3 (Sem–2/CBCS) PHY HC 1

2022

PHYSICS

(Honours)

Paper : PHY–HC–2016

(Electricity and Magnetism)

Full Marks : 60

Time : Three hours

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

1. Answer ***any seven*** questions : 1×7=7

   (a) Give *one* example where the electric potential is zero at a point or line but electric field is not zero.

   (b) What is conservative nature of electric field ?

(c) If surface charge density of an infinite thick sheet is σ and $-q$ amount of charge is deposited on the sheet, then the amount of work done will be _____ . *(Fill in the blank)*

(d) What is displacement current?

(e) What is electric susceptibility?

(f) Define Curie temperature.

(g) Define intensity of Magnetic field in Tesla.

(h) Define electric dipole moment.

(i) State Lenz's law of electromagnetic induction.

(j) What is meant by paramagnetic material?

2. Answer ***any four*** questions : 2×4=8

(a) Distinguish between magnetic vector potential and electric potential.

(b) Mention the S.I. unit and dimension of electric flux.

(c) Show that the curl of an electric field $\vec{E}$ is equal to zero.

(d) Show that $\mu = \mu_0(1+\chi_m)$, where the symbols have their usual meaning.

(e) Mutual inductance of two coils is $4mH$. If the current in one coil changes from $6A$ to $1A$ in $0{\cdot}1$ second, find the e.m.f. induced in the other coil.

(f) An electron moving with velocity $\vec{v}$ enters a magnetic field $\vec{B}$ in a direction normal to it. Find an expression for the frequency of its circular motion.

(g) Find the force of attraction between two long, parallel wires at distance 'd' apart, carrying currents I_1 and I_2 respectively.

(h) What do you mean by current sensitivity and charge sensitivity of a ballistic galvanometer?

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

(a) Two infinite parallel plates carry equal but opposite uniform charge densities $\pm \sigma$. Find the electric field in between the two plates and also outside the two plates.

(b) Derive Poisson's equation. From this, write Laplace's equation. Express both the equations in Cartesian co-ordinate system.

(c) Show that the electric field inside a charged hollow sphere is zero.

(d) Starting from electric field intensity due to a point charge, derive the Gauss law in differential form.

(e) Show that a small current loop is equivalent to a magnetic dipole.

(f) Derive the expression for electric potential at any point due to an electric dipole.

(g) Find out the vector potential at a point near a straight conductor carrying current.

(h) Obtain an expression for the torque acting on a rectangular current loop in a uniform magnetic field.

4. Answer ***any three*** questions : 10×3=30

(a) (i) Using Gauss's law, find the expressions for electric field due to a spherical charge distribution (volume charge density ρ)

(1) at an outside point

(2) on the surface

(3) at an inside point 2+2+3=7

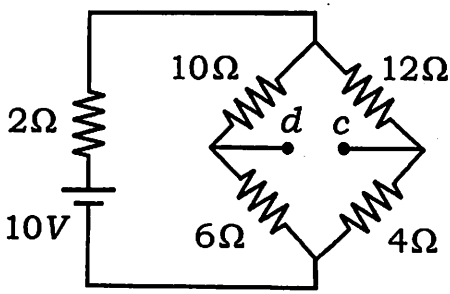
(ii) Using Gauss's law, find the electric field due to an infinite plane sheet of charge having surface charge density σ. 3

(b) What is electrical image ? Find out the potential, electric field and induced charge density on an earthed conductor plane.

(c) State and prove Ampère's circuital law. Using this, find the magnetic field due to a toroid. 2+3+5=10

(d) Find the divergence and curl of magnetic field. 5+5=10

(e) State Thevenin and Norton theorems. Find the Thevenin's and Norton's equivalent circuit with respect to the terminals *c*, *d* in the network given below. Also find the resistance to be connected between *c* and *d* to dissipate maximum power.



(f) (i) What do you mean by resonance in series LCR circuit? Derive the expression for resonant frequency and also draw the resonance curve. 2+2+2=6

(ii) Explain the terms Quality Factor and Bandwidth in case of a series LCR circuit. 2+2=4

(g) (i) Draw a neat labelled diagram of a moving coil ballistic galvanometer. What is logarithmic damping? 3+3=6

(ii) Derive the expression for the torque acting on an electric dipole placed in a uniform electric field. 4

(h) What is hysteresis? Explain the hysteresis loop in the case of a ferromagnetic material. 2+8=10

3 (Sem–2/CBCS) PHY HC 2

2022

PHYSICS

(Honours)

Paper : PHY–HC–2026

(Waves and Optics)

Full Marks : 60

Time : Three hours

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

1. Answer ***any seven*** of the following questions : 1×7=7

   (a) Write the expression of pressure of a longitudinal wave.

