TECHNICAL UNIVERSITY OF MOMBASA

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

Faculty of Engineering and Technology

SECOND YEAR/SECOND SEMESTER EXAMINATIONS FOR THE DEGREE

OF BACHELOR OF ENGINEERING IN ELECTRICAL & ELECTRONIC ENGINEERING

EEE 2215 ELECTROMAGNETICS I

AUGUST 2011 SERIES **TIME: 2 HOURS**

INSTRUCTION TO CANDIDATES

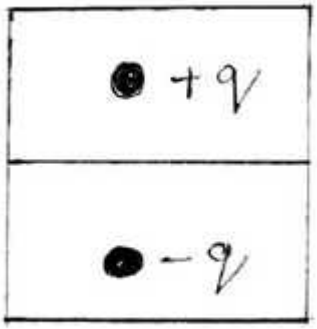
Answer question **ONE** and any other **TWO** questions.

1. (a) A surface charge distribution is contained in a flat, wedge shaped surface whose corners are defined in a rectangular coordinate system by (2,1,2)m, (1,1,2)m and (1,3,2)m. The charge distribution is given by

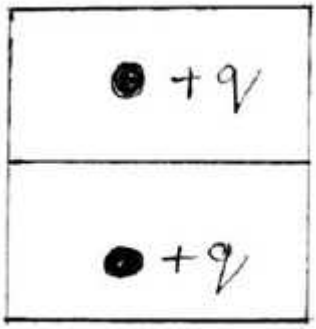
$$P_S = 3xyz \ \text{C/m}^2$$

Determine the total charge on the surface. (10 marks)

(b) Draw the approximate field lines for the following charge pairs enclosed in square metal boxes): (2 marks)



(i)



(ii)

(c) The electric field in a certain region of space is given by $E = E_y a_y$. How much flux passes through an area A if it is a portion of the

(i) xy-plane

(ii) xz-plane

(iii) yz-plane (3 marks)

(d) A toroid is constructed of a ring of highly permeable material as shown in figure Qu.(1d). The inner radius of the toroid is a , the outer radius is b and there are N turns wound on

it. The windings are tightly wound so that all flux remains in the toroid. Determine an expression for the magnetic field intensity vector for

(i) r < a

(ii) a < r < b

(iii) r > b (7 marks)

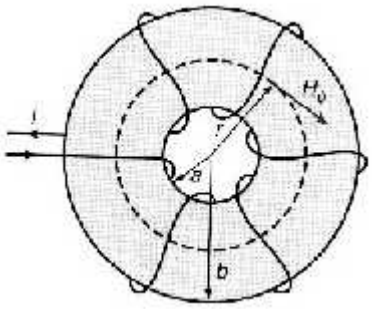


Figure Qu.(1d)

(e) With an appropriate example illustrate:

(i) The need for electrostatic shielding and how it Is accomplished.

(ii) Component parasitic effects in electronic circuit operation (8 marks)

2.(a) Define the following electromagnetic quantities indicating their units

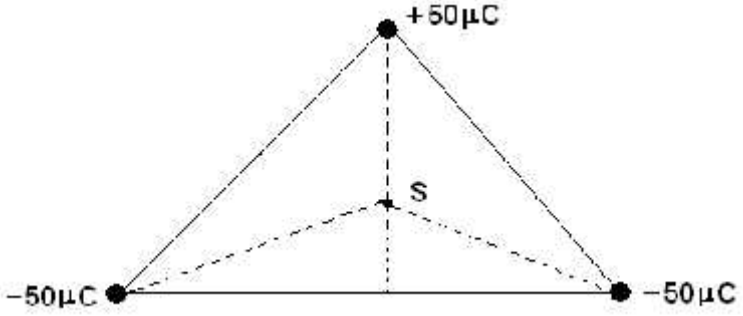
(i) Electric field intensity vector $\overline{E}$

(ii) Electric flux density vector $\overline{D}$

(iii) Magnetic field intensity vector $\overline{H}$

(iv) Magnetic flux density vector $\overline{B}$ (4 marks)

(b) (c) A positive $50«C$ point charge and two negative $50«C$ charges are placed on the corners of an equilateral triangle whose sides are of length 5m. Determine the magnitude of the electric field intensity at the centre of the triangle S (Figure Qu.(2c)).



