SLR-GV-1

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (Nanophysics)
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-GV-2

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (NANOPHYSICS)
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-GV-3

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (NANOPHYSICS)
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-GV-4

Seat No.		Set	P

M.Sc. (Semester-I) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (NANOPHYSICS)
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 μ = _____.
   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 ϵ = 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-GV-6

Seat No.		Set	P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (NANOPHYSICS)
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) $E_{zero\ point} = \frac{h^2}{4m_e a^2}$

b) $E_{zero\ point} = \frac{h^2}{8m_e a^2}$

c) $E_{zero\ point} = -\frac{h^2}{8a^2}$

d) $E_{zero\ point} = \frac{h^2}{8m_e}$

8) The potential energy of particle in harmonic oscillator is given by

a) $V = kx^2$ b) $V = \frac{1}{2}kx^2$

c) $V = \frac{1}{4}kx^2$ d) $V = \frac{1}{8}kx^2$

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) $\nabla^2 = \frac{\partial^2}{\partial x^2} - \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$

b) $\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$

c) $\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} - \frac{\partial^2}{\partial z^2}$

d) $\nabla^2 = \frac{\partial^2}{\partial x^2} - \frac{\partial^2}{\partial y^2} - \frac{\partial^2}{\partial z^2}$

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-GV-7

Seat No.		Set	P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (NANOPHYSICS)
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-GV-8

Seat No.		Set	P

M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (NANOPHYSICS)
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-GV-10

Seat No.		Set	P

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

Day & Date: Monday, 13-02-2023 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) Select the correct alternative. **10**

1) Breaking of _____ produces electron hole pair.
   a) metallic bond b) Covalent bond
   c) ionic bond d) hydrogen bond

2) In case of good conductors, the valence band and conduction band are
   a) having very small gap
   b) just touched
   c) overlapped
   d) having large gap

3) GaAs is used in LED because _____.
   a) Low cost as compared to silicon
   b) Indirect band gap semiconductor
   c) Direct band gap semiconductor
   d) None of above

4) The energy of trapping level is due to _____
   a) conduction band
   b) forbidden gap
   c) valence band
   d) all are true

5) The diffusion current in semiconductor is due to _____.
   a) carrier gradient
   b) uniform distribution of carrier
   c) external potential
   d) all of above

6) Haynes-Shockley experiment is used to measure the minority carrier ____.
   a) mobility b) concentration
   c) density d) charge

7) The value of potential outside the potential well is _____.
   a) Zero
   b) Infinite
   c) Finite
   d) Equal to applied potential

8) Inverse effective mass tensor is a _____ dimensional quantity.
   a) one b) two
   c) three d) four

9) The fermi energy level in P-type semiconductor is ____.
   a) near conduction band b) at the center of forbidden gap
   c) near the valence band d) inside the valence band

10) As nucleation is depends up on _____.
   a) pressure b) temperature
   c) saturation d) all of above

B) Write True/False **06**

1) The momentum of electron changes when it jumps from conduction band to valence band in indirect semiconductor.
2) All radiation incident on semiconductor produces EHP.
3) At thermal equilibrium rate of EHP generation and recombination are equal.
4) The effective mass of electron is always less than rest mass.
5) Nucleation is a beginning of phase change.
6) All recombination of EHP produces photon.

Q.2 Answer the following **16**

a) Explain the ionic and covalent bond with example.
b) Derive the expression for absorption of light in semiconductor.
c) Explain the formation of rectifying contact between metal and semiconductor.
d) Write a note on super cooling and super saturation.

Q.3 Answer the following

a) Derive an expression for fermi energy and explain carrier concentrations in intrinsic semiconductor in thermal equilibrium. **10**
b) Explain the conductivity of metals, semiconductors and insulators on the basic of band theory. **06**

Q.4 Answer the following

a) Derive the one dimensional continuity equation. **10**
b) Explain the indirect recombination processes in semiconductor. Explain different types of trapping levels. **06**

Q.5 Answer the following **16**

a) Derive an expression for inverse effective mass tensor and give its significance.
b) Derive an expression for current density in intrinsic semiconductor.

