CBCS SCHEME

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18EE62

Sixth Semester B.E. Degree Examination, Dec.2024/Jan.2025
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 in unit Quantity. Enumerate the advantages of per unit representation. **(05 Marks)**

b. Show that per – unit impedance of transformer referred to primary or secondary remains same. **(05 Marks)**

c. Draw the per unit reactance diagram for the power system shown in Fig Q1(c), selecting the generator rating as the base. Also find the generator terminal voltage.

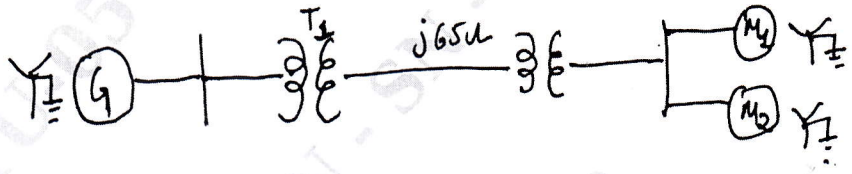

Fig Q1(c)

The rating of the various components are
G = 13.8 KV, 25 MVA, X″ = j0.15 PU ;
T_1 = 13.2/69 KV, 25 MVA, X = j0.11 PU ;
T_2 = 69/13.2 KV, 25 MVA, X = j0.11 PU ;
M_1 = 13 KV, 15 MVA, X″ = j0.15 PU
M_2 = 13 KV, 10 MVA, X″ = j0.15 PU
Determine the generator terminal voltage, when both the motors operate at 12 KV, 75% full load and unity power factor. **(10 Marks)**

OR

2 a. Draw single Line diagram of lower system indicating the various components of it, Obtain the impedance diagram and reactance diagram. Explain each component and the assumption made to draw the reactance diagram. **(10 Marks)**

b. The Schematic diagram of a radial transmission system is shown in Fig Q2(b). The ratings and reactance of the various components are shown there in. A load of 60 MW at 0.9 pf lagging is tapped from 66 kV substations which is to be maintained at 60 kV. Calculate the terminal voltages of the machine. Represent the transmission line and transformer by series reactance only.

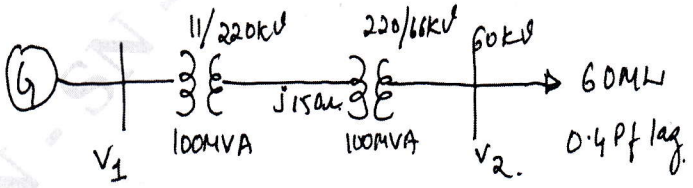

Fig Q2(b) **(10 Marks)**

Module-2

3 a. With the help of waveform at the time of three phase symmetrical fault, On synchronous generator define steady state, transient and sub transient reactances. **(10 Marks)**

b. For the radial network shown in Fig Q3(b) a 3 phase fault occurs at point F. Determine the fault current, choose the generator ratings as base values.

Generator G_1 : 10 MVA, 11 KV, X" = 15%
Generator G_2 : 10 MVA, 11 KV, X" = 12.5%
Transformer T_1 : 10 MVA, 11/33 KV, X = 10%
Transformer T_2 : 5 MVA, 33/6.6 KV, X = 8%
Over head line impedance Z = 0.27 + j0.36
Feeder impedance Z = (0.135 + j0.08)Ω/km

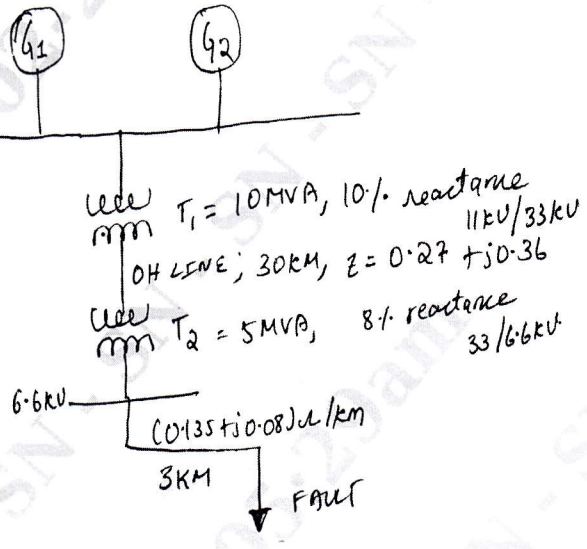

Fig Q3(b) **(10 Marks)**

OR

4 a. What is Doubling effect in a transmission line? Substantiate with equations. **(08 Marks)**

b. A synchronous generator and motor are rated 30 MVA, 13.2 KV, both have sub transient reactance of 20%. The line connecting them has a reactance of 20%, on the base of machine rating. The motor is drawing 20 MW at 0.8 pf (lead). The terminal voltage of motor is 12.8 KV. When a symmetrical fault occurs at motor terminals find sub transient current in generator, motor and at the point of fault? **(12 Marks)**

