2016

PHYSICS

PAPER : PHY 201

CLASSICAL ELECTRODYNAMICS

Full Mark : 80

Time : 3 Hrs

Figures in the right hand margin indicate full marks for the question

1. Answer the following 1×3

(a) Ampere's law $\nabla \times B = \mu_0 J$ is not valid for 1

(i) Electrostatics (ii) Magnetostatics

(iii) Electrodynamics (iv) None of these

(b) The Debye shielding length is 1

(i) $\propto T_e$ (ii) $\propto T_e^{\,2}$ (iii) $\propto T_e^{\,1/2}$ (iv) $\propto T_e^{\,3/2}$

(c) Cyclotron frequency of a charge particle of mass m is 1

(i) $\propto m$ (ii) $\propto m^2$ (iii) $\propto m^{-2}$ (iv) $\propto m^{-1}$

2. Answer the following 2×5

(a) Define scalar and vector potential in electrodynamics 2

(b) Discuss the physical significance of skin depth. 2

(c) Write three criteria for an ionized gas to be plasma?2

(d) What do you understand by plasma approximation?2

(e) Can you find any similarity between the earth magnetic field and a mirror? Justify your answer. 2

3. Answer the following 5×5

(a) Show that under Gauge transformation the electric and magnetic field remains invariant. 5

(b) Derive Poisson's and Laplace's equation in electrostatic. 5

(c) Deduce the expression of Debye shielding length. 5

(d) What is loss cone? If a proton with parallel velocity of 10^4 m/s at the middle of the magnetic mirror has to be stopped from going out of the mirror, what should be the minimum strength of the magnetic field B_m at the neck? Given the strength of the magnetic field at the mid-plane B_o =2.5 T and the total kinetic energy of the particle is 10 eV. 5

(e) Show that the propagation vector *k* for electromagnetic wave in a conducting medium is complex. 5

4. Answer the following (any two) 9×3

(a) Find the reflection and transmission coefficients (R and T) of electromagnetic wave at normal incidence at the boundary of a media and show that 7+2

R+T=1

(b) Obtain the expression for electric and magnetic field in a conductor. Find the skin depth for both good and poor conductor. 6+3

(c) Derive the general boundary conditions between two different media in electrodynamics. 9

5. Answer the following (any two) 12×2

(a) What is Alfven wave? Derive the dispersion relation of Alfven wave and hence find the velocity Alfven wave. 1+11

(b) Find the expression of the drift velocity of a charge particle in a gradient magnetic field. Discuss qualitatively the basic principle of plasma confinement. 7+5

(c) Using Laplace's equation, find the potential inside the two infinite grounded 2D metal plates. 12

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