Q.6 Answer the following

a) Explain zone melting and zone refining processes in semiconductor. **10**
b) Explain liquid phase epitaxial growth. **06**

Q.7 Answer the following **16**

a) Explain direct band gap and indirect band gap semiconductors. Give their applications.
b) Explain thermal equilibrium state and study state carrier generation under illumination in semiconductor.

SLR-GV-11

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (NANOPHYSICS)
Automatic 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. (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-GV-12

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (NANOPHYSICS)
Functional Nanomaterials

Day & Date: Wednesday, 15-02-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 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) Which of the following electrolyte used in synthesis of TiO_2 Nanotube array in Third generation?
   a) Aqueous electrolyte b) Non Aqueous electrolyte
   c) Polar organic electrolyte d) Polar inorganic electrolyte

2) Nano indentation is effective technique for probing _____ thin coated systems.
   a) Electrical b) Mechanical
   c) Thermal d) Optical

3) The Electrospinning process can be adjusted to control the fibre diameter by varying _____ and polymer solution concentration.
   a) Magnetic field Strength
   b) Electric field strength
   c) Magnetic and Electric Field Strength
   d) None of these

4) Which one of the following is an example for top down approach?
   a) Sol-Gel process b) Ball milling technique
   c) CVD d) None of the above

5) Which of the following is an electrically conducting or semiconducting nanofibre?
   a) Nanowires b) Nanotubes
   c) Nanorods d) None of these

6) At room temperature, the polymer is formed the then it is _____.
   a) brittle b) viscofluid state
   c) amorphous d) rubbery

7) The curing process of thermoset is completely _____.
   a) reversible b) irreversible
   c) adiabatic d) isothermal

8) The TNT array is an expected material for _____.
   a) hydrogen splitting from oil
   b) hydrogen splitting from air
   c) hydrogen splitting from film
   d) hydrogen splitting from water

9) It is experimental evidence to believe that TiO_2 nanotube arrays are an expected _____.
   a) photocatalytic material responding to the visible light
   b) photocatalytic material responding to the IR light
   c) photocatalytic material responding to the X-ray light
   d) photocatalytic material responding to the γ-ray light

10) Nanofiber technology provides a critical link between _____.
   a) nanoscale effect and microscopic
   b) meterscale effect and macroscopic
   c) nanoscale effect and macroscopic
   d) meterscale effect and microscopic

B) Write true or false. **06**

1) The motion of electron confined in two directions in the nanowires. (True/False)
2) In second generation, method of TiO_2 Polar organic electrolyte is used. (True/False)
3) The electrospinning process can be adjusted to control fibre diameter by varying electric filed strength and polymer solution concentration. (True/False)
4) The range of identical Temperature for synthesis of MOF is 500° C to 600° C. (True/False)
5) Carbon atom can form four covalent bonds. (True/False)
6) Quantum dots have two dimensions. (True/False)

Q.2 Answer the following **16**

a) Write the short on the structural properties of TiO_2 Nanotube arrays.
b) Discuss the applications of quantum dots in Biomedicine.
c) What are structural applications nanocomposite fibre?
d) Write the short on the fabrication techniques of Polymer Nanocomposites.

Q.3 Answer the following.

a) Discuss the fabrication process of TiO_2 nanotube arrays by electrochemical anodization with First synthesis generation. **10**
b) Explain the basic material used for Polymer Nanocomposites. **06**

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

a) Write in detail Electrospinning Process for Nanofibres.
b) Explain the synthesis method of semiconductor Nanocrystal in organic solvent.

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

a) What is polymerisation? Explain Emulsion polymerisation.
b) Explain in detail Arc discharge and Arc melting synthesis method of Boron Nitride Nanotube.

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

a) Describe Layer-by-Layer (LBL) assembly with semiconductor Nanoparticles and Nanowires.
b) Define Metal Oxide Frameworks. Write down its advantages and disadvantages.

Q.7 Answer the following.

a)	What are the key processing parameters of Electrospinning process of Nanofibre and explain any four key parameters in detail?	**10**
b)	What are properties of polymer Nanocomposites?	**06**

SLR-GV-14

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (NANOPHYSICS)
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-GV-15

Seat No.	

