SLR-GU-1

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: Oct/Nov-2022
Physics (Solid State 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) $A^TA = 1$
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-GU-2

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (SOLID STATE 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-GU-3

Seat No.	

Set P

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

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

Instructions: 1) Question no. 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) Multiple choice questions. **10**

1) A (A+B) = ?
   a) AB b) 1
   c) (1+AB) d) A

2) Master slave flip is also referred to as?
   a) Level triggered flip flop b) Pulse triggered flip flop
   c) Edge triggered flip flop d) Edge-Level triggered flip flop

3) Which interrupt is not level sensitive in 8085?
   a) RST 7.5 b) RST 6.5
   c) RST 4.5 d) RST 5.5

4) Which of the following flag condition is used for BCD arithmetic operations in microprocessor?
   a) Sign flag b) Auxiliary carry flag
   c) Parity flag d) Zero flag

5) The AND gate output will be high if the two inputs are _____.
   a) 00 b) 01
   c) 10 d) 11

6) A one-shot is a type of _____ multivibrator.
   a) Astable b) Monostable
   c) Timer d) b & c are correct

7) In 8085 microprocessor _____ register used as a working area in CPU.
   a) A b) B
   c) H d) None of these

8) An Integrator has _____ in the input terminal, for an Opamp based circuit.
   a) Resistance b) Inductor
   c) Capacitor d) None of these

9) Output impedance of IC 741 is typically _____ Ω.
   a) 100 b) 1000
   c) 10 d) 1

10) _____ Oscillator uses capacitive voltage divider feedback.
   a) Hartley b) Phase shift
   c) Colpit d) Wien bridge

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

1) Differential Amplifier consists of _____ transistors.
2) Data bus of 8085 microprocessor is _____ bit.
3) SR flip flop does not accept the input entry when _____.
4) Phase shift of the Phase shift circuit at the resonance frequency is 180^0 (True/False)
5) Switching regulator is used for high power applications. (True/False)
6) Ideal op-amp has infinite voltage gain because to obtain finite output voltage. (True/False)

Q.2 Answer the following **16**

a) Virtual ground concept
b) DeMorgans Theorem
c) PIPO shift register
d) Flags in 8085

Q.3 Answer the following.

a) What is feedback? Explain effect of negative feedback on input resistance of OpAmp. **10**
b) Draw and explain Integrator using 741 OpAmp. **06**

Q.4 Answer the following.

a) Describe 4 bit D flip-flop with timing diagram. **10**
b) Draw and explain 8:1 Multiplexers. **06**

Q.5 Answer the following.

a) Draw and explain Phase shift Oscillator using Opamp. Obtain an expression for frequency. **10**
b) Design a non-inverting amplifier with Av =11, Given Ib=100nA, Vi >1V. **06**

Q.6 Answer the following.

a) Explain inverting configuration of 3 inputs Op Amp as a summing, scaling and averaging amplifier. **10**
b) Reduce the following logical expressions using Boolean laws: **06**

$$\overline{A}BC + A\overline{B}\overline{C} + ABC + \overline{A}B$$

Draw logic diagram of reduced expression.

Q.7 Answer the following.

a) Draw and explain architecture of 8085 microprocessor. **10**
b) Draw and explain memory write cycle of 8085 microprocessor. **06**

SLR-GU-4

Seat No.	

Set P

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

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

Instructions: 1) Question no. 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) Multiple choice questions. **10**

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

2) The point transformation is the transformations of _____.
   a) Phase space b) configuration space
   c) both a & b d) point space

3) The reduced mass $\mu =$ _____.
   a) $(m_1 + m_2)/m_1 m_2$ b) $m_1 m_2/(m_1 - m_2)$
   c) $m_1 m_2/(m_1 + m_2)$ d) $(m_1 - m_2)/m_1 m_2$

4) In equations of motion $\dot{P}_J =$ _____.
   a) $-\partial H/\partial P_j$ b) $\partial H/\partial P_j$
   c) $\partial H/\partial q_j$ d) $-\partial H/\partial q_j$

