SLR-GY-1

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (CONDENSED MATTER PHYSICS)
Mathematical Physics

Day & Date: Monday, 13-02-2023 Max. Marks: 80
Time: 03:00 PM To 6:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Fill in the blanks by choosing correct alternatives given below. **10**

1) If A and B are orthogonal matrices, then the product AB is
a) Symmetric b) Antisymmetric
c) Orthogonal d) Unitary

2) What is the value of a_0 in the fourier series of t^2 in the interval $-\pi < t < \pi$?
a) 0 b) $\frac{\pi^2}{3}$
c) $\frac{\pi^2}{8}$ d) $\frac{\pi^2}{4}$

3) The solution of $(y-2)p + (z-x)9 = x - y$ is
a) $f(x+y+z) = xyz$
b) $f(x^2+y^2+z^2) = xyz$
c) $f(x^2+y^2+z^2, x^2\, y^2\, z^2) = 0$
d) $f(x+y+z) = x^2 + y^2 + z^2$

4) Laplace transform of $e^{-2t}\sin 4t$ is
a) $\frac{2}{s^2+4s+20}$ b) $\frac{s-2}{s^2+4s+20}$
c) $\frac{s-4}{s^2+4s+20}$ d) $\frac{4}{s^2+4s+20}$

5) If λ is an eigen value of a non-singular matrix A then the eigen value of A^{-1} is
a) $\frac{1}{\lambda}$ b) λ
c) $-\lambda$ d) $\frac{-1}{\lambda}$

6) For two matrices A and B, $(A+B)^{-}$ is equal to
a) $A^2 + B^2 + 2AB$ b) $A^2 + B^2 + AB$
c) $A^2 + B^2 + AB + BA$ d) $A^2 + B^2$

7) What is the value of integral $\oint f(z)\,dz$ around a circle of radius z with its centre at the origin if $f(z) = \frac{1}{(z-1)}$
a) Zero b) πi
c) $4\pi i$ d) $2\pi i$

8) Find the value of $\int_0^{2\pi} e^{\cos\theta}\cos(2\theta - \sin\theta)\,d\theta$

a) 2π b) π

c) $\frac{\pi}{2}$ d) $\frac{3\pi}{2}$

9) The eigen vectors of a Hermitian matrix are

a) Real b) Imaginary

c) Complex d) ± 1

10) A square matrix is said to be orthogonal if

a) A is singular

b) A is non-singular

c) $A^T A = 1$

d) $A = -A^T$

B) State True/False **06**

1) Inverse of unitary matrix is unitary matrix

2) Fourier transform is aa linear operator

3) Legendre polynomial of degree one i.e $P_1(x) = \partial$

4) The ODE $\frac{dy}{dx} = (x + y + 5)^2$ is separable

5) The order of matrix $A = \begin{bmatrix} 1 & 5 & 9 \\ 4 & 8 & 6 \end{bmatrix}$ is 2×3

6) The first order ODE can never be linear separable and exact at the same time

Q.2 Answer the following **16**

a) Find the eigen value of $A = \begin{pmatrix} 3 & 1 \\ 2 & 2 \end{pmatrix}$

b) Find the Fourier transform of e^{-ax^2} where $a > 0$

c) Evaluate $\oint_C \frac{1}{\sin hz}\,dz$, where C is the circle $|z| = 4$

d) Derive an expression for 2nd order homogeneous equation with consent coefficients

Q.3 Answer the following **16**

a) If $A = \begin{pmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{pmatrix}$ show that $A^2 - 4A - 5I = 0$ where I, O are the unit matrix & the null matrix of order 3 respectively use this result & find A^{-1}

b) Derive a Jacobi - Bernoulli equation and solve the equation use J.B equation $y^1 + x = \frac{y}{x}$

Q.4 Answer the following **16**

a) Evaluate $\int_0^{\infty} \frac{\cos 3\theta}{5 + 4\cos\theta}\,d\theta$

b) Explain the details of Parseval Theorem

Q.5 Answer the following **16**

a) Explain the first order linear differential education.

b) In square wave expand the function

$f(x) = 0; -\pi \le x \le 0$

$f(x) = 4; -0 \le x \le \pi$ Fourier

Q.6 Answer the following **16**

a) Show that the eigen value of Hermitian matrix are real?

b) Find the General solution of $x(z^2 - y^2)\frac{\partial z}{\partial y} + y\,(x^2 - z^2)\frac{\partial z}{\partial y} = z(y^2 - x^2)$

Q.7 Answer the following **16**

a) Determine whether the following equation is exact and find its solution if it is exact

$$(4x^3 + 6xy + y^2)\frac{dx}{dy} = -(3x^2 + 2xy + 2)$$

b) Write matrix A gives below as the sum of symmetric & a skew symmetric matrix $A = \begin{pmatrix} 1 & 2 & 4 \\ -2 & 5 & 3 \\ -1 & 6 & 3 \end{pmatrix}$

SLR-GY-2

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (CONDENSED MATTER PHYSICS)
Solid State Physics

Day & Date: Tuesday, 14-02-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q.Nos.1 and 2 are compulsory
2) Attempt any three questions from Q.No.3 to Q.No.7
3) Figure to right indicate full marks.

Q.1 A) Choose the correct alternative. **10**

1) Plane cut to negative x-axis have the miller indices ______.
   a) (011) b) (001)
   c) (110) d) (100)

2) Effective mass depends on _____ ratio.
   a) dP/dt b) dE/dP
   c) dP/dK d) dE/dK

3) The intrinsic concentration of charge carriers in a semiconductor varies as ....
   a) T b) T^2
   c) T^3 d) T^{-1}

4) Relative permittivity εr of the air is _______
   a) 2 b) 0.5
   c) 1 d) 0

5) The electronic polarizability αe of a monoatomic gas is _____.
   a) $4\pi\varepsilon_0$ b) $4\pi\varepsilon_0 R$
   c) $4\pi\varepsilon_0 R^3$ d) $4\pi{\varepsilon_0}^2$

6) Packing fraction of BCC is _____.
   a) 74% b) 68%
   c) 52% d) 58%

7) FCC structure contains the contribution of _____ atoms.
   a) Two b) Four
   c) Nine d) Six

8) Conductivity in metal depends on _____ mobility.
   a) Proton b) Neutron
   c) Electron d) None of these

9) Miller indices of a plane parallel to X and Z axes are _______.
   a) (001) b) (100)
   c) (010) d) (101)

10) Number of tetrad axis in a simple cubic system are ____.
   a) 2 b) 3
   c) 4 d) 8

B) Write True or False. **06**

1. The addition of pentavalent impurity creates an n-type semiconductor
2. Fermi energy level in the case of a p-type semiconductor is close to the conduction band.
3. At Debye's temperature materials show the transition from normal to the superconducting state.
4. Rectifier rectifies internal resistance.
5. Conductance of the superconductor becomes zero at T_c.
6. Dielectric constant of metal is finite.

Q.2 Answer the following. **16**

a) Define packing fraction in detail.
b) Write about dielectric loss.
c) Derive an expression for the effective mass of the electron.
d) Write a short note on specific heat

Q.3 Answer the following. **16**

a) Show that the FCC is reciprocal of BCC.
b) Differentiate polycrystalline, nano-crystalline and amorphous materials

Q.4 Answer the following. **16**

a) Give the expression for inter-planar spacing (d).
b) What is Meissner's effect. Derive an expression for penetration depth.

Q.5 Answer the following. **16**

a) Classify the magnetic materials.
b) Write about the behavior of electrons in a periodic potential.

Q.6 Answer the following. **16**

a) Write about direct and indirect band gaps of semiconductors.
b) What is dielectric polarization? Give the expression for electronic polarization.

Q.7 Answer the following. **16**

a) What is meant by imperfections in crystals? Explain the various defects in the crystal.
b) What is a superconductor? Write about the London equation.

