TECHNICAL UNIVERSITY OF MOMBASA

Paper 2

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 Ouma

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) Show that a $\frac{\lambda}{8}$ section of a 300Ω. transmission line can behave like a

(i) pure capacitor (ii) pure inductor. (6 marks)

(b) State mathematically and explain the following terms as applied in electromagnetics giving appropriate units: (i) Coulomb's law (ii) Electric flux density $\bar{D}$ (4 marks)

(c) 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, (01,0)m, (-1,0,0)m and (0,-1,0)m. Determine the (i) vector force (ii) the electric field exerted on another 100 μF charge that is located at (0,2,0)m (10 marks)

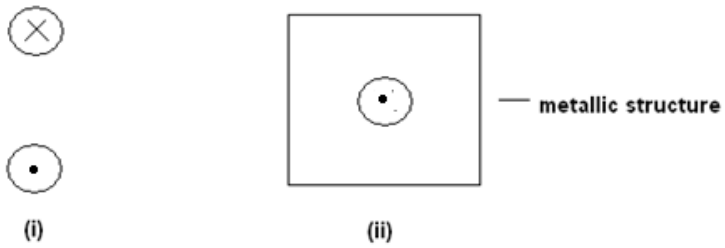
(d) Two long parallel straight wires are 20 cm apart and carry currents of 10A each in the same direction. Determine the value of $\bar{B}$ midway between the two wires and with the current directions reversed. (4 marks)

(e) State the FOUR Maxwell's equations in point form and explain the significance of each in electromagnetic theory. (6 marks)

Question TWO

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

(2 marks)



(b) Distinguish between (i) Conduction current (ii) Displacement current (2 marks)

(c) A 50 V generator at 20 MHz is connected to the plates of an air-dielectric parallel plate capacitor with plate area $2.8\ cm^2$ and a separation distance of 0.2 mm. Determine the

(i) Displacement current density (ii) Displacement current (6 marks)

(d) Show that the voltage between two points at radial distances r_a and r_b away from an infinite line charge bearing a distribution $p_l\ C/m$ that is uniformly distributed along it is given by

$$V_{ba} = \frac{P_l}{2\pi e}\ln(\frac{r_a}{r_b})$$ (6 marks)

(e) Two point charges are placed in a rectangular coordinate system as follows, $Q_1 = 10\mu C$ is placed at (0,-2,0)m, and $Q_2 = 5\mu C$ is placed at (0,3,0)m. Determine the voltage at a point (0,0,5)m with respect to the origin of the coordinate system. (4 marks)

Question THREE

(a) State Gauss' electric and magnetic laws in integral form and explain the significance of each in electromagnetic theory. (6 marks)

(b) Determine the magnetic field intensity for a TEM wave with electric field intensity of $5\mu V/m$ in (i) air (ii) a lossless dielectric with $\varepsilon_r = 4.7$ (6 marks)

(c) A 300 MHz uniform plane wave is travelling in the following lossless medium: Mylar ($\mu_r = 1, \varepsilon_r = 3.7$). Determine the

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

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

Question FOUR

(a) With reference to electric circuits distinguish between

(i) Lumped circuit model (ii) Distributed circuit model

(ii) Using appropriate sketches explain how displacement current causes an antenna to radiate electromagnetic waves. (12 marks)

(b) Explain the practical significance of characteristic impedance z_0 in the design of high frequency circuits. (3 marks)

(c) Assuming water has the following properties, $= \mu_0,\ \varepsilon = 81\varepsilon_0, \delta = 20\ S/m$, determine the frequency at which the conduction current density is 10 times the displacement current density in magnitude. (5 marks)

Question FIVE

(a) Consider Faraday's law:

(i) State this law mathematically (ii) 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 $v = \omega BAsin(\omega t)$ (3 marks)

(c) A spherical volume charge distribution $P_v = \frac{2}{r^2}\ C/m^3$ 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 (14 marks)