



MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONIC ENGINEERING)

EEE 506: HIGH VOLTAGE TECHNOLOGY AND HVDC TRANSMISSION

DATE: 14/12/2021

TIME: 11.00-1.00 PM

INSTRUCTIONS:

Answer Question One and Any Other Two Questions

QUESTION ONE (30 MARKS)

- a) A line of surge impedance 400 ohms is charged from a battery of constant voltage 135 volts. The line is 300 meters long and it is terminated in a resistance of 200 ohms. Plot reflection lattice and the voltage across the terminating resistance for three reflections. (6 marks)
- b) Discuss any FOUR technical advantages of HVDC transmission over ac transmission. (4 marks)
- c) Sketch a well labelled diagram of a homopolar HVDC link. (3 marks)
- d) A 200 KV travelling on a line of surge impedance 400 ohms and reaches a junction of the line with two branch lines of surge impedance 500 ohms and 300 ohms respectively. Determine:
i. Transmitted voltage and current.
ii. Reflected voltage and current. (10 marks)
- e) A student travelling from Kwacha to Machakos passed three high voltage transmission lines during the night at different locations. In one of the lines, he heard a hissing sound emanating from the transmission lines. In the next line, he observed violet glow around the transmission lines. On the third line he observed nothing. Explain the student observations and classify the three line in terms of their voltage levels. Discuss the assumptions made when doing the classification. (7 marks)

QUESTION TWO (20 MARKS)

- a) In an experiment, final year electrical power students were observing reduction of specimen thickness with increase in voltage. The specimen finally broke down mechanically. Explain this process of breakdown and derive expression for ideal minimum thickness at which breakdown occurs. (7 marks)
- b) Discuss why three phase overhead lines are transposed. A three phase overhead line consists of three conductors transposed and arranged as shown in fig. 1. The conductor diameter is 15 millimetre and surface factor of 0.8. the air temperature and pressure are 298.1°K and 75 cmHg. Find disruptive critical voltage. (7 marks)

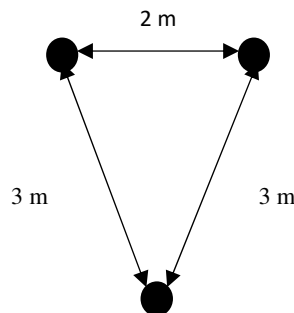


Fig.1

- c) A student during industrial attachment observed that a high voltage dc link had two conductor. The polarity of the two conductors was the same. Explain the type of dc link the student observed and its advantages. (6 marks)

QUESTION THREE (20 MARKS)

- a) During a tutorial lesson on breakdown of gases, students were given four cases where 1st year students were given a task to wire a fluorescent tube. Student A put a starter only in the circuit. Student B put a choke only in the circuit. Student C put a starter in series with a choke in the circuit and student D put a starter in parallel with a choke in the circuit. From the context of the tutorial lesson, explain which student's fluorescent lamp light and which did not light and why. (6 marks)
- b) Intrinsic strength is the highest breakdown strength of a solid dielectric. Explain why normally solids breakdown at lower strengths and explain THREE lower breakdown mechanisms. (7 marks)

- c) A 113km long, 315 KV, 50 Hertz three phase overhead line comprises three conductors, each of overall diameter 3.91 cm, symmetrically spaced with 3.81 m between centers. The barometric pressure is 735mm of mercury and the temperature is 15°C. Assuming irregularity factor of 0.85, determine:
- Visual critical voltage
 - Total power loss. (7 marks)

QUESTION FOUR (20 MARKS)

- a) A company which was dealing with transformers, imported new transformer oil and directly used it to replace old oil in a transformer. The oil failed to offer the expected performance. Explain the possible causes and what the company should have done. (6 marks)
- b) Derive the expression of total number of electrons, n , reaching anode due to Townsend first and second ionization coefficient. (8 marks)
- c) A nonlinear resistance medium is used in series with rod gap to make a surge diverter. The expression of the nonlinear medium is given by $i = kv^\alpha$, where k is a constant. If $\alpha=8$, determine by what factor the voltage will increase if the current increases by a factor of 200. (6 marks)

QUESTION FIVE (20 MARKS)

- a) Explain Townsend first ionization coefficient. A steady current of 500μA flows through the plane electrode separated by a distance of 0.4cm when a voltage of 12KV is applied. Determine the Townsend's first ionization coefficient if a current of 50 micro amperes flows when the distance of separation is reduced to 0.08 cm and the field is kept constant at the previous value. (7 marks)
- b) Briefly describe the role of a converter transformer in a converter station. (3 marks)
- c) During a stormy weather, a student noted that an arc stroke between two L-shaped rods in the circuit near transformer terminals. The arc was sustained and this was followed by a blackout.
- Explain the purpose of the rods and how they function.
 - Explain improvement that can be done to ensure the arc is not sustained. (10 marks)