SLR-GY-3

Set No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (CONDENSED MATTER PHYSICS)
Analog and Digital Electronics

Day & Date: Wednesday, 15-02-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Select Correct Alternatives. **10**

1) Differential Amplifier consists of ______ transistors.
   a) One b) Two
   c) Three d) Four

2) When two In-phase signals applied to the differential amplifier then the mode is called _____.
   a) Common Mode Input b) Real Mode Input
   c) Common Mode Gain d) all are correct

3) The 4-bit adder circuit can be designed using one half adder and _____ full adder circuits.
   a) 3 b) 4
   c) 5 d) 7

4) Which of the following is a non-vectored input?
   a) TRAP b) RST-7.5
   c) RST-6.5 d) INTR

5) IC 74150 is ______.
   a) 16:1 MUX b) 8:1 MUX
   c) 1:16 DMUX d) 1: 8 DMUX

6) _____ logic gate represents $Y = \overline{A + B}$ operation.
   a) OR b) NOR
   c) AND d) NAND

7) Which of the following stack is used in 8085?
   a) LIFO b) FIFO
   c) LILO d) FILO

8) What is the active element of the Colpitts oscillator?
   a) Diode b) Transformer
   c) Transistor d) All the above

9) According to Boolean law: A + 1 = ?
   a) 1 b) A
   c) 0 d) -A

10) How many select lines would be required for an 8-line-to-1-line multiplexer?
   a) 2 b) 4
   c) 8 d) 3

B) Fill in the blanks / State True or False. **06**

1) In 8085, _____ signal is used to demultiplex address/ data bus.
2) _____ flip flops required to design MOD 10 counter.
3) In 8085, Opcode fetch cycle is _____ stated.
4) A demultiplexer is used to perform serial to parallel conversion.
   a) Ture b) False
5) Multivibrator are two stage feedback amplifiers.
   a) Ture b) False
6) The negative feedback is used in oscillators.
   a) Ture b) False

Q.2 Attempt following. **16**

a) Opamp as Integrator
b) Demultiplexing of AD0-AD7
c) SIPO shift register
d) Addressing modes of 8085

Q.3 a) What is Multivibrator? Deduce operation of Opamp 741 Astable multivibrator. **10**
b) Elucidate Switched Mode Power Supply (SMPS). **06**

Q.4 a) What is flip flop. Draw and explain JK- flip-flop. **10**
b) Reduce the logical expressions using Boolean laws: **06**
$\overline{A}BC + AB\overline{C} + \overline{A}\,\overline{B}C + \overline{A}B$
Draw logic diagram of reduced expression.

Q.5 a) Draw and explain functional diagram of 8085 microprocessor. **10**
b) Write an ALP for addition of two 8 bit numbers using immediate addressing mode. **06**

Q.6 a) Draw and explain operation of 4- bit Down counter. **10**
b) Draw and explain 1:8 Demultiplexer. **06**

Q.7 a) Describe dual input balanced output differential amplifier with dc and ac analysis. **10**
b) Draw and explain Instrumentation amplifier. **06**

SLR-GY-4

Set No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (CONDENSED MATTER PHYSICS)
Classical Mechanics

Day & Date: Thursday, 16-02-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Nos.1 and 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No.7
3) Figure to the right indicates full marks

Q.1 A) Choose Correct Alternative: 10

1) The configuration space is _____ dimensional space.
   a) 6N b) 3N
   c) 2N d) 4N

2) The Poisson bracket of $[u, p_j] =$ ______.
   a) $-\partial u/\partial p_j$ b) $+\partial u/\partial p_j$
   c) $\partial u/\partial q_j$ d) $-\partial u/\partial q_j$

3) The generating function F_2(q, P, t) generates ______ transformations.
   a) Exchange b) Identity
   c) Infinite d) None

4) The Hamiltonian is defined as ______
   a) H = T-V b) H = T.V
   c) H = T+V d) H=T/V

5) In Lagrangian, the motion of the system has been described by the _____ consideration.
   a) Force b) Momentum
   c) Energy d) Acceleration

6) If $m_1 << m_2$, then the centre of mass of the system coincides with the centre of mass of ______.
   a) m_1 b) m_2
   c) in between mi and m2 d) away from mi

7) If $\epsilon > 1$, then the shape of the orbit formed will be _______
   a) Ellipse b) Circle
   c) Hyperbola d) Parabola

8) In mechanics the action is
   a) Σ q.p b) Σ q + p
   c) Σ q - p d) $\Sigma q^2 .p^2$

9) The canonical transformations are the transformations of _______
   a) point space b) configuration space
   c) phase space d) none of the above

10) The path of the particle is ______ when it is moving under the constant conservative force field.
a) Cycloid b) Hyperbolic
c) Parabolic d) Straight line

B) State True or False: **06**
1) The areal velocity of the particle in a central force field is conserved.
2) [X,Y] = [Y,X] is the property of the Poisson bracket.
3) There is only one degree of freedom for a flywheel.
4) In Lagrange's equation, the motion of the system has been described by force.
5) The motion of the planets around the sun is the example of the motion under central force field.
6) In phase space, there is only one possible path.

Q.2 Answer the following. **16**
a) State Hamilton's variational principle and derive the Lagrange's equation of motion form it?
b) Show that the transformation P = q cot p and Q = log{(sin p) / q} is canonical.
c) Show that the Poisson bracket obeys the distributive law of algebra.
d) The particle describes a circular orbit given by $r = 2a \cos \theta$ under the influence of an attractive central force. Show that the force varies as inverse 5^{th} power of the distance.

Q.3 Answer the following. **16**
a) What is canonical transformation? Discuss the exact differential condition to show that the transformation is to be canonical.
b) Distinguish between the configuration space and phase space.

Q.4 Answer the following. **16**
a) What is the D'Alembart principle? Derive Lagrange's equation of motion using' D'Alembert's principle.
b) Define Hamiltonian. Give its physical significance.

Q.5 Answer the following. **16**
a) Obtain canonical transformation equations corresponding to the first two types of generating functions.
b) Write a note on Hamilton's - Jacobi Theory.

Q.6 Answer the following. **16**
a) Explain the term differential scattering cross section and derive the formula for the same.
b) What is generalized momentum? What are cyclic or ignorable coordinates?

Q.7 Answer the following. **16**
a) Show that Poisson Brackets remain invariant under canonical transformations.
b) What is the principle of least action? Explain it.

SLR-GY-6

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (CONDENSED MATTER PHYSICS)
Quantum Mechanics

Day & Date: Monday, 20-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Choose correct alternative. (MCQ) **10**

1) Which of the following is the velocity at which a given crest moves?
   a) The phase velocity ω b) Group velocity
   c) Particle velocity d) Sound velocity

2) In which of the following effect, the electrons are emitted from a metal surface illuminated by the ultraviolet radiation.
   a) Photoelectric effect b) Diffraction
   c) Compton scattering d) Interference

3) The relationship between velocity v, momentum p and wavelength λ is given by
   a) $p = hv$ b) $p = \frac{h}{\lambda}$
   c) $p = \frac{mv}{c}$ d) $p = \frac{\lambda}{h}$

4) The Schrodinger's wave equation for a particle moving in one dimension is given by
   a) $\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}(E - V)\psi = 0$
   b) $\frac{d^2\psi}{dx^2} - \frac{8\pi^2 m}{h^2}(E - V)\psi = 0$
   c) $\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}(E + V)\psi = 0$
   d) $\frac{d^2\psi}{dx^2} - \frac{8\pi^2 m}{h^2}(E + V)\psi = 0$

