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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOVEMBER 2019

SUBJECT: POWER SYSTEM ANALYSIS [ELE 3105]

Date: 25 November 2019 **Time : 3 Hours** **Max. Marks: 15**

Instructions to Candidates:

- Answer **ALL** the questions.

1A. The single line diagram of a two-machine system is as shown in Fig.1A. Draw the impedance diagram of the system choosing a base of 11.5 kV, 60 MVA in the motor circuit. The transformer T_2 comprises of 3 single phase units each rated 15 MVA, 11/127 kV and 10% reactance.

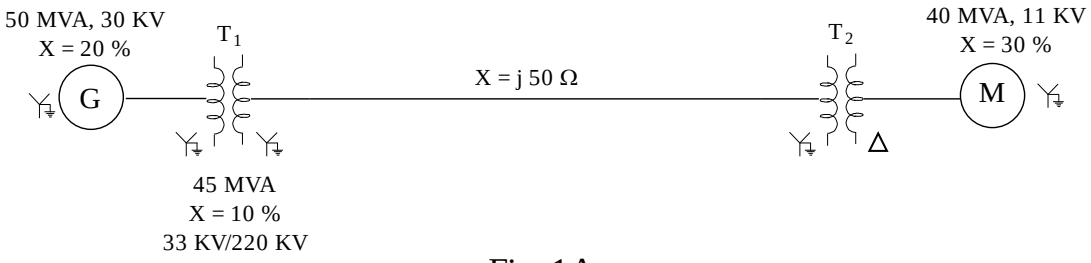

Fig. 1A ***(06)***

1B. The three-phase ratings of a three winding transformer are:

Primary: Y connected 15MVA, 66kV
Secondary: Y connected 10MVA, 13.2kV
Tertiary: Δ connected 5MVA, 2.3kV

Neglecting resistance, the leakage reactances are, x_{PS}=7% and x_{PT}=9% (both measured on primary); x_{ST}=8% (measured on secondary). Calculate the per unit reactance of the per phase equivalent circuit for a base of 6 MVA, 86 kV in the primary circuit. ***(02)***

1C. Define the following: (i) Momentary current and (ii) Interrupting current as applied to the rating of a Circuit Breaker. Mention the suitable multiplication factors to determine the above currents in terms of respective symmetrical currents. ***(02)***

2A. For the system shown in fig.2A, Calculate the fault current fed by G_1 and G_2 for a three-phase solid fault on the 132kV bus. Choose a base of 45MVA, 13.2kV on generator circuit. Neglect pre-fault current. ***(05)***

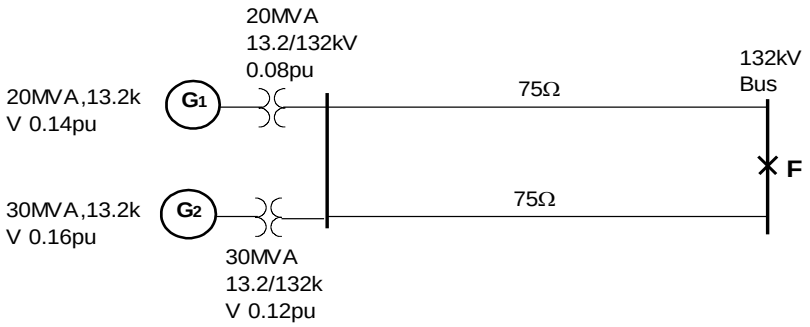

Fig. 2A

2B. Derive the expression for 3 phase complex power in terms of symmetrical components. ***(02)***

2C. Compute the unbalanced currents I_a, I_b and I_c, if the sequence components are I_{a1}=10+j9 A, I_{a0}=0 A and I_{a2}= 4.5738-j0.6778 A. Assume abc sequence. ***(03)***

3A. Derive an expression for the fault current when a short circuit fault occurs between lines `b' and `c' through a fault impedance Z_f. Also show the interconnection of sequence networks for this fault. ***(03)***

3B. Draw the sequence networks and the corresponding Thevenin's impedances when an unsymmetrical fault occurs at bus 2 shown in fig. 3B. The ratings of the components are given below
G_1, G_2: 20 MVA, star grounded through reactance, 11 kV, x_1=0.15 pu, x_2= 0.1 pu, x_0=0.05 pu, x_n=0.03 pu
T_1, T_2, T_3, T_4: 20 MVA, 11/110 kV, x=0.1 pu
Lines 1 & 2: x_1=x_2=0.1 pu, x_0=0.35 pu on a base of 20 MVA, 110 kV.

