USN | | | | | | | | | | |

15EE62

Sixth Semester B.E. Degree Examination, June/July 2019
Power System Analysis – I

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Show that per unit impedance of two winding transformer will remain same referred to primary as well as secondary. **(06 Marks)**

b. A 300 MVA, 20 KV, 3-phase generator has subtransient reactance of 20%. The generator supplies two synchronous motors through a 64 KVA transmission line having transformers at both ends as shown in Fig.Q1(b). T_1 is a 3-phase transformer and T_2 is composed of 3-single phase transformers of rating 100 MVA each, 127/13.2 KV, 10% reactance, series reactance of transmission line is 0.5 ohm/km. Draw the reactance diagram with all reactances marked in per unit. Select generator rating on base values.

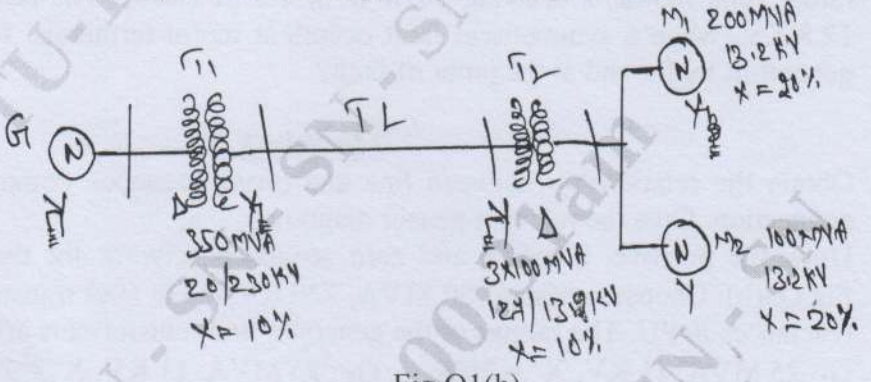

Fig.Q1(b) **(10 Marks)**

OR

2 a. Define per unit quantity. Mention the advantages of per unit system. **(04 Marks)**

b. The one line diagram of an unloaded generator is shown in Fig.Q2(b). Draw the PU reactance diagram. Choose a base of 50 MVA, 13.8 KV in the circuit of generator G_1. The ratings are as follows:

G_1 : 20 MVA, 13.8 KV, X″ = 20% T_1 : 25 MVA, 13.8/220 KV, X = 10%
G_2 : 30 MVA, 18 KV, X″ = 20% T_2 : 30 MVA, 220/18 KV, X = 10%
G_3 : 30 MVA, 20 KV, X″ = 20% T_3 : 35 MVA, 220/22 KV, X = 10%

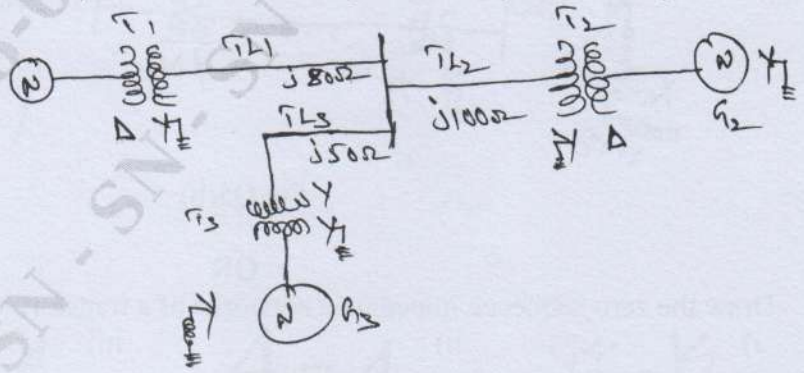

Fig.Q2(b) **(12 Marks)**

Module-2

3 a. With the help of waveform at the time of three phase symmetrical fault, on synchronous generator define steady state, transient and subtransient reactances. **(08 Marks)**

b. A generator is connected to a synchronous motor through transformer. Reduced to a common base, the per unit subtransient reactances of generator and motor are 0.15 and 0.35 PU respectively. The leakage reactance of the transformer is 0.1 PU. A 3-phase star circuit fault occurs at terminals of the motor when terminal voltage of generator is 0.9 P.U and output current of generator is 1 P.U at 0.8 pf leading. Find the subtransient current in the fault, generator and motor.

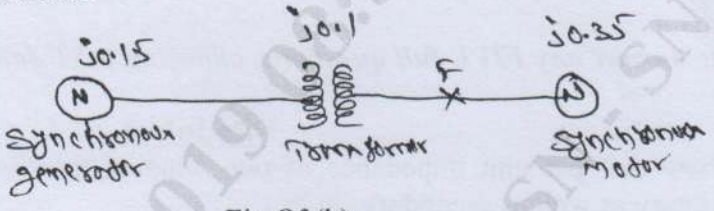

Fig.Q3(b) **(08 Marks)**

OR

4 a. Explain clearly, how circuit breaker are rated? **(06 Marks)**

b. A synchronous generator and motor are rated 30 MVA, 13.2 KV, both have subtransient reactance of 20%. The line connecting them has a reactance of 20%, on the base of machine rating. The motor is drawing 20 MW at 0.8 pf (lead). The terminal voltage of motor is 12.8 KV, when a symmetrical fault occurs at motor terminals, find subtransient current in generator, motor and at the point of fault? **(10 Marks)**

Module-3

5 a. Obtain the relationship between line and phase sequence components of voltages in star connection. Give the relevant phasor diagrams. **(08 Marks)**

b. Draw the positive, negative and zero sequence network for the power system shown in Fig.Q5(b). Choose a base of 50 MVA, 220 KV in the 50Ω transmission lines and marks all reactances in PU. The ratings of the generator and transformers are:

G_1: 25 MVA, 11 KV, X″ = 20%; G_2 : 25 MVA, 11 KV, X″ = 20%

3ϕ transformers (each) : 20 MVA, 11/220 KV, X = 15%

The negative sequence reactance of each synchronous machine is equal to the sub-transient reactance. The zero sequence reactance of a each machine is 8%. Assume that the zero sequence reactances of lines are 250% of their positive sequence reactances.