5) The Born interpretation of ψ is that
   a) $|\psi * \psi|\ \mathrm{dr}$ is proportional to the probability of finding the electrons in an infinitesimal region between r and $\mathrm{r} + \mathrm{dr}$
   b) $|\psi * \psi|\ \mathrm{dr}$ is inversely proportional to the probability of finding the electrons in an infinitesimal region between r and $\mathrm{r} + \mathrm{dr}$
   c) $|\psi * \psi|\ \mathrm{dr}$ is proportional to the negative probability of finding the electrons in an infinitesimal region between r and $\mathrm{r} + \mathrm{dr}$
   d) $|\psi * \psi|\ \mathrm{dr}$ is not related with the probability of finding the electrons in an infinitesimal region between r and $\mathrm{r} + \mathrm{dr}$

6) Acceptable / well behaved wave functions are those which satisfy the
   a) Ψ must be single valued
   b) Ψ and its first derivative with respect to its variables are continuous
   c) For bound states, Ψ must vanish at infinity
   d) All of the above

7) The zero-point energy of an electron in a one dimensional box is given by
   a) $E_{zero\ point} = \dfrac{h^2}{4m_e a^2}$
   b) $E_{zero\ point} = \dfrac{h^2}{8m_e a^2}$
   c) $E_{zero\ point} = -\dfrac{h^2}{8a^2}$
   d) $E_{zero\ point} = \dfrac{h^2}{8m_e}$

8) The potential energy of particle in harmonic oscillator is given by
   a) $V = kx^2$
   b) $V = \dfrac{1}{2}kx^2$
   c) $V = \dfrac{1}{4}kx^2$
   d) $V = \dfrac{1}{8}kx^2$

9) The first theory of chemical bonding is given by______.
   a) G. N. Lewis in 1916
   b) G. N. Mendis in 1916
   c) G. N. Lewis in 1961
   d) G. N. Mendis in 1906

10) The Laplacian operator in quantum mechanics is defined
   a) $\nabla^2 = \dfrac{\partial^2}{\partial x^2} - \dfrac{\partial^2}{\partial y^2} + \dfrac{\partial^2}{\partial z^2}$
   b) $\nabla^2 = \dfrac{\partial^2}{\partial x^2} + \dfrac{\partial^2}{\partial y^2} + \dfrac{\partial^2}{\partial z^2}$
   c) $\nabla^2 = \dfrac{\partial^2}{\partial x^2} + \dfrac{\partial^2}{\partial y^2} - \dfrac{\partial^2}{\partial z^2}$
   d) $\nabla^2 = \dfrac{\partial^2}{\partial x^2} - \dfrac{\partial^2}{\partial y^2} - \dfrac{\partial^2}{\partial z^2}$

B) Fill in the blanks or Write true /false **06**

1) The condition for an operator $\hat{A}$ to be hermitian is given by _______.
2) The minimum energy required to remove an electron from the hydrogen atom in its ground state is the _______.
3) The atomic unit of magnetic moment is known as ________.
4) Write whether following statement is true or false.
   The electron inside the box is not at rest even at 0 K
5) Write whether following statement is true or false.
   It is assumed that electrons in molecules occupy certain orbitals, which extend over all the nuclei in a molecule.
6) Write whether following statement is true or false.
   The general concept of molecular orbitals and of the building up principle using molecular orbitals was developed in 1927 by Hund and Mulliken and in 1929 by Lennard Jones.

Q.2 Answer the following questions. **16**

a) Discuss the wave and particle nature of radiation
b) Write a note on break down of Born-Oppenheimer approximation.
c) State the postulates of quantum mechanics
d) Write a note on Normalization and Characteristics of Eigen functions of harmonic oscillator

Q.3 Answer the following

- **a)** Obtain the Schrodinger's wave equation in three dimensions. **10**
- **b)** Explain the Eigen functions of the position operator and Dirac delta function. **06**

Q.4 Answer the following

- **a)** Obtain the expression for energy of particle in harmonic oscillator. **10**
- **b)** With neat diagram explain the shape of atomic orbital. **06**

Q.5 Answer the following.

- **a)** Obtain the expression for ground state energy of hydrogen atom. **10**
- **b)** Explain the self-consistent field method in calculation of the ground state energy and wave functions of many electron atoms. **06**

Q.6 Answer the following.

- **a)** Describe the molecular orbital treatment of hydrogen molecule. **10**
- **b)** Apply the Born-Oppenheimer approximation and LCAO molecular orbital theory to Hydrogen molecule ion. **06**

Q.7 Answer the following.

- **a)** With a diagram of P, Q, R Branches, explain the Vibration and vibrational spectra of diatomic molecules. **10**
- **b)** Write a note on Eigen functions of position operator. **06**

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (CONDENSED MATTER PHYSICS)
Electrodynamics

Day & Date: Tuesday, 21-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. No 1 and 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to 7
3) Figures to the right indicate full marks.

Q.1 A) Choose the correct alternatives from the options. **10**

1) The scalar potential for quadrupole varies as ______.
   a) $V \propto \frac{1}{r^2}$ b) $V \propto \frac{1}{r^3}$
   c) $V \propto \frac{1}{r^4}$ d) $V \propto \frac{1}{r^5}$

2) In vacuum divegence of electric field over a surface is _____.
   a) zero b) charge enclosed by surface
   c) one d) none of above

3) A wire wound in the form of a solenoid has ______ self-inductance than when it is unwound.
   a) Smaller b) Equal
   c) Nearly equal d) Larger

4) The scalar potential is due to ______.
   a) Charge density b) Current density
   c) Surface current d) Line element

5) The normal component of magnetic field, above and below the surface _______.
   a) discontinuous b) continuous
   c) different d) independent of charges

6) The electric field inside a conductor is ______.
   a) Greater than zero b) Less than zero
   c) Zero d) none of these

7) Angular distribution of energy due to accelerated charged particle at low velocity is proportional to ______.
   a) $\mathrm{Sin}^2\theta$ b) $\mathrm{Sin}^3\theta$
   c) $\frac{1}{\mathrm{Sin}^3_\theta}$ d) $\frac{1}{\mathrm{Sin}^2_\theta}$

8) The radiation from an oscillating electric dipole is generally _____.
   a) Transverse electric b) Zero
   c) Positive d) Transverse magnetic

9) Unit of Poynting vector is ______.
   a) W/m b) W.m
   c) W/m^2 d) m/W

10) For radiation fields the ratio E/B is always equal to ______.
   a) One b) 1/velocity of light
   c) velocity of light d) less than velocity of light

Q.1 B) Fill in the blanks. **06**

1) When a high-speed electron hits a metal target, it rapidly decelerates, giving off what is called ______.
2) A charge Q is uniformly distributed on the surface of a cube and there is no other charge in consideration. Divergence of electric field is ______.
3) Amount of electrostatic energy stored in unit volume of electric field is _______.
4) Magnetic field does work _______.
5) Two particles with identical charges and mass collide, there is _____.
6) The Lorentz gauge condition is ______.

Q.2 Answer the following. **16**

a) What are boundary conditions?
b) State the Coulomb and Lorentz gauge conditions.
c) What are scalar and vector potentials?
d) Write the Maxwell's equations in differential form.

Q.3 Answer the following. **16**

a) Show that vector potential for dipole is $A_{dip} = \frac{\mu_0}{4\pi}\frac{m\times\hat{r}}{r^2}$.
b) Find the magnetic field at a distance 's' from a long straight wire, carrying a steady current 'I'.

Q.4 Answer the following. **16**

a) Derive an expression for the electric potential at a distance 'r' due to a point charge.
b) Explain the concept of Maxwell's displacement current.

Q.5 Answer the following. **16**

a) State and prove Poyntings theorem and explain the significance of Poyntings vector.
b) Obtain electromagnetic wave equations in conducting medium.

Q.6 Answer the following. **16**

a) Obtain the Fresnel's relation for the polarization parallel to the plane of incidence.
b) What is Hertz potential and explain its importance?

Q.7 Answer the following. **16**

a) Derive the relation for total power radiated by electric dipole.
b) Explain radiation from half wave antenna.

SLR-GY-8

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (CONDENSED MATTER PHYSICS)
Statistical Physics

Day & Date: Wednesday, 22-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. Nos. 1 and 2 are compulsory.
2) Attempt any three questions from Q. No.3 to Q. No.7.
3) Figure to the right indicates full marks.

