TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF MEDICAL ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MEDICAL ENGINEERING

EEE 4333 ELECTROMAGNETICS

SPECIAL SUPPLEMENTARY EXAMINATION

SERIES: 2017

TIME: 2 HOURS

DATE: SEPT. 2017

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.**

$\varepsilon_0 = \frac{1}{36\pi} \times 10^{-9}\ F/m\ ;\ \mu_0 = 4\pi \times 10^{-7}\ H/m\ ;\ Z_{in} = Z_0\ (\frac{Z_L + jZ_0 \tan(\beta l)}{Z_0 + jZ_L \tan(\beta l)})$

Do not write on the question paper.

Question ONE

(a) (i) Show that a section of transmission line can behave like a pure inductor. Assume $Z_L = 0$ or $Z_L = \infty$, $\beta = \frac{2\pi}{\lambda}$, $l = \frac{\lambda}{8}$, and $Z_0 = 300\Omega$.

(ii) The electric field strength of air is about $3 \times 10^6\ v/m$. Explain the meaning of this statement.

(iii) State mathematically and explain the practical significance of the term Electric flux density $\overline{D}$ giving appropriate units. (8 marks)

(b) Four 100 μF point charges are located on the corners of a square that are defined in a rectangular coordinate system by (1,0,0)m, (0,1,0)m, (-1,0,0)m and (0,-1,0)m. Determine the

(i) vector force (ii) the electric field as experienced by the 5th 100 μF charge that is located at (0,0,2)m. (12 marks)

(d) (i) Discuss the parasitic effects of the component's connection leads as shown in Fig. Qu.1(d).

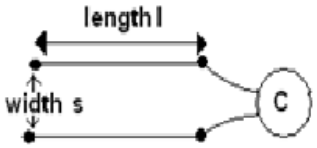


Fig. Qu.1(d)

(ii) Two long parallel straight wires are 20 cm apart and carry currents of 10A each in the same direction. Determine the value of $\bar{B}$ midway between the two wires and with the current directions reversed. (10 marks)

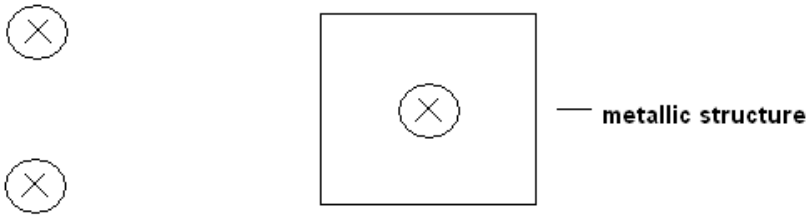
Question TWO

(a) State mathematically and explain the following terms as applied in electromagnetics giving appropriate units

(i) Coulomb's law (ii) Magnetic flux density $\bar{B}$ (6 marks)

(b) Draw the approximate magnetic field lines for the following line current distributions:

(2 marks)



(i) (ii)

(b) Two point charges $Q_1 = 18\mu C$ and $Q_2 = 72\ \mu C$ are separated by 3cm. A third charge $Q3 = -8\mu C$ is introduced 1cm fromQ_1. Determine the force on Q_3 due to Q_1 and Q_2. Comment on the significance of you answer.

(7 marks)

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

(ii) Explain the importance of radial electric fields in EM analysis (5 marks)

Question THREE

(a) State Ampere's law in point form and explain its significance in electromagnetic theory.

(2 marks)

(b) The electric field in a certain region is given by $\bar{E} = E_z\hat{a}_z + E_y\hat{a}\ V/m$. Determine how much flux passes through an area A if it is a portion of the :

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

(c) Determine the magnetic field intensity for a TEM wave with electric field intensity of $1\mu V/m$ in

(i) air (ii) a lossless dielectric with $\varepsilon_r = 5$ (6 marks)

(d) A 30 MHz uniform plane wave is travelling in the following lossless medium: Mylar ($\mu_r = 1, \varepsilon_r = 5$). Determine the

(i) Phase constant β (ii) Intrinsic impedance η

(iii) Phase velocity of propagation v (iv) Wavelength λ (8 marks)

Question FOUR

(a) (i) Distinguish between electrically small and electrically large structures.

(ii) Determine the conditions for which lumped-circuit models are valid for a 6 GHz satellite circuit. (4 marks)

(b) A positive $30\mu C$ point charge and two negative $40\mu C$ and $50\mu C$ 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 (Fig Qu.4(b)). (10 marks)

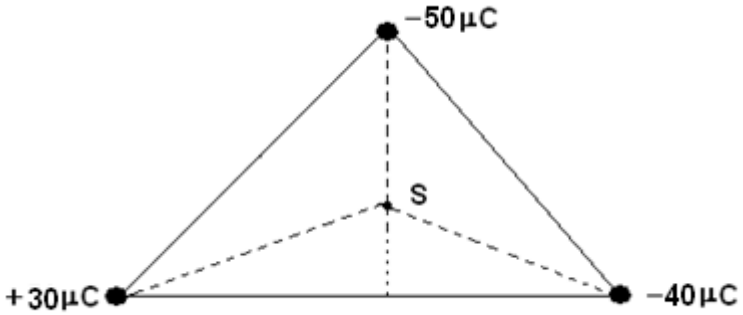


Fig. Qu. 4(b)

(c) Two point charges are placed in a rectangular coordinate system as follows, $Q_1 = 10\mu C$ is placed at (0.-2m,0) and $Q_2 = 50\mu C$ is placed at (0.3m,0). Determine the voltage at a point (0.0,5m) with respect to the origin. (6 marks)

Question FIVE

(a) Consider Faraday's law:

(i) State this law mathematically (ii) Using an appropriate sketch explain this law in your own words. (3 marks)

(b) With the aid of appropriate sketches, show that the voltage induced in a rotating loop is given by $v = \omega BAsin(\omega t)$ (5 marks)

(c) A spherical volume charge distribution $P_v = \frac{2}{r}\ C/m^3$ 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 r > a

(iii) The electric field intensity for r < a (12 marks)