UNIVERSITY COLLEGE
TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET

COURSE CODE	: BET 1043
COURSE	: ELECTROMAGNETIC THEORY
SEMESTER/SESSION	: 1-2023/2024
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 6 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) Answer the following question:

i. Describe the meaning of unit vector in Electromagnetic (2 marks)

ii. State the formula for unit vector (2 marks)

b) Given vector A = 3ax + 7ay - 5az and B = ax – 7az, determine:

i. |2A+B| (2 marks)

ii. 5A – 2B (2 marks)

iii. The component of B along ay (1 mark)

iv. A unit vector parallel to 2A + B (3 marks)

c) Given vector A = 3ax + 7ay + 2az and B = 2ay -5az, compute the angle between A and B.

(5 marks)

QUESTION 2

a) Define the following terms:

i. Static electric field (2 marks)

ii. Static magnetic field (2 marks)

b) Describe **two (2)** difference between conduction current and convection current.

(4 marks)

c) Point charges -3mC and 5mC are located at (2, -5, 3) and (-2,-2, 5) respectively. Calculate the electric force on a 8nC charge located at (1,2,7) (9 marks)

d) Two point charges -4μC and 8μC are located at (3, -4, 1) and (1, 5, -3) respectively. Analyze the potential at (-1, 2, 7) by assuming zero potential at infinity (8 marks)

QUESTION 3

a State **two (2)** types of the distributed current sources on the Biot-Savart Law (2 marks)

b Given that $H_1 = -3a_x + 4a_y + 2a_z$ A/m in region $y - x - 8 \leq 0$, where $\mu_1 = 4\mu_o$, calculate:

i. M_1 and B_1 (5marks)

ii. H_2 and B_2 in region $y - x - 8 \geq 0$, where $\mu_2 = 2\mu_o$ (12 marks)

c) Figure 1 shows the series magnetic circuit. Calculate The value of current, *I* required to develop a magnetic flux of $\Phi = 5 \times 10^{-4}$ Wb. The magnetization curve of magnetic material is given in **Attachment 1** (6 marks)

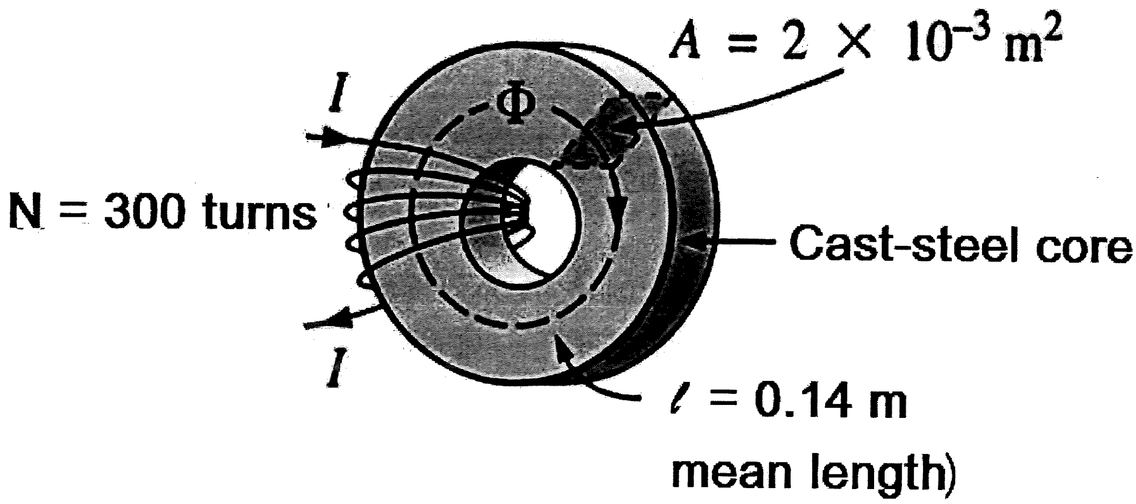

Figure 1

QUESTION 4

a) List **two (2)** type of transmission line (2 marks)

b) A distortionless line has Z_o = 60 Ω, α = 20 mNp/m, *u* = 0.5c, where c is the speed of light in a vacuum at 120 MHz. Determine the following :

i. Resistance, R (2 marks)

ii. Inductance, L (2 marks)

iii. Conductance, G, (2 marks)

iv. Capacitance, C (2 marks)

v. Wavelength, λ (2 marks)

c) Explain the properties of transmission line (4 marks)

d) An electromagnetic wave propagating in free space with its electric field vector is described by $E = 10 \sin(4 \times 10^8 t + \beta x) a_y$ V/m

i. State the direction of wave propagation. (2 marks)

ii. Determine the phase constant, β and the period, T (4 marks)

iii. Calculate the wavelength, λ and the time t_1 it takes to travel a distance of λ/4 (4 marks)

iv. Produce the wave at $t = 0$, $t = T/4$ and $t = T/2$. (7 marks)

...END OF QUESTION...

FORMULA TABLE	
$V(r) = \frac{Q_1}{4\pi\varepsilon o\lvert r - r_1\rvert} + \frac{Q_2}{4\pi\varepsilon o\lvert r - r_2\rvert} + Co$	
$E_1 = E_{1t} + E_{1n}$ $E_2 = E_{2t} + E_{2n}$ $\frac{E_{2n}}{E_{1n}} = \frac{\varepsilon_{r1}}{\varepsilon_{r2}}$	$\cos\theta_{AB} = \frac{A.B}{\lvert A\rvert\lvert B\rvert}$ $Proj_B A = \frac{A.B}{\lvert B\rvert}$ Area Parallelogram = $\lvert AXB\rvert$ Volume of parallelepiped = C.(AXB)
$\tan\theta_1 = \frac{E_{1t}}{E_{1n}}$ $W_{E1} = \frac{1}{2}\varepsilon_1\lvert E_1\rvert^2$ $W_E = \int x \int y \int z \, dxdydz$	$R_o = \sqrt{\frac{L}{C}}$ $\beta = 2\pi f\sqrt{LC}$ $u = \frac{2\pi f}{\beta}$ $R = \alpha Z_o$
$M_1 = Xm_1 H_1 = (\mu_{r1} - 1)H_1$ $B_1 = \mu_1 H_1$ $B_2 = \mu_2 H_2$ $H_1 = H_{1n} + H_{1t}$ $H_2 = H_{2n} + H_{2t}$ $H_{1n} = (H_1 \cdot an)an$ $H_{1t} = H_{2t}$ $B_{2n} = B_{1n} \rightarrow \mu_2 H_{2n} = \mu_1 H_{1n}$	$L = Z_o / \mu$, $\mu = \omega / \beta$ $G = \alpha^2 / R$ $C = 1 / \mu Z_o$

Attachment 1

The magnetization curve