Q.1 A) Choose Correct Alternative: **10**

1) Which one of the following definitions best describes the concept of work?
   a) The flow of energy from one object or substance to another due to a difference in temperature
   b) The flow of energy from one body to another through uniform molecular motion
   c) The force associated with molecular motion
   d) The random motion of molecules in a gas at low pressure

2) An isolated system is best described by which one of the following statements.
   a) Neither matter nor heat can pass into or out of the system
   b) The system has a boundary which allows heat to be transferred but does not allow material to pass into or out of the system
   c) The system has a diathermic boundary
   d) A system which has reached thermal equilibrium with its surroundings

3) Which one of the following statements describes a path function?
   a) A property of a system that depends only on the current state of the system, not on the path the system took to reach that state
   b) A property of a system that depends on the path taken between the initial and final states.
   c) The sum of kinetic and potential energy contained in a substance
   d) The heat energy absorbed by a system at constant pressure

4) Which one of the following equations defines the enthalpy of reaction, ΔH, for a reaction occurring at constant pressure that does expansion work? All terms have their usual meanings.
   a) $\Delta H = \Delta U$ b) $\Delta H = \Delta U + p\Delta V$
   c) $\Delta H = \Delta G - T\Delta S$ d) $\Delta H = q + w$

5) Gibbs paradox in statistical mechanics is related to.
   a) Additive property of the energy
   b) Additive property of the momentum
   c) Additive property of the entropy
   d) Additive property of the temperature

6) What is a process during which the pressure remains constant?
   a) Isometric process b) Isobaric process
   c) Isochoric process d) Isothermal process

7) What type of system energy is related to the molecular structure of a system?
   a) Macroscopic form of energy
   b) Microscopic form of energy
   c) Internal energy
   d) External energy

8) Consider the three collections of particles (ensembles) named micro canonical, canonical and grand canonical. Which one physical property is constant in all three ensembles?
   Total number of particles N incorrect
   a) Pressure, p
   b) Temperature, T
   c) Volume, V
   d) Total number of particles N

9) Consider the general labelling of systems as open, closed, or isolated. The first allows the exchange of matter and energy with its surroundings; the second allows only the exchange of energy, whereas the third allows no exchange at all. Which one of the following statements is correct?
   a) An isolated system obeys the rules of the canonical ensemble.
   b) An open system obeys the rules of the canonical ensemble.
   c) An open system obeys the rules of the microcanonical ensemble.
   d) A closed system obeys the rules of the microcanonical ensemble.

10) The ensemble which allows the subsystem to allow exchange of energy as well as
   a) Canonical ensembles
   b) Micro canonical ensembles
   c) Grand canonical ensembles
   d) Both a and c

B) State True or False: **06**

1) The Kinetic Energy of the particle is dependent on Temperature only. (True/False)
2) If a liquid crystallises in to a solid, entropy will be decrease. (True/False)
3) Gibbs paradox in statistical mechanics is related to additive properties of entropy. (True/False)

4) The Fermi energy (Ef) of the white dwarfs is 10 MeV. (True/False)
5) A system can exist in a state of negative temperature because the total energy E has an upper bound. (True/False)
6) If the system is known to be in a state of equilibrium, the corresponding ensembles must be Hamiltonian. (True/False)

Q.2 Answer the following. **16**

a) State and explain the Bose-Einstein condensation.
b) Explain the Pauli Paramagnetism.
c) Explain the concept of canonical, and microcanonical ensemble.
d) State the Density of state in phase space based on classical and quantum physics.

Q.3 Answer the following. **16**

a) Derive an expression for partition function of ideal gas in grand canonical ensemble.
b) State and explain the planks distribution law and derive the necessary expression for it.

Q.4 Answer the following. **16**

a) State and derive the equipartition theorem
b) What is Ensemble? What are different type of ensemble? Explain the concept of ensemble average and discuss the concept at stationary ensemble.

Q.5 Answer the following. **16**

a) State and explain nature of particle in Boson- Einstein statistics.
b) Show that the change in the entropy due to mixing of two ideal gases results in to the Gibb's paradox.

Q.6 Answer the following. **16**

a) Describe in detail the concept of Density Distribution in phase space.
b) Derive an expression for Entropy, Gibb's Free energy for canonical ensemble.

Q.7 Answer the following. **16**

a) State and describe the Liouville's equation.
b) Show that the change in the entropy due to mixing of two ideal gases results in to the Gibb's paradox

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (CONDENSED MATTER PHYSICS)
Semiconductor Physics

Day & Date: Monday, 13-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. (1) and (2) are compulsory.
2) Attempt any there from Q. (3) to Q. (7).
3) Figures to the right indicate full marks.

Q.1 a) Choose the correct alternatives. **10**

1) If σ is the conductivity, what is the relation between the electric field E and the current density J in a conducting medium?
   a) σ = J/E b) σ = 1/JE
   c) σ = E/J d) σ = EJ

2) Liquid-phase epitaxy (LPE) uses ______ to grow crystals on a substrate.
   a) The solid b) The solution
   c) The gas d) The vapors

3) The equilibrium number of electron-hole pairs in pure Si at room temperature is about _____.
   a) 10^{10} EHP/cm^3 b) 10^{12} EHP/cm^3
   c) 10^{10} EHP/m^3 d) 10^{12} EHP/m^3

4) Particles in an ionic crystal are held together by ______
   a) Nuclear forces b) Electrons
   c) Covalent bonds d) Electrostatic forces

5) The atoms of solid are held together by ______.
   a) Van der Waals forces b) Hydrogen bonds
   c) Ionic bonds d) Hydrophobic forces

6) The shape of E-K diagram of the conduction band and valance band is _______.
   a) Horizontal b) Vertical
   c) Parabolic d) Elliptical

7) What is the role of seed crystal in crystal growth?
   a) Nucleation center b) Catalyst
   c) Solvent d) Solution

8) In Czochralski crystal growth process, the material is heated up to ____
   a) 950 °C b) 1420 °C
   c) 1000 °C d) 1200 °C

9) Charge carriers can move in semiconductor via:
   a) Diffusion mechanism b) Floating mechanism
   c) Drift mechanism d) Both drift and diffusion mechanism

10) The effective mass of an electron is _____.
   a) mass of free electron
   b) mass of electron in periodic potential
   c) both a & b
   d) none of above

b) Fill in the blanks/ State True or false **06**

1) Molecular Beam Epitaxy is a _____ process.
2) A trivalent impurity has ______ valance electrons.
3) The conductivity of a sample due to excess carriers created by phonon vibration is called _____.
4) In a direct bandgap semiconductor, a transition between conduction band and valance band resulted due to light. (True/False)
5) In ohmic contact, the barrier height is small. (True/False)
6) For potentials that are periodic, the wavefunction does not satisfy Bloch Theorem. (True/False)

Q.2 Answer the following. **16**

a) Effective mass of an electron
b) Draw optical spectrum of common semiconductor with their band gap
c) Conditions for growth of crystal
d) Supersaturation

Q.3 Answer the following.

a) Describe Molecular Beam Epitaxy method of crystal growth. **10**
b) Explain Liquid phase epitaxy. **06**

Q.4 Answer the following.

a) What is Luminescence? Explain various type of Luminescence with example. **10**
b) A 0.5μm thick sample of Indium (In) is illuminated with monochromatic light of hυ=1.5eV. The absorption coefficient 10^4 cm^{-1}. The power incident on the sample in 15mW. Find the total energy absorbed by the sample per second (J/sec). **06**

Q.5 Answer the following.

a) Describes variation of energy bands with alloy composition with suitable example. **10**
b) Explain optical absorption in semiconductors. **06**

Q.6 Answer the following.

a) Explain crystal growth by Czochralski method. **10**
b) Explain Hydrothermal method with suitable example. **06**

