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10EE61

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Power System Analysis and Stability

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. What is per unit quantity? What are the advantages of per unit quantities? **(05 Marks)**

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

c. A 100 MVA, 33 KV, 3 phase generator has a subtransient reactance of 15%. The generator is connected to the motors through a transmission line and transformer as shown in Fig.Q1(c). The motors have rated inputs of 30 MVA, 20 MVA and 50 MVA at 30 KV with 20% subtransient reactance. The 3 phase transformers are rated at 11 MVA, 32 KV Δ/100 KV Y with leakage reactance 8%. The line has a reactance of 50 Ω. Selecting the generator rating as the base quantities in the generator circuit, determine base quantities in the other parts of the system. Evaluate the corresponding pu values. Hence draw the per unit reactance diagram.

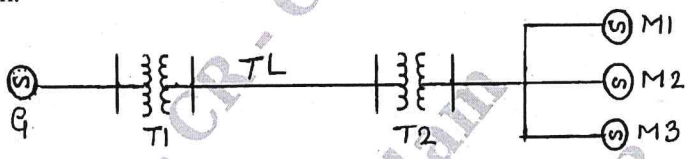

Fig.Q1(c) **(10 Marks)**

2 a. Derive an expression for short circuit, when sudden short circuit occurs on a transmission line at no load. **(08 Marks)**

b. For the radial network shown in Fig.Q2(b), a 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″ = 20%
Generator G_2: 10 MVA, 11 KV, X″ = 12.5%
Transformer T_1: 10 MVA, 11/33 KV, X = 10%
Transformer T_2: 25 MVA, 33/6.6 KV, X = 8.7%
Overhead line impedance, z = 6 + j10Ω
Feeder impedance, z = 0.5 + j0.15Ω

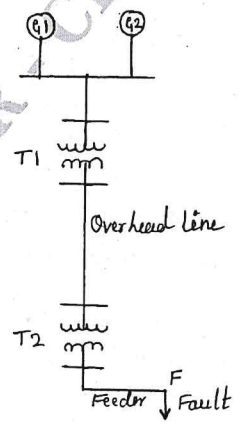

Fig.Q2(b) **(12 Marks)**

3 a. Derive an expression for neutral current for an unbalanced system in terms of sequence currents. **(06 Marks)**

b. Describe the phase shifting of symmetrical components in star delta transformer bank. **(06 Marks)**

c. A 3 phase, star connected load shown in Fig.Q3(c) is connected to a 3 phase supply having a line voltage of 440 volts. Calculate the sequence current in line 'a'.

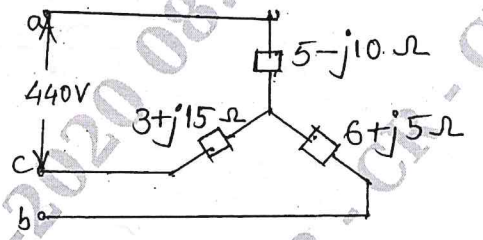

Fig.Q3(c) **(08 Marks)**

4 a. Derive an expressions for positive, negative and zero sequence reactances for a transmission line in terms of self and mutual reactances. **(06 Marks)**

b. Draw the positive, negative and zero sequence networks for the network shown in Fig.Q4(b).

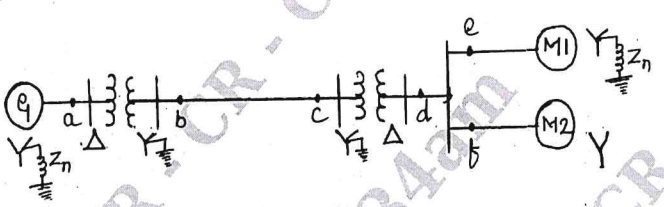

Fig.Q4(b)

G: 300 MVA, 20 KV, $X''_d = 15\%$, $X_o = 5\%$, $Z_n = 0.4\ \Omega$

M1: 200 MVA, 13.2 KV, $X''_d = 20\%$, $X_o = 5\%$, $Z_n = 0.5\ \Omega$

M2: 100 MVA, 13.2 KV, $X''_d = 20\%$, $X_o = 5\%$

T1: 300 MVA, 230 KV/20 KV, X = 10%

T2: Three single phase transformers rated: 100 MVA, 132 KV/13.2 KV, X = 10%

Transmission line: 10 KM, reactance 0.5 Ω/KM, $Z_o = 3Z_1$

Choose generator rating as base values in generator circuit. **(14 Marks)**

PART – B

5 a. Define "fault" in a power system, and how are the faults be classified and write them in the order of their severity and which is the most frequently occurring fault. **(08 Marks)**

b. A double line to ground fault occurs at the terminals 'b' and 'c' of an unloaded generator through a fault impedance Z_f. Show that the expression for fault current is given by

$$I_f = \frac{-3E_a z_2}{\sum z_1 z_2 + 3z_f(z_1 + z_2)},$$

also draw the connection of sequence diagram. **(12 Marks)**

6 a. An unloaded fully excited three phase alternator is subjected to a LG fault at its terminals. Find the fault current, using symmetrical components by showing the interconnection of all the sequence networks. **(08 Marks)**

b. A 30 MVA, 13.8 KV, 3 phase alternator has a subtransient reactance of 15% and negative and zero sequence reactance of 15% and 5% respectively. The alternator supplies two motors over a transmission line having transformers at both ends as shown in Fig.Q6(b). The motors have rated inputs of 20 MVA, 10MVA, both 12.5 KV with 20% subtransient reactance. Negative and zero sequence reactances are 20% and 5% respectively. The current limiting reactor of 2Ω each are in the neutral at alternator and the larger motor. The three phase transformers are both rated at 35 KVA, 13.2 Δ/115 Y KV with leakage reactance of 10%. Series reactance of the line is 80 Ω. The zero sequence reactance of the line is 200 Ω. Determine the fault current, when LG fault occurs at point 'P'. Assume V_f = 120 KV and base values of 30 MVA and 13.8 KV in the generator circuit.

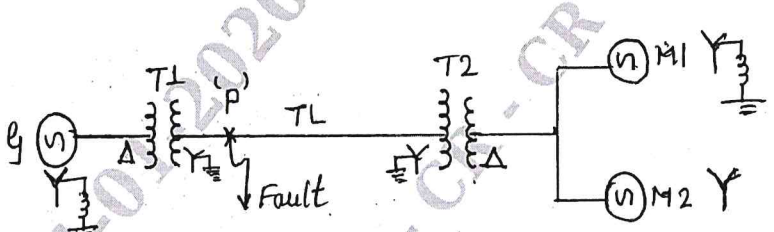

Fig.Q6(b) **(12 Marks)**

7 a. Derive an expression for inertia constant 'M' in terms of energy stored in a rotor of synchronous machine in MJ sec/degree electrical. **(08 Marks)**

b. Explain the significance of swing curve in stability studies. **(04 Marks)**

c. An alternator operating at 50 Hz delivers 1 pu of power to an infinite bus through a transmission line. A fault occurs, reducing the maximum power transferred to 0.5 pu, whereas before the fault it was 2 pu, and after the fault is cleared it is 1.5 pu. Calculate the critical clearing angle. **(08 Marks)**

8 Write short notes on the followings:

a. Analysis of 3 phase induction motor with unbalanced voltages

b. Two conductor open fault on power system

c. LL fault on unloaded synchronous generator without fault impedance

d. Reclosure **(20 Marks)**

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