



MACHAKOS UNIVERSITY

University Examinations for 2018/2019

**SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

**FIFTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR
BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)**

EEE 506: HIGH VOLTAGE TECHNOLOGY & HVDC

DATE:

TIME:

INSTRUCTIONS

This paper consists of **FIVE** questions.

Answer **QUESTION 1** and ANY **OTHER TWO** questions.

Question 1 carries 30 marks and is COMPULSORY.

QUESTION ONE (30 MARKS)

- a) Describe the corona phenomenon. (3 marks)
- b) A 400KV surge travels on an overhead line of surge impedance 500 Ohms towards its junction with a cable which has a surge impedance of 50 ohms. Find:
 - i. Transmitted voltage
 - ii. Transmitted current
 - iii. Reflected voltage
 - iv. Reflected current. (10 marks)
- c) A three phase line has conductors 2 cm in diameter spaced equilaterally 1 meter apart. If dielectric strength of air is 21.2kv (rms) per centimeter, find the disruptive critical voltage for the line. Take air density factor $\delta=0.9$ and irregularity factor $m=0.8$. (8 marks)
- d) Describe electromechanical breakdown in solids. (3 marks)
- e) Describe factors that affect breakdown in a liquid. (6 marks)

QUESTION TWO (20 MARKS)

- a) Derive the expression of surge impedance in a transmission line. (5 marks)
- b) With aid of a diagram explain how rod gap surge diverter works. (3 marks)
- c) With aid of a diagram describe monopolar dc link. (4 marks)
- d) A transmission line has an inductance of 0.933mH/km and a capacitance of $0.00778\mu\text{F/km}$. This overhead line is connected to an underground cable having an inductance of 0.155mH/km and a capacitance of $0.187\mu\text{F/km}$. A surge of crest 40KV travels on the cable towards its junction with the overhead line. Determine:
 - i. Surge velocity in the overhead line
 - ii. Surge velocity in the underground cable
 - iii. Surge impedance of the overhead line
 - iv. Surge impedance of the underground cable. (8 marks)

QUESTION THREE (20 MARKS)

- a) Briefly explain why a nonlinear resistor is normally used together with a rod gap arrester. (4 marks)
- b) Derive the expression of transmitted voltage when an incident surge voltage reaches the following types of boundaries:
 - i. Open circuit
 - ii. Short circuit (7 marks)
- c) Discuss the advantages and disadvantages of ground return in a HVDC system. (5 marks)
- d) State the equipments found in a converter station. (4 marks)

QUESTION FOUR (20 MARKS)

- a) With aid of a diagram describe homopolar dc link. (4 marks)
- b) Briefly discuss the liquid immersion method of determining the intrinsic dielectric strength of a material. (6 marks)
- c) Briefly discuss any TWO advantages of dc systems over ac systems. (4 marks)
- d) Find the disruptive critical voltage and the visual critical voltage for a three phase system consisting of 20 mm diameter conductors spaced six meters apart in a horizontal configuration. Take temperature of 28°C , pressure of 70 cm of mercury and irregularity factor of 0.85 . (6 marks)

QUESTION FIVE (20 MARKS)

- a) Briefly describe dark discharge, glow discharge and arc discharge electric discharge regimes in a gas. (6 marks)
- b) In an experiment in a certain gas it was found that the steady state current is 4.5×10^{-8} amperes at 10 kilovolt at a distance of 0.5 centimeter between plane electrodes. Keeping the field constant and reducing the distance to 0.2 centimeter results in a current of 4.5×10^{-9} amperes. Calculate Townsend's primary ionization coefficient α . (6 marks)
- c) Describe TWO methods of reducing corona. (4 marks)
- d) Briefly discuss the following electrical breakdowns in solids:
 - i. Intrinsic breakdown
 - ii. Streamer breakdown. (4 marks)