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10EE61

Sixth Semester B.E. Degree Examination, Jan./Feb. 2023
Power System Analysis and Stability

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO full questions from each part.***

PART – A

1 a. Define per unit quantity. Mention the advantages and disadvantages of per unit system. **(05 Marks)**

b. Show that per unit impedance of a transformer remains same whether it is referred to primary (or) secondary side. **(05 Marks)**

c. A 300MVA, 20KV, 3 phase generator has a sub transient reactance of 20%. The generator supplies 2 synchronous motors over a transmission line of 64km as shown in Fig.Q.1(c). The motors M_1 and M_2 are rated 200MVA, 13.2KV and 100MVA, 13.2KV respectively. The motors have sub transient reactance of 20% each. The 3 phase transformer T_1 is rated 350MVA, 20Δ/230Y KV with a leakage reactance of 10%. The transformer T_2 is composed of 3 single phase transformers each rated 100MVA, 127Y/13.2 Δ KV with a leakage reactance of 10%. The series reactance of the transmission line is 0.5Ω/km. Draw the p.u. reactance diagram of the power system. Select the generator rating as the base in the generator circuit. **(10 Marks)**

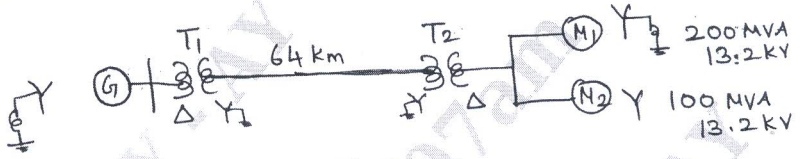


Fig.Q.1(c)

2 a. With the help of oscillogram of short-circuit current of a synchronous generator, operating on no load. Distinguish between sub-transient, transient and steady state reactances. Also show that $X''_d < X'_d < X_d$ with equivalent circuit diagrams. **(10 Marks)**

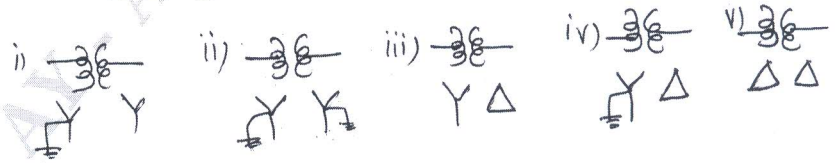
b. A synchronous generator and motor are rated for 30MVA, 13.2KV and both have sub-transient reactance of 20%. The line connecting them has a reactance of 10% on the base of machine ratings. The motor is drawing 20MW at 0.8PF (lead). The terminal voltage of the motor is 12.8KV. When a symmetrical 3 phase fault occurs at motor terminals. Find the subtransient current in i) Generator ii) Motor iii) Fault. **(10 Marks)**

3 a. Prove that a balanced 3 phase voltages of a power system will have only positive sequence components. **(06 Marks)**

b. Show that the symmetrical component transformation is power invariant. **(06 Marks)**

c. One conductor of a 3 phase line is open. The current flowing to the delta connected load through line 'a' is 100A. With the current in line 'a' as reference and assuming line 'c' is open. Find the symmetrical components of the line current. **(08 Marks)**

4 a. What are sequence impedances and sequence networks? Draw the zero sequence equivalent circuit for the following configuration of transformer.



(08 Marks)

b. For the power system shown in Fig.Q4(b). Draw the positive, negative and zero sequence networks.

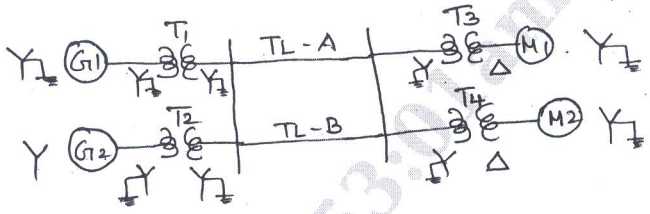


Fig.Q.4(b)

(12 Marks)

PART – B

5 a. Derive an expression for fault current if a double line to ground fault occurs at the terminals of an unloaded generator. And hence obtain the connection diagram of sequence networks. **(10 Marks)**

b. Two 11KV, 20MVA, 3 phase star connected generator operate in parallel as shown in Fig.Q.5(b). The positive, negative and zero sequence reactance of each being 0.18, 0.15 and 0.1pu respectively. The star point of one of the generator 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 the grounding resistor iii) the voltage across the grounding resistor. **(10 Marks)**

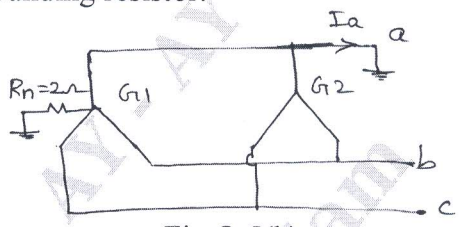


Fig.Q.5(b)

6 a. Derive an expression for fault current if a line to line fault occurs at the terminals of an unloaded generator through fault impedance Z_f. And hence obtain the connection diagram of sequence networks. **(10 Marks)**

b. Derive an expression for fault current if a single line to ground fault occurs on a power system through fault impedance Z_f. Draw the connection diagram of sequence networks. **(10 Marks)**

7 a. Derive the swing equation of a synchronous machine with usual notations. Mention the uses of swing equation. **(10 Marks)**

b. A 50HZ, 4 pole turbo alternator 500MVA, 22KV has an inertia constant of 10MJ/MVA.

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

ii) If the mechanical input is suddenly raised to 100MW for an electrical load of 60MW, find the rotor acceleration, neglecting mechanical and electrical losses.

iii) If the acceleration calculated is maintained constant for 10 cycles, find the change in torque angle and rotor speed in rpm at the end of this period. **(10 Marks)**

8 Write notes on the following:

a. Unbalanced operation of 3 phase induction motor

b. Equal area criterion

c. Selection of circuit breakers

d. Methods of improving transient stability. **(20 Marks)**

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