

USN

Course Code

Sixth Semester B.E. Degree Examinations, May/June 2026

POWER SYSTEM ANALYSIS-1

Duration: 3 hrs

Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Missing data, if any, may be suitably assumed

<u>Q. No</u>	<u>Question</u>	<u>Marks</u>	<u>(RBTL:CO:PI)</u>
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Module-1

1. a. Draw the per phase basis, representation of synchronous machine, transmission line and two winding transformers. 06 (2:1:1.4.1)
- b. Draw Impedance and reactance diagram for the SLD shown in Fig.Q1(b). 06 (2:1:1.4.1)

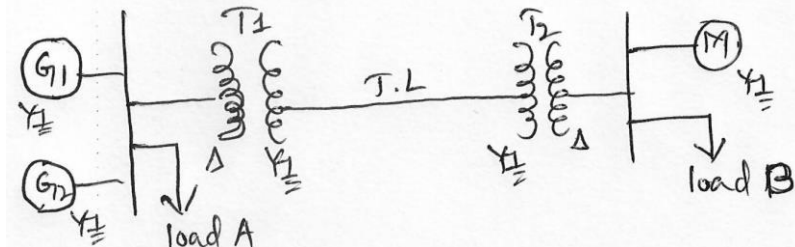


Fig. Q1(b)

- c. A three phase Δ - Δ transformer with rating 100 kVA, 11 kV/400 V has its primary and secondary leakage reactance as 12 Ω /phase and 0.05 Ω /phase respectively. Calculate the p.u. reactance of the transformer referred to both primary and secondary side. 08 (3:1:2.3.1)

(OR)

2. a. Define per unit quantity. Mention the advantages and disadvantages of per unit system. 06 (2:1:1.4.1)
- b. The per unit value of an impedance is 0.7 by considering the bases as 300 kVA, 11 kV. Find (i) Ohmic value of impedance (ii) Does this Ohmic value changes if the bases are changed to 400 kVA, 33 kV. (iii) Find the new per unit value considering above new base values. 06 (3:1:2.3.1)
- c. Draw the per unit reactance diagram for the system shown in Fig. Q2(c) marking all impedance values in p.u. on a base value of 15 MVA, 6.6 kV from generator side. The ratings of components are
G : 15 MVA, 6.6 kV, X= 12 % ; T1 : 20 MVA, 6.6/66 kV, X=8 %
T2 : 20 MVA, 66/6.6 kV, X= 8 % ;
M1 & M2 : 5 MVA, 6.6 kV, X= 20 % ; TL : j60 Ω 08 (3:1:2.3.1)

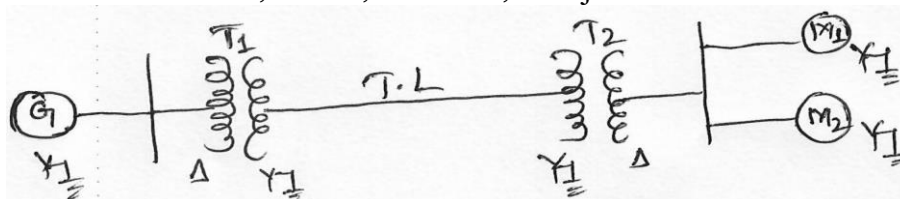


Fig. Q2(c)

Module-2

3. a. What is doubling effect in transmission line? Substantiate with equations. 10 (2:2:2.1.2)

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI- Performance Indicator)

- b. A synchronous generator and motor shown in Fig. Q3(b) are rated 30 MVA, 13.2 kV and both have sub-transient reactance of 20 %. The line connecting them has a reactance of 10 % on the base of machine rating. The motor is drawing 20 MW at 0.8 p.f. (leading). The terminal voltage of motor is 12.8 kV when a symmetrical fault occurs at motor terminals, find (i) Sub-transient current in generator (ii) Sub-transient current in motor (iii) Total fault current

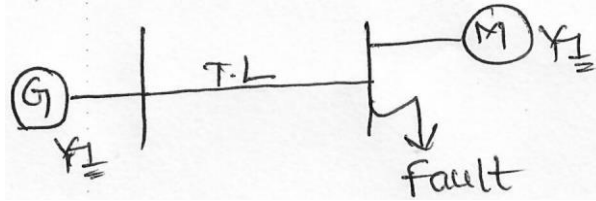


Fig. Q3(b)

(OR)

