CBCS SCHEME

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21EE53

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.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. Define per unit quantity. Show that the per unit impedance of a transformer is same irrespective of the side on which it is calculated. **(08 Marks)**

b. Fig.Q1(b) shows the schematic diagram of a radial transmission system. The ratings and reactances of various components are also shown. A load of 60 MW at 0.9 p.f. lagging is tapped from the 66 KV substation which is to be maintained at 60 KV. Calculate the terminal voltage of the machine. Represent the transmission line and transformer by series reactances only.

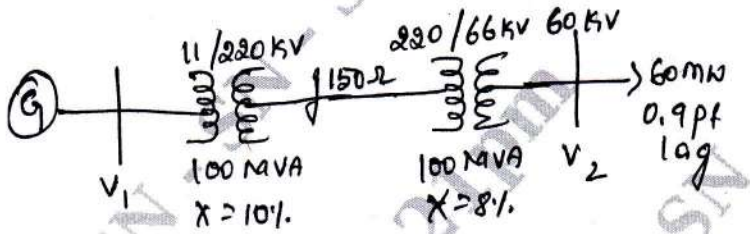

Fig.Q1(b) **(12 Marks)**

OR

2 a. Define impedance and reactance diagrams. Explain with the help of typical electrical power system. **(08 Marks)**

b. Draw the reactance diagram of the system shown in Fig.Q2(b). The ratings of the components are:

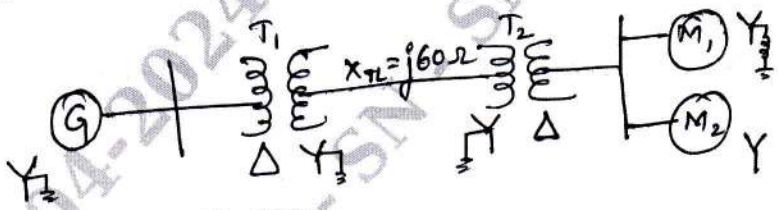

Fig.Q2(b)

G : 15 MVA, 6.6 KV, X″ = 12% T_1 : 20MVA, 6.6/66 KV, X = 8%

T_2 : 20 MVA, 66/6.6 KV, X = 8% M_1 and M_2 : 5 MVA, 6.6 KV, X″ = 20% **(12 Marks)**

Module-2

3 a. Explain clearly the variation of current and impedance of an alternator when is 3ϕ sudden short circuit occurs at its terminals. **(08 Marks)**

b. A synchronous generator and motor are rated for 30,000 KVA, 13.2 KV and both have subtransient reactance of 20%. The line connecting them has a reactance of 10% on the base of machine ratings. The motor is drawing 20,000 KW at 0.8 p.f. leading. The terminal voltage of the motor is 12.8 KV. When a symmetrical 3ϕ fault occurs at motor terminals, find the subtransient current in generator, motor and at the fault point. Solve using Kirchoff's laws. **(12 Marks)**

OR

4 a. Write a short note on selection of circuit breakers. **(08 Marks)**

b. A 25 MVA, 13.8 KV generator with X''_d = 15% is connected through a transformer to a bus that supplies four identical motors as shown in Fig.Q4(b). Each motor has X''_d = 20% and X'_d = 30% on a base of 5 MVA, 6.9 KV. The three phase rating of the transformer is 25 MVA, 13.8 – 6.9 KV, with a leakage reactance of 10%. The bus voltage at the motors is 6.9 KV when a three phase fault occurs at point P. For the fault specified, determine:

(i) Subtransient current in the fault
(ii) Subtransient current in the breaker A
(iii) Momentary current in breaker A
(iv) Current to be in interrupted by breaker in 5 cycles.

Assume X''_{dc_1} = j0.15.

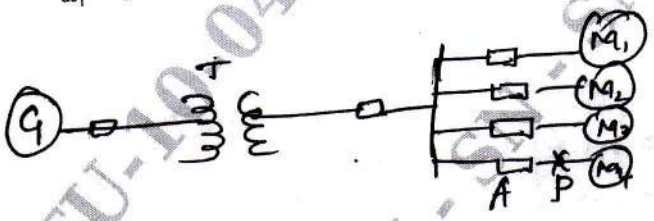

Fig.Q4(b) **(12 Marks)**

Module-3

5 a. Prove that a balanced set of 3ϕ voltages will have positive sequence components of voltages only. **(08 Marks)**

b. A delta connected balanced resistive load is connected across an unbalanced three phase supply as shown in Fig.Q5(b), find the symmetrical components of line current and delta current.

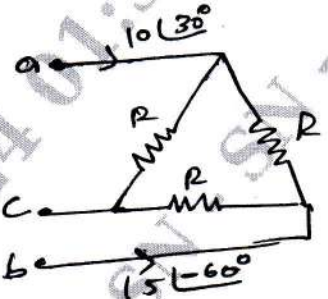

Fig.Q5(b) **(12 Marks)**

OR

6 a. Obtain the relation sequence components of phase and line voltages in star connected systems. **(10 Marks)**

b. A 250 MVA, 11 KV, 3ϕ generator is connected to a large system through a transformer and a line as shown in Fig.Q6(b).

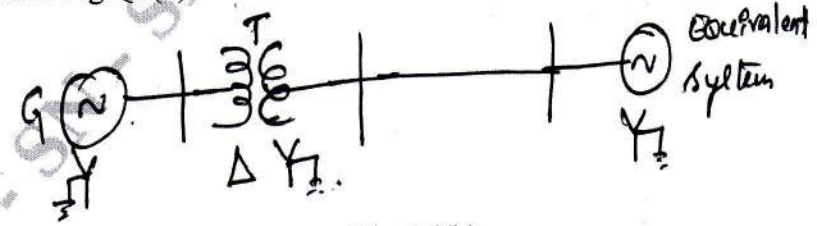

Fig.Q6(b)

The parameters on 250 MVA base are:
G : $X_1 = X_2 = 0.15$ pu, $X_0 = 0.1$ pu
Transformer : $X_1 = X_2 = X_0 = 0.12$ pu
Line : $X_1 = X_2 = 0.25$ pu, $X_0 = 0.75$ pu
Equivalent system : $X_1 = X_2 = X_0 = 0.15$ pu
Draw the sequence network diagrams for the system and indicate all per unit values. **(10 Marks)**

Module-4

7 a. For a double line to ground fault on an unloaded generator, derive the equation for fault current and draw the interconnected sequence network. **(10 Marks)**

b. A three phase, 50 MVA, 11 KV, star connected neutral solidly grounded generator operating on an no load at rated voltage gave the following sustained fault current for the faults specified.
Three phase fault – 2000 A
Line to line fault – 1800 A
Line to ground fault – 2200 A
Determine the three sequence reactances in ohms and pu. **(10 Marks)**

OR

8 a. Explain the series types of faults in a power system. **(06 Marks)**

b. A three phase generator with an open circuit voltage of 400 V is subjected to an LG fault through a fault impedance of j2Ω. Determine the fault current in $Z_1 = j4\Omega$, $Z_2 = j2\Omega$ and $Z_0 = j1\Omega$. Solve the problem for LL and LLG fault. **(14 Marks)**

Module-5

9 a. Derive power system stability and differentiate between steady stability and transient stability. **(10 Marks)**

b. Derive the swing equation with usual notation. Also the graph of swing curve. **(10 Marks)**

OR

10 a. Explain equal area criterion when a power system is subjected to sudden change in mechanical input. **(10 Marks)**

b. Write a note on multi machine system stability. **(10 Marks)**

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