PAPER 2

TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

TEE 4209 ELECTROMAGNETIC FIELDS AND WAVES

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: MARCH 2025

TIME: 2 HOURS

DATE: March 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 mathematically and explain the practical significance of the following set of Maxwell's equations:

(i) Faraday's law in integral form (ii) Ampere's law in point form

(iii) Gauss' electric law in integral form (iv) Gauss' magnetic law in point form (8 marks)

(b) Given $\overline{A}=A_x\hat{a}_x+A_y\hat{a}_y+A_z\hat{a}_z$; $\overline{B}=B_x\hat{a}_x+B_y\hat{a}_y+B_z\hat{a}_z$ Determine:

(i) $\overline{A}.\overline{B}$ (ii) $\overline{A}\times\overline{B}$ (12 marks)

(c) Using appropriate sketches explain the practical significance of $a(i)$ and $a(ii)$. (4 marks)

(d) Using the concept of electric fields describe antenna operation. (6 marks)

Question TWO

(a) In free space $\overline{E}=10\cos(\omega t-30x)\hat{a}_y$. Find (i) I_d (ii) ω (iii) $\overline{H}$ (10 marks)

(b) Point charges $Q_1=100\,\mu C$ and $Q_2=50\,\mu C$ are located at $(2,2,0)m$ and $(7,5,0)m$ respectively. Determine the

(i) Force on charge $Q_3=100\,\mu C$ at $(3,7,0)$ (ii) Electric field at $(3,7,0)$ (10 marks)

Question THREE

(a) With reference to Fig. Qu.3(a), determine the time domain expressions for ALL the fields in these two media if the transmitted electric field is

(14 marks)

$$E^t = 10\cos\left(wt - \left(\frac{8\pi}{3}\right)z\right)a_x$$

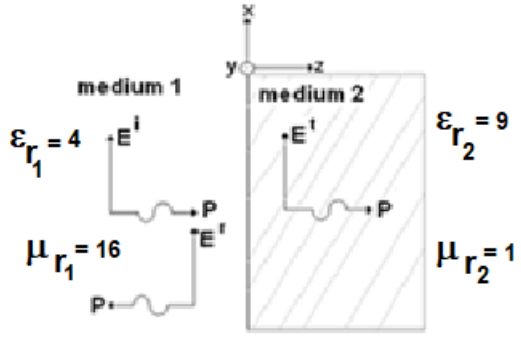

Fig. Qu.3(a)

(b) Consider circuit Fig.Qu.3(b). Determine the time delay and phase shift at $3\,GHz$ (6 marks

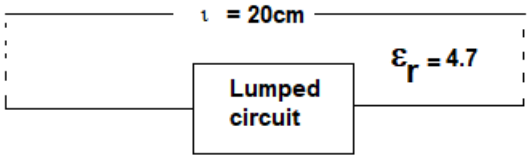

Fig. Qu.3(b)

Question FOUR

(a) Determine the voltage V in the circuit of Fig.Qu.4(a). Show all your workings clearly and motivate all steps taken. (14 marks)

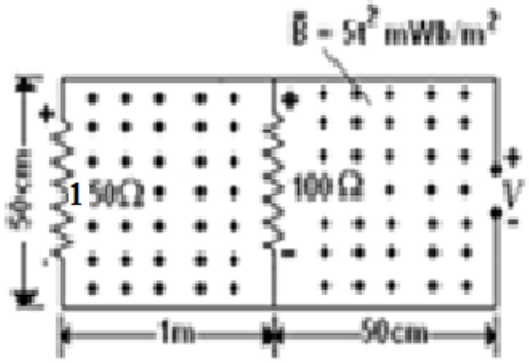

Fig. Qu.4(a)

(b) Assuming sea water has a conductivity of $20\,S/m$ and $\varepsilon_r = 81$, determine the frequency at which the conduction current is 10 times the displacement current. (6 marks)

Question FIVE

(a) Given the Maxwell's equations $\nabla X \hat{E} = -jw\mu \hat{H}$ and $\nabla X \hat{H} = jw\varepsilon_0 \hat{E}$

Motivating all your steps prove that $\hat{E}_x = E_m^{+¿} e^{-j\beta z} + E_m^{-¿} e^{+j\beta z} ¿$

$$\hat{H}_y = \frac{E_m^{+¿}}{\eta} e^{-j\beta z} + \frac{E_m^{-¿}}{\eta} e^{+j\beta z} ¿¿$$ (20 marks)