Q.7 Answer the following.

a) Explain MS structure with band diagram. Explain current flow mechanism in MS junction. **10**
b) Show the equilibrium energy band diagram for a metal to an p-type semiconductor where (a) $\phi_M < \phi_S$ and (b) $\phi_M > \phi_S$ **06**

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (CONDENSED MATTER PHYSICS)
Automatic, Molecular Physics

Day & Date: Tuesday, 14-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. Nos. 1 and 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Choose correct alternative. (MCQ) **10**

1) In the case of 1st order, Stark effect for the hydrogen atom (Z =1) the ground state splits into ____.
   a) 2 levels b) 3 levels
   c) 4 levels d) does not split

2) The rotational constant for $H^{35}Cl$ is observed to be 10.5909 cm^{-1}. What is the value of B for $^2D^{35}Cl$?
   (Given: atomic masses (in kg): $^1H = 1.673 \times 10^{-27}$, $^2D = 58.06 \times 10^{-27}$, $^{35}Cl = 1.673 \times 10^{-27}$, $^{37}H = 61.38 \times 10^{-27}$)
   a) 5.44 cm^{-1} b) 4.44 cm^{-1}
   c) 6.44 cm^{-1} d) 54.4 cm^{-1}

3) The equilibrium vibration frequency for an oscillator is observed at 2990 cm^{-1}. The ratio of the frequencies corresponding to the first overtone band and the fundamental spectral lines is 1.96. Considering the oscillator to be anharmonic, the anharmonicity constant is
   a) 0.005 b) 0.02
   c) 0.05 d) 0.1

4) What is the moment of inertia I_B, of $^1H^{79}Br$ if the bond distance is 143 pm? Atomic masses are: ^1H=1.008 amu, ^{79}Br = 78.92 amu
   a) 3.33×10^{-47} kg.m^2 b) 3.00×10^{46} kg.m^2
   c) 2.34×10^{-37} kg.m^2 d) 1.22×10^{-7} kg.m^2

5) Put the energies of the $K\alpha, K\beta$, and $L\ \alpha$ X-rays from an element in order of increasing energy (from smallest to largest).
   a) $L\alpha, K\alpha, K\beta$ b) $K\alpha, K\beta, L\alpha$
   c) $K\alpha, L\alpha, K\beta$ d) $L\alpha, K\beta, K\alpha$

6) The bond order for the O_2 molecule is _________
   a) 1 b) 2
   c) 2.5 d) 0

7. The transition of longer wavelength observed in the case of Orthohelium is ____.
   a) $2^3P_{0,1,2} \longrightarrow 2^3S_1$ b) $2^3P_1 \longrightarrow 2^1S_0$
   c) $2^3P_{0,1,2} \longrightarrow 2^3S_1$ d) $3^1P_1 \longrightarrow 1^1S_0$

8) The total number of emission lines observed during the transition of electrons from $3^2P_{3/2}$ to $3^2S_{3/2}$ are _____.
   a) 2 b) 4
   c) 6 d) 8

9) The spectroscopic symbol for the ground state of Al (Z = 13) is $2P_{1/2}$. Under the action of a strong magnetic field (when L-S coupling can be neglected) the ground state energy level will split into ________
   a) 3 levels b) 4 levels
   c) 5 levels d) 6 levels

10) The fine structure of atomic spectral lines arises from
   a) Electron spin-orbit coupling
   b) Interaction between electron and nucleus
   c) Nuclear spin
   d) Stark effect

B) Fill in the blanks OR Write true /false **06**

1. According to Moseley's law, the frequency of a spectral line in an X-ray spectrum varies as a square of the atomic number of the element. (True/False)
2. The shortest wavelength observed in the Paschen series of hydrogen spectra is ______.
3. The spectral term separation ΔT is expressed in terms of cm^{-1} which is caused due to spin-orbit interaction and is related to the atomic number Z by Z^{-4}. (True/False)
4. The energy of the Kα X-ray of sodium (Z = 11) is 1.02 keV.
5. The Lande's g-factor for $8G_{1/2}$ is - 4/3
6. Oxygen has the electronic configuration 1s22s22p4. In the ground state, the total ms of all 8 of the electrons has the largest possible value consistent with the Pauli principle is 1.

Q.2 Answer the following questions. **16**

A) Write an electronic configuration of Na_2 (Na, Z = 11) and S_2 (S, Z = 16) diatomic molecules in accordance with molecular orbital approach and state the bond order in each case.

B) Find the possible multiplicities × of the terms of the types (a) $\times D_2$; (b) $\times P_{3/2}$

C) What is Stark effect? discuss the weak-field Stark effect in hydrogen for Hα line.

D) From the following data, find the energy required to dissociate a KCl molecule into a K atom and a Cl atom. The first ionization potential of K is 4.34 eV; the electron affinity of Cl is 3.82 eV; the equilibrium separation of KCl is 2.79 Å. (Hint: Show that the mutual potential energy of K^+ and Cl^- is — (14.40/R) eV if R is given in Angstroms).

$$\left(\frac{e^2}{4\pi\varepsilon_0} = 1.44 \times 10^{-9}\ eV.m\right)$$

Q.3 Answer the following questions. **16**

A) i) Discuss the rotational spectrum of a diatomic molecule treated as a non-rigid rotator.

ii) The rotational spectrum of $^{79}Br^{19}F$ shows a series of equidistance lines 0.71433 cm^{-1} apart. Calculate the rotational constant, B, and hence the moment of inertia and bond length of the molecule. Determine the wave number of the J = 9 to J = 10 transition, and find which transition gives rise to the most intense spectral line at room temperature, (say 300 K). Calculate the number of revolutions per second which the BrF molecule undergoes when (a) the J = 0 state (b) J = 1 state, and (c) the J = 10 state. (Atomic masses in kg: ^{79}Br = 131.03 x 10^{-27}, ^{19}F = 31.55 x 10^{-27}; h = 6.626 x10^{-34} Js, c = 2.998 x 10^{8} m/s, k = 1.381 x 10^{-23} J/K) Hint: Use E= ½ $I\omega^2$

B) i) Discuss the basic foundation behind the magnetic spin resonance spectroscopy techniques?

ii) Differentiate between nuclear magnetic resonance and electron paramagnetic resonance spectroscopic techniques,

iii) Show how many signals you will see in the electron spin resonance spectrum of H-atom considering nuclear hyperfine interaction. Sketch the predicted spectrum in first derivative form and label it properly.

iv) If the observed chemical shift of a proton is 200 Hz from tetramethylsilane $(CH_3)_4Si$ and instrument frequency is 60 MHz, what is the chemical shift in terms of δ? Express it in τ value.

Q.4 Answer the following questions. **16**

A) i) Draw a neat labelled schematic diagram showing electronic, vibrational and rotational energy levels of a molecule and comment on their individual separations with typical energy/wavenumber values.

ii) Give a brief account of Franck-Condon principle and discuss how it is useful in explaining the intensity distribution in absorption bands of molecules based on internuclear separations of upper and lower electronic states.

iii) Obtain the number of vibrational modes for the following molecules and sketch them

a) H_2O b) CO_2

B) i) In a multielectron atom, consider two identical particles (electrons, noninteracting). Let ψ_α and ψ_β be the eigenfunctions corresponding to the states α and β, in which the two particles can be found. Considering total eigenfunctions, show that the two particles can not be in a state with the same set of quantum numbers.

ii) Evaluate the Lange' g factor for the $^3P_1$ state in 2p3s configuration of ^6C. On the application of a magnetic field B = 0.1 tesla, calculate the Zeeman splitting of the state ΔE in joules. (μ_b = 9.2740 x 10^{-24} J/T)

iii) Nitrogen (Z = 7) has three electrons in the 2p level (in addition to two electrons each in the 1s and 2s levels), (a) Consistent with the Pauli principle, what is the maximum possible value of the total M_s of all seven electrons? (b) List the quantum numbers of the three 2p electrons that result in the largest total M_s. (c) If the electrons in the 2p level occupy states that maximize M_s, what would be the maximum possible value for the total M_L? (d) What would be the maximum possible total M_L if the three 2p electrons were in states that did not maximize M_s?