5) If eccentricity $\epsilon = 0$, then the shape of the orbit, which is formed due to motion under central force field will be _____.
   a) Ellipse b) Circle
   c) Hyperbola d) Parabola

6) The Hamiltonian is defined as _____.
   a) H=T-V b) H=T/V
   c) H=T*V d) H=T+V

7) The generating function $F_2(q, P, t)$ generates _____ transformations.
   a) exchange b) identity
   c) none d) infinite

8) The Phase space is _____dimensional space.
   a) 3N b) 2N
   c) 6N d) N

9) The Poisson bracket of [u,u] = _____.
   a) 1 b) u^2
   c) 0 d) 2u

10) If $m_1 \ll m_2$, then the centre of mass of system coincides with the centre of mass of _____.
   a) m_1 b) m_2
   c) in between m_1 and m_2 d) away from m_1

B) Fill in the blanks or write true or false. **06**

1) [X,Y]= [Y,X] is the property of the Poisson bracket.
2) The Hamiltonian formulation is more advantageous than the Newtonian.
3) In the Configuration space, the system is having a unique path.
4) There are three degrees of freedom for a flywheel.
5) The path of the particle is a straight line when it is moving under the constant conservative force field.
6) The Δ – variation involves time.

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

a) State and prove the law of conservation of linear momentum of system particles.
b) Write a note on Kepler's laws of planetary motion.
c) Which conditions are used to verify that the transformation is canonical? Prove any one condition.
d) What is generating function? What are its different forms?

Q.3 Answer the following.

a) Discuss the Hamilton-Jacobi theory and derive the Hamilton-Jacobi partial differential equation and its solution. **10**
b) Deduce the relation between the Hamiltonian and Lagrangian. **06**

Q.4 Answer the following.

a) Define Hamiltonian. Why Hamiltonian formulation is preferred over Langrangian formulation. **10**
b) How the equations of motion are written in terms of Poisson brackets. **06**

Q.5 Answer the following.

a) What are the main features of the motion of a particle under the action of central force? Show that the area swept per unit time i.e. dA/dt remains constant in such a motion. **10**
b) What are constraints? Explain with its example. **06**

Q.6 Answer the following.

a) What is Poisson Bracket? List its properties. Explain Jacobi's identity with its proof. **10**
b) Distinguish between the configuration space and phase space. **06**

Q.7 Answer the following.

a) How a two-body problem does reduce to a single-body problem? Derive the equation of motion for it. **10**
b) Write a note on Rutherford's scattering. **06**

SLR-GU-6

Seat No.		Set	P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (SOLID STATE 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**

SLR-GU-7

Seat No.		Set	P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (SOLID STATE 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-GU-8

Seat No.		Set	P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (SOLID STATE 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

SLR-GU-10

Seat No.		Set	P

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

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

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

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

1) Epitaxial techniques have been used for the growth of epilayers of III -V and, II -VI compound _____ and other materials.
   a) metals b) insulators
   c) semiconductors d) conductors

2) The maximum packing factor for a SC lattice of identical atoms with a lattice constant of 20 A^0 will be _____.
   a) 0.52 b) 0.68
   c) 0.34 d) 0.74

3) The initial process that occur in the formation of a crystal is_____.
   a) growth b) nucleation
   c) atomic bonding d) clusters

4) Czochralski method is crystal growth from_____.
   a) melt b) vapour
   c) solution d) solid

5) A semiconductor absorbs photons with energies_____.
   a) smaller than band gap energy only
   b) equal to the band gap energy only
   c) equal to the band gap or larger
   d) equal to the band gap or smaller

6) The driving force needed for the nucleation and growth of crystal is referred as ____.
   a) molecular force b) super saturation
   c) growth force d) atomic force

7) In indirect recombination the electron and hole pairs recombine at recombination level; *Er* in ____ steps.
   a) 2 b) 3
   c) 4 d) 5

