Total No. of printed pages = 5

63/2 (SEM-2) PHY 201

2022

PHYSICS

(Theory paper)

Paper Code : PHY 201

(Classical Electrodynamics)

Full Marks – 80

Time – Three hours

The figures in the margin indicate full marks for the questions.

1. Choose the correct option of the following : 1×5=5

(a) Suppose the potential function is a step function. The equation that gets satisfied is

(i) Laplace equation

(ii) Poisson equation

(iii) Maxwell equation

(iv) Ampere equation

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(b) In free space, the Poisson equation becomes

(i) Maxwell equation

(ii) Ampere equation

(iii) Laplace equation

(iv) Steady state equation

(c) Which of the following is not the integral form of Maxwell's equation ?

(i) $\oint E.da = \frac{1}{\varepsilon_0} Q$

(ii) $\oint B.da = 0$

(iii) $\oint E.dl = -\frac{dD}{dt}$

(iv) $\oint B.dl = \mu_0 I_{enc} + \mu_0 \varepsilon_0 \frac{\partial \Phi_E}{\partial t}$

(d) Why is the sky orange/red at sundown ?

(i) Waves of light travel a longer distance

(ii) Waves of light travel a shorter distance

(iii) The particles are bigger

(iv) The waves of light are smaller than 650 nanometers

(e) Thomson scattering of electromagnetic waves depends on

(i) Wavelength of incident wave

(ii) Intensity of incident wave

(iii) Classical electron radius

(iv) None of these.

2. Answer the following questions : 2×5=10

(a) Write the boundary conditions for electrodynamics in linear media.

(b) Verify whether the electric potential $V = 15x^2yz - 5y^3z$, satisfies Laplace equation.

(c) Calculate the coefficient of reflection and transmission of energy of EM waves incident normally on sea water surface having $\varepsilon_r = 81$.

(d) Distinguish between Rayleigh scattering and Thomson scattering.

(e) What do you mean by resonance fluorescence ? Give an example of it.

3. Answer any *five* from the following questions : 5×5=25

(a) Find the potential and electric field at a point charge near infinite grounded conducting plane.

(b) Obtain the gauge transformation equation and discuss its significance.

(c) For Aluminium conductor $\mu_r = 1$, $\varepsilon_r = 1$, $\sigma = 3.54 \times 10^7$ mho/m. Calculate the skin depth for an EM wave of frequency 100 MHz.

(d) Calculate the value and dimension of Thomson scattering cross-section.

(e) Discuss the magnetic mirror confinement in plasma.

(f) Derive Maxwell's equation in covariant form.

(g) Find the retarded potentials for a point charge q moving with a constant velocity.

4. Answer any *four* of the following questions : 10×4=40

(a) Obtain the electric potential of Laplace equation in spherical polar coordinate.

(b) Using Maxwell's equations derive the dispersion relation of electromagnetic waves in vacuum to show that EM waves are dispersionless in vacuum. Also show that both the electric field and magnetic field components are perpendicular to each other as well as perpendicular to the direction of propagation.

(c) What is skin depth ? Discuss the mechanism of electromagnetic wave propagation in a conductor. Show that in a conductor the electric field and magnetic field components are no longer in phase.

(d) Discuss the propagation of electromagnetic waves at the interface of two linear homogeneous medium using Maxwell's equations. Discuss the reflection and transmission of the wave for normal incidence and derive the expressions for reflectance and transmittance in terms of refractive indices of the two medium.

(e) What is Rayleigh scattering ? Derive an expression for Rayleigh scattering cross-section.