MODEL QUESTION PAPER

13.706.6 HIGH VOLTAGE ENGINEERING (E) (Elective III)

Time:3 Hrs   **Max Marks:100**

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PART – A
(All questions are *compulsary*)

1. Find the optimum number of stages for a Cockroft-Walton voltage multiplier built using 100nF capacitor units with following specifications. $V_{o\,max}$=100 kV, f = 500Hz, I_o=50 mA.
2. List out the various methods for High Voltage AC and DC generation.
3. What are the advantages and disadvantages of High Voltage generation using cascaded transformers?
4. List out the different tests conducted on cables.
5. What do you mean by non-destructive testing? List out various techniques used.
6. Define partial discharge. List out various types of partial discharges.
7. Describe various materials used for insulation of E.H.V. cables.
8. What is insulation coordination?
9. Differentiate between different types of over voltages in a power system.
10. List out the various types of environments encountered by an E.H.V. cable along with the methods of cooling.

(10*2 marks)

PART – B
(Answer *one complete question* from each module)

Module - I

11. (a) Describe Cockroft- Walton voltage multiplier circuit in detail. Derive the expression for voltage regulation for an n-stage voltage multiplier. (15 marks)

    (b) A ten stage Cockraft-Walton circuit has all capacitors of 0.04 µF. The secondary voltage of the supply transformer is 120 kV at a frequency of 150 Hz. If the load current is 1.2 mA, determine

    (i) Voltage regulation

    (ii) Ripple content in output voltage   (5 marks)

OR

12. (a) Define a standard impulse voltage wave. Define its basic parameters along with a near sample waveform. (5 marks)

    (b) Describe a modified multi-stage Marx circuit for generation of impulse voltages. (15 marks)

Module – II

13. (a) Describe various methods implemented for protection against lightning over-voltages in an electrical power system. (15 marks)

    (b) Describe in brief about insulation co-ordination in EHV systems (5 marks)

OR

14. (a) Write detailed notes on surge arresters along with their general characteristics. (10 marks)

(b) What are the reasons for power frequency over voltages in an electrical power system?

(10 marks)

Module – III

15. (a) Explain with neat diagram, the method to measure the specific resistivity of an insulation specimen, along with dielectric constant and loss factor (15 marks)

(b) Following measurements are made to determine the dielectric constant and complex permittivity of a test specimen:

The air capacitance of the electrode system = 60 pF

The capacitance and loss angle of the electrodes with specimen = 180 pF and 0.0085 respectively.   (5 marks)

OR

16. (a) Explain in detail about the various tests conducted on overhead line insulators. (10marks)
   (b) Define the following:
   (i) Disruptive discharge voltage.
   (ii) Impulse flashover voltage and impulse ratio.
   (iii) 50% flashover voltage.   (5 marks)
   (c) Explain the method of impulse testing of high voltage transformers. What is the procedure adopted for locating the failure?   (5 marks)

Module – IV

17. (a) List out the various electrical characteristics/parameters associated with an E.H.V. cable (10 marks)
   (b) A 500 kV XLPE cable is required to be designed under the following continuous working and testing conditions.

   Maximum working voltage = 550kV, R.M.S. line-to-line;

   Test voltages   : V_{ac} = 1100 kV, R.M.S. line-to-neutral;
                                                V_{imp} = 2200 kV, peak, without lightning arresters;
   Average electric stresses : E_{ac} = 30 kV/mm;
                                                E_{imp} = 55 kV/mm;
   Area of conductor   : A_c = 220mm^2 (No central oil duct).

   (i)   Calculate d_i, the diameter to the outside of insulation, for least value of maximum stress and the magnitude of the stress on the conductor surface.
   (ii)   Calculate the maximum and average voltage stresses in the insulation if the actual value of insulation thickness (t_i) is 40mm based on impulse strength
   (iii) Find the power transmitted at 550 kV, if current density for the conductor is 0.75 A/mm^2.

(10 marks)

OR

18. (a) Explain in brief about Weibull Probability Function for Breakdown Gradient and its significance. (5marks)

(b) List out the various steps involved in correct sequence for designing an E.H.V. cable. (10marks)

(c) A 3-core, 3-phase metal-sheathed cable had capacitance of 1 µF between shorted conductors and sheath and capacitance of 0.6 µf between two conductors shorted with sheath and the third conductor. Find

(i) Capacitance between any two conductors and
(ii) Capacitance between any two shorted conductors and the third conductor. (5marks)

(4 * 20 marks = 80 marks)