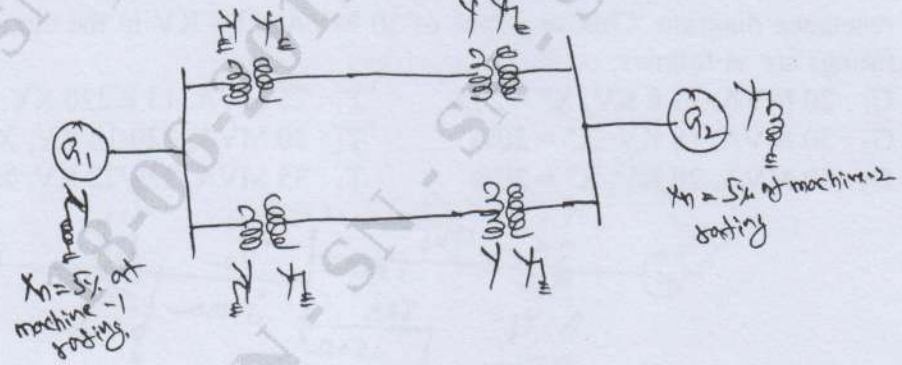

Fig.Q5(b) **(08 Marks)**

OR

6 a. Draw the zero sequence impedance networks of a transformer for the following connections:

i) Y - Y ii) Δ - Δ iii) Δ - Y

(06 Marks)

b. The positive, negative and zero sequence components of line currents are $20\angle 10^\circ$, $6\angle 60^\circ$ and $3\angle 30^\circ$ A respectively. Determine the line currents. **(04 Marks)**

c. In a 3ϕ, 4 wire system, the sequence voltages and currents are:

$V_{a1} = 0.9\angle 10^\circ$ PU ; $V_{a2} = 0.25\angle 110^\circ$ PU ; $V_{a0} = 0.12\angle 300^\circ$ PU ;

$I_{a1} = 0.75\angle 25^\circ$ PU ; $I_{a2} = 0.15\angle 170^\circ$ PU ; $I_{a0} = 0.1\angle 330^\circ$ PU

Find the complex power in PU. If the neutral gets disconnected, find the new power. **(06 Marks)**

Module-4

7 a. An unloaded fully excited three phone aftemafor is subjected to an L-G fault at its terminals. Find the fault current. Using symmetrical components by showing the interconnection of all sequence networks. **(08 Marks)**

b. Draw the sequence networks for the system shown in Fig.Q7(b). Determine the fault current if a line to line occurs at F. The PU reactances all referred to the same base are as follows. Both the generators are generating 1.0 PU.

Component	X_0	X_1	X_2
G_1	0.05	0.30	0.20
G_2	0.03	0.25	0.15
Line-1	0.70	0.30	0.30
Line-2	0.70	0.30	0.30
T_1	0.12	0.12	0.12
T_2	0.10	0.10	0.10

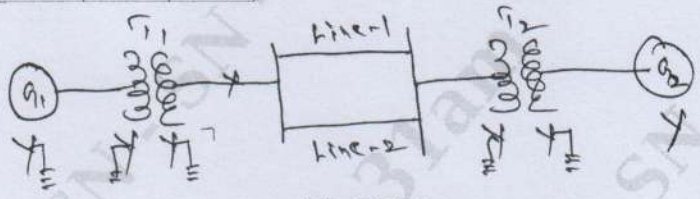

Fig.Q7(b) **(08 Marks)**

OR

8 a. Derive expression for fault current if Line-Line-Ground (LLG) fault occurs through fault impedance Z_f in power system. Show the connection of sequence networks to represent the fault. **(08 Marks)**

b. A three phase generator with an open circuit voltage of 400 V is subjected to an LG fault through a fault impedance of j2Ω. Determine the fault current is $Z_1 = j4\Omega$, $Z_2 = j2\Omega$ and $Z_0 = j1\Omega$. Repeat the problem for LL fault. **(08 Marks)**

Module-5

9 a. Explain 'equal area criteria' concept when a power system is subjected, to sudden loss of one of the 'parallel lines'. **(08 Marks)**

b. Define stability pertaining to a power system and classify the different types of stability. **(04 Marks)**

c. A 2 pole, 50 Hz, 11 KV turbo alternator has a rating of 100 MW, 0.85 p.f. lagging. The rotor has moment of inertia of 10000 kg-m^2. Calculate H and M. **(04 Marks)**

OR

10 a. Derive the power angle equation of a salient pole synchronous machine connected to an infinite bus. Draw the power angle curve. **(08 Marks)**

b. Derive an expression for the swing equation. **(08 Marks)**

* * * * *