Enrolment No./Seat No_______________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–V (NEW) EXAMINATION – WINTER 2024

Subject Code:3150911 **Date:17-12-2024**

Subject Name:Power System- II

Time:10:30 AM TO 01:00 PM **Total Marks:70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	What is meant by three-phase balanced circuit? Write down expressions of three-phase balanced voltage phasors in polar form.	**03**
	(b)	With the help of phasor diagram for π-model of the transmission line, show that the receiving-end voltage magnitude becomes greater than the sending-end voltage magnitude when the transmission line is under no-load condition. What is the name of this effect?	**04**
	(c)	Compare nominal-T and nominal-π method for analysis of medium transmission line with phasor diagrams and necessary expressions.	**07**
Q.2	**(a)**	Evaluate percentage voltage regulation of a medium line that has the following parameters: $A = 0.95\angle 1^o,\ B = 100\angle 75^o\,\Omega$ The receiving-end and sending-end voltage magnitudes are found to be $\lvert V_R \rvert = 132\,kV$ and $\lvert V_S \rvert = 139\,kV$ respectively when the transmission line delivers a typical load.	**03**
	(b)	Show the steps to draw the receiving-end circle diagram to obtain the sending-end voltage magnitude and angle.	**04**
	(c)	Create per unit reactance diagram for the power system shown in Fig.-1. Start with base MVA of 100 and base kV of 220 in 50Ω line. The ratings of components are: Generator: 40 MVA, 25 kV, X=20% Motor: 50 MVA, 11 kV, X=30% T1: 40 MVA, 33/220 kV (Y-Y), X=15% T2: 30 MVA, 11/220 kV (Δ-Y), X=15% Line: Inductive reactance of 50Ω	**07**

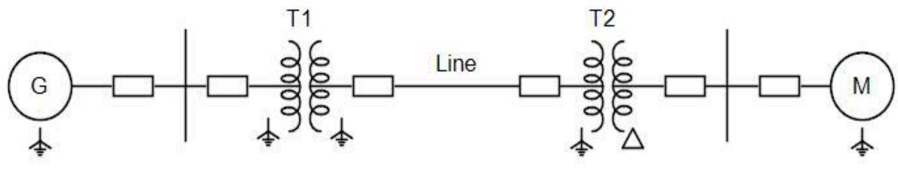

Fig.-1

OR

	(c)	Create per unit impedance diagram for the sample power system shown in Fig.-2. Start with base MVA of 100 and base kV of 10 in generator circuit. The ratings of components are: Generator: 100 MVA, 10 kV, X=j0.5 pu T1: 3-phase, 2-winding, delta-star transformer developed by using three single-phase units, each single-phase unit rated 35 MVA, 10/230 kV, X=j0.1 pu. T2: 90 MVA, 400/10 kV (Y-Δ), X=j0.1 pu Line 1 and Line 2: Inductive reactance of each line 200Ω.	**07**

Load: Impedance of (0.1+j0.5) Ω.

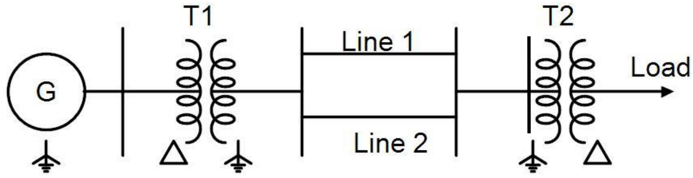

Fig.-2

Q.3 **(a)** How many symmetrical components are required to analyze 12-phase unbalanced system? What will be the sequence operator in that case? **03**

(b) Draw zero sequence network of the power system shown in Fig.-3. The transformers and lines are to be represented as reactance only. **04**