8) The relation between frequency and wavelength is known as_____.
   a) the dispersion relationship
   b) de Broglie relation
   c) Cauchy's relation
   d) Planck relation

9) Which of the three semiconductors, Ge, Si and GaAs has a direct bandgap?
   a) Ge and GaAs b) Si and GaAs
   c) GaAs d) Ge and Si

10) Which of the following semiconductor has indirect band gap?
   a) Ge and GaAs b) Si and GaAs
   c) GaAs d) Ge and Si

Q.1 B) Fill in the blanks OR write True /False **06**

1) For lightly doped junction's electron tunneling is dominant phenomenon. (True/False)
2) In a semiconductor, the electrons occupy states near the top of the conduction band. (True/False)
3) A semiconductor with band gap of about 2 eV wide, allows only long wavelengths and the red part of the visible spectrum to transmit through it. (True/False)
4) First step in crystal growth is the transport of atoms through solution. (True/False)
5) Epitaxy means growth of many crystal films on top of a crystalline substrate. (True/False)
6) ____ epitaxy is a process of depositing epitaxial thin films from molecule of atomic beams on a heated substrate under UHV conditions.

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

a) Write a note on direct recombination of electrons and holes.
b) Discuss bonding forces in semiconductors.
c) What are the advantages of Epitaxial technology?
d) Explain the term nucleation rate and induction time.

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

a) Describe steady state carrier injection in case of semiconductor.
b) Explain with neat diagram Czocharalski method of crystal growth.

Q.4 Answer the following.

a) Discuss in detail "Effective mass" of an electron in a band. **10**
b) Explain with neat diagram Liquid Phase Epitaxy. **06**

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

a) Obtain an expression for electrical conductivity (σ) and mobility (μ) in case of semiconductors.
b) Explain with neat diagram Molecular Beam Epitaxy.

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

a) Explain Zone melting method of crystal growth.
b) Write a note on high field effects in semiconductors.

Q.7 Answer the followings. **16**

a) Explain indirect recombination and trapping of charge carriers of semiconductors.
b) Explain theory of nucleation and growth.

SLR-GU-11

Seat No.		Set	P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (SOLID STATE PHYSICS)
Atomic and 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. **10**

1) No two electrons in an atom can have the same quantum numbers is called _____
   a) Hund's rule b) Bhor's equation
   c) Pauli exclusion principle d) Dalton 's atomic theory

2) L-S coupling occurs often in _____
   a) All atoms b) Lighter atoms
   c) Heavier atom d) Occurs only in nuclei

3) The splitting of a spectral line in the presence of an electric filed is called _____
   a) Zeeman effect b) Stark effect
   c) Paschen-Back effect d) Raman effect

4) The excited energy of hydrogen atom is _____
   a) 10.2eV b) 7.2eV
   c) 1.02eV d) 9.18eV

5) Near infrared spectrum of diatomic molecule is known as _____
   a) Rotational spectrum b) Vibrational spectrum
   c) Electronic band spectrum d) Rotational-vibrational spectrum

6) The selection rule for pure rotational Raman spectra is _____
   a) $\Delta J = 0, \pm 1$ b) $\Delta J = 0, \pm 2$
   c) $\Delta J = 0$ d) $\Delta J = \pm 1$

7) The L_{β} line of X-Rays emitted from an atom with principal quantum number n=1,2,3 _____arises from the transition _____
   a) n= 4 → n=2 b) n= 3 → n=2
   c) n= 5 → n=2 d) n= 3 → n=1

8) The spin quantum number refers to _____
   a) Energy of electron
   b) Direction of electron spin
   c) Sublevel or shape of the orbital
   d) Orientation of orbital nucleus

9) The first Stokes line of a rotational Raman spectrum is observed at 12.96 cm^{-1}. Considering the rigid rotor approximation, the rotational constant is given by _____
   a) 6.48 cm^{-1} b) 3.24 cm^{-1}
   c) 2.16 cm^{-1} d) 1.62 cm^{-1}

10) Which of the following molecules does not exhibits a rotational spectrum?
   a) H2 b) CO
   c) HCl d) HBr

B) Write true/false **06**

1) Stem and Garlach experiments atom are placed in electric field.
2) The different quantum states have the same energy levels are called degeneracy.
3) A heteronuclear diatomic molecule consists of two unlikely atoms.
4) Raman effect is scattered a proton.
5) The change in frequency due to transition between vibrational energy levels.
6) The $2l$+1 number of splitting levels are present in the presence on magnetic field.

