PAPER TWO

TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 4203 ELECTROMAGNETICS I

END OF SEMESTER EXAMINATION

SERIES: APRIL 2025

TIME: 2 HOURS

DATE: April 2025

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attempt **Question ONE and ANY other TWO questions.**

Do not write on the question paper.

Question ONE

(a) State Faraday's law of induction in integral form and explain its practical significance. (3 marks)

(b) Given that $Z_{i} = \frac{\left(z_L + j\, z_0 \tan\beta l\right) Z_0}{Z_0 + j\, z_L \tan\beta l}$ Determine the capacitance of an open-circuited section of a transmission line. Assume $\beta = 2\pi/\lambda$; $l = \lambda/8$; $Z_0 = 100\,\Omega$; $Z_L = \infty\,\Omega$; $Freq = 2\,GHz$ (6 marks)

(c) (i) Charge is distributed over a disk of radius $3\,m$ and has the following distribution: $P_V = 5 \times 10^{-6}\, r\, C/m^3$. Determine the total charge contained in the disk volume (take $Z = 3\,m$).

(ii) Determine using Gauss' law the electric field at a distance r due to a sphere of charge of radius a where the charge q is uniformly distributed throughout the sphere with volume charge distribution $P_V\, C/m^3$ for $r > a$. 12marks)

(d) Determine the voltage v in the circuit of Fig.Qu.1(d) (9 marks)

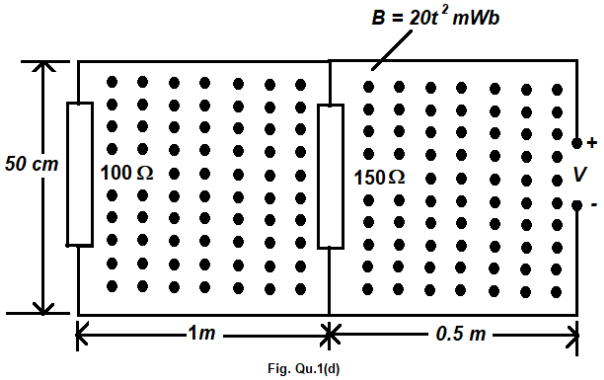
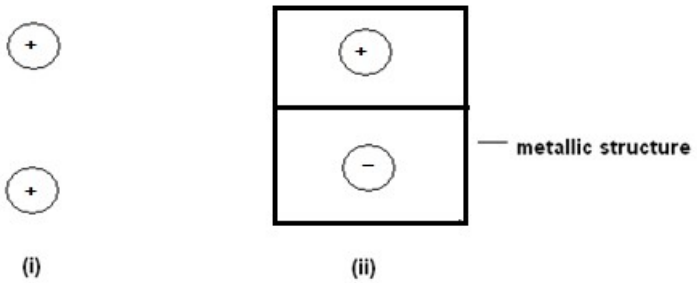


Fig. Qu.1(d)

Question TWO

(a) State mathematically and explain the physical meaning of Ampere's law in integral law. (3 marks)

(b) Draw the approximate field lines for the following charge pairs:



(c) Point charges $Q_1=3\,\mu C$, $Q_2=4\,\mu C$, & $Q_3=5\,\mu C$ are located at $(4,3,2)m$, $(1,5,0)m$, and $(-1,-2,-3)m$. Determine the:

(i) Vector force exerted on Q_3 by Q_1 & Q_2

(ii) Electric field $\overline{E}$ on Q_3 by Q_1 & Q_2 (15 marks)

Question THREE

(a) State mathematically and explain the practical significance of Gauss' law in integral form (3 marks)

(b) The electric field in a certain region of space is given by $\overline{E}=\overline{E}_x a_y+\overline{E}_z a_z$. Determine how much flux passes through an area $\overline{A}$ if it is a portion of the:

(i) xy plane (ii) xz plane (iii) yz plane (4 marks)

(c) Consider charges placed on the corners of an equilateral triangle Fig. Qu.3(c). Determine the magnitude of the electric field intensity $\overline{E}$ at the centre of the triangle S. (13 marks)

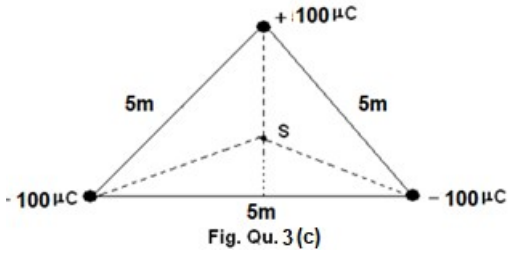


Fig. Qu. 3 (c)

Question FOUR

(a) State mathematically and explain the practical significance of Gauss' magnetic law. (3 marks)

(b) With reference to electric circuits distinguish between lumped and distributed circuit models. (6 marks)

(c) Determine the conditions for which lumped circuit model is valid for the following situations:

(i) Cell phone circuit ($2\,GHz$) (ii) Satellite circuit ($12\,GHz$) (6 marks)

(d) The electric field strength of air is about $3\times10^{-6}V/m$. Using relevant sketches explain the physical meaning of this statement and hence show how lightning occurs. (5 marks)

Question FIVE

(a) State mathematically and describe using an appropriate sketch the concept of the curl of a vector $\overline{A}$. (4 marks)

(b) Consider Fig. Qu.5(b); show that the voltage between two points that are at radial distances $r_a$and r_b from point charge Q is given by $v_{ba}=\frac{Q}{4\pi\varepsilon}(\frac{1}{r_b}-\frac{1}{r_a})$. Justify any assumptions made in arriving at your solution. (8 marks)

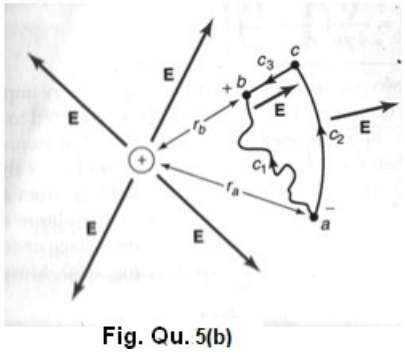


Fig. Qu. 5(b)

(c) Fig. Qu.5 (c) shows a straight wire of radius $a$carries a current I_1 along the axis of a metal tube with inner radius $b(20\,cm)$ and outer radius c. The tube carries a current I_1 in a direction opposite to that in the wire. Determine justifying any assumptions made:

(i) H for$a<r<b$ (ii) H for$r<b$ (8 marks)

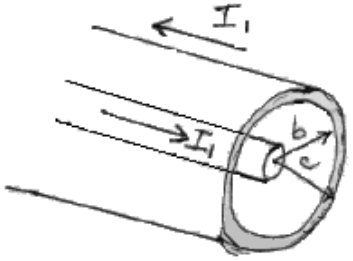


Fig. Qu.5(d)