Module-3

5 a. Draw the zero sequence impedance networks of a transformer for the following connections.

i) Y - Y ii) Δ - Δ iii) Δ - Y

(06 Marks)

b. Draw the negative, positive and zero sequence networks shown in Fig Q5(b)

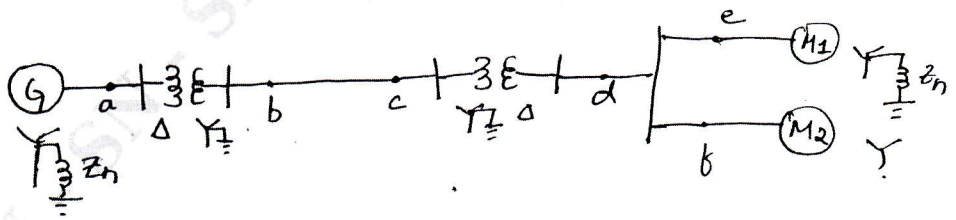

Fig Q5(b)

G = 300 MVA, 20 KV, $X_d'' = 15\%, X_o = 5\%$, $Z_n = 0.4\ \Omega$
M_1 = 200 MVA, 13.2 KV, $X_d'' = 20\%$, $X_0 = 5\%$, $Z_n = 0.5\Omega$
M_2 = 100 MVA, 13.2 KV, $X_d'' = 20\%$, $X_0 = 5\%$
T_1 = 300 MVA, 230 KV/20 KV, X = 10%
T_2 = Three single phase transformers rated 100MVA, 132 KV/13.2 KV, X = 10%.
Transmission line: 10 KM, reactance 0.5 Ω/Km. $Z_0 = 3z_1$.
Choose generator rating as base values in generator circuit. **(14 Marks)**

OR

6 a. Explain the concept of phase shift in star – delta transformer bank. **(06 Marks)**

b. Prove that
i) $(1 + \alpha + \alpha^2) = 0$ ii) $[\alpha - \alpha^2] = j\sqrt{3}$ iii) $[\alpha^2 - \alpha] = -j\sqrt{3}$ **(06 Marks)**

c. A 3 phase star connected load shown in Fig Q6(c) is connected to a 3 phase supply having a line voltage of 440 volts. Calculate the sequence current in line 'a'.

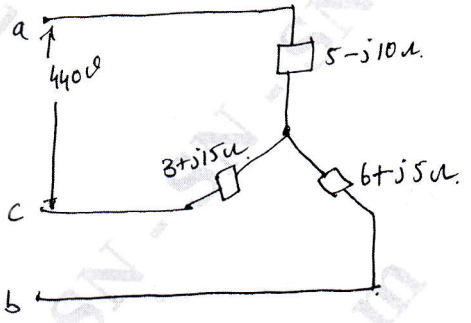

Fig Q6(c) **(08 Marks)**

Module-4

7 a. An unloaded fully excited three phase alternator is subjected to an LG fault at its terminals. Find the fault current. Using symmetrical components by showing the interconnection of all sequence networks. **(10 Marks)**

b. A 3-phase generator with line to line voltage of 400V is subjected to an LLG fault if $Z_1 = j2\Omega$, $Z_2 = j0.5\Omega$, and $Z_0 = j0.25\Omega$. Determine the fault current. **(10 Marks)**

OR

8 a. Derive the expression for fault current in Line – Line – Ground [LLG] fault occurs through fault impedance Z_f in power system. show the connection of sequence networks to represent the fault. **(10 Marks)**

b. Draw the sequence networks for the system shown in Fig Q8(b). Determine the fault current if a line to line occur at 'F'. The PU reactance all referred to the same base are as follows :

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

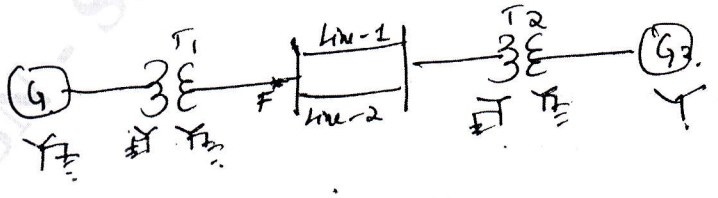

Fig Q8(b) **(10 Marks)**

Module-5

9 a. Derive Power angle equation of a salient pole synchronous machine. (10 Marks)

b. Explain "Equal area criteria" concept when a power system is subjected to sudden loss of one of the "Parallel lines". (10 Marks)

OR

10 a. Derive an expression for the swing equation. (10 Marks)

b. An Alternator operating at 50Hz delivers 1 PU of power to an infinite bus through a transmission line. A fault occurs, reducing. The maximum power transferred at 0.5 PU, whereas before the fault it was 2 PU, and after the fault is cleared it is 1.5 PU. Calculate the criteria clearing angle. (10 Marks)

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