The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical & Computer Engineering

099

Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX5338**
	High Voltage Engineering
Academic Year	: 2022/2023
Date	: 22nd February 2024
Time	: 1330-1630hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions in **Three (03)** pages.
3. Answer **all questions**, All the questions carry **equal marks**.
4. Answer for each question should commence from a new page.
5. Relevant figures and tables are provided with the question paper
6. This is a Closed Book Test **(CBT).**
7. Answers should be in clear hand writing.
8. Do not use red colour pen.

Question 1

a) In an experiment using a certain gas, it was found that a steady current of 600μA flowed through the plane electrode separated by a distance of 0.5cm when a voltage of 10kV is applied. Then the distance of separation is reduced to 0.1cm while keeping the field (V/d) at the previous value. It was found that a steady current of 60μA flowed through the plane electrode at this time. Finally, the breakdown occurred when the gap distance was increased to 0.9cm. What are the values of Townsend's first and second ionization coefficients? **[6 marks]**

b) Do you completely agree with the method which was used in this experiment to find the Townsend's first ionization coefficient? Explain your answer. **[4 marks]**

c) Briefly explain below causes which lead to the breakdown of solid dielectrics below their intrinsic strength. **[4 Marks]**

I. Surface breakdown (tracking and erosion)
II. Electro-chemical Breakdown

d) Define the terms **keraunic level** and **isokeraunic level map**. **[2 Marks]**

e) Describe very briefly with the aid of suitable diagrams (including relevant technical terms) about the mechanism of lightning stroke discharge through the earth **[4 Marks]**

Question 2

a) Show that the deflecting torque of an electrostatic voltmeter is proportional to square of the applied voltage **[4 Marks]**

b) Figure Q02 shows a high Voltage Schering Bridge used in a particular measurement. The values of the components at balance are shown on the diagram. Determine the value of the unknown capacitor and its loss tangent. All necessary equations must be derived. **[8 Marks]**

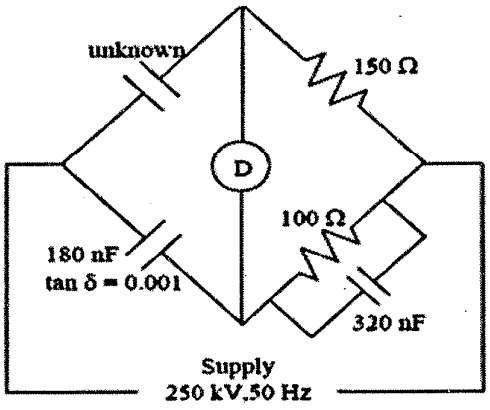


Figure Q02

c) Define below terms which are associated with insulation coordination. **[2 Marks]**

I. Maximum System Voltage
II. Factor of Earthing

d) Briefly explain the following terms with the aid of suitable diagrams. **[6 Marks]**

I. Statistical Impulse Withstand Voltage
II. Statistical Impulse Voltage

Question 3

a) Explain the terms wave front time and wave tail time with the help of suitable diagrams. **[4 Marks]**

b) An overhead line AJ (surge impedance = 400Ω, 15 km long) is connected at a junction J to another overhead line JB (surge impedance = 400Ω, 15 km long) and a cable JC (surge impedance = 50Ω, 5 km long). A triangular wave of vertical front of 100 kV and linear decay to zero in 75μs, originates at A on line and travels towards J. The attenuation in the line and cable can be neglected. If the line BJ is open circuit at the far end and cable CJ is terminated by a load of surge impedance 150 Ω, determine and sketch the voltage waveforms appearing at J, B & C for the first 130μs. [velocity in overhead line = 3 X108 m/s, velocity in cable = 2 X108 m/s]. **[12 Marks]**

c) Briefly explain four advantages of DC transmission over AC transmission. **[4 Marks]**

Question 4

a) Describe briefly, with the aid of suitable diagrams Cascade arrangement of transformers to obtain high alternating voltage for testing purposes. **[4 Marks]**

b) High voltages are primarily used for power transmission purposes and secondly used for equipment testing purposes. Why the high voltage generating methods used in high power applications are not applicable for equipment testing purposes? **[3 Marks]**

c) An impulse generator is to be designed to generate 600 kV standard impulse voltage waveform (1.2/50 μs) to the test equipment. The nominal energy desired for the impulse generator is 10 kJ. A 60 kV single phase transformer is available.

I. Obtain the values of the coefficients α and β for the standard waveform. **[4 Marks]**
II. If the desired voltage efficiency is 95%, determine the required number of stages for the impulse generator. **[3 Marks]**
III. Sketch the basic impulse generator circuit and determine the values of the associated elements in the circuit to produce the required waveform. **[6 Marks]**

Question 5

a) State and explain the types of power losses that can incur in a high voltage cable. **[3 Marks]**

b) Briefly explain the term "Cross-Bonding of Cables". **[2 Marks]**

c) Briefly describe two methods that are used to distribute the stress more equally in the high voltage underground cables. **[4 Marks]**

d) A single core cable in a 3-phase 66 kV system, has a conductor radius of 1 cm and a sheath of inside radius 2.65 cm.

I. Find the maximum stress. **[3 Marks]**

II. If two inter-sheaths are used to minimize the maximum stress, determine the optimum radius/positions of the inter-sheaths. **[4 Marks]**

III. For this grading system, find the maximum stress and the inter-sheath voltages. **[4 Marks]**