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

A) Define Paulis Exclusive Principle in detail.
B) Write a note on orbital and spin angular momentum.
C) Explain characteristics and continuous X-Ray spectrum in detail.
D) Write a note on Covalent, ionic and van der Waal bonding

Q.3 Answer the followings. **16**

A) Discuss the rotational spectra of a diatomic molecule as a nonrigid rotator.
B) Describe the hybridisation and types of hybridisations.

Q.4 Answer the followings. **16**

A) Explain Stem and Garlach Experiment and derive the expression for separation of an atom inside non-homogeneous magnetic field.
B) Explain Selection rule with example.

Q.5 Answer the followings. **16**

A) Explain Paschen-Back effect for 2S-2P transition.
B) Discuss the magnetic dipole moment of an electron.

Q.6 Answer the followings. **16**

A) Derive an expression for interaction energy of an electron due to spin orbit interaction.
B) Write a note on exchange symmetry of wavefunction.

Q.7 Answer the followings. **16**

A) State and explain Franck-Condon principle
B) Explain the principle of ESR and what are its basic requirements.

SLR-GU-13

Set No.		Set	P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (SOLID STATE PHYSICS)
Experimental Techniques for 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. **10**

1) Dielectric spectroscopy measure as _____ a function of frequency.
   a) Conductivity b) Permittivity
   c) Resistivity d) absorbance

2) The Principle of Pirani gauge is based on _____ of the medium.
   a) Combustibility b) thermal conductivity
   c) Humidity d) none of the above

3) A microscope in which an image is formed by passing an electron beam through a specimen and focusing electrons by magnetic lens is called as _____.
   a) SEM b) TEM
   c) Optical d) STM

4) X-rays are generated by _____.
   a) Geiger tube b) Goniometer
   c) Coolidge tube d) Rotameter

5) One of the widely used target material for generation of X-ray spectral line is _____.
   a) Zinc b) Molybdenum
   c) Xenon d) Manganese

6) The secondary electrons generated in SEM are useful for _____.
   a) morphology and topography
   b) contrast in composition
   c) elemental analysis
   d) to measure conduction of electrons

7) The _____ is a type of electrical transformer used for measuring linear displacement.
   a) inductive transducer
   b) linear variable differential transformer
   c) capacitive transducer
   d) resistive transducers

8) The differential scanning calorimetry technique is used to measure _____.
   a) Electrical conductivity b) impact energy
   c) thermal expansion d) specific heat

9) A device which converts a physical quantity into the proportional electrical signal is called a _____.
   a) Transducer b) Sensor
   c) Transistor d) none of these

10) In electromagnetic spectrum, the infrared region is located between the _____.
   a) visible and ultraviolet regions
   b) visible and microwave region
   c) visible and x-ray regions
   d) visible and γ-ray regions

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

1) He-Ne laser considered as gas LASER.
2) For a given gas at sufficiently low pressures, the thermal conductivity increases with pressure.
3) Raman lines are weak.
4) When a molecule absorbs infrared radiation then molecule vibrate slower.
5) The Thermogravimetric analysis measures the change in specific heat with temperature.
6) The basic material for optical fibre is silica.

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

a) Explain different types of dielectric relaxation in material.
b) Write the advantages of four probe method over two probe method.
c) What is transducer. What factors should be considered while selecting a transducer.
d) Explain the working of Hygrometer.

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

a) Explain in details construction and working of scanning electron microscopy.
b) What is shielding? Discuss types of shielding.

