TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:2023/2024

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE4506: HIGH VOLTAGE TECHNOLOGY PAPER 2

END OF SEMESTER EXAMINATION

SERIES: MARCH 2025

TIME: 2 HOURS

DATE: Pick DateSelect MonthPick Year

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of five Questions; Question ONE is compulsory. In addition, attempt any Other TWO Questions.

Do not write on the question paper.

QUESTION ONE (Compulsory 30 marks)

a) Briefly outline the factors that influence the design of the compensating reactors used in multistage transformers. **4 Marks**

b) A 100kVA, 250V/200kV feed transformer has a resistance and reactance of 2% and 6% respectively. This transformer is used to test a cable at 500kV at 50Hz. The cable takes a charging current of 0.75A at 500kV. Using a circuit diagram, determine;

i. The series inductance required under such conditions.

ii. Input voltage to the transformer

Assume 2% resistance as internal resistance of the inductor and neglect the dielectric loss of the cable.

7

Marks

c) A steady current of 600μA flows through the plane electrode separated by a distance of 0.6cm when a voltage of 12kV is applied. Determine the Townsends first ionization coefficient if a current of 65μA flows when the distance of separation is reduced to 0.11cm and the field is kept at the same value.

5

Marks

d) Briefly explain the procedure for carrying out the "***Wet Flash Over and One Minute Rain Test***" on high voltage insulators **4**

Marks

e) State the advantages of using an electrostatic voltmeter in high voltage measurement **3 Marks**

f) List the factors which influence the peak voltage measurement using sphere gap? **3 Marks**

g) Briefly explain the following terms used in high voltage

i. Streamers

ii. Ionization

iii. Electron attachment process

iv. Townsend ionization coefficient **4 Marks**

QUESTION TWO 20 Marks

a) Using a section of a labeled diagram of a transmission line, derive the expression for surge impedance for a travelling wave in a transmission line as;

$$\frac{V}{I} = \sqrt{\frac{L}{C}} = Z_n$$

10 marks

b) Briefly explain what is a Generating Voltmeter and its limitation in measurement of high voltage?

4

Marks

c) Briefly explain what purpose liquid dielectrics serve in transformers and switchgear **3 Marks**

d) State the six most important properties of liquid dielectrics **3 Marks**

QUESTION THREE 20 Marks

a) Use a clearly labelled diagram to explain

i. The operation of the three stage Marx impulse generator in a circuit "b" configuration.

8 Marks

ii. State reasons why it is inconvenient to use single stage high impulse voltage circuit. **2 Marks**

b) Using labelled diagrams explain the Townsends first ionization coefficient for electron avalanche in high voltage **8 Marks**

c) Briefly explain the similarities between the Greinarcher voltage doubler and the Cockcroft and Walton voltage multiplier high voltage generator **2 Marks**

QUESTION FOUR 20 Marks

a) A 100kVA, 200V/250kV feed transformer has a resistance and reactance of 2% and 4% respectively. This transformer is used to test a cable at 400kV at 80Hz. The cable takes a charging current of 0.75A at 500kV. Using a circuit diagram, determine;

i. The series inductance required under such conditions.

ii. Input voltage to the transformer

Take 2% resistance as internal resistance of the inductor and neglect the loss of the cable. **8 Marks**

b) Using a labelled diagram, briefly explain the

i. Operation of a Van-de Graaf electrostatic high voltage generator

ii. Calculate the surface charge density σ under an electric field of 60kV/m^2

iii. And the current supplied by the generator when the belt width b = 1.8 meters and the velocity is 14 meters/second **12 Marks**

Question FIVE 20 Marks

a) Explain the following terms as used in impulse high voltage generation.

i. Impulse puncture voltage

ii. Impulse ratio for flash over

iii. Impulse ratio for puncture **6 Marks**

b) A steady current of 870μA flows through the plane electrode separated by a distance of 0.75cm when a voltage of 12kV is applied. Determine the ionization collisions/cm when a current of 115μA flows when the distance of separation is reduced to 0.18cm and the field is kept constant at 12kV. **6 Marks**

c) State the advantages and disadvantages of the Van de Graaf method of generating high voltage

5 Marks

d) State the methods to measure ac high voltages at power frequency? **3 Marks**