Registration Number: 22BCON130

JECRC University, Jaipur
Second-Sem Examination, Dec 2022
B.Tech. I Year, II Semester
Subject: -Applied Physics (DPH001A)

Time: - **1:30 Hrs.** Max. Marks: - **50**

Note: - Attempt all questions. Draw the figures wherever necessary. Write on the both sides of the answer book.

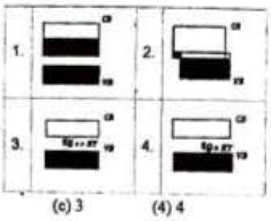
CO2: Analyze and apply quantum theory and quantum statistics in understanding the physics of materials and its role in electronics.

CO3: Understand the importance of coherent radiations, and analyze the fundamentals of Lasers and its applications.

Section- A: Answer the following multiple choice questions. [1x10=10 marks]

1. [CO2] At T=0K, when $E > E_f$ then Fermi-Dirac distribution function f(E) will be .....
2. [CO2] Total energy of Fermi gas is .....
3. [CO2] A bar of intrinsic germanium 5 cm long is subjected to an electric potential of 12 V. If the velocity of electrons in bar is 75 m/s, then find mobility of electrons.
   (a) 3.125 cm^2/V-sec (b) 60.25 cm^2/V-sec
   (c) 3125 cm^2/V-sec (d) 31.25 cm^2/V-sec
4. [CO2] For an intrinsic semiconductor, the conductivity is also expressed as
   (a) $\sigma_i = Const\ e\ \gamma\ e^{-E_g/KT}$ (b) $\sigma_i = n_i e\ \gamma\ T^{-3/2}$
   (c) Only (a) (d) only (b) (e) Both (a) and (b)
5. [CO2] The energy band diagrams for semiconductor samples of silicon are shown. We may conclude that-

   (a) Sample X is undoped while both Y and Z samples are doped with fifth group impurity.
   (b) Sample X is undoped while sample Y is doped with third group impurity and sample Z is doped with fifth group impurity
   (c) Sample X is doped with equal amounts of third and fifth group impurities while sample Y and Z are undoped.
   (d) Sample X is undoped while sample Y is doped with fifth group impurity and sample Z is doped with third group impurity
6. [CO2] Which of the energy band diagrams shown in the figure corresponds to that of a semiconductor



   (a) 1 (b) 2 (c) 3 (4) 4
7. [CO3] The maximum value of the time interval in which wave maintain constant and have predictable phase difference is known as.....
8. [CO3] The condition for obtaining fringes of good contrast in Young's double slit experiment is
   (a) $d << \frac{\lambda a}{l}$ (b) $d << \frac{\lambda}{\theta}$ (c) $d << l_c$ (d) All of these.
9. [CO3] Form of light whose photons share the same frequency and whose wavelengths are in phase with one another is known as.....
10. [CO3] When is the wave interference strong?
    (a) When the paths taken by all of the interfering waves are greater than the coherence length
    (b) When the paths taken by all of the interfering waves are lesser than the coherence length
    (c) When the paths taken by all of the interfering waves are equal than the coherence length
    (d) When the paths taken by all of the interfering waves are independent of the coherence length

Section- B: Answer the following questions in short [2x4 = 8 marks]

1. [CO2] Why quantum model for free electron theory is successful?
2. [CO2] What do you mean by the splitting of energy levels and what does it lead to?
3. [CO3] if a source is temporal coherent, then what it signifies about the source?
4. [CO3] Define the term "Visibility". Write the expression for visibility for the different intensities of the sources.

Section- C: Answer the following questions in brief [6x2 = 12 marks]

1. [CO2] Use the fermi function to obtain the value of f(E) for E-E_f= 0.01 eV at 200 K.
2. [CO3] Calculate the coherent length and coherent time of white light of wavelength range from $3500A^0$ to $6500A^0$.

Section- D: Answer the following questions in detail. [10x2 = 20 marks]

1. [CO2] Define the density of energy states in metals? Derive an expression for the density of states for free electron gas in metal and hence find expression for the Fermi-energy at 0K.

   OR

   [CO2] Making using the Fermi distribution function, derive the expressions for carrier concentration for both holes and electron in intrinsic semiconductor.

2. [CO3] What do you mean by Spatial Coherence? Two sources, each emitting waves of wavelength "λ", are separated by a distance "a" obtained in Young's double slit experiment by placing a single slit at a distance "d". Show that coherent length is given by (λa/d).