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

a) Explain the working rotary oil pump.
b) Explain the working of linear variable differential transformer LVDT.

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

a) Discuss various method used for obtaining low temperature.
b) Explain the working of Pirani gauge for low pressure measurement.

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

a) Explain the working of X-ray diffraction method for the analysis of crystal structure.
b) Explain the working of Scanning Tunnelling Microscopy with suitable diagram.

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

a) What is Ruby Laser? Explain the working of Ruby Laser with suitable diagram.
b) Explain the working principle of FTIR spectroscopy.

SLR-GU-15

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (SOLID STATE 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) $1/C^2VsV^2$

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**

SLR-GU-16

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (SOLID STATE 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. **06**
[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]

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**

SLR-GU-17

Seat No.		Set	P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (SOLID STATE)
Thin Film Physics and Technology

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) _____ gas is used in PVD
   a) Ammonia b) Carbon
   c) Hydrogen d) Argon

2) The gate electrode in MOS devices is _____
   a) Polysilicon b) Silicon dioxide
   c) Silicon nitride d) Silicon dinitride

3) Polysilicon can be doped with P or B to reduce _____.
   a) temperature b) volume
   c) resistivity d) mobility

4) _____ metal is not used in metallization.
   a) Aluminium b) Chromium
   c) Sodium d) Nickel

5) To ensure the formation of condensation nuclei, the evaporation rate must be sufficiently _____.
   a) low b) high
   c) no any relation d) low as well as high

6) PECVD is used for the deposition of _____ thin film.
   a) metal b) dielectric
   c) plasma d) conducting

7) Spray pyrolysis is an example of _____ phase synthesis.
   a) solid b) liquid
   c) gas d) plasma

8) In RF sputtering, the frequency of _____ is used for RF power supply equipment.
   a) 13.56 Hz b) 13.56 K Hz
   c) 13.56 MHz d) 13.56 GHz

9) Electrodeposition is a _____ phase chemical method of synthesis of nanostructured material.
   a) solid b) liquid
   c) gas d) plasma

10) Magnetron sputtering deposition process in which the _____ voltage is delivered across a ____pressure gas to create high energy plasma.
   a) high, high b) high, low
   c) low, low d) low, high

Q.1 B) Fill in the blanks OR Write True/False. **06**

1) Thermal evaporation is a popular chemical vapor deposition technique for t thin film deposition. **(True/False)**
2) Spray pyrolysis is physical deposition technique. **(True/False)**
3) Energies of the order of 0.1 to 0.5 eV correspond to physical adsorption. **(True/False)**
4) Thin film growth in which small nuclei are formed over the surface of substrate is called _____.
5) Phosphorous doped silicon dioxide referred as phosposilicate glass. **(True/False)**
6) _____ serves as conducting material for multilevel metallization.

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

a) What is condensation and nucleation.
b) Write a note on dielectric deposition.
c) Draw neat diagram of ion assisted deposition.
d) Write advantages and disadvantages of sputtering deposition.

Q.3 Answer the following.

a) Explain sol-gel process for deposition of thin films. What are its advantages? **10**
b) Explain silicon dioxide deposition. **06**

Q.4 Answer the followings.

a) Discuss briefly about chemical bath deposition of thin films, what are its advantages and drawbacks? **10**
b) Write a note on thin film transistor. **06**

Q.5 Answer the followings.

a) Discuss the various factors that affect the synthesis of nanoparticles. **08**
b) Explain metallization. **08**

Q.6 Answer the followings.

a)	Discuss thermal evaporation method of deposition of thin film, what are its advantages and drawbacks?	**10**
b)	Explain crystallographic structure of thin film.	**06**

Q.7 Answer the followings.

a)	Describe pulsed laser deposition method for depositing thin film. State its advantages and drawbacks.	**08**
b)	With neat diagram, explain formation stages of thin film.	**08**

SLR-GU-18

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (SOLID STATE PHYSICS)
Material Characterization Techniques

