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

Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX5338**
	: High Voltage Engineering
Academic Year	: 2023/2024
Date	: 17th February 2025
Time	: 09:30 -- 12:30 hrs.

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 handwriting.
8. Do not use red colour pen.

Question 1

a) Figure Q1 shows the experimental set-up for studying the Townsend discharge. The experiment is conducted by measuring the current I at the different gap distance, *d*. Table Q1 gives the set of observation obtained when studying the conduction and breakdown in a gas.

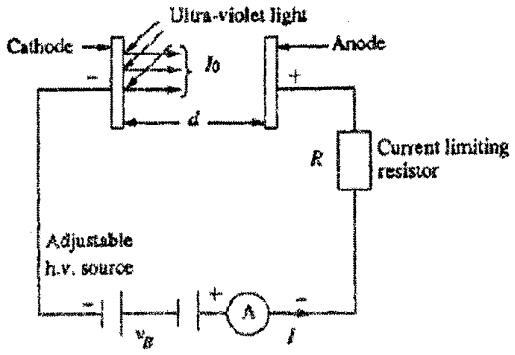


Figure Q1 – Townsend's experimental set-up

d (mm)	1	2	3	4	5	6	8	10	12	14	16
I (pA)	19	21	26	32	40	45	80	106	152	255	430

Table Q1- Townsend's experimental data

I. Determine the initial current (I_0) **[4 Marks]**

II. Calculate the value of the Townsend's primary and secondary ionization coefficients. **[4 Marks]**

b) State **three** causes which lead to the breakdown of solid dielectrics below their intrinsic strength. Briefly explain **one** of the mentioned causes. **[4 Marks]**

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

d) Describe very briefly with the aid of suitable diagrams about the

I. Mechanism of lightning stroke discharge through the earth **[3 Marks]**

II. Three possible lighting discharging paths that can cause surges on the transmission line **[3 Marks]**

Question 2

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

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

c) 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]**

d) Define below terms which are associated with insulation coordination. **[3 Marks]**

I. Maximum System Voltage
II. Factor of Earthing

e) Briefly explain the term 'Statistical Impulse Withstand Voltage' with the aid of suitable diagrams. **[3 Marks]**

Question 3

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

b) Figure Q3 shows an overhead line AB (length 225 km, Zo = 450 Ω, attenuation factor = 0.95) feeding a terminal equipment (Zo = 3550 Ω) at B. A voltage of 250kV with effective surge impedance of 50 Ω is switched on at A. Sketch the Bewley lattice diagram indicating significant values on it for the first 2.5 ms. State any assumptions made in your calculations. **[10 Marks]**



Figure Q3 – Overhead Line AB

c) List two advantages of DC transmission over AC transmission. **[2 Marks]**

d) Briefly explain why the proposed HVDC line from Tamil Nadu to Sri Lanka is not financially viable with respect to the Sri Lankan context. **[4 Marks]**

Question 4

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

I. List **two** High Alternating Voltage generating methods used for the testing purposes? **[2 Marks]**

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

b) A six-stage impulse generator is to be designed to deliver 600 kV, 1.2/50 μS standard waveform at a voltage efficiency of 95%, with a nominal energy of 5 kJ.

I. Sketch a suitable single-stage equivalent circuit, and with the aid of suitable calculations, indicate on it the values of the associated elements. **[10 Marks]**

II. Draw the basic circuit diagram of the six-stage impulse generator, indicating on the diagram the wavefront and wavetail control resistors and the charging resistors. **[5 Marks]**

Question 5

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

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

c) What are the difficulties associated with the grading methods which are used for stress distribution in high voltage underground cables? **[4 Marks]**

d) A single-core lead sheathed cable has a conductor diameter of 3 cm; the diameter of the cable being 9 cm. The cable is graded by using two dielectrics of relative permittivity 5 and 4 respectively with corresponding safe working stresses of 30 kV/cm and 20 kV/cm. Calculate the radial thickness of each insulation and the safe working voltage of the cable. **[9 Marks]**