   OR

   [CO2] Discuss in detail that how the bands, namely, CB, VB and band gap are formed in Na crystal? Sketch the necessary energy levels and energy band figs.

JECRC University, Jaipur
Department of Physics
First In-Sem Examination, October 2022
B. Tech. - I Semester (Session 2022-23)
Sub: Applied Physics, Code: DPH001A

Duration: 1.30 Hr | Max. Marks: 50

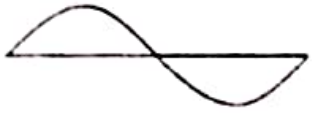
Note:

i. *All questions are compulsory*
ii. *Don't write anything other than Reg. No. on question paper*
iii. *Write the question number clearly while answering and draw figures wherever necessary*

CO1: Learn the fundamentals of quantum mechanics to analyze the quantum behavior of matter in its microstate and its applications

Section A (Answer the following appropriately) **(1x10=10)**

1. For which quantum state (n), the wave function is shown in the figure?



(a) 1 (b) 2 (c) 3 (d) 4

2. Which of the following is the correct expression for group velocity?

(a) $v_g = \frac{dE}{dk}$ (b) $v_g = \frac{d\omega}{dk}$ (c) $v_g = \frac{dE}{dk}$ (d) None of these

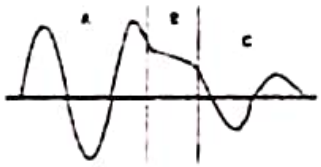
3. Which function is considered independent of time to achieve the steady state form?

(a) ψ (b) $d\psi/dt$ (c) $d^2\psi/dx^2$ (d) V (potential energy)

4. For a particle inside a box of finite potential well, the particle is most stable at what position of x?

a) $x \geq L$ (b) $x \leq 0$ (c) $0 < x < L$ (d) Not stable in any state

5. In which of the following, the solution of Schrodinger wave equation for region A and C is of the form



(a) $\psi = Ae^{ikx} + Be^{ikx}$ (b) $\psi = Ae^{ikx} - Be^{ikx}$

(c) $\psi = Ae^{ikx} + Be^{-ikx}$ (d) $\psi = Ae^{kx} + Be^{-kx}$

6. If the photon is scattered in opposite direction to the direction of incident photon then Compton shift is ..... and given by ....

7. The operator $\frac{d^2}{dx^2}$ operates on $\psi = e^{4x^2}$, gives an eigen value of

(a) 4 (b) 8 (c) 16 (d) None

8. Particle trapped in a cubical box will always have non-degeneracy. (T/F)

9. In Alpha decay, the potential barrier appears on alpha particle is due to the ..... force

10. In STM, tunneling current depend upon of

(a) tip position (c) applied voltage
(c) local density of states of the sample (d) All of these

Section B {Answer the followings in short} **(2x4=8)**

1. Why the term "Group velocity" is needed for wave function?
2. Why the wave function Ψ itself has no physical significance?
3. Numerically show that the Compton Effect is not observed experimentally for visible rays.
4. What do you understand with "Operator" and "Expectation Values" in quantum mechanics?

Section – C {solve the numerical explicitly} **(6x2=12)**

1. Show that the value of energy which a photon must have so that it may transfer half of its energy to an electron at rest is about 256 KeV in a Compton scattering.

2. For a particle in 3D cubical box, the state is defined with the energy $\frac{27\pi^2\hbar^2}{2ma^2}$. Write the possible combinations of quantum numbers and define the orders of degeneracy.

Section-D {Answer the followings in detail} **(10x2=20)**

1. What is Compton shift? Deduce the expressions for Compton shift and give its experimental verification.

OR

Making use of Planck's quantization and de-Broglie's hypothesis, derive time independent Schroedinger's wave equation and deduce $\hat{E}\Psi = \hat{H}\Psi$.

2. A particle is moving three dimensionally inside the cubical region of box. Write down the boundary conditions for the potential and solve the Schroedinger's wave equations to obtain eigen wave function and energy eigen values.

OR

What is Quantum Mechanical Tunneling? Write down the Schrödinger's equations for all the regions of potential barrier problem and interpret the solutions. Define the Reflectivity and Transmittance at the boundaries x=0 and x=a.

$p = \frac{h}{\lambda}$

$C = \frac{E}{p}\lambda$

$C = E/p$

$C = \lambda\nu$

$\lambda = \frac{C}{\nu}$.