



HEI-003-1151003 Seat No. _____

M. Sc. (Electronics) (Sem. I) (CBCS) Examination

November/December – 2017

P3 : Electromagnetics

Faculty Code : 003

Subject Code : 1151003

Time : $2\frac{1}{2}$ Hours]

[Total Marks : 70

1 Answer any seven from the following. 14

1. Fill in the blanks :

(A) $\nabla \times A = \text{-----} a_r + \text{-----} a_\theta + \text{-----} a_\phi$

(B) $\nabla \times \nabla \times C = \text{-----}$ and $\oint_L C \cdot dL = \int_S \text{-----}$

2. Write on Dirac Delta function with its graph.

3. Do the following.

(A) Write the expression for nPr and nCr.

(B) Write the evaluation formula of n! in which Stirling's approximation is used.

4. Choose the correct alternative from the following.

(A) Relaxation time is

(a) e/σ (b) σ/ϵ

(c) $\sigma/\omega \epsilon$ (d) $\omega \epsilon/\sigma$

(B) In dielectrics,

(a) $\int_v \rho_v \cdot dv = Q_b$ (b) $\int_v \rho_b \cdot dv = Q_b$

(c) $\int_v \rho \cdot dv = Q_b$ (d) $\int_v \rho_b \cdot dv = Q_b$

5. Solve the following.
 - (A) If a charge element, whose volume charge density is 2.0 C/m^3 , is moving with a velocity of $3a_x \text{ m/s}$ then calculate its current density.
 - (B) If $E_{\tan 1} = a_x$, and $E_{n1} = 0$, then what will be electric field E_2 in a dielectric medium 2.
6. Fill in the blanks.
 - (A) The unit of constant of proportionality in Coulomb's law is _____
 - (B) Atomic polarizability has unit of _____
 - (C) If $\epsilon_r = 3$, electric susceptibility is _____
 - (D) Laplace's equation is _____
7. Write the properties of the charges.
8. Answer the following.
 - (A) What is the unit of magnetic dipole moment?
 - (B) If a charge of 2.0 C is placed in an electric field of 2.0 V/m , then what will be the force on the charge?
9. Answer the following.
 - (A) Comment on the normal components of D.
 - (B) What is E if $J_C = 1 \text{ mA/m}^2$ in a medium whose conductivity is $\sigma = 10 \text{ mho/m}$
10. State Helmholtz theorem.

2 Answer any two from the following.

- (A) Write the expression of Coulomb's law in Gaussian form, SI form and Heaviside - Lorentz form. Two charges $Q_1 = 2\mu\text{C}$ and $Q_2 = 5\mu\text{C}$ are located at $(-3, 7, -4)$ and $(2, 4, -1)$, respectively. Determine the force on Q_2 due to Q_1 . **7**

(B) Derive the formula of electric field strength due to infinite line charge. Find E at $(2,0,2)$ if a line charge of 10 PC/m lies along the Y - axis. 7

(C) Prove that electric field E , due to surface charge 7

density ρ_s is $E = \frac{\rho_s}{2\epsilon_0}$, A point charge Q is at the center

of a neutral spherical conducting shell. Find the surface charge density at the inner surface at distance "a" away from the center of the shell and at the outer surface which is "b" distance far from the center of the shell.

3 Answer the following.

(A) Derive the formula for the potential due to electric dipole. Also, derive formula of electric field of dipole. If an electric dipole located at the origin is represented 7

by $0.1a_z \text{ nC}\cdot\text{m}$, find E at $(1, \frac{\pi}{4}, \frac{\pi}{4})$.

(B) Discuss Gauss's law for a regular surface and arbitrary surface. 7

Consider concentric spherical shells in free space in which $V = 0$ volts at $r = 10 \text{ cm}$ and $V = 10$ volts at $r = 20 \text{ cm}$. Find E and D .

OR

3 Answer the following.

(A) Discuss boundary conditions on E and D for two different mediums having ϵ_1 and ϵ_2 for medium 1 and medium 2, respectively. 7

The region $y < 0$ contains a dielectric material for which $\epsilon_{r1} = 2.0$ and region $y > 0$ contains a dielectric material for which $\epsilon_{r2} = 4.0$. If $E_1 = -3.0a_x + 5.0a_y + 7.0a_z \text{ V/m}$, find E_{n2} .

- (B) Prove that relation between current density J and volume charge density ρ_v is $J = \rho_v V$, where $V =$ velocity of charge, m/s. Also, prove that $\nabla \cdot J = -\dot{\rho}_v$. 7

- 4 (A) Prove the following. 7
 (1) Capacitance of parallel plate capacitor of n dielectric

slabs is,
$$C = \frac{A}{\sum_{i=1}^n \frac{d_i}{\epsilon_i}}$$

- (2) Capacitance between two concentric spheres is,

$$C = 4\pi\epsilon \left[\frac{r_1 r_2}{r_2 - r_1} \right].$$

- (B) Prove that the magnetic field produced due to, 7

(1) Infinitely long element is $H = \frac{1}{2\pi\rho} a_\phi$

(2) Finite current element is $H = \frac{I}{4\pi R} [\cos \alpha_2 - \cos \alpha_1] a_\phi$.

- 5 Answer any two from the following :

- (A) Discuss differential form of Ampere's circuit law. 7
 (B) Discuss boundary conditions on H and B . Write briefly on inductor. 7
 (C) Write the proof of all four Maxwell's equations. 7
 (D) If the retarded electric potential is $V = x - v_0 t$ and 7

vector magnetic. potential $A = \left(\frac{x}{v_0} - t \right) a_x$ where

v_0 is the velocity of propagation, then

find $(\nabla \cdot A)$, B , H , E and D .