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15EE62

Sixth Semester B.E. Degree Examination, June/July 2023
Power System Analysis - I

Time: 3 hrs. Max. Marks: 80

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Represent the equivalent circuit model per phase basis of the following components.
i) syn.Generator ii) Syn.Motor iii) Tr. line iv) Static load. **(04 Marks)**

b. Define per unit quantity. Write the procedure to draw the per unit reactance diagram from single line diagram. **(04 Marks)**

c. Obtain the reactance diagram of the electrical power system shown in Fig Q1(c). Mark all the reactance in per unit on a base of 50 MVA, 138kV in the 40Ω line. Machine rating are : G_1 : 20MVA,13.2kV, X″ = 15%, G_2 = 20MVA,13.2kV, X″ = 15%, M: 30MVA, 6.9kV, X″ = 20%
3P Y – Y Transformer : 20MVA, 13.8/138KV, X = 10%
3P Y – D Transformer : 15MVA, 138/6.9KV, X = 10%

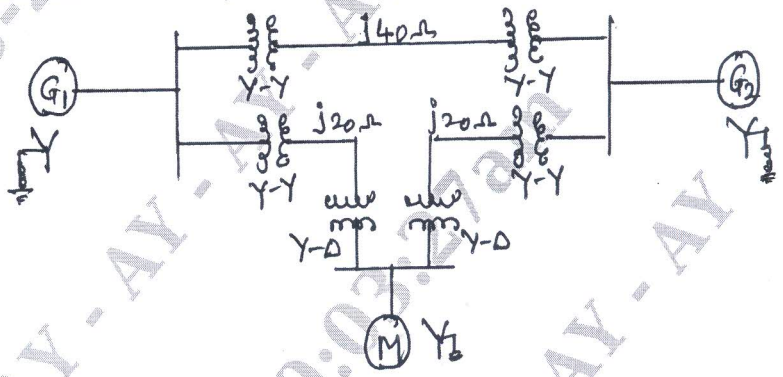

Fig Q1(c) **(08 Marks)**

OR

2 a. What is meant by one line diagram of a power system? What is its significance? **(04 Marks)**

b. Show that the per unit impedance of transformer is same on both primary and secondary sides. **(06 Marks)**

c. A three winding transformer has rating as follows :
Primary : Y – connected 6.6kV, 15MVA
Secondary :Y – connected 33kV, 10MVA
Tertiary : Δ - connected 2.2kV, 7.5MVA
Leakage impedance measured from primary side as Z_{ps} = j0.232Ω, Z_{pt} = j0.29Ω and Z_{st} = j8.7Ω. Find the star connected equivalent on a base of 15MVA, 6.6KV in the primary circuit, Neglect resistances. **(06 Marks)**

Module-2

3 a. Discuss the different types of faults in a power system. What are the common causes for faults? **(03 Marks)**

b. With the help of oscillogram of short circuit current of a Syn. Generator operating on no load. Show that $X''_d < X'_d < X_d$ with equivalent circuit diagrams. **(05 Marks)**

c. For the power system shown in Fig Q3(c). The rating of the various components are :
G : 25MVA, 12.4kV, X''_d = 10%, μ : 20MVA, 3.8KV, X''_d =15%
T_1 : 25MVA, 11KV/33KV, X = 8%, T_2 : 25MVA, 33/3.3KV, X = 10%
The system is loaded such that the motor is drawing 15MVA at 0.9p.f leading. Motor terminal voltage being 3.1 KV. Find the sub transient current in the generator and motor. Considering for a fault at generator bus

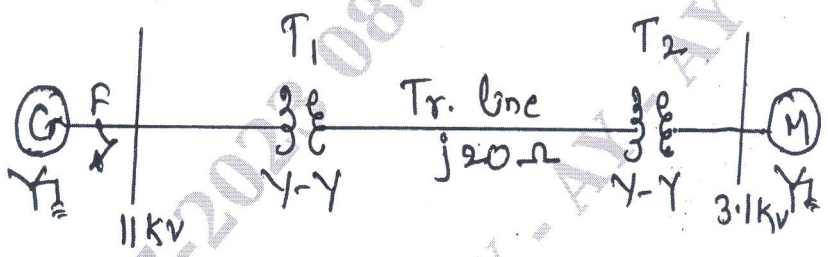

Fig Q3(c) **(08 Marks)**

OR

4 a. Describe the transients occurring in a transmission line due to short circuit. **(05 Marks)**
b. Write a note on selection of circuit breaker. **(04 Marks)**
c. A three – phase, 5MVA, 6-6kV alternator with a reactance of 8% is connected to a feeder of series impedance of (0.12 + j0.48)Ω/phase/Km. The transformer is rated at 3MVA, 6.6kV/33kV, X = 5%. Determine the fault current supplied by the generator operating under no load with a voltage of 6.9KV. When a 3ϕ, symmetrical fault occurs at a point 15km along the feeder.

