterion, drive an expression for critical clearing angle and critical clearing time for a system having a generator feeding a large system through a double circuit line with a temporary three-phase bolted fault on one of the line at the sending end. **(13)**

(OR)

b) Discuss the procedure for solving the swing equation using modified-Euler method. **(13)**

PART – C **(1×15=15 Marks)**

16. a) Fig. 5 shows transmission network. The pu reactances of the equipments are as shown. The voltage behind transient reactance of generator is 1.1 pu. The system is transmitting 1 pu real power when fault occurs at the middle of one of the line. Determine :

i) transfer reactance for prefault, during fault and post fault conditions and **(8)**

ii) critical clearing angle for the fault at the mid-point of the line. **(7)**

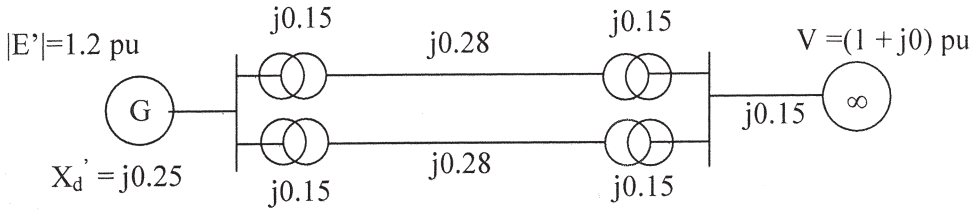

Fig. 5

(OR)

b) The one line diagram of a simple power system is shown in Fig. 6. The neutral of each generator is grounded through a current-limiting reactor of 0.25/3 pu on a 100 MVA base. The system data expressed in per unit on a common 100 MVA base is tabulated below. The generators are running on no-load at their rated voltage and rated frequency with their emfs in phase. Using bus impedance matrix determine the fault current for a single line to ground fault at bus 3 through a fault impedance Z_f = j0.1 pu. Also determine the bus voltages and line currents during fault. **(15)**

Element	Base MVA	V-rating	X_1	X_2	X_0
G1	100	20 kV	0.15	0.15	0.05
G2	100	20 kV	0.15	0.15	0.05
T1	100	20/220 kV	0.1	0.1	0.1
T2	100	20/220 kV	0.1	0.1	0.1
L12	100	220 kV	0.125	0.125	0.3
L13	100	220 kV	0.15	0.15	0.35
L23	100	220 kV	0.25	0.25	0.7125

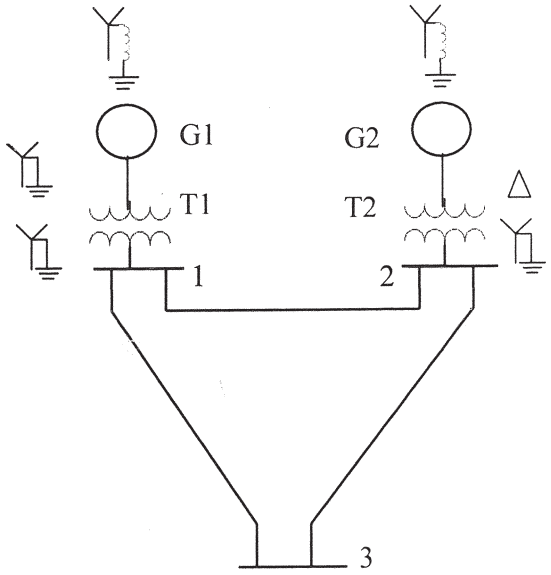

Fig. 6