(10 Marks)

(c) (i) By means of a sketch describe a radial electric field

(ii) Explain the importance of radial electric fields in EM analysis (6marks)

3.(a) Consider Gauss's law for static fields

(i) State this law mathematically in integral form

(ii) Explain this law in your own words. Use an appropriate sketch to illustrate your answer. (3 marks)

(b) A spherical volume charge distribution $P_V = \frac{k}{r}$ C/m^3 is contained in a spherical volume of radius a and the medium is free space. Determine:

(i) The total charge enclosed by the volume

(ii) The electric field intensity for a $\leq r \geq$ b

(iii) The electric field intensity for r < a (14 Marks)

(c) Can Gauss' law be used to determine the electric field at a distance d from the centre and on a line perpendicular to a disk? If not, why not? (3 marks)

4.(a) Consider figure Fig. Qu.(4a). Prove that the line integral of the electric field around the closed path c yields a result of zero. What is the significance of this result in terms of EM laws? (4 marks)

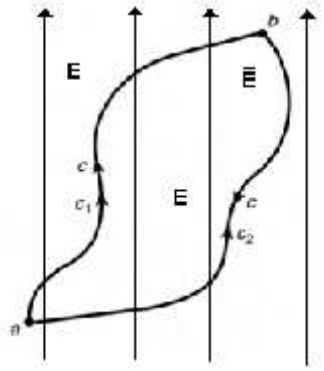


Fig. Qu.(4a)

(b) Consider Fig. Qu.(4b); show that the voltage between two points that are at radial distances r_a and r_b from point charge Q with point b at radius r_b at an assumed positive or higher voltage than point a at radius r_a .is given by $V_{ba} = \frac{Q}{4®£}(\frac{1}{r_b} - \frac{1}{r_a})$. Justify any assumptions made in arriving at your solution. (8 marks)

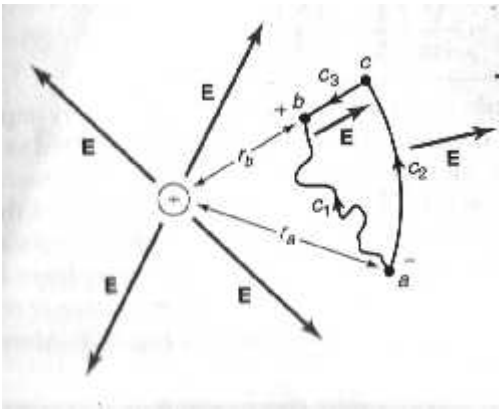


Fig. Qu.(4b)

(c) Two concentric spherical metal shells carry net charges $Q1$ and $Q2$, where $Q1$ is the charge on the inner sphere. If the electric field between the spheres is $3000/r^2$ (V/m) radially inward and the electric field outside is $2000/r^2$ (V/m) radially inward, determine the values of $Q1$ and $Q2$. (8 marks)

5.(a) Suppose that a 10 MHz uniform plane wave is travelling in the x-direction in a lossless dielectric ($\mu_r = 1, \varepsilon_r = 5$) with 100V/m electric field component in the –z direction:

(i) Draw the phasor diagram of the electric and magnetic field vectors.

(ii) Give the complete time-domain expressions for the electric and magnetic field vectors.

(iii) Determine the average power density of the wave. (10 Marks)

(b) With reference to the electromagnetic environment define the following terms giving appropriate examples:

(i) Electromagnetic interference (EMI)

(ii) Electromagnetic compatibility(EMC) (4 Marks)

(c) Explain how the following techniques help to reduce the effects of EMI:

(I) Grounding

(ii) Shielding

(iii) Filtering (6 marks)