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# Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

## V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

## END SEMESTER EXAMINATIONS, NOVEMBER 2015

SUBJECT: POWER SYSTEM ANALYSIS [ELE 309]

**REVISED CREDIT SYSTEM**

Time: 3 Hours MAX. MARKS: 50

**Instructions to Candidates:**

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

**1A.** A 20MVA, 11kV three-phase generator has a reactance of 15% supplies a synchronous motor and a static load over a transmission line having transformers ($T_1$ and $T_2$) at both ends. The ratings are as follows:
Synchronous motor: 15MVA, 11kV with X=15%
Transformer $T_1$: 25MVA, 12.5Δ/132Y kV with leakage reactance of 10%
Transformer $T_2$: 20MVA, 132Y/11Δ kV with leakage reactance of 10%
Line: (200+j500) Ω
Static load: 5MVA, 0.8 p.f lagging.

i. Draw a single line diagram of the sample power system described above.
ii. Draw the impedance diagram with all reactances marked in per-unit. Choose a base voltage of 132kV for the transmission line and a base volt-ampere of 20MVA.
iii. If the motor is drawing 15MVA at 0.9 power factor leading and the terminal voltage is 1.1 p.u. find the generator bus voltage in kV. **07**

**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% on 15MVA, 66kV base; $X_{ST}$=8%, on 10MVA, 13.2kV base. Calculate the per unit reactance of the per phase equivalent circuit for a base of 5MVA, 2.3kV in the tertiary circuit. **03**

**2A.** The single line diagram of a simple power system is shown in Fig. 2(A). The per-unit reactances of the components marked are based on 100MVA. Determine the short circuit MVA rating of the circuit breaker at the location A for a three phase solid fault shown.

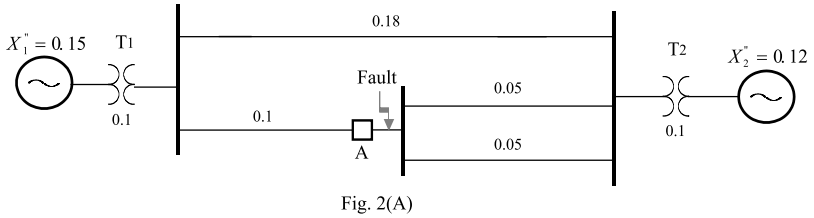


Fig. 2(A)

**05**

| Reg. No. | | | | | | | | | | |
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**2B.** A generator is connected through a transformer to a synchronous motor. Reduced to the same base, the p.u. 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 p.u. 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. Use terminal voltage of the generator as the reference phasor and find the sub-transient currents in p.u. in the faulted generator and motor using Thevenin's theorem. **05**

**3A.** Find an expression for the fault current when a double line to ground fault occurs at the terminals of an unloaded generator. **04**

**3B.** Three 6.6 kV, 3 phase 10 MVA alternators are connected to a common bus. Each alternator has $x_1$=0.15 p.u., $x_2$=75% of $x_1$ and $x_0$=30% of $x_1$. A double line to ground fault occurs on the bus. Find the fault current if i) all the alternator neutrals are solidly grounded ii) one alternator neutral is grounded through 0.3 ohm resistance and the other two neutrals are isolated. **06**

**4A.** A synchronous generator supplies power to two identical synchronous motors. The reactance of the machines are in p.u. as shown:

| Machine | $X_1$ | $X_2$ | $X_0$ |
|---|---|---|---|
| Generator | 0.4 | 0.3 | 0.1 |
| Motor | 0.3 | 0.2 | 0.2 |

The neutral of the generator is grounded through an inductive reactance of 0.05 p.u. One motor is solidly grounded while the other motor neutral is isolated. The system is on no load with generator at its rated terminal voltage. Find the fault current and the three unbalanced line currents of the generator for a single line to ground fault at generator terminals. **07**

**4B.** Using matrix algebra eliminate node 3 of the network given in Fig.4(B) and obtain the reduced network. Verify the result by star delta transformation.

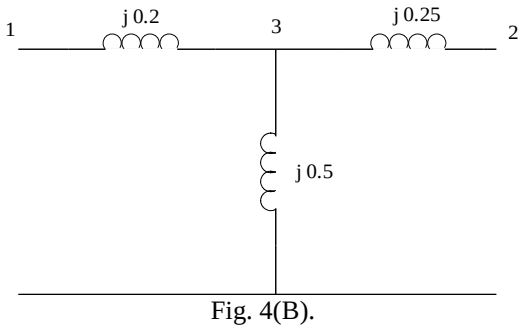


Fig. 4(B). **03**

**5A.** What is transient stability? Explain the factors which affect transient stability. **04**

**5B.** A power system network is delivering 0.9 p.u. active power to a substation. The power angle characteristic of the network is given by $P_e$ = 1.6 *Sin δ. The mechanical input of the system is suddenly increased to 1.2 p.u. Comment on the stability of the system using equal area criterion. **06**

| Reg. No. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|

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**6A.** What is acceleration factor used in Gauss-Seidal method? **03**

**6B.** A 3-bus network is described as shown below:

| Bus no. | Per Unit Voltage | Per Unit Injected power |
|---|---|---|
| 1 | $1.05 \angle 0^o$ | ? |
| 2 | $1.08 \angle 3.8^o$ | 1.0 + j 0.6 |
| 3 | $0.98 \angle - 1.7^o$ | – 1.2 – j 0.5 |

The line impedance between any two bus is (0.03 + j 0.12) p.u. Determine line losses and injected power of slack bus. **07**