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	:	2024/25
Date	:	9th February 2026
Time	:	0930-1230h
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions in **Four (4)** pages.
3. Answer **all** questions.
4. All questions carry equal marks.
5. Answer for each question should commence from a new page.
6. This is a Closed Book Test (CBT).
7. Graph paper will be provided upon request.

Question 01

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

b) A long overhead transmission line (Surge impedance = 550 Ω) is connected to the terminal equipment (Surge impedance = 2450 Ω) through a cable AB (Length = 1 km, surge impedance = 50 Ω, attenuation in single transit = 0.95) as shown in Figure Q1.

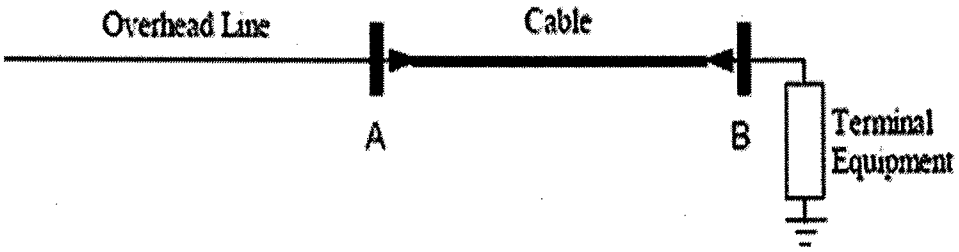


Figure Q1 – Overhead Transmission line Connected to the terminal equipment

A triangular voltage surge (vertical front, 200 kV peak decaying to zero in 40 μs) originates in the overhead line and arrives at A at time t = 0. Draw the Bewley Lattice diagram and sketch the voltage variation at A and B for the first 25 μs (velocity in overhead line = 3×10^8 m/s, velocity in cable = 2×10^8 m/s). (10 Marks)

c) State three advantages of DC transmission over AC transmission. (3 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. (3 Marks)

Question 02

a) A 3 phase, 50 Hz, 220 kV transmission line consists of conductors of 1.2 cm radius and spaced 2 m at the vertices of an equilateral triangle. Calculate the corona disruptive critical voltage and corona power loss per km of the line at temperature of 20^0 C and barometric pressure of 72.2 cm of Hg. Take the surface factor of the conductor as 0.96 (take standard temperature as 20^0 C and standard pressure as 76 cm of Hg).

(6 Marks)

b) With the aid of suitable diagrams and relevant technical terms, briefly describe about the mechanism of lightning stroke discharge through the earth.

(4 Marks)

c) If the measurements given in Table Q2 were made in a Townsend type discharge, determine the value of the Townsend's first and second ionization coefficients.

(10 Marks)

Table Q2: Discharge current measurements at different electrode gap distances

d (mm)	1	2	3	4	5	6	8	10	12	14	16
I (pA)	22	26	30	35	42	50	75	110	185	400	1060

Question 03

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)

Question 04

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 testing purposes? (3 Marks)

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

b) The simplified equivalent circuit of an impulse generator is shown in Figure Q4, with the capacitor C1 being initially charged.

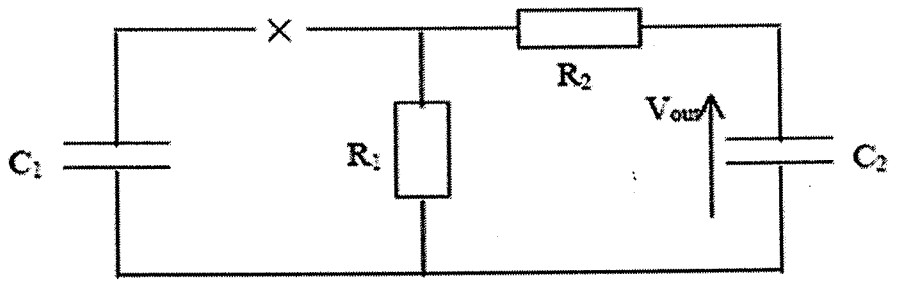


Figure Q4 – Simplified equivalent circuit of an impulse generator

I. Obtain expressions for the wave front time (based on 30% to 90%) and the wave tail time in terms of charging time constant (τ_c), discharging time constant (τ_d) and voltage efficiency (η). (4 marks)

II. It is desired to design a 6-stage impulse generator to have an output voltage of 1000 kV of standard IEC waveform (1.2/50 μs with 90% voltage efficiency), and to have an output energy of 50 kJ. Making reasonable judgments determines the main components of the multistage impulse generator. (7 marks)

III. Draw the complete impulse generator circuit indicating values for each component. (3 marks)

Question 05

a) What is the definition of 'partial discharge'? State the importance of conducting partial discharge tests. (6 Marks)

b) Figure Q5 shows a circuit diagram of a high voltage Schering Bridge, with the values at the balance condition. If the dielectric has a cross-section area of 0.01 m^2 and the spacing of 2 cm, determine the relative permittivity and the resistivity of the material (Absolute permittivity = 8.854 $\times 10^{-12}$ F/m). (7 Marks)

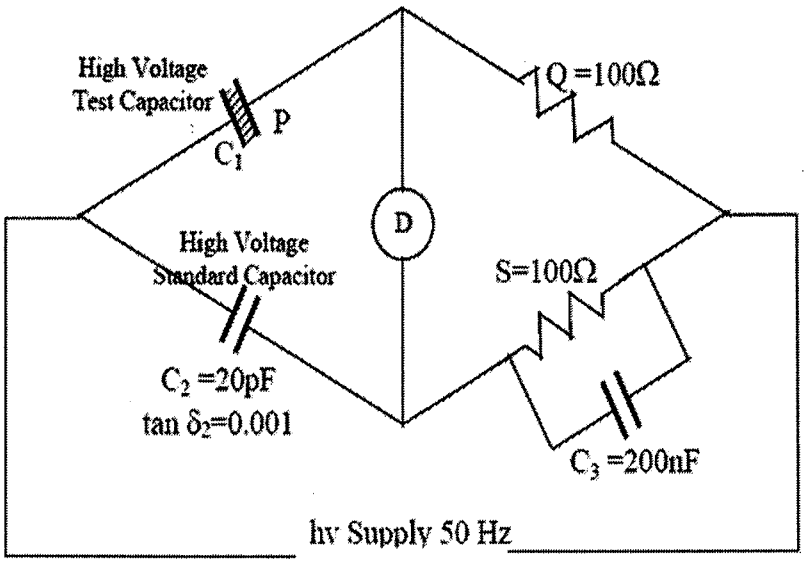


Figure Q5 - High voltage Schering Bridge

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. (5 Marks)

I. Statistical Impulse Withstand Voltage

II. Statistical Impulse Voltage

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