



MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 506: HIGH VOLTAGE TECHNOLOGY AND HVDC TRANSMISSION

DATE: 14/5/2019

TIME: 8.30-10.30 AM

INSTRUCTIONS

Answer Question ONE and any other TWO Questions.

QUESTION ONE (30 MARKS)

- a) State any TWO methods of reducing corona loss. (2 marks)
- b) A 3-phase 220kV, 50 Hz transmission line consists of 1.5 cm radius conductors spaced 2 m apart in an equilateral triangle formation. If the temperature is 40°C and atmospheric pressure 76cm of mercury, determine the corona loss per km of the line. Take $m_0=0.8$. (6 marks)
- c) Derive the expression of surge velocity in a transmission line. (4 marks)
- d) In an experiment in a certain gas it was found that the steady state current is 5.5×10^{-8} amperes at 8 kilovolt at a distance of 0.4 centimeter between plane electrodes. Keeping the field constant and reducing the distance to 0.1 centimeter results in a current of 5.5×10^{-9} amperes. Calculate Townsend's primary ionization coefficient α . (4 marks)
- e) Briefly discuss the following electrical breakdowns in solids:
 - i. Intrinsic breakdown
 - ii. Electromechanical breakdown
 - iii. Streamer breakdown. (6 marks)
- f) Sketch a converter station with two 12 pulse units forming a dipole. (4 marks)
- g) Briefly describe sphere gap method of high voltage measurement. (4 marks)

QUESTION TWO (20 MARKS)

- a) With aid of a diagram explain how horn gap surge diverter works. (3 marks)
- b) 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)
- c) Discuss any THREE technical and TWO economic advantages of dc systems over ac systems. (5 marks)
- d) Discuss why the modern HVDC systems use 12 pulse converters. (4 marks)

QUESTION THREE (20 MARKS)

- a) Differentiate between direct and indirect lightning strokes to transmission lines. (2 marks)
- b) 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. (3 marks)
- c) Briefly describe the following equipments in a converter station.
- i. Converter transformer
 - ii. Thyristor valves
 - iii. Harmonic filtering equipment. (6 marks)
- d) Derive the expression of transmitted voltage when an incident surge voltage reaches a boundary between two mediums. (4 marks)
- e) Discuss the advantages and disadvantages of ground return in a HVDC system. (5 marks)

QUESTION FOUR (20 MARKS)

- a) Briefly describe the term flashover. (2 marks)
- b) Briefly discuss the three methods that can be used to determine the intrinsic dielectric strength of a material. (6 marks)
- c) 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)
- d) With aid of VI- characteristic, describe the three electric discharge regimes namely dark discharge, glow discharge and arc discharge. (6 marks)

QUESTION FIVE (20 MARKS)

- a) Differentiate between monopolar, bipolar and homopolar DC links. (6 marks)
- b) A 500KV surge travels on an overhead line of surge impedance 400 Ohms towards its junction with a cable which has a surge impedance of 40 ohms. Find:
 - i. Transmitted voltage
 - ii. Transmitted current
 - iii. Reflected voltage
 - iv. Reflected current. (8 marks)
- c) With aid of expression, discuss how gas bubbles, water globules and solid particles impurities in a liquid lowers its dielectric strength. (6 marks)