



MACHAKOS UNIVERSITY

University Examinations for 2022/2023 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONIC ENGINEERING)

EEE506: HIGH VOLTAGE TECHNOLOGY AND HVDC TRANSMISSION

DATE:

TIME:

INSTRUCTIONS:

- Answer Question **ONE** and any other **two** questions.

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) In gas ionization in a gap, after the first set of electrons reaches the anode, there is probability of electrons being released in the gap by other mechanisms. Describe the **THREE** mechanisms that results in secondary processes. (6 marks)
- b) A steady current of $600 \mu\text{A}$ flows through the plane electrode separated by a distance of 0.5 cm when a voltage of 10 kV is applied. Determine the Townsend's first ionization coefficient if a current of $60 \mu\text{A}$ flows when the distance of separation is reduced to 0.1 cm and the field is kept constant at the previous value. (6 marks)
- c) A travelling wave of 50 KV enters an overhead line of surge impedance 400 Ohms and a conductor resistance of $6 \text{ Ohm per kilometer}$. Determine:
- The value of the voltage wave when it has travelled through a distance of 50 kilometer .
 - The power loss. (6 marks)

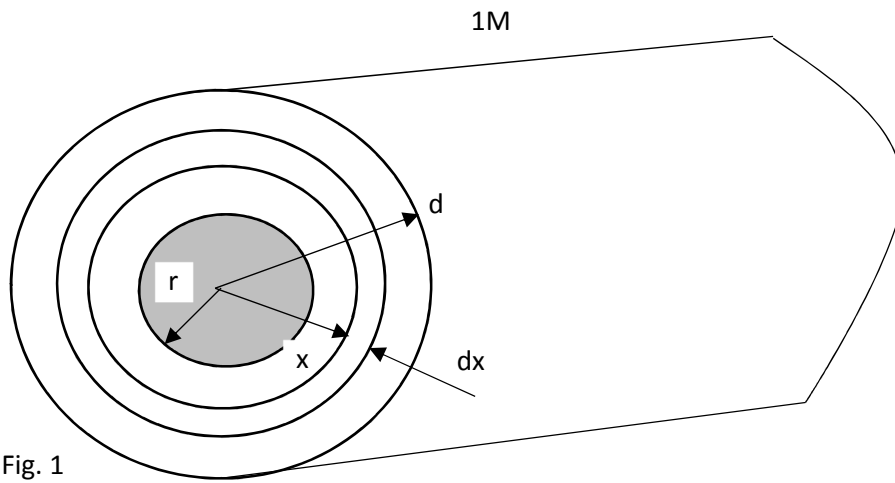
- d) Describe the function of the following equipments in a converter station:
- Converter transformer
 - DC reactor. (6 marks)
- e) A certain three phase equilateral spaced three phase line has total corona loss of 53 KW at 106 KV and a loss of 93KW at 110.9 KV. Determine:
- Disruptive critical voltage
 - Corona loss at 113 KV. (6 marks)

QUESTION TWO (20 MARKS)

- a) With aid of a well labelled diagram, describe the Ohmic, saturation and Townsends regions of a curve for the current growth in a gas. (6 marks)
- b) With aid of diagram, show the relationship between various solid breakdown mechanisms against time. (6 marks)
- c) A transmission line has an inductance of 0.933 mH/km and a capacitance of 0.00778 μ F/km. This overhead line is connected to an underground cable having an inductance of 0.155 mH/km and capacitance of 0.187 μ F/km. If a surge of crest 50 kV travels on the cable towards the junction with the line, determine:
- Voltage transmitted
 - Voltage reflected.
 - Current transmitted
 - Current reflected. (8 marks)

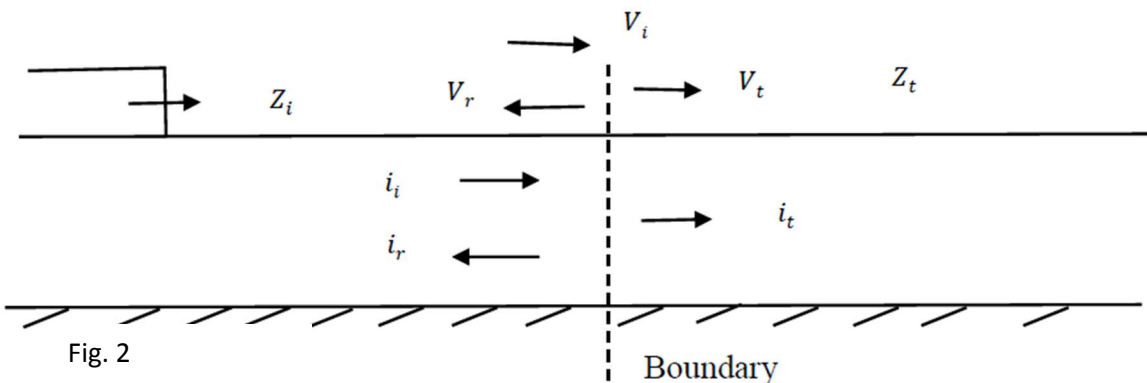
QUESTION THREE (20 MARKS)

- a) Discuss why when a new line is put into operation, the corona loss in the initial few months is more than the rest of time later. (4 marks)
- b) Explain with aid of neat sketches the mechanism of lightning discharge. (6 marks)
- c) What is 'Treeing' and 'Tracking' as applied to failure mechanisms of solid insulating materials? (4 marks)
- d) Potential gradient of the medium surrounding the conductor is very important and determines whether the medium will breakdown or not. For the diagram shown in fig.1, show that the potential gradient at any point x is given by: $E_x = \frac{V}{x \ln \frac{d}{r}} V/M$, where r is the radius of the conductor and d is distance of earthed metallic sheath. (6 marks)



QUESTION FOUR (20 MARKS)

- Define Townsend's first and second ionization coefficients. (4 marks)
- Briefly discuss breakdown in insulating liquids due to:
 - Gaseous inclusions
 - Liquid globule
 - Solid particles. (6 marks)
- Derive the expressions of surge velocity and surge impedance of a transmission line. (4 marks)
- The diagram fig.2 shows an incident wave V_i travelling towards a boundary. Derive the expressions of the reflected wave V_r and transmitted wave V_t . (6 marks)



QUESTION FIVE (20 MARKS)

- Briefly describe four design considerations of an electrode in a converter station. (4 marks)
- Discuss any TWO technical advantages of high voltage dc transmission system. (4 marks)

- c) A three phase has conductors 2 cm in diameter spaced equilaterally 1 meter apart. If the dielectric strength of air is 30 kV (max) per cm, find the disruptive critical voltage for the line. Take air density factor as 0.952 and irregularity factor as 0.9. (6 marks)
- d) For any value of voltage V, proof that the reduction in thickness of the specimen cannot be more than 40% (6 marks)