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15EE62

Sixth Semester B.E. Degree Examination, Feb./Mar. 2022
Power System Analysis - I

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Show that per unit impedance of two winding transformer will remain same referred to primary as well as secondary. **(06 Marks)**

b. A 300MVA, 20KV, 3phase generator has sub-transient reactance of 20%. The generator supplies two synchronous motors through a 64km transmission line having transformer at both ends as shown in Fig Q1(b), T_1 is a 3-phase transformer and T_2 is composed of 3 single phase transformers of rating 100MVA each, 127/13.2KV, 10% reactance. Series reactance of transmission line is 0.5Ω/km. Draw the reactance diagram with all reactance marked in per unit. Select generator rating as base values.

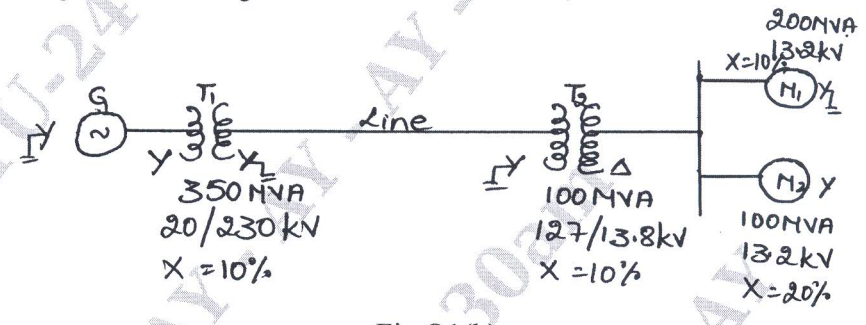

Fig Q1(b) **(10 Marks)**

OR

2 a. Define per unit quantity. Mention the advantages and per unit system. **(06 Marks)**

b. A load of 60mW at 0.9pF lagging is tapped from the 66KV substation which is to be maintained at 60KV. Calculate the terminal voltage of the synchronous machine. Represent the transmission line and the transformers by series reactance only.

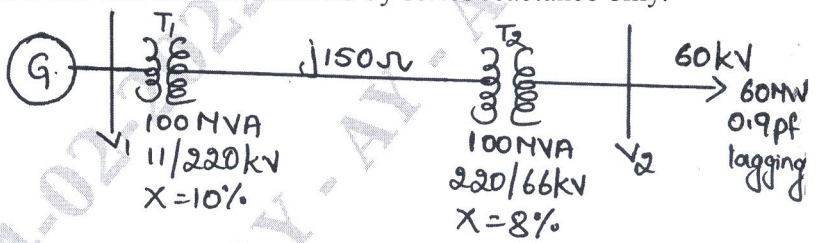

Fig Q2(b) **(10 Marks)**

Module-2

3 a. Explain in detail the transients on a transmission line. **(08 Marks)**

b. A 1250KVA, 5000V generator with $X''_d = 0.08$ pV applies purely resistive load of 1000KW at rated voltage. The load is connected directly across the terminal of the generator. All the 3phase of the load are short circuited simultaneously. Find initial symmetrical short circuit current in the generator. **(08 Marks)**

OR

4 a. In a synchronous machine $X''_d < X'_d < X_d$ why? **(08 Marks)**

b. A generator is connected through a transformer to a synchronous motor. The sub-transient reactance of generator and motor are 0.15 and 0.35pu respectively. The leakage reactance of the transformer is 0.1pu. All the reactance are calculated on a common base. A three phase fault occurs at the terminals of the motor when the terminal voltage of the generator is 0.9pu. The output current of generator is 1pu and 0.8pf leading. Find sub-transient current in pu in the fault, generator and motor. **(08 Marks)**

Module-3

5 a. Derive an expression for symmetrical components in terms of phase voltages. **(08 Marks)**

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

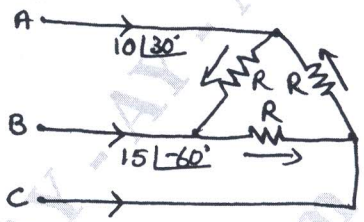

Fig Q5(b) **(08 Marks)**

OR

6 a. What are sequence impendence and sequence networks? **(04 Marks)**

b. A 25MVA, 11KV, 3 – ϕ generator has a sub-transient reactance of 20%. The generator supplies two motors over a transmission line with transformers at both ends as shown in the one-line diagram of Fig Q6(b). The motors have rated inputs of 15 and 7.5MVA, both 10kV with 25% sub-transient reactance. The 3 – ϕ transformers are both rated 30MVA, 10.8/121kV, connection Δ - Y with leakage reactance of 10% each. The series reactance of the line is 100 ohms. Draw the positive and negative sequence networks of the system with reactance marked in per unit. Assume that the negative sequence reactance of each machine is equal to its sub-transient reactance. Omit resistance select generator rating as base in the generator circuit.

