Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

MAKE UP EXAMINATIONS, DEC 2015 / JAN 2016

SUBJECT: POWER SYSTEM ANALYSIS [ELE 309]

REVISED CREDIT SYSTEM

Time: 3 Hours 06 JANUARY 2016 MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitably assumed.

1A. Draw the reactance diagram for the system shown in Fig. Q1A and mark all the reactances in pu on 20MVA, 6.9 KV base in the generator 1 circuit.

Gen 1 10MVA, 6.6KV, 0.1 pu

Gen 2 20MVA, 11.5KV, 0.1 pu

Tr.1 3-phase unit 10MVA, 6.6 / 115KV, 0.15 pu

Tr.2 Three phase bank of single-phase transformer units each rated 10MVA, 7.5 / 75KV, 0.1pu

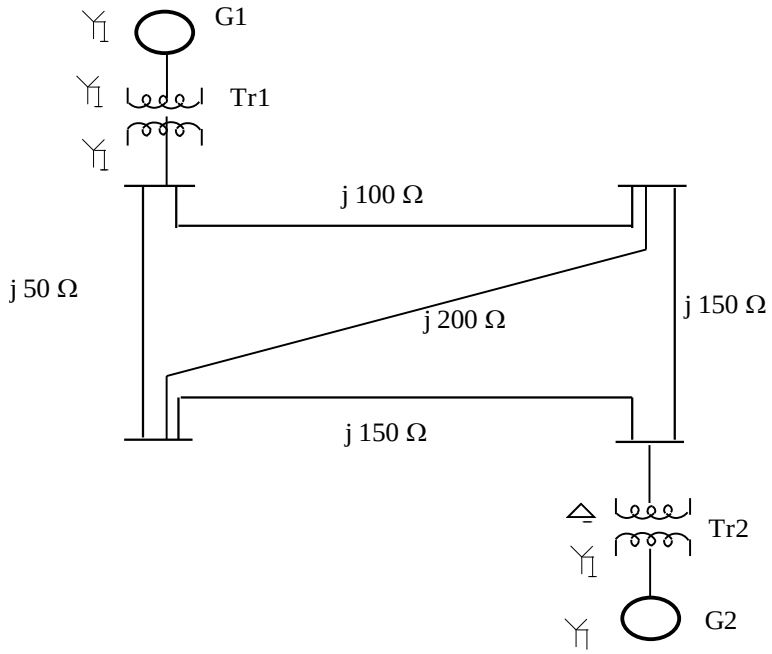

Fig. Q1A

07

1B. Derive the equivalent circuit of a three winding transformer. Explain how to obtain pu impedance. **03**

2A. A generator-transformer unit is connected to a line through a circuit breaker. The unit ratings are generator 10MVA, 6.6 KV, X_d'' = 0.1 pu, X_d' = 0.2 pu, X_d = 0.8 pu and transformer 10MVA, 6.9 / 33 KV, reactance = 0.08 pu. The system is operating on no load at a line voltage of 30 KV, when a 3 phase fault occurs on the line just after the circuit breaker. Find

i) Initial symmetrical r.m.s. current in the circuit breaker.

ii) Maximum possible dc offset current in the breaker.

iii) Momentary current rating of the breaker.

iv) Current to be interrupted by the breaker and interrupting KVA.

Sustained short circuit current in the breaker. **05**

2B. A generator is connected through a transformer to a synchronous motor. Reduced to the same base the pu sub-transient reactance of the generator and motor are 0.15 and 0.35 respectively and the leakage reactance of the transformer is 0.1 pu. A 3 phase fault occurs at the terminals of the motor, when the terminal voltage of the generator is 0.9 pu and the output current is 1.0 pu at 0.8 p.f. leading. Use terminal voltage of the generator as the reference phasor and find the sub-transient currents in pu in the faulted generator and motor, calculating the voltage behind the sub-transient reactance. **05**