Q.5 Answer the following questions. **16**

A) What do you mean by spin-orbit interaction? Calculate the change in total energy of the atom due to spin-orbit coupling. Find the magnitude of spin-orbit energy for $2_{P_{\frac{3}{2}}}$ state of the hydrogen (Z=1) atom. The radius of the orbit is $3a_0 = 1.5\text{Å}$

$e = 1.6 \times 10^{-19}C, \hbar = 6.58 \times 10^{-16}\ eV.s, m = 9.1 \times 10^{-31}kg$

$c = 3 \times 10^8 ms^{-1};\ \varepsilon_0 = 8.8542 \times 10^{-12}F.m^{-1}$ spin g -factor $g_s = 2$

(Bohr radius $a_0 = 0.529\text{Å}, \vec{S}.\vec{L} = \frac{\{j(j+1)-l(l+1)-s(s+1)\hbar^2}{2}; \langle\frac{1}{r^3}\rangle = \frac{z^3}{a_0^3 n^3 l(l+\frac{1}{2})(l+1)}$

B) i) Discuss the vibrational-rotational spectra of a diatomic molecule by showing P, Q and R branches with proper selection rules,

ii) Designate proper branches (P, Q and R) for the following type of vibrations of a heteronuclear diatomic molecule

a) Symmetric stretching mode in which dipole vibrate parallelly along the bond length.

b) Bending mode in which dipole vibrate perpendicularly along the bond length,

iii) Explain why vibrational-rotational spectra cannot be obtained for homonuclear diatomic molecules having identical nuclei?

Q.6 Answer the following questions. **16**

A) Discuss the Paschen Back effect for one vale nce electron system by considering the principal doublet (i.e. D1 and D2 lines) $^2S_{1/2} \longleftarrow {}^2P_{1/2,3/2}$ transitions of sodium. Justify the phenomenon of Paschen Back effect by considering magnetic interaction energy i. e. ΔE

B) Find the most probable radius for the electron of a hydrogen (Z =1) atom in the 1s states. Given, $P_{1,0}(r) = \frac{4r^2}{a_0^3} e^{\frac{-2r}{a_0}}$. Calculate the average orbital radius of a 1s electron in the hydrogen atom. What is the probability of the electron in the 1s state of the hydrogen atom being at a radius greater than the Bohr radius a_0? (Given, e = 2.71818)

Given: $\int_0^\infty x^m . e^{-ax^n} dx = \frac{1}{n} \frac{\Gamma(\frac{m+1}{n})}{a^{(m+1)/n}};\ \Gamma(n) = (n-1)!$

Q.7 Answer the following questions. **16**

A) Explain the valence band theory of Heitler- London i.e. Quantum mechanical treatment of Hydrogen (H_2) Molecule.

B) i) What are non-equivalent and equivalent electrons? Is it possible to have two equivalent electrons in the same atom? Calculate the spectral terms for non-equivalent (s,s) (s,p) and (p,p) electrons and for two equivalent (s^2) and (p^2) electrons.

ii) What do you mean fine structure? With neat labelled diagram discuss the fine structure of doublets for a) $^2P_{1/2}$ and $^2P_{3/2}$ and b) $^2D_{3/2}$ and $^2D_{5/2}$ states with justification based on magnitude of ΔT_{ls}

iii) Calculate the ESR frequency of an unpaired electron in a magnetic field of 3000 G
(0.30 T). (g = 2.00, μ_B = 9.273 x 10^{-24} J/T, h = 6.626 x 10^{-34} Js)

SLR-GY-12

Set No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (CONDENSED MATTER PHYSICS)
Soft Condensed Matter Physics

Day & Date: Wednesday, 15-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Choose correct alternative. (MCQ) **10**

1) Soft condensed matter is a convenient term for materials in states of matter that are _____.
   a) Simple liquids
   b) Crystalline solids
   c) Either simple liquids or crystalline solids
   d) Neither simple liquids nor crystalline solids

2) Which of the following is true about colloidal dispersions?
   a) Submicrometre particles of solid or liquid are dispersed in another liquid
   b) Submicrometre particles of solid or liquid are dispersed in another solid
   c) Submillimetre particles of solid or liquid are dispersed in another solid
   d) Submillimetre particles of solid or liquid are dispersed in another liquid

3) The coarse-grained models emphasize _____.
   a) Universality b) Crystallinity
   c) Amorphous nature d) Flexibility

4) The potential U_{dis} between a pair of atoms or molecules, each with polarisability 'α', separated by a distance 'r', varies as _____.
   a) $U_{dis} \sim \frac{\alpha^2}{r^6}$ b) $U_{dis} \sim \frac{\alpha^6}{r^2}$
   c) $U_{dis} \sim \frac{2a^2}{r^6}$ d) $U_{dis} \sim \frac{\alpha^2}{r^3}$

5) In a phase transition, the order parameter for the disordered phase is _____.
   a) Zero b) Finite
   c) Infinite d) Negative

6) The free energy of mixing the two species A and B in separate, unmixed states is given by _____.
   a) $F_{mix} = F_{A+B} - (F_A + F_B)$ b) $F_{mix} = F_{A+B} + (F_A + F_B)$
   c) $F_{mix} = F_{A+B} - (F_A - F_B)$ d) $F_{mix} = F_{A+B} + (F_A - F_B)$

7) In which of the following crystallinity the system is prevented from reaching its equilibrium state of full long-ranged order for kinetic or other reasons?
   a) Liquid crystallinity b) Partial crystallinity
   c) Solid crystallinity d) Gaseous crystallinity

8) In which of the following liquid crystalline phase the director and the layer normal make an angle?
   a) Nematic A b) Smectic A
   c) Nematic C d) Smectic C

9) The order parameter S is defined as _____.
   a) $S = \frac{1}{2}\langle 3\cos^2\theta - 1\rangle$ b) $S = \frac{1}{2}\langle 3\cos^2\theta + 1\rangle$
   c) $S = \frac{1}{2}\langle 2\cos^2\theta - 1\rangle$ d) $S = \frac{1}{3}\langle 3\cos^2\theta - 1\rangle$

10) The driven lattice gas model for non-equilibrium phase transitions was introduced by ______.
   a) Katz b) Newton
   c) Albert Einstein d) Stokes

B) Fill in the blanks / State True or False. **06**

1) The typical structures in soft matter are _____ than atomic sizes.
2) An ordered arrangement of domains of the two polymer types on mesoscopic length scales is called _____.
3) In the Driven lattice gas models particles may move preferentially along, _____ induced by an external applied electric field assuming the particles are positive ions.
4) The basic aim of condensed matter physics is to understand the collective properties of large assemblies of atoms and molecules in terms of the interactions between their component parts. (True / False)
5) Liquid crystallinity are equilibrium phases. (True / False)
6) When amphiphiles have the property that part of the molecule has an affinity to water and another part of the molecule is repelled from water. (True / False)

Q.2 Answer the following questions. **16**

a) Write a note on mechanism of phase separation in liquid-liquid unmixing.
b) Write a note on two different types of intermediate orders in soft matter systems.
c) Explain, why oil and water do not mix.
d) Write a note on the elastic constants of a Nematic liquid crystal.

