CBCS SCHEME

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18EE62

Sixth Semester B.E. Degree Examination, June/July 2024
Power System Analysis – I

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Show that per unit impedance of a transformer remains same whether it is referred to HV or LV winding. **(08 Marks)**

b. Draw the per unit reactance diagram for the power system shown in Fig.Q1(b). The ratings of the various components are:

G_1 : 10 MVA, 6.6 KV, X″ = 0.1 PU

G_2 : 20 MVA, 11.5 KV, X″ = 0.1 PU

T_1 : 10 MVA, 3 phase, 6.6/115 KV, X = 0.15 PU

T_2 : 3 single phase units each rated 10 MVA 7.5/75 KV, X = 0.1 PU

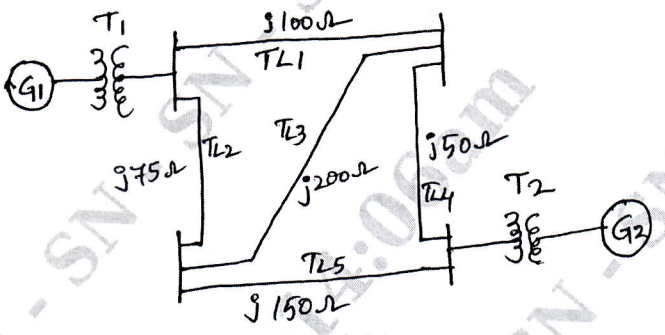

Fig.Q1(b)

Selecting generator 1 ratings as the base **(12 Marks)**

OR

2 a. Define per unit quantity. Mention its advantages. **(06 Marks)**

b. Draw the reactance diagram with all reactances marked in per unit. Choose a base of 50 MVA, 13.8 KV in the circuit of generator 1. For the system shown in Fig.Q2(b).

G_1 : 20 MVA, 13.8 KV, X″ = 0.20 PU

G_2 : 30 MVA, 18 KV, X″ = 0.20 PU

G_3 : 30 MVA, 20 KV, X″ = 0.20 PU

T_1 : 25 MVA, 220 Y/13.8Δ KV, X = 10%

T_2 : Single phase units each rated 10 MVA, 127/18 KV, X = 10%

T_3 : 35 MVA, 220 Y/22 Y KV X = 10%

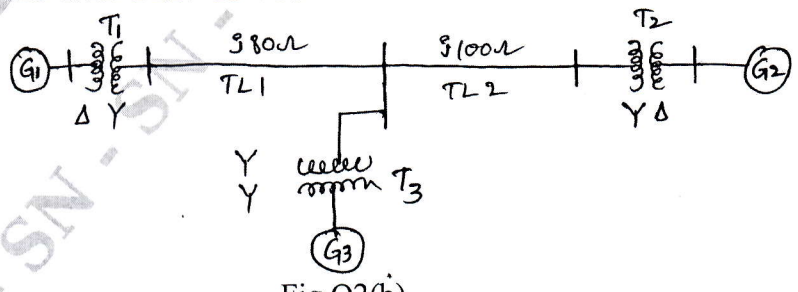

Fig.Q2(b) **(10 Marks)**

c. Mention the assumptions made while drawing the impedance diagram. **(04 Marks)**

Module-2

3 a. With the help of oscillogram of short circuit current of a synchronous generator operating at no load. Explain subtransient, transient and steady state periods. **(10 Marks)**

b. Fig.Q3(b) shows a generating station, feeding 132 KV system. Determine fault current, fault level, fault currents supplied by generators for a 3 phase fault at the receiving end of the bus. The line is 200 km long. Take a base of 100 MVA, 11 KV on the generator circuit.

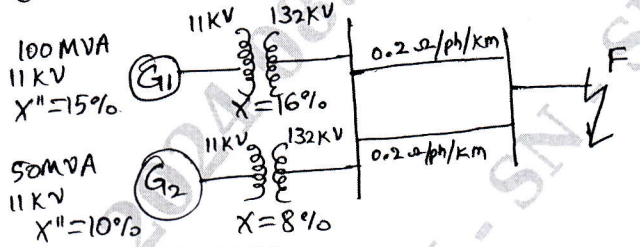

Fig.Q3(b) **(10 Marks)**

OR

4 a. What is doubling effect in transmission line? Explain with suitable waveforms and diagram. **(10 Marks)**

b. A 75000 KVA, 6.6 KV generator connected through a 5 cycle breaker has reactance $X''_d = 9\%$, $X'_d = 15\%$ and $X_d = 100\%$. It is operating at no load and at rated terminal voltage, when a short circuit occurs beyond the circuit breaker. Find:

(i) Sustained short circuit current
(ii) Initial symmetrical rms current
(iii) Maximum possible DC offset current after 5 cycles
(iv) Making capacity required
(v) Braking capacity required
(vi) Interrupting MVA **(10 Marks)**

Module-3

5 a. Define symmetrical components. Resolve an unbalanced 3 phase voltages of a power system into the symmetrical components and also in vice versa. **(08 Marks)**

b. The line to neutral voltage in a 3 phase system are $V_{an} = 200\angle 0^\circ$ V, $V_{bn} = 200\angle 100^\circ$ V and $V_{cn} = 400\angle 270^\circ$ V. Find symmetrical components of the voltages. **(06 Marks)**

c. Draw the zero sequence impedance networks of a transformer for the following connections:
i) $Y_{\perp}$-Y ii) $\Delta - Y_{\perp}$ iii) $\Delta - \Delta$ **(06 Marks)**

OR

6 a. What are sequence impedances and networks? Explain sequence impedances and networks of synchronous generator. **(10 Marks)**

d. Draw positive, negative and zero sequence networks for the power system shown in Fig.Q6(b). Choose a base of 50 MVA, 220 KV in the 50Ω transmission line.

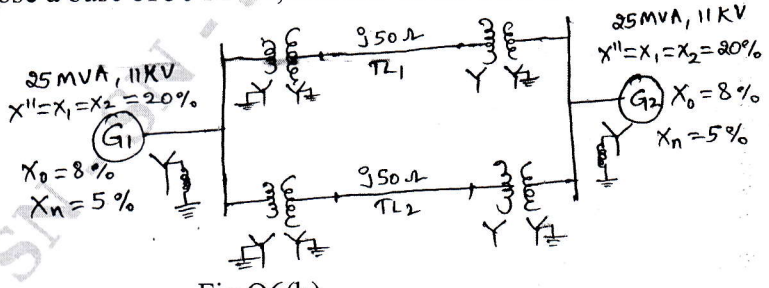

Fig.Q6(b)

Assume transmission line $X_0 = 250\%$ of X_1.
Three transformers (each) : 20 MVA, 11 Y/220Y KV, X = 15%. **(10 Marks)**

Module-4

7 a. Derive an expression for single line to ground (SLG) fault through impedance (Z_f) in a power system. Show the interconnection of sequence networks. **(08 Marks)**

b. A synchronous motor is receiving power of 10 MW at 0.8 PF lagging at a voltage of 6 KV as shown in Fig.Q7(b). A SLG fault occurs at the middle of the transmission line through fault reactance of 5 Ω. Determine the fault current. The ratings of the apparatus are:
G : 20 MVA, 11 KV, $X_1 = 0.2$ PU, $X_2 = X_0 = 0.1$ PU
T_1 : 18 MVA, 11.5/34.5 KV, $X_1 = X_2 = X_0 = 0.1$ PU, $X_n = 0.066$ PU
T_2 : 15 MVA, 34.5/6.9 KV, $X_1 = X_2 = X_0 = 0.1$ PU
Motor : 15 MVA, 6.9 KV, $X_1 = 0.2$ PU, $X_2 = X_0 = 0.1$ PU, $X_n = 0.066$ PU
Tr. Line : $X_1 = X_2 = 5\Omega$, $X_0 = 20\ \Omega$
Choose 20 MVA, 11 KV on G circuit.

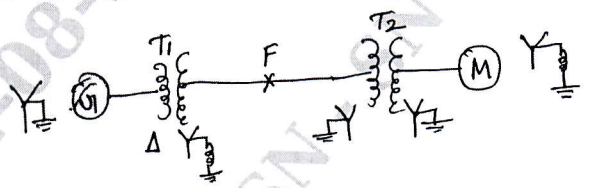

Fig.Q7(b) **(12 Marks)**

OR

8 a. Discuss one conductor and two conductor open faults. **(10 Marks)**

b. Derive an expression for fault current when line to line (LL) fault occurs in a power system through fault impedance. **(10 Marks)**

Module-5

9 a. Explain the classification of power system stability. **(08 Marks)**

b. Derive the expression for swing equation. **(06 Marks)**

c. A 60 Hz, 4 pole turbo-generator rated 500 MVA, 22 KV has an inertia constant H = 7.5 MW-sec/MVA. Find:
(i) Kinetic energy stored in the rotor at the synchronous speed.
(ii) The angular acceleration, if electrical power developed is 400 MW, when the input less rotational losses is 740000 HP
(iii) Moment of inertia
(iv) Inertia constant M and angular acceleration **(06 Marks)**

OR

10 a. Explain the concept of equal area criterion when a power system is subjected to sudden increase in load. **(08 Marks)**

b. Write short note on critical clearing angle and critical clearing time. **(06 Marks)**

c. Mention the factors affecting transient stability. **(06 Marks)**

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