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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent Institution of MAHE, Manipal)

V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

MAKE-UP EXAMINATIONS, MAY 2018

POWER SYSTEM ANALYSIS [ELE 3105]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 15 May 2018** **Max. Marks: 50**

Instructions to Candidates:

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

1A. Two generators operate in parallel supplying a motor through a transmission line having transformers at both the ends. There are lagging loads at the generator and motor terminal buses.

i) Draw a single line diagram of the sample power system described above.
ii) Draw reactance diagrams of the system for

a) Load flow study b) Fault analysis, justifying the assumptions made. **(03)**

1B. For the power system shown in Fig Q1B draw the reactance diagram. Use a base of 50 MVA, 138 kV in the 40 Ω line.

Generator1: 20 MVA, 13.2 kV, X = 15%
Generator2: 20 MVA, 13.2 kV, X = 15%
Motor: 30 MVA, 6.9 kV, X = 20%
3 phase star-star transformers: 20 MVA, 13.8 kV star/138 kV star, X = 10%
3 phase star-delta transformers: 15 MVA, 6.9 kV delta/138 kV star, X = 10%

The motor draws 24 MW at 0.8 p.f. lead at 6.6 kV. Find the bus voltages at A and C. Assume generators share the load equally.

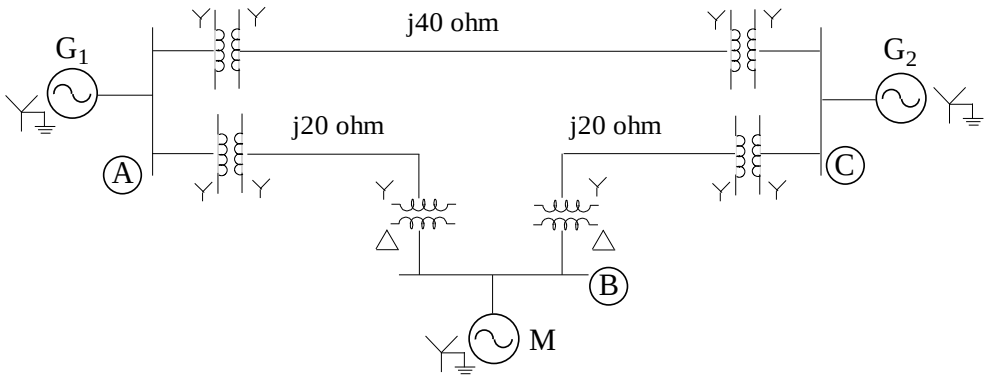

Fig Q1B **(07)**

2A. A generator is connected through a transformer to a synchronous motor. Reduced to the same base the per unit 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 per unit. A 3 phase fault occurs at the terminals of the motor, when the terminal voltage of the generator is 0.9 p.u. and the output current is 1.0 p.u. at 0.8 p.f. leading. Find the sub-transient current in p.u. in the faulted generator and motor. Use terminal voltage of the generator as the reference phasor and obtain the solution by

1) Computing voltages behind sub-transient reactance of the generator and motor
2) Using Thevenin's theorem. **(08)**

2B. For a 3 bus system the line impedances are as given below. Determine the Y_{bus} for the system.

1-2 0.06+j 0.18
1-3 0.03+j 0.09
2-3 0.08+j 0.24 **(02)**

3A. A 50 MVA 11 KV, 3 phase alternator has the following fault currents:

3 phase symmetrical – 3750 A
L – L – 3800 A
S – L – G – 6074 A

The alternator neutral is solidly grounded. Find the per unit value of the three sequence reactances of the alternator. **(03)**

3B. Derive an expression for three phase power in terms of symmetrical components. **(02)**

3C. Derive expressions for the sequence components of the fault current for a single line to ground fault on an unloaded generator **(05)**

4A. A synchronous generator supplies power to two identical synchronous motors. The reactances of the machines are in pu as shown:

Machine	X_1	X_2	X_0	X_n
Generator	0.4	0.3	0.2	0.0
Motor (each)	0.3	0.2	0.1	0.05

The neutral of the machines are grounded. A double line to ground fault occurs at the terminals of the motor. Neglecting prefault current, find (i) the fault current and (ii) line currents of generator. **(07)**

4B. State and explain equal area criteria applicable to transient stability. **(03)**

5A. The network details for a power system is as given.

Bus data:

Bus Number	Type of Bus	P_L in MW	Q_L in MVAR
1	Slack	----------	----------
2	Load	400	320
3	Load	300	270

Line Data:

From Bus	To Bus	Line Reactance in PU
1	2	J0.033
2	3	J0.05
3	1	J0.0125

Determine the voltages at the buses 2 and 3 at the end of two iterations using Gauss-Siedal method. Also find the reactive power loss in the line 1-2. **(05)**

5B. A 60 Hz, Synchronous generator has H= 5.66 MJ/MVA and X'_d = 0.2 pu. 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 pu on a common base MVA. The voltage magnitude at the sending end of the double circuit line (bus bar 1) is 1.1 pu. The generator is delivering a real power of 0.77 pu to bus bar 1. A three phase fault occurs at the middle of one of the lines. The fault is cleared by opening of the faulted line. Determine the critical clearing angle. **(05)**