Q.3 Answer the following.

a) With the help of phase diagram, describe the Liquid-liquid unmixing. **10**
b) Write a note on phase transitions in soft matter. **06**

Q.4 Answer the following.

a) Discuss the elasticity and fluctuations of membranes in Supramolecular self-assembly in soft-condensed matter. **10**
b) Discuss the distortions and topological defects in liquid crystals. **06**

Q.5 Answer the following.

a) Discuss the idea of aggregation and phase separation in case of Amphiphilic molecules in solutions. **10**
b) What is the most spectacular property of soft matter? Write a note on Supramolecular self-assembly in soft-condensed matter. **06**

Q.6 Answer the following.

a) Discuss the driven lattice gas model in two-dimensional non-equilibrium systems. **10**

b) Write a short note on driven lattice gas classes. **06**

Q.7 Answer the following.

a) Describe the mean field theories of phase-transition in soft matter. **10**

b) Write a note on thermodynamics of solutions. **06**

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (CONDENSED MATTER PHYSICS)
Semiconductor Devices

Day & Date: Monday, 20-02-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. Nos.1 and 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Choose correct alternatives. **10**

1) Ideally solar cells having _______series resistance and __shunt resistance.
   a) Infinite, Zero b) Low, High
   c) Zero, infinite d) Not possible to measure

2) CMOS is popular due to _____.
   a) Low noise immunity b) High power consumption
   c) Low power consumption d) High power dissipation

3) The intercept of _____variation corresponds to the built-in potential, V_{bi}, of Schottky device.
   a) $1/C^2$ Vs V b) C^2Vs1/V
   c) C^2VsV d) $1/C^2$VsV^2

4) GaAs is better for MESFET than silicon due to _____.
   a) Low mobility b) Temperature stability
   c) Low power levels d) High capacitance

5) The lasing threshold current density for ____ junction LASER is lowest.
   a) homo b) graded
   c) hetero d) double hetero

6) The switching ON behavior of SCR is based on _______
   a) regenerative b) Blocking
   c) breakdown d) Etching

7) A CCD involves _____actions.
   a) charge storage and transfer
   b) only storage
   c) only charge transfer
   d) charge storage and loss

8) Two valley model of TEDs based on GaAs is proposed by ____.
   a) BCS b) BBS
   c) RWH d) NWH

9) The condition hv < Eg causes _____ of light in semiconductor.
   a) absorption
   b) transmission
   c) reflection
   d) modulation

10) Thicker oxide layer of MOSFET reduces its ________.
   a) bias b) field strength
   c) work function d) fermi energy

b) State True or False/Fill in gaps. **06**

1) The potential well is created by applying positive voltage to p - substrate.
2) LASERS convert electrical energy to optical energy.
3) Sum of $\alpha 1$ and $\alpha 2$ must be Zero for SCR to become ON.
4) The drift of stable domains in TEDs is attainable in ____ loaded circuits.
5) HFD collapses when the field outside drops below ____field.
6) The life time of charge carriers to emit fluorescence is ________ seconds.

Q.2 Attempt following. **16**

a) LASCR
b) Heterostructures Laser.
c) Operating modes of GaAs Gun Oscillator.
d) GTOs

Q.3 a) Describe MS structure with band diagram. Explain current flow mechanism in MS junction. **10**
b) Charge trapping in MOSFET. **06**

Q.4 a) Discuss in brief various methods of triggering pnpn device. **10**
b) Reverse conducting thyristor **06**

Q.5 a) Describe basic structure of Charge Coupled Devices and its dynamic effect. How performance of CCD is improved. **10**
b) Obtain an expression of drain current in MOSFET. **06**

Q.6 a) Explain IR and Visible LED. Discuss in detail the operating principle of LED. **10**
b) LDR device. **06**

Q.7 a) Draw the band gap and wavelength scales and show the band gaps of some common semiconductors relative to the optical spectrum. **10**
b) Explain the conditions of absorption of light by semiconductor. **06**

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (CONDENSED MATTER PHYSICS)
Nuclear and Particle Physics

Day & Date: Tuesday, 21-02-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Question Nos.1 and 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7.
3) Figure to right indicate full marks.

Q.1 A) Choose the correct alternatives from the options. **10**

1) The ratio will be _____. Where, R is the mean nuclear radius.0.5
   a) 0.5 b) 2
   c) 0.2 d) 4

2) Simplest two nucleon system exists in nature is of ____
   a) p-p b) n-n
   c) n-p d) Does not exist

3) What is the correct sequence of shell closure according to extreme single particle shell model?
   a) 2, 6, 10, 14, 18, 32
   b) 2, 8, 18, 32, 50, 86
   c) 2, 8, 20, 50, 82, 126
   d) 2, 8, 20, 40, 82, 126

4) In a typical nomenclature of nuclear reaction _____
   a) is incident photon and n being outgoing particle
   b) n is incident particle and photon is out-going
   c) Both n and are incident particles
   d) Both n and are out-going particles

5) Nucleons in the nucleus of an atom are _____.
   a) Uniformly distributed up to a certain distance and then falls off sharply at the boundary
   b) They are dense at the center and then distribution falls sharply at the boundary
   c) Distribution is even and uniform at the centre as well as at the boundary.
   d) Distribution is uneven everywhere.

6) Nuclear forces between the nucleons are _______.
   a) Central force b) Non-central forces
   c) Purely Coulombic forces d) Cohesive forces

7) The height of potential barrier faced by an alpha-particle inside the nucleus is ______.
   a) 31.2 MeV b) 31.2 KeV
   c) 31.2 GeV d) 31.2 eV

8) In a typical nomenclature of nuclear reaction, _______.
   a) is parent, is incident photon, is daughter and n being outgoing particle
   b) is parent, n is incident particle, is daughter and photon is out-going
   c) is daughter, n is incident particle, is parent and photon is out-going
   d) is parent, is daughter, n and both are out-going particles

9) A proton is stopped in an ionization chamber producing ion pairs. Average energy required to produce an ion pair is 35 eV. What is the kinetic energy of proton entering the ionisation chamber?
   a) 3.5 MeV b) 35 MeV
   c) 3.5 GeV d) 35 GeV

10) The average binding energy per nucleon of nucleus is ______.
   [Given: neutron mass m_n= 1.008665 u, proton mass m_p=1.007825 u, where 1 u = 931.5 MeV/c^2]
   a) 7.07MeV b) 28.3 MeV
   c) 8.5 MeV d) 36 MeV

B) Fill in the blanks OR Write True/False. **06**

1) Nuclear forces are purely central forces?
2) n-n forces are same as n-p forces?
3) Quarks experiences all four fundamental forces of nature.
4) Baryons contains one quark and one anti-quark.
5) Electron capture is one of the modes of gamma decay process.
6) In radioactivity, after one half-life, mass of radioactive substance reduces to half.

Q.2 Answer the following. **16**

a) How ^{l4}C carbon dating is performed? Explain the step by step process in detail.
b) Explain the working and basic principle of Proportional counter. Draw neat schematic figure to mention each component of the counter.
c) Obtain the conditions for which, decay, decay, and electron capture process becomes energetically feasible.
d) Draw the baryon decuplet, identify the particles in it along with their quark structures, charges and spins.