3A. A generator with a zero sequence reactance of 0.2 pu is grounded through a reactance of 0.05 pu. It supplies a motor through a transformer. Zero sequence reactance of motor is 0.3 pu and its neutral is solidly grounded. The leakage reactance of transformer is 0.1 pu. Draw the zero sequence networks for the following connections of transformer: i) Star-star (both solidly connected) ii) Star grounded-delta iii) Delta-delta iv) Star isolated - star grounded. **04**

3B. A generator has E_a = 1.0 pu and the magnitudes of the fault currents for L-G, LL and LL-G faults are 5.0, 3.464 and 5.454 respectively. Determine the fault current for LLL fault. **06**

4A. A double line to ground fault occurs on lines b and c of an unloaded synchronous generator with its neutral grounded through impedance Z_n. i) Write down the equations describing the fault ii) Derive the expression for fault current iii) Derive the expression for voltage V_a iv) Show the inter connection of the sequence network to represent the fault. The sequence impedances of the generator are Z_1 , Z_2 and Z_{go}. **05**

4B. A 20 MVA, 13.8 KV generator has X'' = 25%, X_2=35% and X_0 = 10%. Determine the sub transient fault current in the generator and the line to line voltages in KV for sub-transient conditions when a single line to ground fault occurs at the generator terminals with the generator operating unloaded at rated voltage. Neglect resistance. **05**

5A. A 200MVA, 11KV, 50Hz, 6 pole generator has an inertia constant of 5 MJ/MVA. The machine is operating stable at an electrical load of 120MW. The electrical load is suddenly increased to 150MW. Find the rotor retardation. If the retardation is maintained for 10 cycles, find the speed at the end of this period. **04**

5B. A 50 Hz synchronous generator having synchronous reactance of 0.3 pu and inertia constant of 5 MJ/MVA is connected to an infinite bus bar of terminal voltage 1.0 pu through a transformer of leakage reactance of 0.2 pu in series with a double circuit transmission line with each of line of reactance 0.3 pu. Under steady state conditions, the generator has an internal emf of 1.2 pu and is delivering 0.85 pu of real power to the infinite bus. A temporary 3 phase fault occurs at the sending end of the transmission line. When the fault is cleared both the lines are intact. Determine the critical clearing angle and critical clearing time. **06**

6A. Define the following: (i) Load bus (ii) P-V bus (iii) Slack bus **03**

6B. The slack bus voltage of the network shown in Fig. Q 6 B is $V_1 = 1.0\angle 0^0$. With initial voltages of bus #2 and bus #3 as $V_2^{(0)} = 0.9\angle 2^0$ and $V_3^{(0)} = 0.95\angle -1.5^0$, obtain the new values of V_2 and V_3 at the end of one iteration, using Gauss Siedel method. **07**

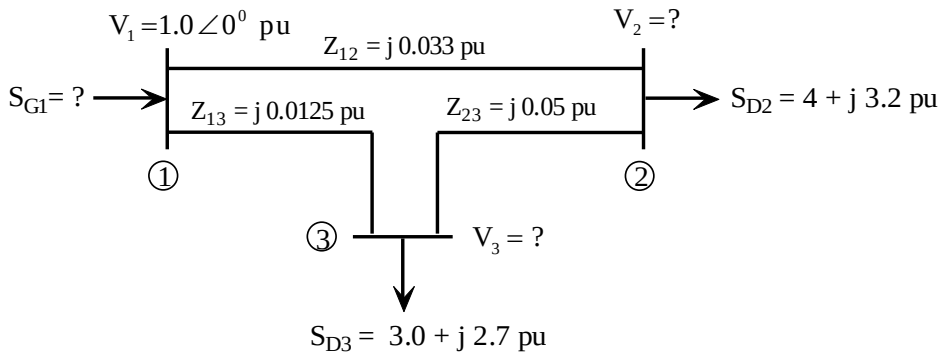

Fig. Q 6 B