   (b) What is a Lissajous figure ?

   (c) Write *one* property of electromagnetic waves.

   (d) What do mean by wavefront ?

   (e) Why are Newton's ring circular in shape ?

(f) Define resolving power of a grating.

(g) What do you mean by diffraction of light ?

(h) Mention *two* methods of producing coherent sources.

(i) Write *one* dissimilarity of a zone plate and a convex lens.

(j) What do you mean by holography ?

2. Answer ***any four*** of the following questions : 2×4=8

(a) What do you mean by temporal and spatial coherence ?

(b) What correction was done by Laplace in Newton's formula for velocity of sound and why ?

(c) In Michelson interferometer 1000 fringes cross the field of view when the movable mirror is displaced through 0.293 *mm*. Calculate the wavelength of light.

(d) In Young's double slit experiment the separation between the slits is 1.2 *mm* and fringe spacing is 0.5 *mm* on a screen kept at a distance of 1 *mm* from the slits. Find the wavelength of the light.

(e) Write *two* uses of Lissajous figures.

(f) Monochromatic light of wavelength 5000 $\mathring{A}$ is diffracted by a grating of 2500 lines per *cm*. Show whether 16th order diffraction is possible.

(g) Define phase and group velocities of waves.

(h) Distinguish between Fresnel and Fraunhofer diffraction.

3. Answer ***any three*** of the following questions : 5×3=15

(a) Discuss the formation of Lissajous figures when the periods of the two vibrations are equal and phase difference is $\pi/2$.

(b) Obtain the expression for velocity of longitudinal waves in a fluid in pipe.

(c) Derive the expression of superposition of two collinear oscillations having equal frequencies.

(d) Draw a neat ray diagram for the experimental arrangement of Newton's rings arrangement. Deduce the relation

$$\lambda = \frac{D_{m+p}^2 - D_m^2}{4pR}$$

for Newton's rings, where D_m and D_{m+p} are the diameters of the mth and $(m+p)$th bright rings, R is the radius of curvature. 1+4=5

(e) A Lloyd's mirror experiment is done with a plane metallic and a microwave source of wavelength 40 *cm*. If the source is 6 *cm* above the plane of the sheet. Find the height of the first maxima above this plane at a distance 4 *m* from the source.

(f) Discuss the phase change due to reflection of light from the surface of a denser medium.

(g) Explain the Fresnel's diffraction due to a straight edge. Show that the separation between successive maxima goes on decreasing as we move away from the region of geometrical shadow. 4+1=5

(h) In a Melde's experiment, when the tension is 100 *gm* and the tuning fork vibrates at right angles to the direction of string, the later is thrown into four segments. If now the tuning fork is set to vibrate along the string, find what additional weight will make the string vibrate in one segment.

4. Answer ***any three*** of the following questions : 10×3=30

(a) Find an expression for the intensity distribution pattern in Fraunhofer diffraction pattern due to a single slit. Discuss the conditions for maxima and minima. 7+3=10

(b) (i) Deduce the expression for velocity of transverse vibrations of stretched strings. 7

(ii) Write the differences between longitudinal and transverse waves. 3

(c) What is Fresnel's half period zone ? Why is it called ? Show that the radii of half-period zones are proportional to the square roots of natural number. 2+2+6=10

(d) (i) Discuss the condition necessary for observing interferences of light. How are these satisfied in a bi-prism ? Explain the interference pattern produced by a bi-prism with white ligth. 1+2+2=5

(ii) Discuss how the Michelson interferometer can be used to measure the wavelength of light. 5

(e) (i) Deduce an expression for resolving power of a telescope. 5

(ii) In a bi-prism arrangement, show that the distance between the virtual images of the source is $d = 2x(\mu - 1)\alpha$, where x is the distance of the source from the bi-prism base, α is the refracting angle of the prism and μ is the refractive index of the material of the prism. 5

(f) What is stationary wave ? How they are formed ? Explain analytically how antinode and nodes are formed in a stationary waves. Show that in a stationary wave the distance between two consecutive antinode or node is half a wavelength of waves. 1+1+6+2=10

(g) (i) Explain the theory of Fabry-Pérot interferometer. 7

(ii) Compare the grating spectra with prism spectra. 3

(h) Write short notes on ***any two*** of the following : 5+5=10

(i) Melde's experiment

(ii) Plucked string

(iii) Hologram its recording and reconstruction

(iv) Zone plate