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10EE61

Sixth Semester B.E. Degree Examination, Jan./Feb. 2021
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. What are single line diagrams? Explain the procedure for finding per-unit reactance diagrams by stating all the assumptions involved. **(08 Marks)**

b. The three parts of a single phase power system are designated as A, B and C and are connected to each other through transformers T_1 and T_2 as shown below in Fig.Q.1(b). The transformers are rated as,
T_1: 10,000KVA, 13.8-138KV, leakage reactance = 10%
T_2: 10,000KVA, 69-138KV, leakage reactance = 8%
If the base in circuit-B is chosen as 10000KVA, 138KV, find the per – unit impedance of 300Ω resistive load in circuit – C. **(04 Marks)**

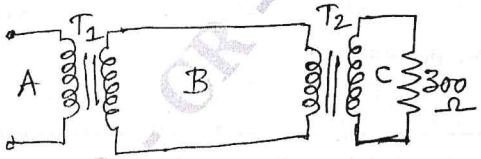

Fig.Q.1(b)

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

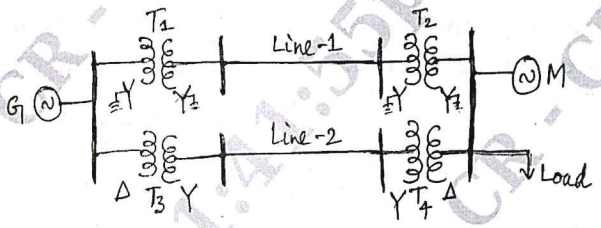

Fig.Q.1(c)

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 10MVA, 11/127KV, X = 9%
T_4: Three 1ϕ units each rated 16.6667MVA, 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. **(08 Marks)**

2 a. Explain with a neat circuit model, short circuit transients on a transmission line with the assumptions involved. Also explain the doubling effect on line under 3ϕ short-circuit, with the neat waveforms. **(10 Marks)**

b. A transformer is rated at 50MVA and having a short circuit reactance of 5% is connected to the bus-bar which is supplied through two 66KV feeder cables (lines) each having an impedance of (1.5 + j2.5)Ω. One of the feeders is connected to a generating station rated at 80MVA and having a short-circuit reactance of 10% and the other feeder is connected to another generating station rated at 100MVA with short circuit reactance of 15%. Determine the MVA at the fault when a 3ϕ short circuit occurring between the secondary terminals of the transformer. Choose base MVA as 400 and base KV as 66 on the generator side. **(10 Marks)**

3 a. Determine the symmetrical components of the asymmetrical phasors given below.
$V_R = 100\angle 250^\circ$ volts, $V_Y = 50\angle -110^\circ$ volts and $V_B = 40\angle 100^\circ$ volts **(06 Marks)**

b. Show that the symmetrical component transformation is power invariant. **(04 Marks)**

c. A delta connected balanced resistive load is connected across an unbalanced three phase supply as shown below in Fig.Q.3(c). Find the symmetrical components of line currents and phase currents. **(10 Marks)**

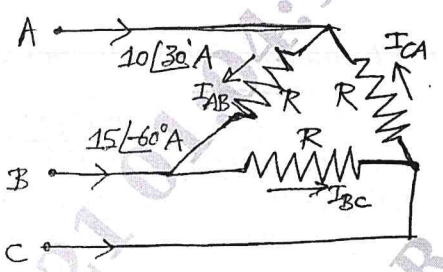

Fig.Q.3(c)

4 a. The symmetrical components of phase A in a 3ϕ - Y connected system of phase voltages are $V_{a_1} = 200\angle 30^\circ$ V, $V_{a_2} = 60\angle 60^\circ$ V and $V_{a_0} = 20\angle -30^\circ$ V. The symmetrical components of line currents of phase A are $I_{a_1} = 20\angle 10^\circ$ A, $I_{a_2} = 5\angle 20^\circ$ A and $I_{a_0} = 3\angle -10^\circ$ A. Determine the 3ϕ power in KVA and also in pu if the base power is 1KVA. Compute, also the active and reactive powers. **(06 Marks)**

b. Draw all the sequence networks for the power system shown in Fig.Q.4(b) below. Choose a base of 50MVA, 220KV in j50Ω transmission lines and mark all reactances in pu. The ratings are, G_1: 25MVA, 11KV, $X''_d = 20\%$, G_2: 25MVA, 11KV, $X''_d = 20\%$
T_1 to T_4: Three single phase units each 6.6667MVA, 6.35KV/127KV, X = 15%.
The negative sequence reactance of each machine is its subtransient reactance. The zero sequence reactance of each machine is 8%. Assume that the zero sequence reactances of lines are 250% of their positive sequence reactances. **(14 Marks)**

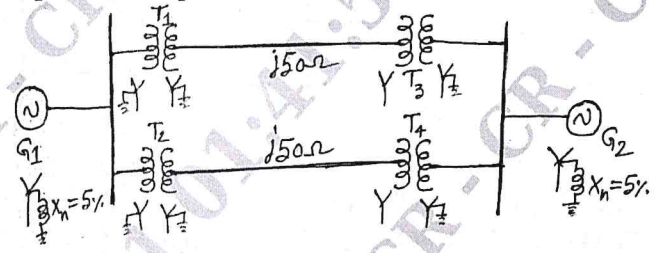

Fig.Q.4(b)

PART – B

5 a. Obtain an expression for the fault current, when a LG fault occurs at the terminals of an unloaded generator through a fault impedance Z_f. **(08 Marks)**

b. A synchronous motor is receiving 10MW of power at 0.8pf lag at 6KV as shown in Fig.Q.5(b) below. A L-L fault occurs at the middle point of transmission line. Find the fault current. The ratings of the components are,
G: 20MVA, 11KV, $X_1 = 0.2$pu, $X_2 = 0.1$pu and $X_0 = 0.1$pu
M: 15MVA, 6.9KV, $X_1 = 0.2$pu, $X_2 = X_0 = 0.1$pu
T_1: 18MVA, 11.5-34.5KV, X = 0.1pu
T_2: 15MVA, 6.9-34.5KV, X = 0.1pu
T.L: $X_1 = X_2 = 5\Omega$ and $X_0 = 10\Omega$

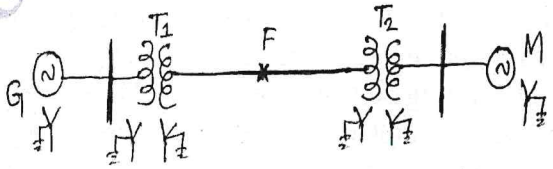

Fig.Q.5(b)

Choose the base values as 20MVA, 11KV on generator side. **(12 Marks)**