CBCS SCHEME

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18EE62

Sixth Semester B.E. Degree Examination, June/July 2023
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. What is single line diagram? What is the need of single line diagram? Explain the procedure for finding the per unit reactance diagram by stating all the assumptions involved. **(10 Marks)**

b. The single line diagram of a power system is shown in Fig.Q.1(b). Draw the per unit independence diagram.

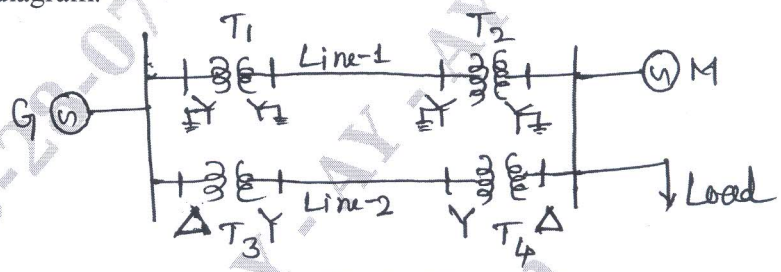

Fig.Q.1(b)

G : 90MVA, 11KV, X″ = 18% Line 1 : Z = j80Ω
T_1 : 70MVA, 11/110KV, X = 15% Line 2 : Z = j120Ω
T_2 : 60MVA, 110/11KV, X = 10% M : 85MVA, 11KV, X″ = 13%
T_3 : Three 1ϕ units, each rated at 10MVA, 11/127KV, X = 9%
T_4 : Three 1ϕ units, each rated at 16.67MVA, 127/11KV, X = 12%.
The load absorbs 74MVA, 0.8pf lagging at 6.5KV. Select a common base of 100MVA, 11KV, on the generator side. **(10 Marks)**

OR

2 a. What is per unit system? List the advantages of a per unit system. **(05 Marks)**

b. Show that the per unit impedance of a two winding transformer on either of its side is equal. **(05 Marks)**

c. A single line diagram of a power system is shown in Fig.Q.2(c). Draw its impedance diagram, choose a base of 100MVA, 220KV in 50Ω line. The ratings of generator, motor and transformer are given below.

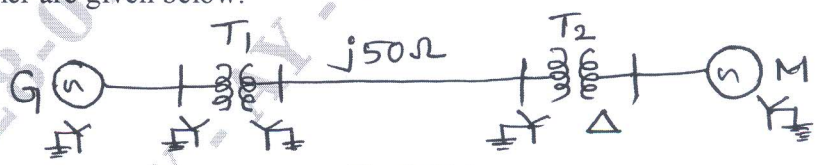

Fig.Q.2(c)

G : 40MVA, 25KV, X″ = 20% ; M : 50MVA, 11KV, X″ = 30%
T_1 : 40MVA, 33/220KV, X = 15%
T_2 : 30MVA, 220/11KV, X = 15%.

(10 Marks)

Module-2

3 a. With the oscillogram of the short circuit current of a synchronous machine, define direct axies synchronous reactance, transient and subtransient reactance. **(10 Marks)**

b. A 100MVA, 13.8KV, 50HZ, Y-connected, 3ϕ synchronous generator is connected to a 13.8/220KV, 100MVA, Δ-Y transformer. The machine reactance on its own base are $X_d = 1.1$ pu, $X'_d = 0.25$pu ; The tansformer reactance is 0.2pu. A 3ϕ load of 100MVA, 0.8pf lag is connected to transformer secondary. A 3ϕ short circuit occurs at the load terminals. Find the generator transient current, if before the fault, the load is operating at 220kV, choose a base of 220KV, 100MVA on HT side of the transformer. **(10 Marks)**

OR

4 a. Explain the doubling effect on transmission line under 3ϕ short circuit with neat sketches. **(08 Marks)**

b. For the radial network shown in Fig.Q.4(b), when a 3ϕ fault occurs at point 'F'. Determine the fault current. Choose the generator ratings as a base values.
G_1 : 10MVA, 11Kv, X" = 20%
G_2 : 10MVA, 11KV, X = 12.5%
T_1 : 10MVA, 11/33KV, X = 10%
T_2 : 25MVA, 33/6.6KV, X = 8.7%
Overhead line impedance, Z = 6 + j10Ω
Feeder impedance, Z = 0.5 + j0.15Ω.