4. a. Explain in detail symmetrical short circuit of a synchronous generator on no-load and constant excitation by drawing Oscillogram. 10 (2:2:2.1.2)
- b. Generator G_1 & G_2 are identical and rated 11 kV, 20 MVA and have transient reactance of 0.25 p.u. at own base. The transformer T_1 & T_2 are also identical and are rated 11/66 kV, 5 MVA and have a reactance of 0.06 p.u. to their own MVA base. The tie-line is 50 km long each conductor has a reactance of $0.848 \Omega/\text{km}$. A three-phase fault is assumed at F, 20 km from Generator G_1 as shown in Fig. Q 4(b). Find the short circuit current. Select generator ratings as base values. 10 (3:2:2.3.1)

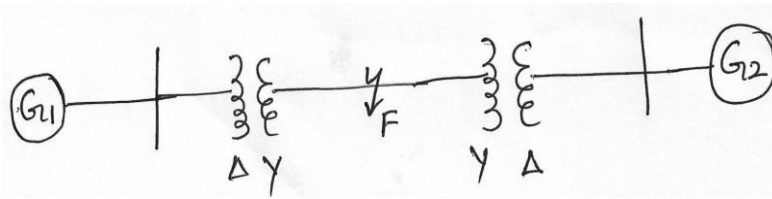


Fig. Q4(b)

Module-3

5. a. Derive an expression for phase voltages in terms of symmetrical components. 06 (2:3:2.1.2)
- b. Derive an expression for complex power in terms of symmetrical components. 06 (2:3:2.1.2)
- c. In a 3-Phase system, are $I_{a1} = 100 \angle 30^\circ$, $I_{b2} = 40 \angle 90^\circ$, $I_{c0} = 10 \angle -30^\circ$ Amps respectively. Determine line currents. 08 (3:3:2.3.1)
- (OR)
6. a. Obtain the relationship between line and phase sequence components of voltages in star connected 3- ϕ system. 06 (2:3:2.1.2)
- b. What is sequence impedance. Obtain expression for sequence impedance of a symmetrical circuit. 06 (2:3:2.1.2)
- c. Across a star connected symmetrical impedance load of 10Ω in each phase and a neutral impedance of 3.33Ω , an unbalanced three phase supply with $V_a = 220 \angle 0^\circ \text{V}$, $V_b = 180 \angle -110^\circ \text{V}$, $V_c = 200 \angle 110^\circ \text{V}$ is applied. Determine the line currents using symmetrical components. 08 (2:3:2.3.1)

Module-4

7. a. Define fault in power system. Classify the unsymmetrical faults with its frequency of occurrence. 06 (2:4:1.4.1)

	b.	Derive an expression for fault current when an L-G occurs on the terminals of an unloaded generator. Show the inter connection of sequence network.	06	(2:4:2.1.2)
	c.	A three-phase generator with an open circuit voltage of 400 V is subjected to an LG fault through a fault impedance of $j2 \Omega$. Determine the fault current if $Z_1 = j4 \Omega$, $Z_2 = j2 \Omega$ and $Z_0 = j1 \Omega$. Also find the fault current if it is L-L and L-L-G faults.	08	(3:4:2.3.1)
		(OR)		
8.	a.	Discuss “Open Conductor Faults”.	06	(2:4:1.4.1)
	b.	Derive an expression for fault current when an L-L fault through impedance Z_f in a power system. Show the inter connection of sequence network.	06	(2:4:2.1.2)
	c.	A 30 MVA, 11 kV generator has $Z_1 = Z_2 = j0.2$ p.u. and $Z_0 = j0.05$ p.u. A L-L fault occurs at the generator terminals. Find the line currents and line to neutral voltages during the fault condition. Assume that the generator neutral is solidly grounded.	08	(3:4:2.3.1)
		<u>Module-5</u>		
9.	a.	Define power system stability. Briefly explain (i) Steady state stability (ii) Transient stability and (iii) Dynamic stability	06	(2:5:1.4.1)
	b.	Derive an expression for swing equation with usual notations.	06	(2:5:2.1.2)
	c.	A two pole, 50 Hz, 11 kV turbo alternator has rating of 100 MW, power factor 0.85 lagging. The rotor has moment of inertia of 10,000 kg-m ² . Calculate H and M.	08	(3:5:2.3.1)
		(OR)		
10.	a.	State and explain Equal Area Criterion (EAC). What are the assumptions made in applying EAC?	06	(2:5:1.4.1)
	b.	Derive the power angle equation of non-salient pole synchronous machine connected to an infinite bus. Draw the power angle curve.	06	(2:5:2.1.2)
	c.	The transfer reactance between a generator and an infinite bus bas operating at 200 kV under various conditions on inter connections are: Prefault : 150 Ω per phase During fault : 400 Ω per phase Post fault : 200 Ω per phase If the fault is cleared when the rotor has advanced 60 degrees electrical from the prefault position, determine the load that could be transferred without loss of stability.	08	(3:5:2.3.1)

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