Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV EXAMINATION – SUMMER 2025

Subject Code: 3140914 Date:21-05-2025

Subject Name: Power System- I

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)**	Define the following terms: (i) tariff (ii) diversity factor (iii) load curve	**03**
	(b)	An alternator supplies load of 100 kW at 0.8 lagging power factor at 11 kV. If the power factor of the load is raised to unity, how much more real power in kW can the alternator supply for the same kVA loading?	**04**
	(c)	Consider a string of suspension type insulators consisting of three identical insulator disc units. If *'C'* is the disc capacitance and *'C_1'* is the shunt capacitance between metal fitting pin of each disc and tower (earth), derive expressions for voltages across all the three discs and string efficiency in terms of ratio K of C_1 to C.	**07**
Q.2	**(a)**	A 220 kV line has the sag of 3 metre for equal support level of tower configuration and weight of each conductor of 1 kg per metre. If working tension of 1200 kg is to be kept, evaluate the length of the span. Consider span curve to be parabolic.	**03**
	(b)	Differentiate clearly constant speed SCIG and WRIG types of wind generation units from operational aspects with their schematic diagram.	**04**
	(c)	Construct schematic layout of conventional steam – turbine based thermal power station and compare it with hydroelectric power station from these aspects : (i) overall efficiency (ii) initial cost (iii) transmission and distribution cost.	**07**
		OR	
	(c)	Construct schematic diagram of grid connected solar PV system and standalone solar PV system. Compare these two systems by any three points from operational & application aspects.	**07**
Q.3	**(a)**	Clarify briefly function of the following in context with underground cables: (i) metallic sheath (ii) bedding (iii) armouring	**03**
	(b)	Applying concept of flux linkages computation, prove that inductance of three-phase transmission line having symmetrical spacing is given by $L = 2\times10^{-7} \ln\left(D/r'\right)$ henry per metre per phase, where notations used have their usual meaning.	**04**
	(c)	A three-phase 50 Hz, 132 kV transmission line has the flat horizontal spacing with 3 metre between the adjacent conductors. The conductors are seven-strand ACSR having outer diameter of 1	**07**

cm. Evaluate the capacitance to neutral in μF/km and the charging current in A/km.

OR

Q.3 **(a)** What is meant by grading of underground cables? Compare briefly capacitance grading and intersheath grading. **03**

(b) Applying concept of charge and potential difference, prove that capacitance to neutral for two – wire line (single-phase line) is given by **04**

$$C_n = \frac{2\pi\varepsilon_0}{\ln\left(D/r\right)} \text{ farad per metre per phase,}$$

where notations have their usual meaning.

(c) Consider fig.1 that shows the first section of a fully transposed double circuit three-phase line labeled with different distances. **07**

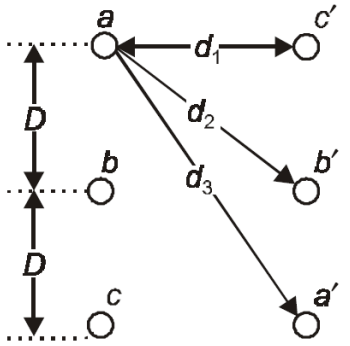

Fig.-1

If D=3 m and d_1=4 m, using GMD (Geometric Mean Distance) method evaluate (i) equivalent self GMD (ii) equivalent mutual GMD and (iii) the inductance of the line in mH/km/phase. Assume conductor radius to be 1 cm.

Q.4 **(a)** Compared to ungrounded neutral system, state three specific advantages of grounded neutral system when a single line to ground fault occurs on one of the three phases. **03**

(b) A single core underground cable has a conductor radius of 1 cm and internal sheath radius of 2 cm. If the relative permittivity of insulation used is 4, determine the capacitance for 1 km length of the cable. **04**

(c) Derive an expression with usual notations of capacitance to neutral for a three-phase transmission line having equilateral spacing. Apply phasor diagram method considering balanced condition for obtaining algebraic sum of line voltages (V_{ab}+V_{ac}) in terms of phase voltage (V_{an}). **07**

OR

Q.4 **(a)** State three specific disadvantages of ungrounded neutral system when a single line to ground fault occurs on one of the three phases. **03**

(b) Prove that insulation resistance of a single core underground cable is given by **04**

$$R = \frac{\rho}{2\pi l}\ln\left(\frac{r_2}{r_1}\right)\Omega$$

where r_1=conductor radius, r_2=internal sheath radius, l=length and ρ =insulation resistivity.

(c) Consider a single infinitely long conductor whose external inductance is to be computed using basic principles of electromagnetism. Show that its external inductance is given by **07**

$$L_{external} = 2\times10^{-7} \ln\left(D_2 / D_1\right) \text{ henry per metre,}$$

where D_1 and D_2 are the distances from centre of the conductor to two external points P_1 & P_2 in the space. Note $D_2>D_1>$radius of the conductor.

Q.5 **(a)** Enlist three advantages with reason or expression of using high voltage for transmission system. **03**

(b) Draw layout and schematic connection diagram of a pole-mounted distribution sub-station and briefly mention how it functions. **04**

(c) Consider an AC distributor AB with concentrated loads at C and B as shown in fig.-2. **07**

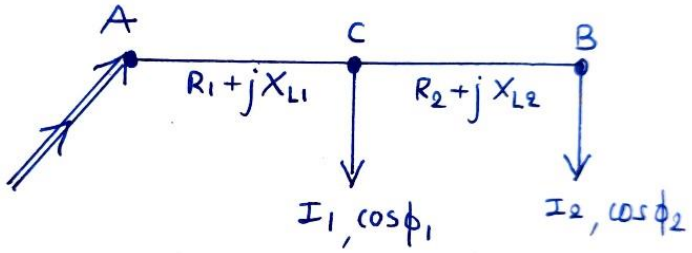

Fig.-2

The power factors of the loads are referred to respective load voltages. Analyze system for computation of V_A, V_B, V_C and voltage drops in the distributor with the help of phasor diagram.

OR

Q.5 **(a)** Classify various AC supply systems in terms of number of phases and number of wires. **03**

(b) Calculate the inductance and inductive reactance of Peterson coil to be deployed for neutral grounding for 132 kV, 50 Hz, 3-phase transmission line having 10 μF capacitance to ground of each phase conductor. **04**

(c) Sketch duplicate busbar system and analyze its operation under fault condition. **07**

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