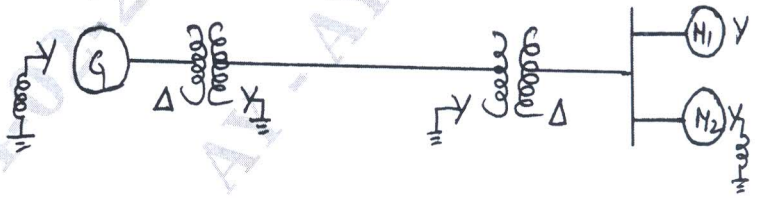

Fig Q6(b) **(08 Marks)**

c. For the power system, shown in Fig Q6(c), sketch the zero sequence networks.

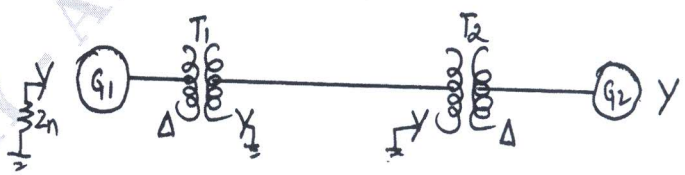

Fig Q6(c) **(04 Marks)**

Module-4

7 a. Derive an expression for fault current if single line to ground fault occurs through fault impedance z_f in power system. Show the connection of sequence networks to represent the fault. **(08 Marks)**

b. Two 11kV, 20MVA, 3 – ϕ, star connected generators operate in parallel as shown in Fig Q7(b), the positive, negative and zero sequence reactances of each being, respectively. j0.18, j0.15, j0.10pu. The star point of one of the generators is isolated and that of the other is earthed through a 2Ω resistor. A single line-to-ground fault occurs at the terminals of one of the generators. Estimate: i) the fault current ii) current in grounding resistor iii) the voltage across grounding resistor.

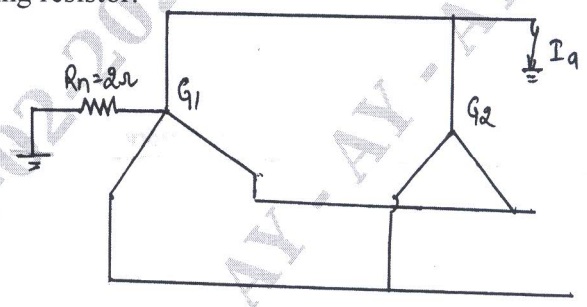

Fig Q7(b) **(08 Marks)**

OR

8 a. Derive expression for fault current if LLG fault occurs through fault impedance z_f in power system. Show the connection of sequence networks to represent the fault. **(08 Marks)**

b. Write a note on open conductor fault. **(08 Marks)**

Module-5

9 a. Derive swing equations with usual notations. **(08 Marks)**

b. A 50Hz, four pole turbo generators rated 100MVA, 11KV has an inertia constant of 8.0mJ/MVA.

i) Find the stored energy in the rotor at synchronous speed

ii) If the mechanical input is suddenly raised to 80mW for an electrical load of 50mW, find rotor acceleration, neglecting mechanical and electrical losses.

iii) If the acceleration calculated in part (ii) is maintained for 10 cycles, find the change in torque angle and rotor speed in revolutions per minute at the end of this period.

(08 Marks)

OR

10 a. Derive an expression for steady state stability limit for maximum power transfer. **(08 Marks)**

b. A synchronous generator of reactance 1.20pu is connected to an infinite bus bar (|V| = 1.0pu) through transformer and a line of total reactance of 0.60pu. The generators no load voltage is 1.20pu and its inertia constant is H = 4MW-S/MVA. The resistance and machine damping may be assumed negligible. The system frequency is 50Hz. Calculate the frequency of natural oscillations if the generator is loaded to i) 50% ii) 80% of its maximum power. **(08 Marks)**

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