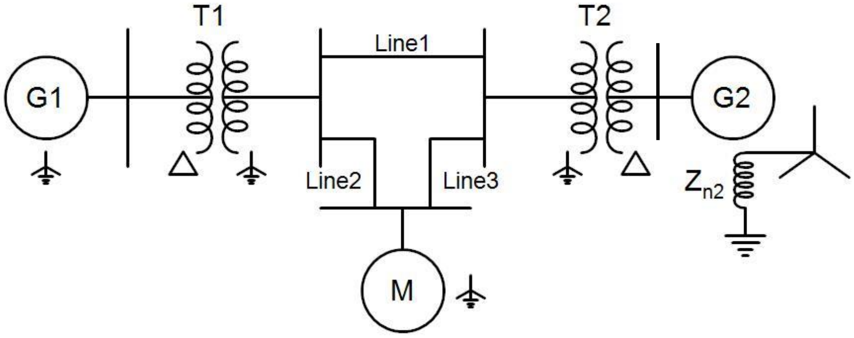

Fig.-3

(c) Formulate Z_{bus} using step-by-step algorithm for symmetrical fault analysis in case of the power network shown in Fig.-4. The reactances are in per unit. **07**

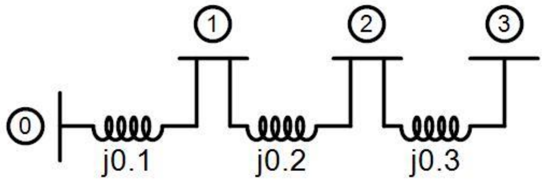

Fig.-4

OR

Q.3 **(a)** Express three-phase unbalanced current phasors in terms of sequence components in matrix form using sequence operator. **03**

(b) A balanced delta-connected load is connected to a three-phase supply and is supplied line current of 15 A. If the line 'b' is opened suddenly, compute symmetrical components I_{a1}, I_{a2} and I_{a0} of the line current. **04**

(c) Analyze behavior of short circuit current with relevant expression and waveforms when a three-phase short circuit occurs suddenly at the end of a transmission line being fed from constant voltage source $v = V_m \sin(\omega t + \psi)$ V. Assume that the line is represented as series impedance $Z=(R+jX_L)\Omega$ and the fault occurs at $t=0$. Line charging capacitance is neglected. **07**

Q.4 **(a)** Why is the zero sequence impedance of the transmission line approximately 2.5 times the positive sequence? **03**

(b) Prove that the fault current is given by the following expression when an LL (line-to-line) fault takes place between terminals *"b"* and *"c"* of an unloaded synchronous generator through Z^f: **04**

$$I^f = \frac{-j\sqrt{3}E_a}{Z_1 + Z_2 + Z^f}$$

where notations have their usual meaning.

(c) A three-phase, 6.9 kV, 10 MVA alternator has $X'' = X_2 = 15\%$ and $X_0 = 5\%$. The neutral is grounded through an inductive reactance of 0.381 Ω. Evaluate the subtransient current in ampere in the faulted phase, when a single line to ground fault takes place on phase-*a*. **07**

OR

Q.4 **(a)** Draw single-phase model of positive, negative and zero sequence network of a three-phase synchronous generator whose star-point of stator winding is connected to ground through Z_n. **03**

(b) Sketch interconnection of sequence networks for single line to ground fault with equations of sequence currents and fault current. **04**

(c) A power system has equivalent positive, negative and zero sequence impedance of *j0.2243* pu, *j0.1741* pu and *j0.15* pu respectively. Evaluate per unit positive sequence current, zero sequence current and fault current if a solid LLG (line-to-line-to-ground) fault is to be simulated. **07**

Q.5 **(a)** Write down corona loss formula given by Peek on basis of weather conditions and name each of the parameters in the expression. **03**

(b) Compare protection provided against lightning by earthing screen and ground wires. **04**

(c) Voltage and current travelling waves passing through line having surge impedance Z_{c1} arrive at discontinuity point from where another line having surge impedance Z_{c2} starts. For this configuration, derive ratio of (i) the reflected voltage wave to incident voltage wave and (ii) the transmitted (refracted) voltage wave to incident voltage wave with usual notations. **07**

OR

Q.5 **(a)** What will be the effect of the following on disruptive critical voltage and corona? **03**
(i) increasing diameter
(ii) reducing spacing between conductors
(iii) rise in barometric pressure of air

(b) Differentiate between direct and indirect lightning strokes. **04**

(c) A line is terminated with (i) short circuit and (ii) open circuit. In these two cases, show by waveforms how voltage and current travelling waves move with time and distance. Assume rectangular wave shape of the waves. **07**

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