CBCS SCHEME

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15EE62

Sixth Semester B.E. Degree Examination, July/August 2021
Power System Analysis – I

Time: 3 hrs. Max. Marks: 80

Note: *Answer any FIVE full questions.*

1 a. What is per unit quantity? What are the advantages of per unit quantities? **(04 Marks)**

b. A 3 phase generator rated 80MVA, 7.5kV with reactance of 20% is connected through a Δ-Y transformer to a HV transmission line. The series impedance of the line is $(30 + j70)\Omega$. The other end of the line is connected to a load of 50mW at 0.9pf lag at 13.8kV through a step-down transformer in Y-Y connection. Both transformer banks are composed of 1ϕ Transformers connected for 3ϕ operation. Each of the 1ϕ transformer in each bank is rated 30MVA, 8/127kV with a reactance of 10%.

i) Draw the impedance diagram and mark all the reactances in p.u on a base of 100MVA, 220kV in the transmission line.

ii) Determine the terminal voltage of the generator. **(08 Marks)**

c. Explain the procedure of drawing reactance diagram. List the assumption made. **(04 Marks)**

2 a. Derive the steady state model of synchronous machine. **(04 Marks)**

b. Explain the representation of loads. **(04 Marks)**

c. The one line diagram of an unloaded power system is shown in Fig Q2(c). The generator and transformer are rated as follows :

G_1 : 20MVA, 13.8kV, $X'' = 0.2$pu
G_2 : 30MVA, 18kV, $X'' = 0.2$pu
G_3 : 25MVA, 20kV, $X'' = 0.2$pu
T_1 : 25MVA, 220Y/13.8 Δkv, X = 10%
T_2 : single phase unit each rated 10MVA, 127/18kv X = 10%
T_3 : 35MVA, 220Y/22Y kV, X = 10%

Draw the impedance diagram with all reactance in pu. Choose a base of 50MVA, 13.8kV in the circuit of generator – 1

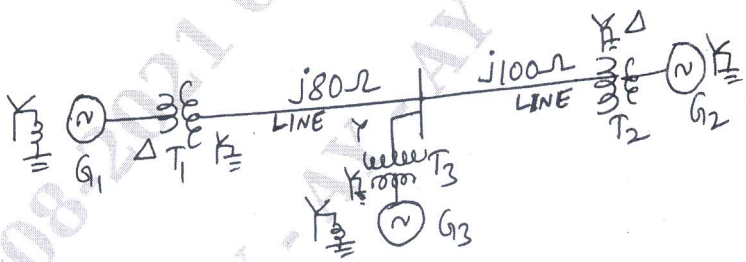

Fig Q2(c) **(08 Marks)**

3 a. A sudden three phase short circuit takes place at the terminals of an unloaded 3-phase alternator. Discuss briefly on different reactance that are met with assuming that the damper windings are provided at the pole faces of the alternator. **(08 Marks)**

b. A synchronous generator and a synchronous motor each rated 25MVA, 11KVA, 15% reactance are connected through transformers and a live as shown in Fig Q3(b). The transformers are rated 25MVA, 11/66kV and 66/11kV with leakage reactance of 10% each. The line has a reactance of 10% on a base of 25MVA, 66kV. The m/r (motor) is drawing 15mW at 0.8pF leading and a terminal voltage of 10.6kV. When a symmetrical three phase faults occurs at motor terminals. Find the subtransient current in the generator motor and fault.

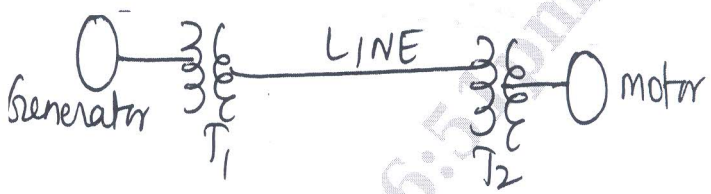

Fig Q3(b) **(08 Marks)**

4 a. Explain in detail the transmits on a transmission line. **(06 Marks)**

b. For the radial network shown in Fig Q4(b) a 3-phase fault occur at F. Determine the fault current and the line voltage at 11KV bus under fault condition.

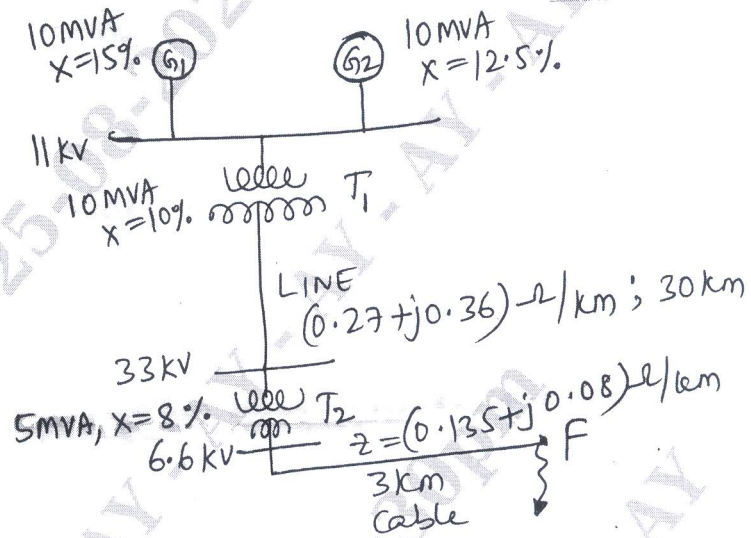

Fig Q4(b) **(10 Marks)**

5 a. Obtain the relationship between line and phase sequence components of voltages is star connection give the relevant phasor diagram. **(04 Marks)**

b. Obtain the expression for power interm of sequence components of line to neutral voltages and line currents. **(06 Marks)**

c. In a 3-phase, 3-wier system, the sequence components of line current are $I_{a1} = 100 \angle 30^\circ$ A $Ia_2 = 20 \angle 60^\circ$ A, the sequence components of line voltage are $V_{A1} = 66 \angle 150^\circ$ kV, $V_{A2} = 11 \angle 60^\circ$ kV. Determine the three phase power. **(06 Marks)**