Set P

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

Day & Date: Tuesday, 21-02-2023 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) Fill in the blanks by choosing correct alternatives given below. **10**

1) Energy equivalent of 1 a.m.u. is _____.
   a) 931 eV b) 931 KeV
   c) 931 MeV d) 931 BeV

2) The energy released per fission of U-235 is about _____.
   a) 200 eV b) 200 KeV
   c) 200 MeV d) 200 ergs

3) The conservation laws of energy and momentum _____.
   a) are valid for all situations at all levels
   b) are always obeyed at the macroscopic level, but always violated at the atomic level
   c) may be violated at the atomic level if the violation does not last too long
   d) are no longer valid at any level

4) Which one of the following is not a member of the lepton family?
   a) electron b) muon
   c) proton d) neutrino

5) When electron annihilates with a positron, the amount of energy released is equal to the _____.
   a) total rest mass of the electron and the positron
   b) rest mass of the electron
   c) rest mass of the positron
   d) binding energy of the hydrogen atom

6) Quantum chromodynamics explains the _____ among the quarks.
   a) chemical reactions b) chain reactions
   c) nuclear fission d) strong interaction

7) The radius R of a nucleus is given by _____.
   a) $R= r_oA^{-1/3}$ b) $R=r_oA^{1/3}$
   c) $R= r_oA^{-3}$ d) $R= r_oA^{3}$

8) Which of the following is the main disadvantage of semiconductor detector?
   a) Low accuracy
   b) Low sensitivity
   c) It should be maintained at low temperature
   d) High avalanche breakdown voltage

9) Scintillation detector is a large flat crystal of which of the following materials?
   a) Sodium chloride b) Sodium iodide
   c) Sodium carbonate d) Sodium sulphate

10) The maximum kinetic energy of the positive ion in the cyclotron is _____.
   a) $qBR^2/2m$ b) $q^2B^2R^2/2m$
   c) $q^2B^2R^2/m$ d) qBR/m

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

1) The strong nuclear force acts over the distance _____.
2) The liquid drop model of nucleus was developed by _____.
3) The Bethe-Weizsacker's mass formula is also called _____.
4) The splitting of the nucleus into two or more parts is called _____.
5) The exchange particle which holds the quarks together is called _____.
6) Nuclear binding energies are usually expressed in units of _____.

Q.2 Answer the following **16**

a) Explain spin-orbit interaction of nucleus.
b) What is Q-value of a nuclear reaction? Explain its significance.
c) Explain short range nuclear forces.
d) Give a short account of the liquid drop model of nucleus.

Q.3 Answer the following **16**

a) Give an account of meson theory of nuclear forces. Explain Yukawa's hypothesis.
b) Explain the conservation laws of nuclear reactions. Give an account of Nuclear fusion and Nuclear fission with examples of nuclear reactions.

Q.4 Answer the following **16**

a) Explain mass, shape, size and spin of nucleus. Write a note on nuclear binding energy. Explain nuclear stability using nuclear binding energy curve.
b) What is radioactivity? Explain the laws of radioactivity. Give a short account of carbon dating.

Q.5 Answer the following **16**

a) What are Cosmic rays? Give an account of origin of Cosmic rays. Explain the properties of primary Cosmic rays.
b) What are particle accelerators? Explain the principle and working of Synchrotron.

Q.6 Answer the following **16**

a) Give an account of Scintillation counter.
b) Give an account of elementary particles. Explain the classification of elementary particles based on symmetry.

Q.7 Answer the following **16**

a) What are Quarks? Explain the types of quarks. Give an account of CPT theorem.
b) Explain the construction and working of cyclotron. What are its disadvantages?

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Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2022
PHYSICS (NANOPHYSICS)
Characterization 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 correct alternative. **10**

1) TGA techniques is used to find _____.
   a) changes in weight b) changes in length
   c) changes in height d) none of A, B, C

2) The essential components of all SEMs are _____.
   a) electron lenses b) electron source (gun)
   c) sample state d) All A, B & C

3) X-ray diffraction is an important technique used to study _____.
   a) crystal structure b) defects in crystal
   c) lattice parameter d) All A, B, C

4) _____ have extremely large surface area to volume ratio.
   a) Medium materials b) Bulk materials
   c) Nano materials d) None of A, B, C

5) If semiconductor particles size reduces then band gap is _____.
   a) decrease b) increase
   c) remains constant d) becomes zero

6) _____ of nano material depend upon reflection, absorption and transmission light phenomenon.
   a) Optical properties b) Magnetic properties
   c) Mechanical properties d) None of A, B, C

