Ref No.: Ex/EE/PC/B/T/322/2023

B.E. ELECTRICAL ENGINEERING THIRD YEAR SECOND SEMESTER - 2023

SUBJECT: HIGH VOLTAGE ENGINEERING

Time: Three Hours | Full Marks 100 (50 Marks for each part)

Use a separate Answer-Script for each part

Two marks for neat and well-organized answers

Question No.	Part I	Marks

Answer any three questions

1. (a) Define the terms 'Total Creepage Distance' and 'Protected Creepage Distance'. Explain their significances. 4

(b) Explain why voltage level in high voltage transmission cannot be increased beyond a certain value to reduce the conductor cost. 4

(c) Investigate the voltage distribution over a string of three-suspension insulators for which the equivalent capacitance arrangement is shown in Fig. 1. The self-capacitance of each unit is C. (a) Express the voltage across each insulator as a percentage of the line voltage to earth, (b) If the capacitance to the line of the tower link pin were increased to 0.3 by means of a guard ring, investigate the redistribution of voltage. (c) Find the "String Efficiency" for each case. 8

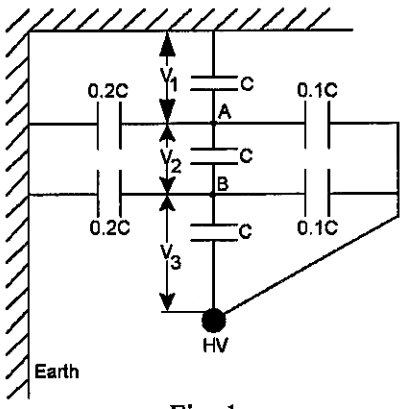

Fig. 1

2. (a) What do you mean by Visual Corona Voltage? Derive the expression of visual corona voltage for a single phase two conductor system. 2+6

(b) Determine the Disruptive Critical Voltage, the Visual Corona inception voltage, and the power loss in the line due to corona, both under fair weather conditions as well as stormy weather conditions 8

for a grid line operating at 132 kV. The conductors being 37/0.286 cm dia ACSR has a spacing of 4m. Temperature and pressure being 15.6°C and 737 mm of Hg. The irregularity factors may be taken as $m_d = 0.83$, $m_v = 0.72$. Consider, the Disruptive Critical Voltage under stormy condition becomes 80% of the corresponding value under fair condition.

3. (a) With proper derivation, show that the surge impedance of transmission line is almost ten times that of a cable. Assume suitable values wherever required. 8

(b) Show how the switching of breakers in a charged high voltage line can give rise to overvoltage. 8

4. (a) What is the advantage of Peterson Coil in reducing the arcing ground condition? With proper derivation give the relationship between the inductive and the capacitive reactance in the case of a correctly tuned Peterson Coil. 8

(b) State the limitations of solidly grounded system. 3

(c) Explain what is meant by insulation co-ordination. State the utilities of using arcing horns. 5

5. (a) Show that cable size is reduced to 69.39% in case of an inter-sheath cable compared to simple optimized cable without inter-sheath. 8

(b) A single core, lead covered cable is to be designed for 66kV to earth. Its conductor radius is 0.5 cm and its three insulating materials, A, B and C have relative permittivity of 4, 4 and 2.5 with maximum possible stress of 50, 40 and 30 kV/cm respectively. Material A being nearer to the conductor and C being near to the sheath. Find the minimum internal diameter of the lead sheath. 8

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B.E. ELECTRICAL ENGINEERING EXAMINATION, 2023

(3rd Year, 2nd Semester)

HIGH VOLTAGE ENGINEERING

Time: Three Hours | Full Marks: 100

(50 marks for each part)

Use a separate Answer-script for each Part

PART-II

Answer question No.1 any *TWO* from the rest

(*Two marks are reserved for neatness and well organized answers*)

1. Answer the following questions: 6x3=18

a) Define statistical time lag and formative time lag.

b) Calculate the air density correction factor for the following atmospheric conditions: (i) dry bulb temperature is 37°C, (ii) wet bulb temperature is 29° C and (iii) barometric pressure is 754 mm of Hg.

c) Why is it necessary to generate high DC voltage in the laboratory?

d) Define the lightning impulse voltage wave shape with the tolerances as per Indian Standard.

e) Why the high frequency potential distribution along a transformer winding is governed primarily by the capacitances?

f) In which conditions, external irradiation is required for voltage measurement using sphere gap method?

2. a) Draw a properly labelled Cockcroft-Walton voltage doubler circuit and explain its principle of operation under loaded condition. 3+5

b) A Cockcroft-Walton voltage doubler circuit is used to test a cable at 160kV. The insulation resistance of the cable is $2.5\times10^{7}\Omega$/m and the length of the cable is 16m. Stage capacitances are 0.1μF and 0.2μF, respectively. The doubler circuit is supplied from a 400V/300kV testing transformer. Calculate the voltage to be applied to the input of the testing transformer at 50Hz. 7

3. a) Design an eight-stage impulse generator to generate 1400kVp with voltage efficiency of 95%. The energy stored in the impulse generator is 20 kJ and the input dc voltage is 150kV. 10

b) Why controlled triggering is required in an impulse generator? Describe a typical triggering arrangement. 2+3

4. a) Draw the circuit diagram of a peak voltmeter that contains a bleeder resistance. Describe the principle of operation of such a peak voltmeter and discuss about the errors associated with this peak voltmeter. 3+3+3

b) Draw and explain a modified circuit diagram of the peak voltmeter mentioned in Q4(a) wherein bleeder resistance is not required. 3+3

5. a) A 230V/160kV testing transformer is required to test a cable. The test voltage level is 100 kVrms and the short-circuit impedance of the transformer is 14%. Calculate the voltage to be applied at the primary of the transformer to conduct the test. 5

b) With the help of circuit and phasor diagrams explain why capacitive voltage transformers are used in resonant condition. 5+5