Day & Date: Tuesday, 23-02-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 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 Correct Alternative. **10**

1) Auger electron spectroscopy can be used for surface chemical analysis in a way similar to which of the following?
   a) ESCA b) SIMS
   c) ISS d) Ion spectroscopy

2) In fluorescence microscopy, which of the following performs the function of removing all light except the blue light?
   a) Exciter filter
   b) Barrier filter
   c) Dichroic mirror
   d) Mercury arc lamp

3) Electron Microscope can give a magnification up to ____.
   a) 15000X
   b) 100,000X
   c) 400,000X
   d) 100X

4) The resolving power of TEM is derived from____.
   a) electrons
   b) specimens
   c) power
   d) ocular system

5) The AFM uses a _____ to scan the surface of a molecule.
   a) X-ray film
   b) Nanosized tip
   c) Non-metal tip
   d) Nanodrop

6) Electron detector has a _____ doped glass tube with a secondary semiconducting coating.
   a) Quartz
   b) Silica
   c) Lead
   d) Caesium

7) What causes the splitting of energy levels in a magnetic field?
   a) Hund's Rule b) Zeeman Effect
   c) van der Waals interactions d) Aufbau Principle

8) Chemical shifts originate from ____.
   a) magnetic momentum
   b) electron shielding
   c) free induction decay
   d) scalar coupling (J -coupling)

9) In NMR the precession of bulk magnetisation generates through ____ law of electromotive force.
   a) Lens
   b) Maxwell
   c) Faraday's
   d) Hamiltonin

10) The relaxation time along the direction of static magnetic field B_0 is _____.
   a) Longitudinal relaxation time T_1
   b) Longitudinal relaxation time T_2
   c) Transverse relaxation time T_1
   d) Transverse relaxation time T_2

B) State True / False. **06**

1. Negative Staining is examining for virus particles, protein molecules and bacterial flagella.
2. Resolving power of a microscope is a function of Wavelength of light.
3. Discrete electrons can be observed in electron ionization of an atom in electron- electron interaction.
4. EPR spectroscopy infrared wavelength of the radiation is not used.
5. Chemical shifts originate from magnetic momentum.
6. Vacuum is not needed inside the X-Ray Photoelectron spectrometer.

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

a) Write a note on Resolution and Magnification.
b) Draw a complete schematic of Scanning Electron Microscope (SEM).
c) Discuss advantages and disadvantages of Scanning Tunnelling Microscope.
d) Explain the sampling depth in XPS.

Q.3 a) Explain Principle of Diffraction of light in detail. **08**
b) Write a note on contact and non-contact modes in Atomic Force Microscope (AFM). **08**

Q.4 a) Explain Bright field microscopy in detail? **08**
b) Explain Magic Angle Spinning (MAS). **08**

Q.5 a) Explain principle, instrumentation and working of AFM (Atomic Force Microscope). Draw schematic of SEM and explain working of each part? **08**
b) Draw the schematic diagram of AES and explain the working of each part of the microscope? **08**

Q.6 a) Explain secondary and backscattered electrons, flow they are formed? **08**
b) Explain principle and working of NMR Spectroscopy and write its applications. **08**

Q.7 a) Discuss Differential Interference Contrast (DIC) microscopy in detail. **08**
b) Explain Raman Spectroscopy with the help of classical and quantum approach. **08**

SLR-GU-20

Seat No.	

Set P

M.Sc. (Semester - IV) (Old) (CBCS) Examination: Oct/Nov-2022
PHYSICS (SOLID STATE 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 the correct alternatives from the options. **10**

1) In a semiconductor, the process whereby particles flow from a region of high concentration to a region of low concentration is called _____.
   a) diffusion b) drift
   c) displacement current d) drift and diffusion

2) Which of the following statements is true in case of mobility of charge carriers in semiconductors?
   a) mobility decreases with increase in doping concentration
   b) mobility is independent of doping concentration
   c) mobility increases with increase in doping concentration
   d) mobility increases with increase in doping concentration up to certain limit and decrease thereafter

3) The total velocity of a charge carrier in a semiconductor is _____.
   a) the sum of the random thermal velocity and drift velocity.
   b) the difference between the random thermal velocity and drift velocity.
   c) the ratio of the random thermal velocity to drift velocity.
   d) the product of the random thermal velocity and drift velocity.