6 a. To prove that in a 3-phase circuit with equal self and mutual impedance $z_1 = z_2$ and is different form z_0. **(06 Marks)**

b. A 25MVA, 11kV 3-phase generator has a reactance of 20% one line diagram shown in Fig Q6(b) the motor have rated inputs of 15 and 7.5MVA both 10kV with X = 25% the 3 phase transformer are both rated 30MVA, 10.8/121/kV connection Δ-Y with X = 10% each. The series reactance of the line is 100Ω. Draw the positive and negative sequence networks of the system with reactance marked in p.u. Assume that the negative sequence reactance of each machine is equal to its subtransient reactance. Select generator rating as base in the generator circuit. Draw the zero sequence of network. Assume zero sequence reactance of generator and motor of 0.06pu. Current limiting reactors of 2.5Ω each are connected in the neutral of the generator and motor No. 2. The zero sequence reactance of the transmission is 300Ω.

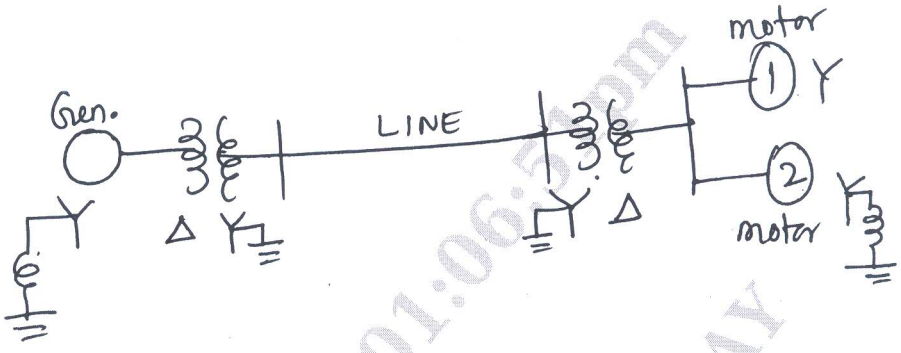

Fig Q6(b) **(10 Marks)**

7 a. For a double line to ground fault on an unloaded generator, derive the equation for the fault current and draw the interconnected sequence network. **(10 Marks)**

b. Find neutral reactance, if LG fault occurs across the terminals of a Generator and its rating 100MVA, 11kV, Y-connected $x_1 = x_2 = 0.15$pu, $x_0 = 0.05$pu. To limit $|I_a|_{LG} = |I_a|_{3\phi}$. **(06 Marks)**

8 Find fault current at fault point under LG fault for the system shown in Fig Q8

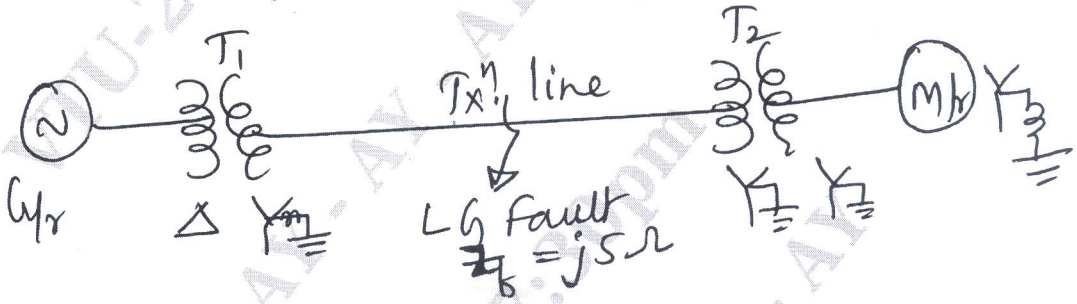

Fig Q8

G/r : 20MVA, 11kV, $x_1 = 0.2$pu, $x_2 = x_0 = 0.1$pu
T_1 : $x_1 = 0.1$pu, 18MVA, 11.5 Δ/34.5YKV $x_n = 0.066$pu
TL : $x_1 = x_2 = 5\Omega$, $x_0 = 10\Omega$
T_2 : x = 0.1pu, 15MVA, 34.5Y/6.9YKV
M/r : 15MVA, 6.9KV, $x_1 = 0.2$, $x_2 = x_0 = 0.1$ $x_n = 0.067$pu
Power absorbed by motor 10mw, 0.8pf lag and 6kV. Choose generator rating as base.
(16 Marks)

9 a. Explain the Dynamics of synchronous machine rotor. **(06 Marks)**

b. Derive the power angle equation for salient and non-salient pole synchronous machines. **(08 Marks)**

c. What are the factors affecting transient stability? **(02 Marks)**

10 a. With the help of relevant sketch, explain the Equal Area Criterion (EAC) for stability studies. **(06 Marks)**

b. A Generator connected to an infinite bus through a double circuit transmission line. A fault occurs at one of the lines and is subsequently cleared. Determine the critical clearing angle. **(10 Marks)**

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