Basavarajeswari Group of Institutions

BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

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

Course Code | 2 | 2 | E | E | 6 | 1 |

Sixth Semester B.E. Degree Examinations, June/July 2025

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

Q. No		Question	Marks	(RBTL:CO:PI)
		Module-1		
1.	**a.**	Show that per unit impedance of two winding transformer will remain same referred to primary as well as secondary.	**06**	**(2:1:1.4.1)**
	b.	Derive an equation for per unit impedance if change of base occurs.	**06**	**(2:1:2.1.2)**
	c.	A 300 MVA, 20 kV, 3-phase generator has sub-transient reactance of 20 %. The generator supplies two synchronous motors through a 64 km transmission line having transformer at both ends as shown in Fig. Q1(c). 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 Ω/km. Draw the reactance diagram with all reactance marked in per unit. Select generator rating as base values.	**08**	**(3:1:2.3.1)**

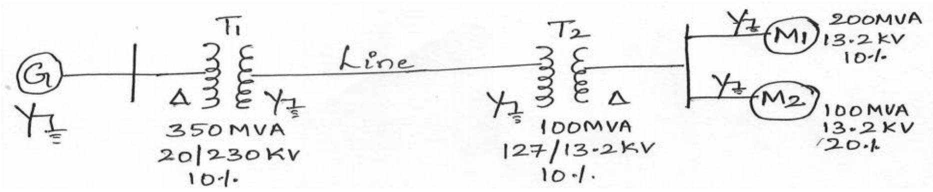

Fig. Q1(c)

OR

Q. No		Question	Marks	(RBTL:CO:PI)
2.	**a.**	Draw the equivalent circuit models of synchronous generator, transmission line and two winding transformer.	**06**	**(2:1:1.4.1)**
	b.	Define per unit quantity and mention the advantages of per unit quantities.	**06**	**(2:1:1.4.1)**
	c.	Draw the per unit reactance diagram for the system shown in Fig. Q 2(c). Choose a base of 50 MVA, 13.8 kV in the circuit of Generator G_1. The ratings of components are: G_1 : 20 MVA, 13.8 kV, X= 20 % ; G_2 : 30 MVA, 18 kV, X= 20 % G_3 : 30 MVA, 20 kV, X= 20 % T_1 : 25 MVA, ⅄ 220 kV/Δ 13.8 kV, X=10 % T_2 : 30 MVA, ⅄ 220 kV/Δ 18 kV, X= 10 % T_3 : 35 MVA, ⅄ 220 kV/Δ 22 kV, X= 10 %	**08**	**(3:1:2.3.1)**

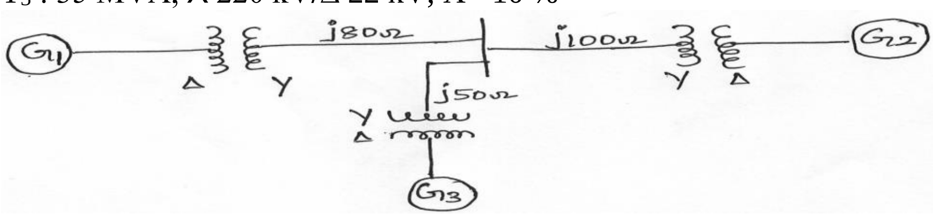

Fig. Q2(c)

Module-2

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

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

b. A synchronous generator and motor are rated for 30,000 kVA, 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 ratings. The motor is drawing 20,000 kW at 0.8 p.f. leading. The terminal voltage of the motor is 12.8 kV. When a symmetrical three-phase fault occurs at motor terminals, find the sub-transient current in generator, motor and at the fault point. **10** **(3:2:2.3.1)**

OR

4. **a.** With the help of Oscillogram of short circuit current of synchronous generator, operating on no load, distinguish between sub-transient, transient and steady state periods. Prove that $X_d'' < X_d' < X_d$. **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 Ω/km. The 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)**

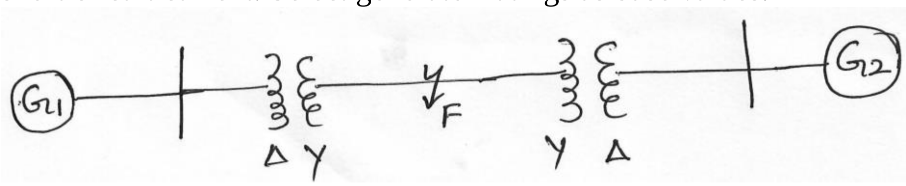

Fig. Q4(b)

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. A balanced delta connected load as shown in Fig. Q 5(c) is connected to three phase symmetrical supply. The line currents are each 10 A in magnitude. If fuse in one of the lines blows out, determine the sequence components of line currents. **08** **(3:3:2.3.1)**

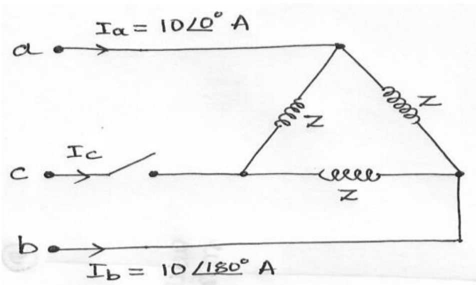

Fig. Q 5(c)

OR

6. **a.** Obtain the relationship between line and phase sequence components of voltages in star connection. **08** **(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. A single-phase resistive load of 100 KVA is connected across line BC of a balanced supply of 3 KV. Compute the symmetrical components of line currents. **06** **(3:3:2.3.1)**

Module-4

7.	**a.**	Define faults. 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 Ω. Determine the fault current if Z_1 = j4 Ω, Z_2 = j2 Ω and Z_0 = j1 Ω. 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	**08**	**(2:4:2.1.2)**
	c.	A 30 MVA, 11 kV generator has Z_1 = Z_2 = j0.2 pu and Z_0 = j0.05 pu. 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.	**06**	**(3:4:2.3.1)**

Module-5

9.	**a.**	Derive power angle equation for a non-salient pole machine.	**06**	**(2:5:2.1.2)**
	b.	Explain equal area criteria for investigating the stability of power system.	**06**	**(2:5:1.4.1)**
	c.	A turbo generator, 6 pole, 50 Hz of capacity 80 MW working at 0.8 p.f. has an inertia of 10 MJ/MVA. (i) Calculate the energy stored in the rotor at synchronous speed (ii) Find rotor acceleration if the mechanical input is suddenly raised to 75 MW for an electric load of 60 MW (iii) Suppose the above acceleration is maintained for a duration of 6 cycles, calculate the change in torque angle and the rotor speed at the end of 6 cycles.	**08**	**(3:5:2.3.1)**

OR

10.	**a.**	Explain the methods for improving transient stability.	**06**	**(2:5:1.4.1)**
	b.	Derive swing equations for a synchronous machine.	**08**	**(2:5:2.1.2)**
	c.	A 50 Hz generator is delivering 50 % of the power that it is capable of delivering through a transmission line to an infinite bus. A fault occurs that increase the reactance between the generator and the infinite bus to 500 % before the fault. When the fault is isolated the maximum power that can be delivered is 75 % of the original maximum value. Determine the critical clearing angle for the condition described.	**06**	**(3:5:2.3.1)**

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