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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 2018

SUBJECT: POWER SYSTEM ANALYSIS [ELE 3105]

Date: 28 November 2018 **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 30 kV, 50 MVA in the generator circuit. The transformer T_2 comprises of 3 single phase units each rated 15 MVA, 11/127 kV and 10% reactance.

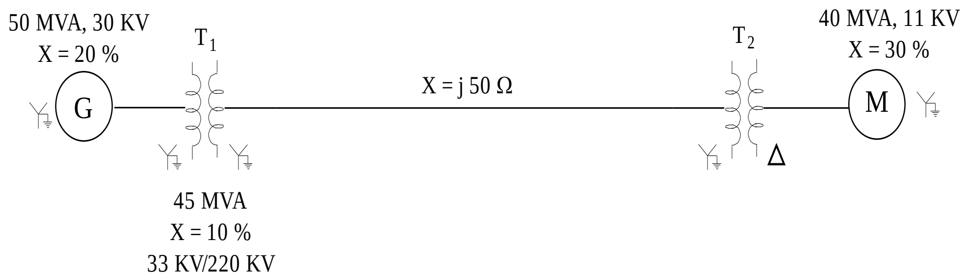

Fig.1A **(05)**

1B The one-line diagram of a simple three-bus power system is shown in Fig.1B Each generator is represented by an emf behind the subtransient reactance. All impedances are expressed in per unit on a common MVA base. All resistances and shunt capacitances are neglected. The generators are operating on no load at their rated voltage with their emfs in phase. A three-phase fault occurs at bus 3 through a fault impedance of Z_f = j0.19 per unit.

Using Thevenin's theorem find the fault current in per unit.

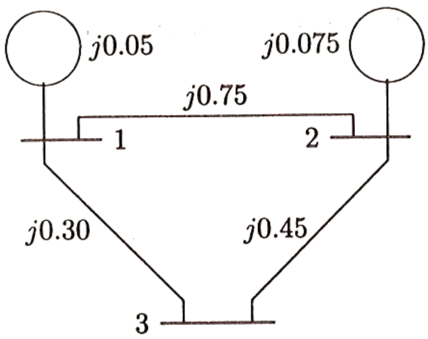

Fig.1B **(05)**

2A The primary, secondary and tertiary windings of a three winding transformer are rated as 11 kV, 6 MVA star/ 3.3 kV, 3 MVA, star/ 400 V, 3 MVA, delta respectively. Three short circuit tests on this transformer gave the following results:

Secondary shorted; primary excited: 500 V, 100 A,

tertiary-shorted; primary excited : 600 V, 100 A,

and tertiary shorted ; secondary excited : 100 V, 200 A

a) Find the per unit leakage reactances of the star equivalent circuit. Neglect resistances.
b) The primary is energised at rated voltage and the secondary is an open circuit. For a three phase balanced short circuit at the tertiary terminals, calculate the short circuit current and the secondary terminal voltage. ***(06)***

2B Derive the expression for three phase power in terms of symmetrical component voltages and currents. ***(04)***

3A For the power system shown in Fig.3A the two synchronous machines A and B generate 1.0 p.u. voltages. The per unit value of reactances of the components are given below

	X_1	X_2	X_0
A	0.3	0.2	0.5
B	0.25	0.15	0.03
T_1	0.12	0.12	0.12
T_2	0.10	0.10	0.10
Each line	0.30	0.30	0.70

Calculate the currents fed in to the LL-G fault from both the generators.