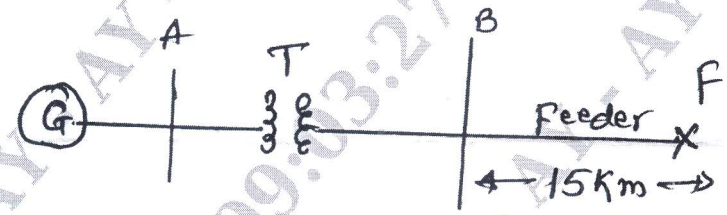

Fig Q4(c) **(07 Marks)**

Module-3

5 a. Explain what are symmetrical components and how they useful in solving the power system problem. **(04 Marks)**
b. Explain phase shift of symmetrical components in a star delta transformer. **(06 Marks)**
c. The positive and negative sequence components of phase voltage of a three phase system are V_{a1}= 230 ∠30°V and V_{a2} = 60∠60° V . Determine the positive and negative sequence components of the line voltages. **(06 Marks)**

OR

6 a. What are sequence impedances and sequence networks? **(03 Marks)**
b. Draw the zero sequence impedance networks of transformer connections.
i) Y-Y ii) Y-Δ iii) Δ-Y iv) Δ-Δ
(08 Marks)

c. Draw the positive and negative sequence network for the power system shown in Fig Q6(c)

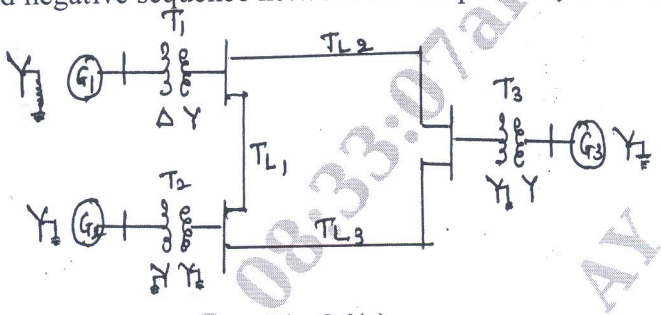

Fig Q6(c)

	Impendence		
Power system component	+Ve sequence	– Ve sequence	Zero sequence
G_1, G_2, G_3	J0.12	J0.08	J0.03
T_1, T_2, T_3	J0.1	J0.1	J0.1
T_{L1}, T_{L2}, T_{L3}	J0.08	J0.08	J0.12

(05 Marks)

Module-4

7 a. What are unsymmetrical faults? Mention their frequency of occurrence. **(03 Marks)**

b. Derive an expression for fault current, when SLG fault occurs on the terminals of an unloaded generator. **(08 Marks)**

c. A three phase generator with an open circuit voltage of 400V is subjected to an SLG fault through a fault impedance of j2Ω. Determine the fault current if Z_1 = j4Ω, Z_2 = j2Ω and Z_0 = j1Ω. Repeat the problem for LL fault. **(05 Marks)**

OR

8 a. For one conductor open fault, derive an expressiosn for fault current. Show the connection of sequence network to represent the fault. **(08 Marks)**

b. Derive expression for fault current if LLG fault occurs through fault impedance Z_f in a power system, show the connection of sequence network to represent the faults. **(08 Marks)**

Module-5

9 a. Define : i) Steedy state stability ii) Transient stability. **(04 Marks)**

b. Derive swing equation with usual notations. **(06 Marks)**

c. A 4 pole, 60Hz turbo generator rated 500MVA, 22KV, has an inertia constant of H =7.5 mJ/MVA. Find:

i) Kinetic energy stored in the rotor at syn.speed.

ii) The angular acceleration if the electrical power developed 400mW when the input minus rotational losses is 740KHP. **(06 Marks)**

OR

10 a. Derive the power angle equation of a Non-salient pole synchronous machine connected to an infinite bus. Draw the power angle curve. **(06 Marks)**

b. State and explain Equal Area Criterion (EAC) What are the assumptions made in Applying EAC. Briefly discuss it applications. **(10 Marks)**

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