MANMOHAN TECHNICAL UNIVERSITY
Office of the Controller Examinations
2083 Bhadra Exam (2026 August) Model Question

School: Engineering	**Level:** Master	**Time:** 3 Hours
Program: M.Sc.P.S.E.	**Year/Part:** I/I	**Full Marks:** 50
Subject: EG803EE – Extra High Voltage AC Systems		**Pass Marks:** 25

✓ *Candidates are required to give their answers in their own words as far as practicable.*
✓ *The figures in the margin indicate Full Marks.*
✓ *Assume suitable data if necessary.*

GROUP A (Attempt any FIVE Questions) **[5x3=15]**

1. Explain the design basis of high-voltage cable insulation systems. Discuss the important factors considered in cable insulation design.
2. Derive the expression for the capacitance per unit length of a long cylindrical conductor placed in a uniform dielectric medium.
3. Discuss the role of shielding wires/earth wires in EHV transmission systems. Explain how induced currents and voltages are developed in these wires and their effect on system performance.
4. A 3-phase, 50 Hz transmission line has conductors of 2 cm diameter arranged in an equilateral triangle with 3 m spacing. The surface irregularity factor is 0.85 and the air density factor is 1. Determine the disruptive critical voltage of the line. Assume the dielectric strength of air is 21.1 kV/cm (peak)
5. Explain the electrical characteristics required for insulating materials used in EHV underground cables.
6. Define Statistical Safety Factor and Risk of Flashover in EHV insulation coordination. How are they mathematically correlated using statistical distribution curves?

GROUP B (Attempt Any SEVEN Questions) **[7x5=35]**

1. An EHV AC line operates at $400\ \text{kV}$. Derive the expressions for reactive power generated by line charging capacitance (Q_C) and consumed by line inductance (Q_L). Show analytically how series capacitor compensation affects the maximum power transfer capability and transient power angle.
2. A 3-phase, $400\ \text{kV}$ horizontal EHV line uses a 2-conductor bundle per phase with sub-conductor radius $r = 1.5\ \text{cm}$ and bundle spacing $B = 45\ \text{cm}$. The phase-to-phase separation is $D = 11\ \text{m}$.

   (a) Formulate the Maxwell's Potential Coefficient Matrix elements $[P]$ considering ground image effects for a line height $H = 18\ \text{m}$ above ground.

   (b) Calculate the maximum surface voltage gradient (E_{max}) on the bundle sub-conductors

3. Explain the mechanisms of Electrical Treeing and Water Treeing in XLPE cable insulation. Describe Townsend's primary (α) and secondary (γ) ionization processes in gases and derive the breakdown condition $\gamma(e^{\alpha d} - 1) = 1$
4. Explain the criteria for selection of conductors in high-voltage transmission lines based on corona performance. Discuss the influence of conductor diameter, spacing, surface condition and operating voltage on corona loss and radio interference.
5. Describe the working principle of partial discharge (PD) measurement and tan-delta testing. Explain how these non-destructive tests help in evaluating the insulation condition and remaining life of high-voltage equipment.
6. Distinguish clearly between glow, streamer, and leader types of electrical discharge mechanisms during corona formation. Explain the generation of Radio Interference (RI) and Audible Noise (AN) due to corona and outline conductor selection criteria to minimize these effects
7. Explain the origins and characteristics of switching overvoltage on EHV transmission lines. Discuss three practical methods used to suppress switching overvoltage during line energization.
8. Compare the breakdown strength and discharge mechanisms of long air gaps under non-uniform electric field geometries (such as point-plane and conductor-tower clearances) versus uniform/semi-uniform fields (such as sphere-sphere gaps).

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