4) Conductivity of the semiconductor material is given by _____.
   a) $\sigma = e(\mu_n n - \mu_p p)$ b) $\sigma = e(\mu_n n + \mu_p p)$
   c) $\sigma = e\mu_n n$ d) $\sigma = e\mu_p p$

5) The original CCD is proposed by_____ in Bell Laboratory.
   a) Boyle and Smith b) Hertz and Rutherford
   c) Newton d) Einstein

6) Which of the following is not a bidirectional thyristor?
   a) SUS b) DIAC
   c) TRIAC d) SBS

7) Semiconductor alloys of group _____ are used for PN junction photodiode.
   a) I & II b) II & III
   c) III & IV d) III & V

8) Phototransistor is same as npn transistor with unconnected _____.
   a) base b) emitter
   c) collector d) substrate

9) LASCR stands for _____.
   a) light activated silicon-controlled rectifier
   b) low anode current silicon-controlled rectifier
   c) laser activated silicon-controlled rectifier
   d) light amplification by silicon-controlled rectifier

10) The IGBT is essentially _____.
   a) A power MOSFET
   b) A power UJT
   c) A BJT on the input side & a power MOSFET on the output side.
   d) A power MOSFET on the input side & a BJT on the output side.

Q.1 B) Fill in the blanks/True or False. **06**

1) In CCD the time required to fill the well thermally is called the _____ time
2) State True or False. Statement: In P-i-n diode, 'i' stands for intrinsic semiconductor.
3) State true or false. Statement: All Lasing semiconductors has direct band gap.
4) The full form of semiconductor triggering device PUT is _____
5) The LED is a p-n junction, under forward bias condition. Whether the statement is True or False?
6) Double heterostructure (DH) laser, in which a thin layer of _____ is sandwiched between layers of a different semiconductor ($Al_xGa_{1-x}As$).

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

a) What are the requirements for electron transfer mechanism?
b) Explain construction of P-i-n diode.
c) Draw energy band diagram for p-type semiconductor showing Fermi level E_F, work function E_w, electron affinity, *x* and band gap, E_g.
d) A SCR has gate trigger voltage of 0.75 V and a trigger current of 7 mA. What is the input voltage that turns the SCR on? If the holding current is 6 mA, what is the supply voltage that turns the SCR off?

Q.3 Answer the following.

a) What is CCD? Explain three phase CCD. **08**

b) Discuss I-V characteristics of SCR. **08**

What is maximum gate-to source voltage that a MOSFET with a 5 nm gate oxide can withstand? Assume that the oxide breaks down at 8 MV/cm and the substrate voltage is zero.

Q.4 Answer the following.

a) Explain how transfer electron effect leads to negative differential resistance (NDR). **10**

b) Write a short note on two transistor analogy of SCR. **06**

Q.5 Answer the followings.

a) Explain charge storage, surface potential under depletion and mechanism of charge transfer in CCD. **08**

b) Discuss MIS structure. **08**

Q.6 Answer the following.

a) What is LASER? Explain semiconductor LASER. What are heterojunction lasers? **10**

b) Explain in brief IGBT. **06**

Q.7 Answer the following.

a) What is solar cell? Explain current voltage characteristics of solar cell. **10**

b) In Fig. Triac Problem, the switch is closed. If the triac has fired, what is the approximate current through the 22 Ω resister. [Given V = 77 V] **06**

