FIELD THEORY
(ELEC 2103)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The magnetic field B is define as
(a) force per unit current (b) force per unit charge
(c) force per unit length (d) per unit volume

(ii) Two parallel wires carry current along same directions. The resultant force experienced by two wire is
(a) Zero (b) Attractive
(c) Repulsive (d) cannot be determined

(iii) For time varying fields $\nabla \cdot B =$
(a) P_v (b) Zero
(c) D (d) μJ

(iv) magnetic fields within a current carrying conductor is example of
(a) solenoidal and irrotational vector fields
(b) non-solenoidal and irrotational vector fields
(c) solenoidal and rotational vector fields
(d) non-solenoidal and rotational vector fields

(v) Point form of Gauss's Law is
(a) $\vec{J} = \sigma\vec{E}$ (b) $\nabla.\vec{J} = \rho_v$
(c) $\vec{J} = \vec{E}/\sigma$ (d) $\rho_v = \nabla.\vec{D}$

(vi) Electrostatic field $\vec{E} = 0$
(a) inside a dielectric medium (b) inside a perfect conductor
(c) at the boundary of two dielectric (d) in air

(vii) For a lossless line propagation constant (γ) is given by

(a) $j\omega\sqrt{LC}$ (b) $j\omega\sqrt{\frac{L}{C}}$

(c) $j\omega\sqrt{C}$ (d) $j\omega\sqrt{L}$

(viii) Skin depth is denoted by

(a) $1/\sqrt{\pi f\mu\sigma}$ (b) $\sqrt{\pi f\mu\sigma}$

(c) $1/\beta$ (d) α/β

(ix) Gradient of a scalar function is

(a) scalar function (b) vector function

(c) may be both scalar and vector function (d) periodic function

(x) A line of length l has characteristic impedance Z_0. The line is cut into half. The value of characteristic impedance becomes

(a) $Z_0/2$ (b) $Z_0/4$

(c) $2Z_0$ (d) Z_0

Group – B

2. (a) Transfer the vector $\vec{A} = 10\hat{a}_x - 8\hat{a}_y + 6\hat{a}_z$ into spherical coordinates at point P (10,-8, 6).

(b) Two points in cylindrical coordinates are P (10, 60^0, 2) and Q (5, 30^0, -4). Determine the distance between the two points.

8 + 4 = 12

3. (a) State divergence theorem.
Prove Divergence Theorem for the vector field :

$$\vec{A} = (x^2 - yz)\hat{a}_x + (z^2 - xz)\hat{a}_y + (y^2 - xy)\,\hat{a}_z$$

for a rectangular region defined by $0 \leq x \leq 2$, $0 \leq y \leq 3$, $0 \leq z \leq 4$.

(b) Check whether the field $\vec{A} = (x + 3y)\hat{a}_x + (y + 5z)\hat{a}_y + (6 + 3z)\,\hat{a}_z$ is solenoid or not, and irrotational or not.

(2 + 6) + 4 = 12

Group – C

4. (a) Derive the electric flux density $\vec{D}$ with the help of Gauss's Law at any point due to infinite line charge distribution.

(b) Derive the continuity equation

(c) Deduce boundary conditions of electric field for dielectric-dielectric boundary.

3 + 3 + 6 = 12

5. (a) Find the self-inductance of a toroid of rectangular cross-section shown in Fig. 1.

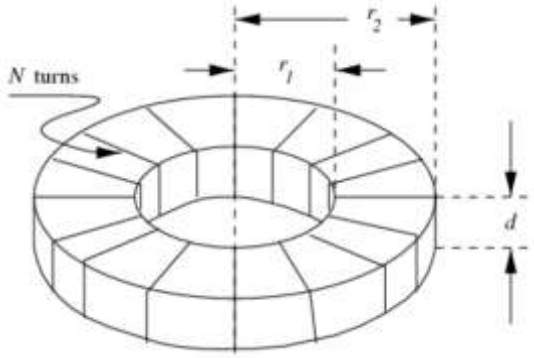

Fig. 1

(b) For a current distribution in free space the magnetic vector is $\bar{A} = ((y + e^x)\hat{a}_z$, calculate flux density ($\bar{B}$) at the origin.

(c) What is the physical significance of $\nabla . \bar{B} = 0$

6 + 4 + 2 = 12

Group – D

6. (a) Explain the significance of displacement current.

(b) Write the Maxwell equations in differential and integral form. Explain the physical significance of each equation.

(c) Given magnetic vector potential $\vec{A} = 5\, e^{-r} \cos\phi\ \hat{a}_r - 5\cos\phi\ \hat{a}_z$ in cylindrical coordinates. Find the flux density at $(2, 3\pi/2, 0)$.

4 + (2 + 3) + 3 = 12

7. (a) State 'Poynting's Theorem'.

(b) The electric field intensity of a uniform plane wave in air is 6500V/m in the $\hat{a}_y$ direction. The wave is propagating in the $\hat{a}_x$ direction at a frequency of 3×10^9 rad/s. Find : (i) the wavelength (ii) the frequency (c) the amplitude of $\vec{H}$.

(c) Clarify 'skin depth' and 'skin effect'.

(d) Prove that in lossless dielectrics the $\vec{E}$ and $\vec{H}$ of the plane wave are in time phase with each other.

2 + 5 + 3 + 2 = 12

Group – E

8. (a) Develop the expression for input impedance (Z_{in}) of transmission line when the line is terminated by a load resistance Z_L.

(b) An air line has characteristic impedance of 86Ω and a phase constant of 7rad/m at 155MHz. Calculate the capacitance and inductance of the line per meter.

(c) What is propagation constant (γ)?

6 + 4 + 2 = 12

9. (a) For loss less two wire transmission line, show that phase velocity u= $\frac{1}{\sqrt{LC}}$.

(b) At 1100 cycles the Z_o and γ are given as Z_o=450-j150, γ=0.005+j0.008 for an open wire transmission line. Calculate the distributed parameters of the line.

(c) Define the reflection coefficient.

4 + 6 + 2 = 12

Department & Section	Submission Link
EE	https://classroom.google.com/c/MjQ4NjQ1NDU0NjMy/a/MjcxMDA4ODQ3NTM4/details