Q.3 Answer the following.

a) Using the semi-empirical mass energy formula, Calculate the coulomb coefficient and estimate the radius, for the mirror nuclei and [Given M() = 22.994124 u, M(=22.989768 u, neutron mass m_n = 1.008665 u, proton mass m_p= 1.007825 u, where 1 u = 931.5 MeV/c^2, constants in semi-empirical formula: Volume term, Surface term, Coulomb term, asymmetry term, pairing term] **08**

b) Using semi-empirical mass formula, for given family of isobars, obtain the relation for most stable nuclei. **08**

Q.4 Answer the following.

a) Explain the parity violation in beta-decay process and write in detail how it was experimentally shown. **10**

b) Find the Q-value and the threshold for the following nuclear reaction. [Given M() = 207.976641 u, M(=55.934939 u, M() =209.984178 u, M(=53.939612 u, neutron mass m_n = 1.008665 u, proton mass m_p=1.007825 u, where 1 u = 931.5 MeV/c^2] **06**

Q.5 Answer the following.

a) Explain meson theory of nuclear force. Using uncertainty principle and phenomenological arguments, obtain an expression for the Yukawa potential between nucleons. **08**

b) From Gamma ray selection rule classify the following multipole transitions. **08**

i) $(1/2)^- \rightarrow (7/2)^-$

ii) $4^+ \rightarrow 2^+$

iii) $1^- \rightarrow 2^+$

iv) $(1/2)^- \rightarrow 3/2^+$

Q.6 Answer the following.

a) Explain the alpha decay process in detail and get the expression for Gamow's factor. Further, obtain the expression for decay probability involving Gamow's factor. **10**

b) Find out the classically forbidden regions in a potential of nuclei's 238-U and 228-U which emits alpha particles of 4.27 MeV and 6.81 MeV energies, respectively. **06**

Q.7 Answer the following.

a) Briefly explain what is the difference between cyclotron and synchrotron accelerators. Draw a neat schematic of synchrotron accelerator and explain the working and principle of each part. **10**

b) Classify nuclear reactions on the basis of projectile and ejectile particles and explain them briefly. **06**

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (CONDENSED MATTER PHYSICS)
Physics of Nano Materials

Day & Date: Wednesday, 22-02-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. Nos. 1 and 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Choose the correct alternatives from the options. **10**

1) The nanoscale involves the range from approximately _______.
   a) 1 nm to 10 nm b) 1 nm to 100 nm
   c) 1 nm to 1000 nm d) 1 nm to 0.001 nm

2) Single wall carbon nanotubes can be thought of cut outs from a _______dimensional hexagonal lattice of carbon atoms.
   a) zero b) One
   c) two d) Three

3) Graphene is a ______ nanomaterial with single atomic layer of carbon structure.
   a) 0D b) 1D
   c) 2D d) 3D

4) Fluorescence is the result of a molecule _______light at a specific wavelength and ______ light at a longer wavelength.
   a) emitting, absorbing b) absorbing, emitting
   c) vibrating, absorbing d) vibrating, emitting

5) In ______ semiconductor repels the negative ions and attracts the positive ions.
   a) hopping b) polar
   c) Schottky effect d) Frenkel effect

6) In ______ process, the substrate is exposed to one or more volatile precursors, which react and/or decompose on the substrate surface to produce the desired thin film deposit.
   a) PVD b) CVD
   c) PLD d) MBE

7) Analysis, provides high-resolution imaging useful for evaluating various materials for surface fractures, flaws, contaminants or corrosion.
   a) SEM b) AFM
   c) TEM d) FE-SEM

8) The BET is commonly used to generate a specific surface area result expressed in units of _______.
   a) area per mass of sample (m^2/g)
   b) mass per area of sample (g/m^2)
   c) area per density of sample
   d) Density per mass of sample

9) Fullerene molecule can be used as an antioxidant because it can easily react with radicals due to the ______.
   a) high affinity of the electron
   b) less affinity of the electron
   c) high affinity of the proton
   d) less affinity of the proton

10) Boron nitride nanotubes have a similar tubular structure as carbon nanotubes in which carbon atoms are replaced entirely by boron and nitrogen atoms, arranging in a ______.
   a) hexagonal lattice b) cubic lattice
   c) tetragonal lattice d) orthorhombic lattice

Q.1 B) Write True/False. **06**

1) Nanotechnology could also enable objects to harvest energy from their environment.
2) A quantum well device is a situation where a thin semiconductor layer of lower band gap material is sandwiched between two thick semiconductor layers of larger band gap.
3) Surface plasmon resonance is the manifestation of a resonance effect due to the interaction of conduction electrons of metal nanoparticles with incident photons.
4) The electroplating process is also known as electrodeposition.
5) A spectrophotometer measures the number of photons emitted to estimate the intensity of light spectra absorbed and transmitted by a sample
6) Nanoelectronics examines the electronic and magnetic properties of systems at the nanoscale

Q.2 Answer the following. **16**

a) Classify nanomaterials and give examples of each.
b) List major applications of nanotechnology.
c) With suitable example, explain the effect of size on properties of nanomaterials.
d) Draw a flow chart of sol-gel technique for producing nanomaterials.

Q.3 Answer the following.

a) Explain various methods for obtaining CNTs. **08**
b) Write the characteristics of AFM. **08**

Q.4 Answer the following.

a) Discuss the density of states at low-dimensional structures. **10**
b) Explain the mechanism of hopping conduction. **06**

Q.5 Answer the following.

a) Describe the top-down technique in nanoscience. **08**
b) Write a brief account on single electron transistor. **08**

Q.6 Answer the following.

a) Discuss the concept of core-shell in quantum dot. **10**
b) Describe the effect of size on SPR spectra. **06**

Q.7 Answer the following.

a) Explain Schottky and Poole-Frenkel effect. **08**
b) Describe the nanostructure of fullerene. **08**

SLR-GY-18

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (CONDENSED MATTER PHYSICS)
Experimental Techniques in Physics

Day & Date: Thursday, 23-02-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. Nos. 1 and 2 are compulsory.
2) Attempt any three questions from Q. No.3 to Q. No.7.
3) Figure to the right indicates full marks.

Q.1 A) Choose Correct Alternative: **10**

1) LVDT works on the principle of _____.
   a) Self induction b) Mutual induction
   c) Both a) and b) d) emf

2) The transducer which requires the power from an external supply source is known as
   a) Passive b) Active
   c) Inverse d) a) and c)

3) ____ has a zero internal resistance.
   a) Transducer b) Ideal voltmeter
   c) Ideal ammeter d) Power meter

4) The _____ is always connected in parallel with the circuit.
   a) Transducer b) Voltmeter
   c) Power meter d) Oscilloscope

5) _____ is a type of electrical instrument which is used for showing the measurement and analysis of waveforms and others electronic and electrical phenomenon
   a) Transistor b) Cathode ray oscilloscope
   c) Operational amplifier d) LCR meter

6) A pressure of 1000 mbar is _____.
   a) 100 kN/m^2 b) 0.1 kN/m^2
   c) 10 kPa d) 1000 Pa

7) X-ray wavelength of CuKα2 _____.
   a) 1.54051 A° b) 1.54433 A°
   c) 0.154051 A° d) 15.4051 A°

8) In _____ gauge, a Wheatstone bridge principle is employed
   a) Pirani b) Penning
   c) Pressure d) Thermocouple

9) Which of the following parameter influencing the functioning of the diffusion pump _____?
   a) Compression Ratio b) Critical Discharge Pressure
   c) Critical Discharge Pressure d) All of these

10) X-ray photoelectron spectroscopy is used for _____ analysis.
   a) Depth profiling
   b) Oxidation state analysis
   c) Both a) and b)
   d) None of these

B) Fill in the blanks OR Write true/false. **06**

1) If single crystal is analyzed _____ method is generally employed.
2) Elastic scattering takes place in _____.
3) _____ is a measure of the correlation between the phases measured at different points on a wave.
4) LASER is polychromatic, (true/false)
5) Photodiode works on the principle of Photoelectric effect, (true/false)
6) Phototransistor semiconductor device has a light-sensitive base region, (true/false)

Q.2 Answer the following. **16**

a) Write a note on Einstein's coefficients.
b) Explain PIN photodiode.
c) Write a note on regulated power supply.
d) Explain voltage and current driven inversion.

Q.3 Answer the following. **16**

a) Explain in detail X-Ray powder diffraction method.
b) Elaborate in detail Cyro pump.

Q.4 Answer the following. **16**

a) Explain in detail Scanning Electron Microscopy.
b) Write a detailed note on UV-Vis spectroscopy.

Q.5 Answer the following. **16**

a) Explain the working of four probe method.
b) How does Raman spectrometer works?

Q.6 Answer the following. **16**

a) Explain in detail Penning gauge.
b) Write a note on determination of crystal structure and lattice parameter of simple cubic.

Q.7 Answer the following. **16**

a) Explain the basic principle and instrumental configuration of XPS.
b) Write a note on Avalanche photodiode.