00118

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

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX5338**
	High Voltage Engineering
Academic Year	: 2020/2021
Date	: 12th February 2022
Time	: 0930-1230hrs

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) With an aid of a suitable diagram briefly explain the way of determining the Townsend coefficients for a particular gas under laboratory conditions. **[5 marks]**

b) Define the term intrinsic strength of dielectrics. 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

III. Thermal breakdown

c) A 3 phase, 50 Hz, 220 kV transmission line consists of conductors of 1.2 cm radius and spaced 2m at the corners of an equilateral triangle. Calculate the corona disruptive critical voltage and corona power loss per km of the line at temperature of 20^0C and barometric pressure of 72.2 cm of Hg. Take the surface factor of the conductor as 0.96. **[6 Marks]**

d) Describe very briefly with the aid of suitable diagrams (including relevant technical terms) about the mechanism of lightning stroke discharge through the earth **[5 Marks]**

Question 2

a) Describe the use of sphere gaps in high voltage measurements **[5 Marks]**

b) Draw the circuit diagram for a high voltage Schering Bridge where the standard capacitor has a known but very small loss tangent. Derive expressions for the values of the capacitance C and the loss tangent of tan δ the unknown, stating any assumptions made in your calculations. **[5 Marks]**

c) What is the definition of 'partial discharge'? State the importance of conducting partial discharge tests. **[5 Marks]**

d) Briefly explain the following terms with the aid of suitable diagrams. **[5 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) State four advantages and four disadvantages of DC transmission over AC transmission. **[4 Marks]**

Question 4

a) High voltages are primarily used for power transmission purposes and secondly used for equipment testing purposes.

I. What are the different High Alternating Voltage generating methods used for the testing purposes? **[3 Marks]**

II. Why the high voltage generating methods used in high power applications are not applicable for equipment testing purposes? **[3 Marks]**

b) 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 65 kV single phase transformer is available.

I. Obtain the values of the coefficients α and β for the standard waveform. **[5 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) Briefly describe two methods that are used to distribute the stress more equally in the high voltage underground cables. **[4 Marks]**

b) What are the difficulties associated with the grading methods which are used for stress distribution in high voltage underground cables? **[2 Marks]**

c) State the different types of power losses that can incur in a high voltage cable. **[2 Marks]**

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

I. If the system voltage is 66 kV, find the maximum stress within the cable **[2 Marks]**

II. If two intersheaths are used to minimize the maximum stress, show that optimum positions for the intersheaths are 1.465 cm and 2.0192 cm. **[5 Marks]**

III. For this grading system, find the maximum stress and the intersheath voltages. **[5 Marks]**