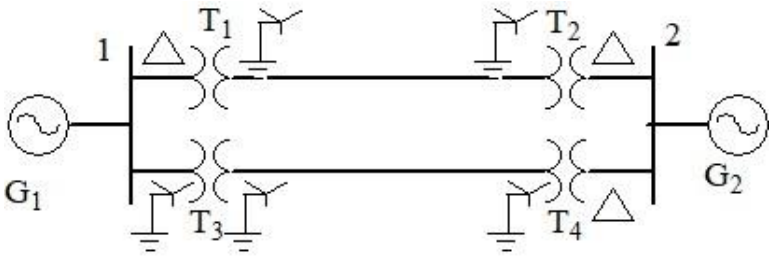

Fig. 3B ***(03)***

3C. Two 6.6 kV, 3 phase 10 MVA alternators are connected to a common bus. Each alternator has x_1=0.15 p.u., x_2=0.1 pu, x_0=0.05 pu and x_n=0.06 pu. An unsymmetrical fault occurs on the bus. Calculate the fault current in kA, if the fault is i) bolted (or solid) L-G, ii) L-L through a fault reactance of 0.01 pu and iii) solid L-L-G fault ***(04)***

4A. A generator is transferring 1 per unit power to a load through a short line. A 3-phase fault occurs at the generator terminals. Use equal area criterion and find critical clearing angle & the corresponding time. Derive the formulae used. Given P_{max}=2 pu (amplitude of power angle curve), H=6MJ/MVA, f=50 Hz. ***(05)***

4B. A 200MVA, 11 kV, 50 Hz, 4 pole generator has H=6MJ/MVA. The machine is operating at a load of 120 MW when the load is suddenly increased to 160 MW. Find the rotor speed if the rotor deceleration is maintained for 5 cycles. ***(03)***

4C. Derive the expression for natural frequency of oscillation when an alternator is subjected to small changes in load. ***(02)***

5A. Eliminate node 3 by matrix algebra for the system shown in Fig.5A

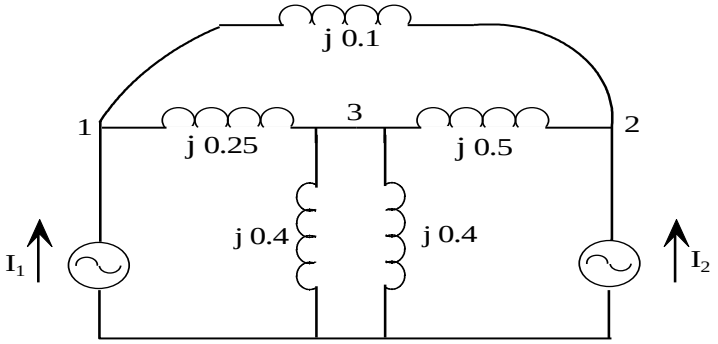

Fig.5A ***(02)***

5B. Compute Jacobian elements for the system shown in Fig.5B at the end of one iteration using N-R method. Consider 100 MVA as the base.

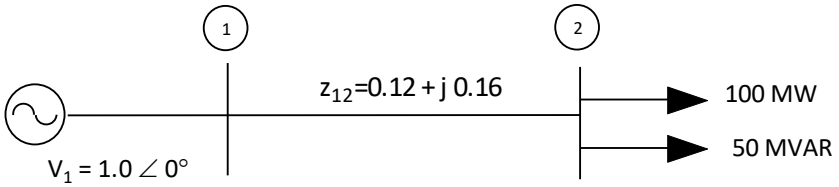

Fig.5B ***(04)***

5C. Considering 100 MVA as base, find the voltages at buses 2 & 3 at the end of first iteration using G-S method for the system depicted in Fig.5C. Also find slack bus real & reactive power generation.

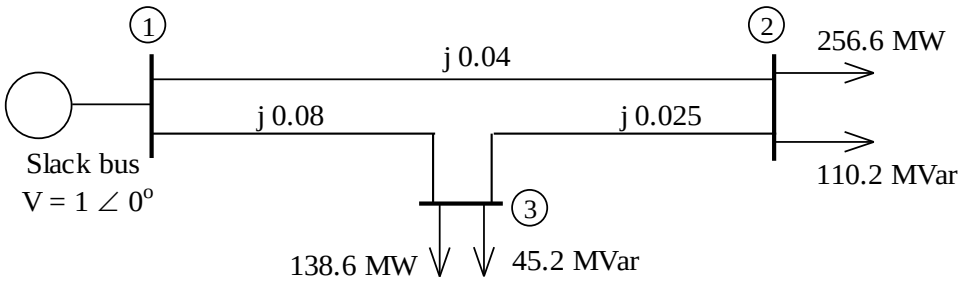

Fig.5C ***(04)***