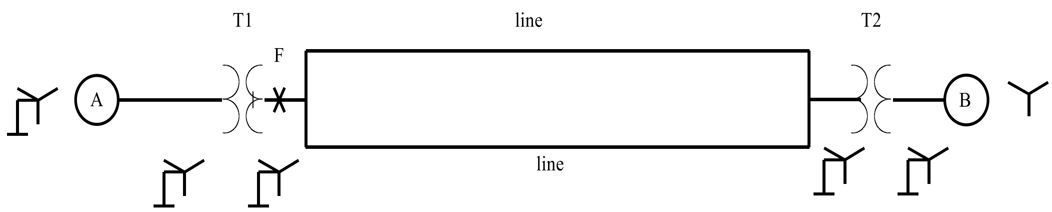

Fig.3A ***(07)***

3B Derive expressions for the sequence components of the fault current for a single line to ground fault on an unloaded generator. Draw the sequence network connections. ***(03)***

4A A 50 Hz, Synchronous generator has H=5 MJ/MVA, and Xd'=0.3 p.u. It is delivering 1 p.u. power to an infinite bus through a transformer and a double circuit line. The transformer reactance is 20 %. Each line has a reactance of 30 %. The voltage behind transient reactance of generator is 1.17 p.u. A three phase fault occurs at the middle of one of the lines. The fault is cleared by the opening of the faulted line. Determine the critical clearing angle and critical clearing time. ***(07)***

4B Form admittance matrix and using matrix algebra, eliminate node-3 in the network shown in Fig. 4B and draw the reduced network. The admitances are given in p.u on a common base. ***(03)***

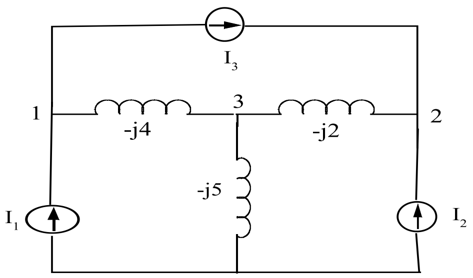

Fig. 4B

5A Using Newton-Raphson method, obtain the voltage magnitude and phase angle of bus 2 for the power system network shown in Fig.5A after one iteration. Assume initial voltage of bus 2 as $0.85\angle{-15^0}$.

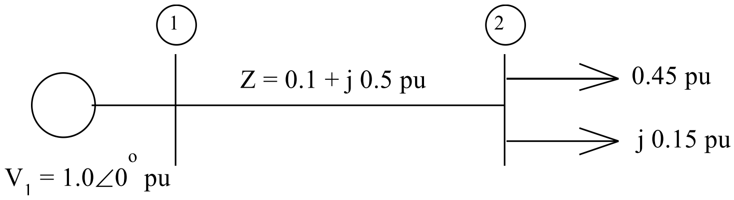

Fig.5A **(05)**

5B In the power system shown in Fig.5B the magnitude of voltage at bus 1 is 1.05 P.U. The scheduled loads at bus 2 are marked on the diagram. Line impedances are marked in per unit on a 100MVA base. Using the Gauss-Seidel method, determine the voltage at the buses 2 and 3. Reactive power injected at bus 3 is $0.8 \le Q \le 1.3$ pu.

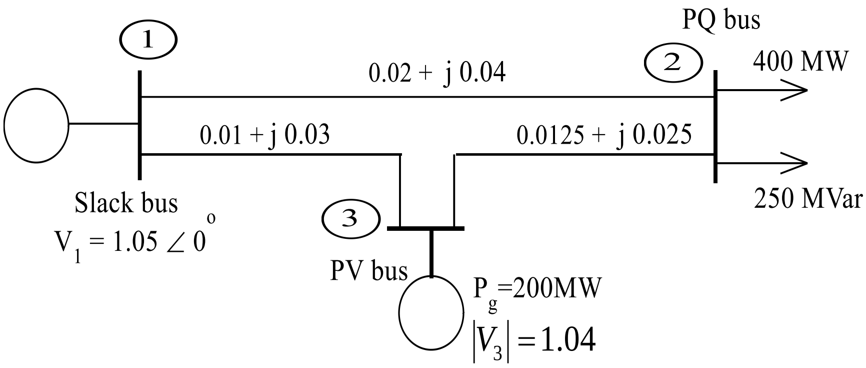

Fig.5B **(05)**