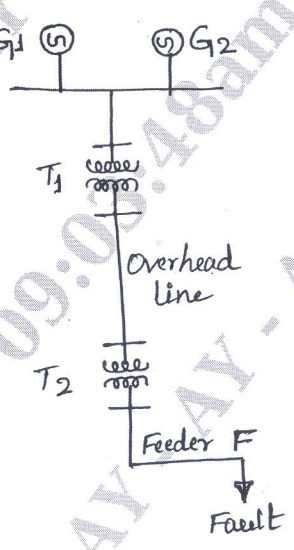

Fig.Q.4(b)

(12 Marks)

Module-3

5 a. What is symmetrical components? How they are useful in the solution of power system. **(05 Marks)**

b. Show that the symmetrical component transformation is power invariant. **(05 Marks)**

c. The original set of voltages are $V_a = 4\angle 0°$ volts, $V_b = 3\angle -90°$ volt and $V_c = 8\angle 143.1°$ is shown in Fig.Q.5(c). Find all the voltage components for the positive, negative and zero sequence systems. **(10 Marks)**

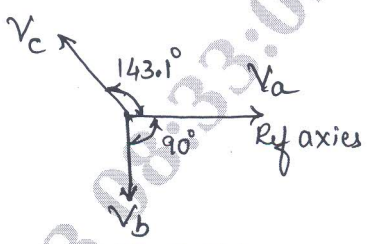

Fig.Q.5(c)

OR

6 a. Show that set of balanced phasors have only positive sequence symmetrical component. **(05 Marks)**

b. Draw the zero sequence networks for the following 3ϕ transformers:
i) Y-Y ii) Y-Δ iii) Δ - Δ iv) Y-Δ v) Y - Δ **(05 Marks)**

c. A 3ϕ, star connected load shown in Fig.Q.6(c), is connected to a 3ϕ supply having a line voltage of 440 volts. Calculate the current in the line in terms of symmetrical components.

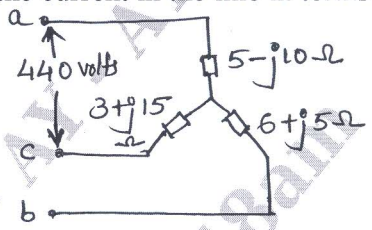

Fig.Q.6(c)

(10 Marks)

Module-4

7 a. Derive an expression for fault current, when double line to ground fault through impedance occurs on power system. **(10 Marks)**

b. For the power system shown in Fig.Q.7(b), double line to ground fault occurs at the middle of the transmission line at point 'P'. Find the total fault current using symmetrical components on a base 50MVA, 220KV in the generator circuit.

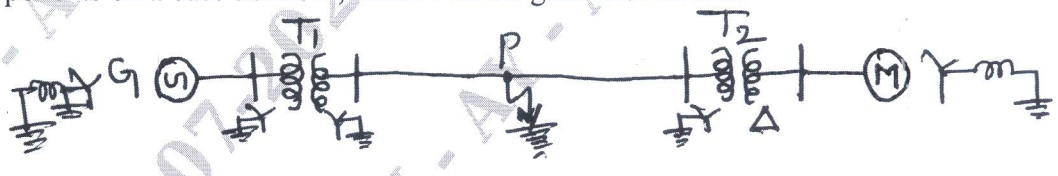

Fig.Q.7(b)

The ratings are
G : 40MVA, 25KV, $X'' = X_2 = 20\%$, $X_0 = 10\%$, $X_n = 2\%$
M : 50MVA, 11KV, $X'' = X_2 = 30\%$ $X_0 = 15\%$, $X_n = 2\%$
T_1 : 40MVA, 33/220KV, X = 15%
T_2 : 30MVA, 11/220KV, X = 15%
Transmission line : $X_1 = X_2 = 50\Omega$, $X_0 = 150\Omega$. **(10 Marks)**

OR

8 a. Derive an expression for fault current for SLG fault, without fault impedance on an alternator. **(10 Marks)**

b. A 25MVA, 13.2KV alternator, with a solidly grounded neutral has a subtransient reactance of 0.25pu. The negative and zero sequence reactance's are 0.35 and 0.1pu respectively. Determine the fault current when the line to line fault occurs at the terminals of the alternator. Neglect the resistance. **(10 Marks)**

Module-5

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

b. A 50HZ, 4 pole turbo generator rated 150MVA, 11KV has an inertia constant of 9MJ/MVA, find:

i) Stored energy at synchronous speed.

ii) The rotor acceleration, if the input mechanical power is raised to 100MW, when the electrical load is 75MW.

iii) The speed at the end of 10 cycles, if the acceleration is assumed constant at the initial value. **(10 Marks)**

OR

10 a. What is critical clearing time? Derive an expression for initial clearing angle, given that $P_1 = P_{max} \sin \delta$, $P_2 = \gamma_2 P_{max} \sin \delta$, $P_3 = \gamma_3 P_{max} \sin \delta$ as the power angle equations respectively for prefault, during fault and post fault conditions respectively. **(10 Marks)**

b. A transfer reactance between a generator and an infinite bus bar operating at 220KV under various conditions on the inter connector are: Pre fault : 150Ω/ph, during fault : 400Ω/ph, post fault : 200Ω/ph. If the fault is cleared when the rotor has advanced by 60° electrical from its prefault position, determine the maximum load that could be transferred without loss of stability. Take a base power of 266.67MW. **(10 Marks)**

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