Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

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A Constituent Institution of Manipal University

V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

MAKEUP EXAMINATIONS, DEC 2016 - JAN 2017

SUBJECT: POWER SYSTEM ANALYSIS [ELE 3105]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 05 January 2017** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Graph sheet may be supplied.

1A. A 33 kV/11 kV/400 V, three winding transformer has the following data during short circuit test:
Rating: Primary – 75 MVA, 33 kV; Secondary – 60 MVA, 11 kV; Tertiary – 15 MVA, 400 V;
Equivalent impedance between primary and secondary referred to primary = (3.5 + j 13) Ω
Equivalent impedance between primary and tertiary referred to primary = (3.2 + j 10) Ω
Equivalent impedance between secondary and tertiary referred to secondary = (0.3 + j 1.22) Ω
Obtain per unit impedance of primary, secondary and tertiary windings on a base of 75 MVA, 33 kV in primary circuit. Also draw impedance diagram indicating all per unit values. ***(05)***

1B. What are the advantages of per unit system? ***(02)***

1C. Give reasons:
(i) Subtransient reactance of synchronous generator is less than steady state reactance.
(ii) Interrupting current is a function of circuit breaker speed of operation.
(iii) Base value is chosen for certain quantities only, but not all quantities of a power system. ***(03)***

2A. The single line diagram of a power network is shown in Fig. Q 2A. On a common base of 11 kV, 150 MVA in generator circuit, following data is available:
Subtransient reactance of generator and motor are j 0.2 and j 0.15 pu respectively.
Leakage reactance of transformers T1 and T2 are j 0.08 and j 0.1 pu respectively.
Transmission line reactance is j 0.3 pu.
Generator is supplying a load current of 0.95 pu, 0.8 pf lagging at a terminal voltage of 11.5 kV under steady state conditions. A 3-phase fault occurs at the midpoint of transmission line at F. Determine the generator and motor currents under subtransient condition by applying Thevenin's theorem. ***(05)***

2B. A synchronous generator is connected to a synchronous motor through a transmission line *Fig. Q2B.* A fault occurs at one-third distance away from the motor towards the generator. The symmetrical components of the current from the generator towards the fault are (in pu):
Ia1 = 0.8 – j 1.4; Ia2 = j 0.5; Ia0 = j 3.375 and from the motor toward the fault are
Ia1 = – 0.8 – j 3.1; Ia2 = j 0.625; Ia0 = 0.
Assume $X_1 = X_2$ for generator, motor and transmission line. Describe the type of fault. What is the fault current? Also find the pre-fault current if any, in line 'a'. ***(05)***

3A. Show how the equal area criteria is applied to a single machine connected to infinite bus through a tie line impedance for a change in mechanical input, for deterring the stability of the system. ***(03)***

3B. A25 MVA, 11kv generator has a direct axis sub transient reactance of 0.2 p.u. Its negative and zero sequence reactances are 0.3 and 0.1 p.u. respectively. The neutral of the generator is solidly grounded. Determine the sub transient current in the generator and the line to line voltages for sub transient conditions when a single line to ground fault occurs at the generator terminals, with the generator operating at rated voltage. Neglect resistance. ***(07)***

4. A 60 Hz, Synchronous generator has H= 5.66 MJ / MVA, and Xd′= 0.2 p.u. It is connected to an infinite bus through a transformer and a double circuit line. Each line has a reactance of 80%. The reactance of the transformer is 0.158 p.u on a common base MVA. The voltage magnitude at the sending end of the double circuit line (bus bar 1) is 1.1 p.u. The generator is delivering a real power of 0.77 p.u to bus bar 1. 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 & critical clearing time. ***(10)***

5A. A three bus power system has generators at buses 1 & 2. The series impedance and shunt admittance of each line are 0.026+j0.11 pu and j0.04 pu respectively.

The generation & load at the buses are as follows:

Bus	P_G	Q_G	P_L	Q_L	V pu
1	unspecified	unspecified	1	0.5	1.03+j0 (Slack)
2	1.5	unspecified	0	0	1.03 (PV)
3	0	0	1.2	0.5	unspecified (PQ)

The injected reactive power limits at bus 2 is 0≤ Q2≤ 0.8 pu. Determine V2 & V3 at the end of one iteration by Gauss- Seidel method. Also find the slack bus power. ***(06)***

5B. For the system shown in Fig. 5B, form bus admittance matrix and reduce it using matrix algebra. Also draw the reduced network. ***(04)***

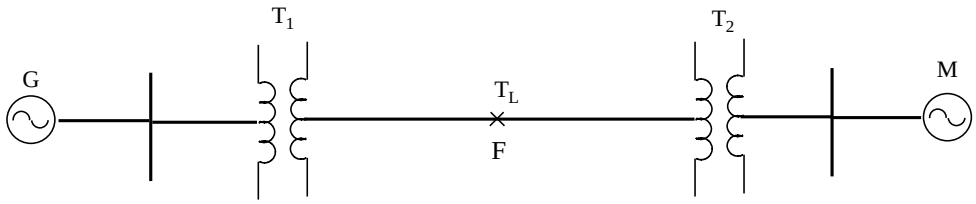

Fig.Q2A

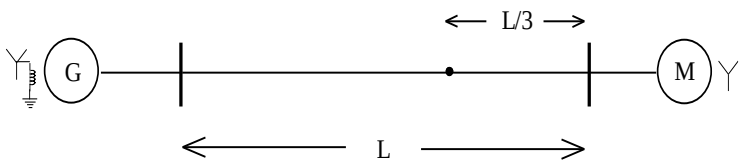

Fig. Q2B

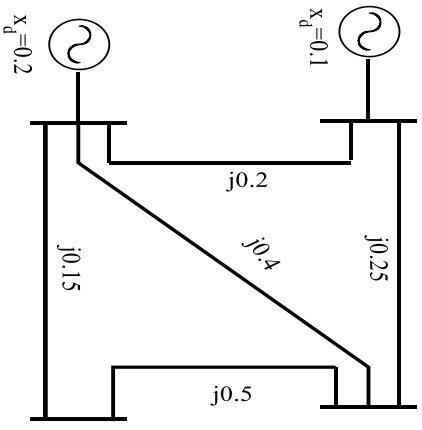

Fig. 5B