3 (Sem–6/CBCS) PHY HC 1

2022

PHYSICS

(Honours)

Paper : PHY–HC–6016

(Electromagnetic Theory)

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) What is a plane wave ?

   (b) Why cannot a plane wave propagate in a conducting medium without attenuation ?

   (c) What do you mean by scaler potential ?

(d) In propagation of EM wave the relation between wave vector and electric field intensity is given as $\vec{k}.\vec{E} = 0$. What does this equation signify ?

(e) How are refractive index, magnetic permeability and electric permittivity related ?

(f) What is polarizing angle ?

(g) Define reflection co-efficient.

(h) What do you mean by anisotropic medium ?

(i) What is a wave guide ?

(j) Draw the path of light through graded index fibre.

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

(a) We know that intensity of a light source is given by $1.33\times10^{-3}\ E_0^2$ where E_0 is electric field intensity. Also intensity of the source is power per unit area. What is the electric field intensity of a laser beam of 10^5 watt with beam cross-sectional area 10^{-6} square *cm* ?

(b) What is the physical significance of displacement current ?

(c) When a plane polarised EM wave is incident on the interface of *two* dielectrics, which components of $\vec{E}$ and $\vec{D}$ and also $\vec{B}$ and $\vec{H}$ are continuous ?

(d) What is evanescent wave ?

(e) What is the function of a half-wave plate ?

(f) Give *one* example each of uniaxial and biaxial crystals.

(g) What do you mean by specific rotation of a liquid ?

(h) Give the differences between single mode and multiple mode fibres.

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

(a) State the *four* Maxwell's equations and write their physical significances.

(b) Construct the electromagnetic wave equation in free space. What is its velocity ?

(c) Show that for a plane wave in conducting medium propagation vector is complex.

(d) How will you use Babinet compensator to analyse polarization of light ?

(e) What are transverse electric and transverse magnetic modes of EM wave in a waveguide?

(f) Derive an expression of numerical aperture for an optical fibre.

(g) Define optic axis in terms of wave surface.

(h) Derive an expression for plasma frequency.

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

(a) Defining Poynting vector. Establish the fact that the rate of decrease of total energy is equal to joule loss plus the net flow out of the surface enclosing the volume.

(b) What are gauge transformations ? Find the conditions of Lorentz gauge and Coulomb gauge. 2+(6+2)=10

(c) Derive Fresnel's relation for EM wave with $\vec{E}$ perpendicular to the plane of incidence with proper diagram.

(d) Estimate the proportion of incident power which is transmitted when a plane wave with frequency 10 *GHz* is incident onto a slab of thickness 8 *mm* and dielectric constant 2·5.

(e) Using Fresnel's relation, discuss the phenomenon of total internal reflection for electric vector polarised perpendicular to plane of incidence. What is skin depth ? Derive its expression for a conducting medium.

6+1+3=10

(f) How can you produce and analyse circularly and elliptically polarized lights ? Explain with relevant ray diagram. (2+2+2+2)+2=10

(g) Explain how you will measure specific rotation of a liquid by half shade polarimeter.

(h) How will you determine the angle at which energy must be coupled into a dielectric waveguide ?

---

3 (Sem–6/CBCS) PHY HC 2

2022

PHYSICS

(Honours)

Paper : PHY–HC–6026

(Statistical Mechanics)

Full Marks : 60

Time : Three hours

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

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

   (a) What is the minimum volume of the phase cell in quantum statistics ?

   (b) What is the dimension of partition function ?

   (c) Write *one* limitation of Maxwell-Boltzmann statistics.

   (d) Name the statistics where Pauli's exclusion principle is used.

   (e) State Kirchhoff's law of heat radiation.

(f) What is Fermi energy ?

(g) What is Chandrasekhar mass limit ?

(h) What is the absorptive power of a perfectly black body ?

(i) Write *one* difference between B–E and F–D statistics.

(j) The temperature of a black body is increased from 27°*C* to 327°*C*. By how many times the emission of energy will be increased ?

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

(a) Define microstate and macrostate.

(b) Define phase space and phase line.

(c) What is ultraviolet catastrophe ?

(d) The wavelength of maximum emissive power of sun's heat radiation is 4750 Å. Find the surface temperature of the sun. [Wien's displacement constant = 0.2892 *cm-K*]

(e) Three particles are to be distributed in four energy levels. Calculate all possible ways of distribution when particles are

(i) fermions;

(ii) classical particles.

(f) What is degenerate Bose gas ?

(g) What is white dwarf star ?

(h) Define ensemble.

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

(a) Write a short note on Gibbs paradox.

(b) Derive the relation $S = k \ln W$, where $S \rightarrow$ entropy, $k \rightarrow$ Boltzmann constant, $W \rightarrow$ probability.

(c) Derive the distribution law of M–B statistics.

(d) Derive the distribution law of F–D statistics.

(e) Show that Fermi energy of electron gas is independent of shape and size of the material.

(f) Derive Rayleigh-Jeans radiation law from Planck's radiation law.

(g) Derive Sackur-Tetrode equation.

(h) What is radiation pressure ? Derive an expression of diffused radiation pressure.

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

(a) State the law of equipartition of energy and prove it. 2+8=10

(b) Write Planck's quantum postulate and derive Planck's law of black-body radiation. 2+8=10

(c) Write the differences between photon and ideal gas. Starting from B–E statistics distribution law derive Planck's law. 3+7=10

(d) Define Stefan-Boltzmann law and deduce it from thermodynamic consideration. 3+7=10

(e) What is electron gas ? Derive the expression of energy distribution of free electrons in a metal using F–D statistics. 2+8=10

(f) Explain Bose-Einstein condensation. Define critical temperature for B–E condensation. 8+2=10

(g) From Planck's law, derive —

(i) Wien's law;

(ii) Stefan-Boltzmann law.

4+6=10

(h) Compare among three statistics M–B, B–E and F–D. Under what condition classical statistics approaches the quantum statistics ? 8+2=10
