



MACHAKOS UNIVERSITY



UNIVERSITY EXAMINATIONS 2017/2018

FIFTH YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING

EEE506: HIGH VOLTAGE TECHNOLOGY AND HVDC TRANSMISSION

DATE: DECEMBER 2017

TIME 2HRS

INSTRUCTIONS: This examination paper contains five questions. Answer **Question ONE** and any other **TWO Questions**. Question ONE carries 30 Marks and ALL the other questions carry 20 Marks each.

Permeability of free space $\mu_0 = 4 \pi \times 10^{-7}$ H/m: Permittivity of free space $\epsilon_0 = 8.854 \times 10^{-12}$ F/m: Velocity of light in free space = 2.998×10^8 m/s:

QUESTION ONE

- a)
- Describe the use of resonance in the generation of high alternating voltages for testing purposes. Why is this method not suitable for power transmission? **[4 marks]**
- b) Explain the following with respect to high voltage technology
- i) Dielectric break down
 - ii) Electron Avalanche **[4 Marks]**

c) With aid of a waveform identify and explain the following

- i) Lightning over-voltage
- ii) Switching Overvoltage

[4Marks]

d) Explain any three types of ionization process

[6 Marks]

e) A 100kms long three, 50Hz 132kV line consists of conductor of diameter 1.04cm is arranged in an equilateral triangle configuration with 3m spacing. The temperature of the surrounding is 40decC and the barometric pressure is 750cm of Mercury. Determine:

[The irregularity factors may be taken as $m_0 = 0.85$ and $m_v = 0.72$]

- i) The disruptive critical voltage
- ii) Visual corona
- iii) Corona Power loss

[12Marks]

QUESTION TWO

- a) Derive an expression for the corona inception voltage in a two conductor system with radius of each conductor r and the spacing between the conductors, d . [4 marks]
- b) Describe the process of stable corona formation by discussing the relationship of the corona radius and electric stress at the corona boundary. [4 marks]
- c) Describe four processes by which solid insulation may breakdown below their intrinsic strength. [2 marks]
- d) Discuss the creepage length associated with high voltage insulators and indicate the methods used to increase the creepage length of disc type insulators used in overhead transmission lines. [4 marks]
- e) Describe the Cockroft Walton dc generator with suitable diagrams. [6 Marks]

QUESTION THREE

- a) Explain any **THREE** causes of high voltages surges [6 Marks]
- b) Show that the surge impedance of a line is given by: [4 Marks]

$$z_0 = \sqrt{\frac{L}{C}}$$

- c) An overhead line A with a surge impedance of 450Ω is connected to a three lines (Overhead lines A, B and C with surge impedance of 600Ω each and a cable D with a surge impedance 60Ω). At a junction J, a travelling waves vertical front of magnitude 25kV & very long tail travels on A towards J. Calculate the magnitude of the voltage and current waves which are transmitted and reflected when the surge reached junction J. Attenuation on the lines can be neglected.

[10Marks]

QUESTION FOUR

- a) Explain the THREE basic tests carried out on insulators **[6Marks]**
- b) Derive the surge impedance and surge velocity of a travelling surge on a transmission line **[8Marks]**
- c) A transformer has a dielectric constant of 2.2 and a dielectric strength of 25kV/mm , is used as an insulation in a spacing of 8mm . Determine the maximum applicable voltage. A barrier of thickness 3mm of transformer board with a higher dielectric strength is of 50kV/mm (dielectric constant 4.4) is used in this space to increase the strength, does the transformer serve the purpose

[6Marks]

QUESTION FIVE

- a) Describe briefly, with the aid of suitable diagram the cascade arrangement of transformer to obtain high alternating voltage for testing. **[6 Marks]**
- b) Show that the deflecting torque of an electrostatic voltmeter is proportional to the product of the square of the applied voltage and the rate of change of capacitance. **[4 Marks]**
- c) Describe the principle of operation of the attracted disc electrostatic voltmeter. **[4 Marks]**
- d) Describe briefly, with the aid of suitable diagrams why a resistive potential divider needs to be matched to the cable connecting it to an oscilloscope, and how the matching may be achieved.

[6 Marks]