



TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:2024/2025
FIFTH YEAR FIRST SEMESTER EXAMINATION FOR THE
DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC
ENGINEERING

EEE4506: HIGH VOLTAGE ENGINEERING PAPER 1

END OF SEMESTER EXAMINATION
SERIES: APRIL 2025

TIME: 2 HOURS

DATE: Pick Date Select Month Pick 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 explain the difference between the Greinarcher voltage doubler and the Cockcroft and Walton voltage multiplier high voltage generator and write the equation for optimum number of stages in Cockcroft Walton Voltage multiplier circuit. **3 Marks**
- b) In an eight stage Cockcroft & Walton circuit has all capacitors of $0.056\mu\text{F}$. The secondary voltage of the supply transformer is 100kV at a frequency of 150Hz . If the load current is 1.75mA , determine;
- i. Voltage regulation
 - ii. The ripple
 - iii. Percentage ripple
 - iv. The optimum number of stages for maximum output voltage
 - v. The maximum output voltage **6 Marks**

- c) Briefly explain how the following high voltage tests are carried out on insulators;

- i. The 50% dry impulse flash over test
- ii. The Impulse withstand test
- iii. The dry flash over and dry one-minute test

6 Marks

d) Show that the force in the parallel plates of an electrostatic voltmeter is expressed

$$\text{by } F = \frac{1}{2} \epsilon \frac{AV^2}{d^2}$$

5 Marks

- e) A 100kVA, 250V/200kV feed transformer has a resistance and reactance of 1% and 5% respectively. This transformer is used to test a cable at 400kV at 50Hz. The cable takes a charging current of 0.5A at 400kV. Using a circuit diagram, determine;
- i. The series inductance required under such conditions.
 - ii. Input voltage to the transformer

Assume 1% resistance as internal resistance of the inductor and neglect the dielectric loss of the cable.

7

Marks

- f) A steady current of 600μA flows through the plane electrode separated by a distance of 0.5cm when a voltage of 12kV is applied. Determine the Townsends first ionization coefficient if a current of 60μA flows when the distance of separation is reduced to 0.1cm and the field is kept at the same value.

3

Marks

Question TWO 20 Marks

- a) Briefly discuss three factors that influence the breakdown voltage of air **5 Marks**
- b) Briefly explain the operation of an Electrostatic Voltmeter and state its advantages **3 Marks**
- c) Briefly explain what is;
 - i. Hall effect
 - ii. Faradays and the advantages of using a Faradays generator **5 Marks**
- d) Using a labelled section of a transmission line, derive the expression for surge impedance for a transmission line. **7 Marks**

Question THREE 20 Marks

- a) Briefly explain how impulse voltage measurement is done using an oscilloscope **3 Marks**

- b) Briefly explain the operation of a Van–de-Graaf high voltage generator and;
- Calculate the surface charge density σ under an electric field of 40kV/m^2
 - Calculate the current supplied by the generator when the belt width $b = 1.8$ meters and the velocity is 16 meters/second
- 8 Marks**
- c) Briefly elaborate how the following type tests are carried out on high voltage capacitors;
- Dielectric loss angle test
 - Test for capacitor loss
 - Stability Test
- 3 Marks**
- d) Using a labelled diagram explain the impulse voltage wave phenomenon
- 4 Marks**
- e) Briefly explain what is a generating voltmeter and list its advantages.
- 2 Marks**

Question FOUR 20 Marks

- a) Briefly explain the difference between single and multi-stage impulse generators and list four factors that make the single stage generator inconvenient
- 6 Marks**
- b) Briefly explain how a dielectric power factor test is carried out on a high voltage cable
- 2 Marks**
- c) Briefly explain the relaxation phenomenon in high voltage technology and what measures are recommended against it.
- 2 Marks**
- d) Briefly explain what is Corona inception field and the two forms of corona
- 4 Marks**
- e) In a Cascaded AC high voltage transformer, if the measured impedances referred to the primary side are $Z_{ps} = Z_p + Z_s$, $Z_{pt} = Z_p + Z_t$ and $Z_{st} = Z_s + Z_t$

Solve the equations and obtain the expressions for; Z_p , Z_s and Z_t

6 Marks

Question FIVE 20 Marks

- a) Using a labelled diagram briefly explain the operation of the Villard circuit used in voltage doubler methods
- 5 Marks**
- b) Using mathematical expressions, explain the **Paschen's Law?**
- 3 Marks**
- c) Use a clearly labelled diagram to explain
- The operation of the three stage Marx impulse generator in a circuit “b” configuration.
- 8 Marks**
- State why a multi-single stage high impulse voltage circuit would be convenient
- 2 Marks**

- iii. Where would you recommend the placement of the wave front control resistances in the Marx impulse generator and how would they be arranged **2 Marks**