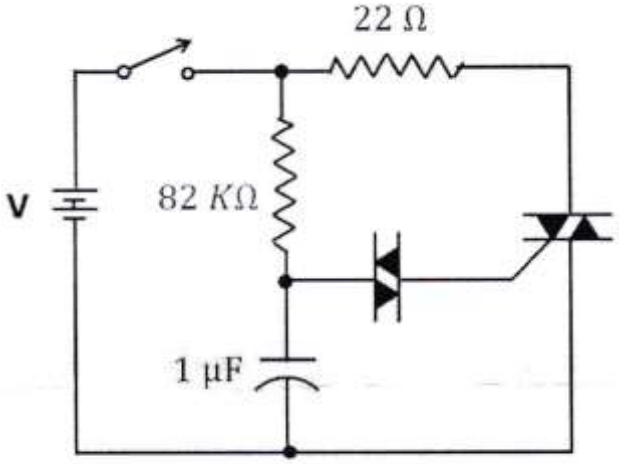

Fig.: Triac Problem

SLR-GU-22

Seat No.		Set	P

M.Sc. (Semester - IV) (Old) (CBCS) Examination: Oct/Nov-2022
PHYSICS (SOLID STATE)
Thin Film Physics and Technology

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) _____ gas is used in PVD
   a) Ammonia b) Carbon
   c) Hydrogen d) Argon

2) The gate electrode in MOS devices is _____
   a) Polysilicon b) Silicon dioxide
   c) Silicon nitride d) Silicon dinitride

3) Polysilicon can be doped with P or B to reduce _____.
   a) temperature b) volume
   c) resistivity d) mobility

4) _____ metal is not used in metallization.
   a) Aluminium b) Chromium
   c) Sodium d) Nickel

5) To ensure the formation of condensation nuclei, the evaporation rate must be sufficiently _____.
   a) low b) high
   c) no any relation d) low as well as high

6) PECVD is used for the deposition of _____ thin film.
   a) metal b) dielectric
   c) plasma d) conducting

7) Spray pyrolysis is an example of _____ phase synthesis.
   a) solid b) liquid
   c) gas d) plasma

8) In RF sputtering, the frequency of _____ is used for RF power supply equipment.
   a) 13.56 Hz b) 13.56 K Hz
   c) 13.56 MHz d) 13.56 GHz

9) Electrodeposition is a _____ phase chemical method of synthesis of nanostructured material.
   a) solid b) liquid
   c) gas d) plasma

10) Magnetron sputtering deposition process in which the _____ voltage is delivered across a ____pressure gas to create high energy plasma.
   a) high, high b) high, low
   c) low, low d) low, high

Q.1 B) Fill in the blanks OR Write True/False. **06**

1) Thermal evaporation is a popular chemical vapor deposition technique for t thin film deposition. **(True/False)**
2) Spray pyrolysis is physical deposition technique. **(True/False)**
3) Energies of the order of 0.1 to 0.5 eV correspond to physical adsorption. **(True/False)**
4) Thin film growth in which small nuclei are formed over the surface of substrate is called _____.
5) Phosphorous doped silicon dioxide referred as phosposilicate glass. **(True/False)**
6) _____ serves as conducting material for multilevel metallization.

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

a) What is condensation and nucleation.
b) Write a note on dielectric deposition.
c) Draw neat diagram of ion assisted deposition.
d) Write advantages and disadvantages of sputtering deposition.

Q.3 Answer the following.

a) Explain sol-gel process for deposition of thin films. What are its advantages? **10**
b) Explain silicon dioxide deposition. **06**

Q.4 Answer the followings.

a) Discuss briefly about chemical bath deposition of thin films, what are its advantages and drawbacks? **10**
b) Write a note on thin film transistor. **06**

Q.5 Answer the followings.

a) Discuss the various factors that affect the synthesis of nanoparticles. **08**
b) Explain metallization. **08**

Q.6 Answer the followings.

a) Discuss thermal evaporation method of deposition of thin film, what are its advantages and drawbacks? **10**

b) Explain crystallographic structure of thin film. **06**

Q.7 Answer the followings.

a) Describe pulsed laser deposition method for depositing thin film. State its advantages and drawbacks. **08**

b) With neat diagram, explain formation stages of thin film. **08**