TECHNICAL UNIVERSITY OF MOMBASA

Paper 1

EXAMINATION RUBRIC

FACULTY ENGINEERING AND TECHNOLOGY

DEPARTMENT ELECTRICAL & ELECTRONIC

Common ☐ **Not common** ☐

COURSE/CLASS **Bachelor of Science in Electrical and Electronic Engineering**

UNIT CODE **EEE 2215**

PAPER **Electromagnetics I**

SERIES **May 2016**

NO. OF STUDENTS 80

INSTRUCTION TO CANDIDATES

Answer Question One (Compulsory) and any other Two Questions

Name of setter: Stephen Sande

Name of moderator: Prof. Heywood O uma

Date submitted to examination centre _____

TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR :

THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 2215 ELECTROMAGNETICS I

END OF SEMESTER EXAMINATION

SERIES: MAY 2016 **TIME : 2 HOURS**

DATE:

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

$\varepsilon_0 = \frac{1}{36\pi} \times 10^{-9}\ F/m\ ;\ \mu_0 = 4\pi \times 10^{-7}\ H/m$

Do not write on the question paper

Question ONE (Compulsory 30 marks)

(a) Suppose a conductor length $l = 18\ cm, \epsilon_r = 4.7$ carries a digital clock signal with a fundamental frequency of 900 MHz . Determine:

(i) Length l in terms of λ_g (ii) time delay (iii) phase shift

(6 marks)

(b) Point charges $100\mu C$ and $50\mu C$ are located at (2,4,0) and (3,5,0) respectively. Draw the sketch and determine the

(i) Force on a $100\mu C$ at (7,3,1) (ii) Electric field at (7,3,1)

(10 marks)

(c) A long straight wire carries a current of 5A along the y-axis. Determine the magnitude and direction of $\bar{B}$ at the point (2,3,0).

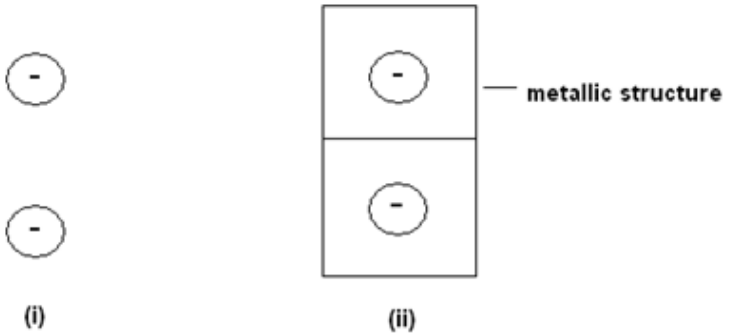
(5 marks)

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

(9 marks)

Question TWO

(a) Draw the approximate electric field lines for the following charge pairs (2 marks)

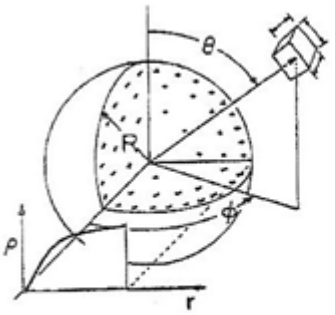


(b) Define the following electromagnetic quantities indicating their units:

(i) Electric flux density vector $\bar{D}$ (ii) Magnetic field intensity vector $\bar{H}$

(4 marks)

(c) The electric field in all space for the charge distribution Fig. Qu.2(c) is to be determined.



$$\rho(r) = \begin{cases} \rho_0 \sqrt{\frac{r}{R}}; & r < R \\ 0; & r > R \end{cases}$$

Figure Qu.2(c)

Determine the electric field for the given charge distribution when:

(i) r < R (ii) r > R

(10 marks)

(d) A long straight wire carries a current $2I$ along the $x-axis$. A second wire carries a current $I/5$ out along the $y-axis$. Determine the location where the combined magnetic field is zero.

(4 marks)

Question THREE

(a) The electric field in a certain region of space is given by $\bar{E} = E_x \hat{a}_x$ 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)

(b) Determine the voltage V in the circuits shown in Fig. Qu.(3b). Show all your working clearly, motivate all the steps taken and show the corresponding Faraday sources using appropriate sketches.

(6marks)

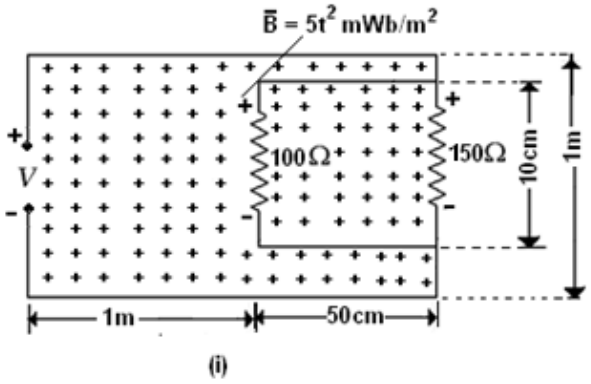


Fig. Qu.3(b)

(c) In Fig. Qu. 3(c) 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.

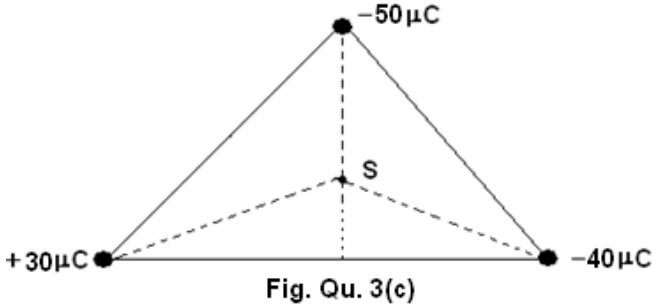


Fig. Qu. 3(c)

(10 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 30 GHz

radar circuit. (4 marks)

(b) Suppose that a 300 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 –x 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)

(c) A volume charge distribution $P_v = \frac{2}{r}\ C/m^3$ is contained in a region defined in Cylindrical coordinates as $0 \le z \le 2m\ ;\ 0 \le r \le 1m\ ; 45^0 \le \phi \le 90^0$.

(i) Draw the structure (ii) Determine the total charge contained in the region (6 marks)

Question FIVE

(a) Consider Ampere's law (under dc conditions):

(i) State this law mathematically (ii) Explain this law in your own words (3 marks)

(b) Using an appropriate sketch explain how you would prevent external magnetic fields from Interfering with sensitive electronic components within a circuit.

3 marks)

(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 and outer radius c. The tube carries a current I_1 in a direction opposite to that in the wire. Determine:

(i) H for $a < r < b$ (ii) H for $r < c$ Comment on the field along the wire and the usefulness of such cables. (9 marks)

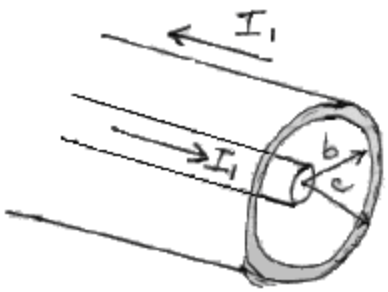


Fig. Qu.5(c)

Fig. Qu.5(d)

(d) Discuss the parasitic effects of the component's connection leads as shown in Fig. Qu.5(d). (5 marks)