MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

EE-302

FIELD THEORY

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

GROUP A
(Multiple Choice Type Questions)

1. Answer any *ten* questions. $10 \times 1 = 10$

(i) A Gaussian surface is

(A) an open surface (B) a closed surface
(C) a semi closed surface (D) any surface

(ii) Curl of a gradient of a scalar field results in

(A) a non-zero scalar function (B) a non-zero vector function
(C) a zero vector (D) a periodic function

(iii) Faraday's law of electromagnetic induction in expressed as

(A) $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ (B) $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{H}}{\partial t}$

(C) $\vec{\nabla} \times \vec{E} = \frac{\partial \vec{H}}{\partial t}$ (D) $\vec{\nabla} \times \vec{E} = \frac{\partial \vec{B}}{\partial t}$

(iv) In a transmission line, electromagnetic energy is transported by

(A) the flow of electrons
(B) the flow of magnetic flux
(C) the associated electric and magnetic field
(D) the electric field only

(v) In a certain region, the electric field $\vec{E} = 0$, the potential V there must be

(A) zero (B) a constant
(C) a function of constant slope (D) infinity

(vi) Capacitance of the earth of radius R is

(A) $2\pi\epsilon_0 R$ (B) $4\pi\epsilon_0 / R$
(C) $\frac{4}{3}\pi\epsilon_0 R^3$ (D) $4\pi\epsilon_0 R$

(vii) If $\vec{A} = \vec{a}_x + \alpha \vec{a}_y + \vec{a}_z$ and $\vec{B} = \alpha \vec{a}_x + \vec{a}_y + \vec{a}_z$ are normal to each other, then α is

(A) –2 (B) $-\frac{1}{2}$
(C) 0 (D) 1

(viii) In good conductors, the phases of $\vec{E}$ and $\vec{H}$ differ by

(A) 45° (B) 0°
(C) 90° (D) 180°

(ix) Ampere's circuital law is equivalent to

(A) Gauss's law (B) Coulomb's law
(C) Lorentz force law (D) Faraday's law

(x) Displacement current can flow through

(A) capacitor (B) induictor
(C) resistor (D) insulator

(xi) A copper conductor carries current I. The magnetic field inside the conductor is

(A) zero

(B) proportional to distance from the centre

(C) proportional to square of the distance from centre

(D) constant

(xii) A vector with zero divergence is

(A) irrotational (B) a null vector

(C) a scalar (D) solenoidal

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. Transform the vector $\vec{A} = y\vec{a}_x - x\vec{a}_y + z\vec{a}_z$ into cylindrical co-ordinates.

3. Deduce boundary conditions on electric vector $\vec{E}$ and $\vec{D}$ for Dielectric-Dielectric interface.

4. Using Biot-Savart's law calculate the field at the centre of a N-turn circular coil carrying current I.

5. State and explain Helmholtz's theorem.

6. Differentiate between magnetic scalar potential and magnetic vector potential.

CS/B.Tech/EE/EEE/ICE/Odd/Sem-3rd/EE-302/2015-16

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) Two point charges Q_1 (200 μc) and Q_2 (−100 μc) are located at (1, 2, 3) m and (2, 0, 5) m respectively in a dielectric medium having relative permeability 2.5. Find the force exerted on Q_2 by Q_1. 8

(b) A circular disc of radius 'r' is situated in the xy plane at z = 0, with its center at the origin. Charge density on the disc is ρ_s c/m^2. Calculate the field at any point (0, 0, h). 7

8. (a) A plane polarized electromagnetic wave is traveling along *z*-axis. Show graphically the variation of $\vec{E}$ and $\vec{H}$ with z. Show that $\frac{E_x}{H_y} = 377\,\Omega$ for the wave. 6

(b) Develop the analogy between the uniform plane EM waves and the electric transmission line. 4

(c) A lossless transmission line is 80 km long and operates at a frequency of 600 MHz. The line parameters are L = 0.25 μH/m and C = 100 PF/m. Find (i) the characteristic impedance (ii) the phase constant (iii) the phase velocity. 5

9. (a) Using Biot-Savart law, derive an expression for inductance per unit length of a long co-axial cable with radii of inner and outer conductors are *a* and *b* (*b*>*a*) respectively. 6

(b) Prove that $\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$, the symbols having usual meaning. 4

(c) Write Lorentz force equation. Hence obtain the expression of force acting on a straight conductor of length L in a uniform magnetic field $\vec{B}$. 5

10.(a) State and explain Maxwell's equations in integral and differential form. 10

(b) Distinguish between transformer and motional emf. 5

11.(a) Derive the wave equation for a wave propagating in a conducting medium. 10

(b) What is polarization of electromagnetic wave? 5