7) _____ is used to measure absorption and transmittance.
   a) SEM b) AFM
   c) UV visible spectrometer d) None of A, B, C

8) FTIR analysis provides information about _____ of material.
   a) chemical bonding b) particle velocity
   c) density d) colour

9) STM was first developed by _____ in 1981.
   a) Ruska b) Thomson
   c) Knoll d) Binning

10) _____ is the length between 1 nm to 100 nm.
   a) Nano scale b) Micro scale
   c) Mile Scale d) None of A, B, C

B) Answer the following. **06**

1) Atomic Force Microscopy has _____ resolution type.
2) NMR is used as advanced medical imaging techniques in _____.
3) 'There is plenty of room at the bottom' this quote by Richard Bradman. **(True/False)**
4) Bulk material has high surface to volume ratio. **(True/False)**
5) Which technique used to identify the elemental composition of specimen?
6) What is the discovery of W.C. Rontgen?

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

a) What is high resolution imaging in SEM?
b) What are different types of chemical sample preparation methods? Explain any one method in detail.
c) How the X-ray production takes place? Write any four application of X-ray.
d) Write a short note on Bulge test.

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

a) What are the different spectroscopic equipment? Explain UV-VIS spectroscope in detail.
b) What are the applications of nano material in medical sector?

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

a) What are the mechanical properties of nano material? Explain any two properties in detail.
b) Explain the FTIR technique in detail with neat diagram.

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

a) Explain HRTEM and find excitation wave length.
b) Explain thermal conductivity property of nano material.

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

a) What is nonlinear Kerr effect? How the optical band gap is found?
b) What is quantum yield? Obtain the relation of quantum efficiency.

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

a) Explain XRD in detail with neat diagram to study crystal structure.
b) Explain TEM in detail with neat diagram.

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Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov - 2022
PHYSICS (NANOPHYSICS)
Nano Material Fabrication Techniques

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 right indicate full marks.

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

1) _____ is emission of light when atoms excited by high electrons turn to their ground state.
   a) Cathode luminescence b) Photoluminescence
   c) Fluorescence d) Electron detection

2) In TEM, the darker area of the image represent those areas of the sample in which few of _____ were transmitted.
   a) Photons b) electrons
   c) Atoms d) None of a, b, & c

3) _____ is designed to measure phase difference between object specimen and surrounding medium.
   a) Phase contrast microscope b) Bright field microscope
   c) Dark field microscope d) Travelling microscope

4) The number of spin for individual proton and neutron, the parallel treatment of electron spin is _____.
   a) ¾ b) ½
   c) 1/3 d) ¼

5) NMR Spectroscopy is used to study _____ properties of matter.
   a) chemical b) physical
   c) biological d) all a, b, c

6) 1×10^{-9} meter is equal to _____.
   a) one nano meter b) one micro meter
   c) one mile meter d) one centimeter

7) The electron radiation in vacuum and the electrons are transmitted through sample. This method of sample image production is known as _____.
   a) SEM b) XRD
   c) TEM d) AFM

8) The XPS and SEM stands for _____.
   a) x-ray polarized spectroscopy and scanning electron microscopy
   b) x-ray photoelectron scattering and scanning electrode microscopy
   c) x-ray photoelectron spectroscopy and scanning electron microscopy
   d) x-ray photo electron scanner and scanning electron microphone

9) AES is used for _____.
   a) surface mapping b) depth profiling
   c) thin film analysis d) All a, b & c

10) Scanning probe microscopy is also known as _____.
   a) atomic force microscopy
   b) scanning tunneling microscopy
   c) transmission electron microscopy
   d) scanning electron microscopy

B) Answer the following **06**

1) In general, _____ is used to measure topography with force probe.
2) DIC Stand for _____.
3) FESEM stands for field emitter scanning electron microscope. Whether this sentence is true or false?
4) In atomic force microscope LASER source is uses. Whether this sentence is true or false?
5) Which force is used between tip and surface of AFM?
6) What is long form of FTIR?

Q.2 Answer the following **16**

a) Write a note on bright field microscope.
b) What is the principal of AFM? What are contact and noncontact modes in AFM?
c) Write a short note on auger transition.
d) What is resonance condition in ESR and NMR?

Q.3 Answer the following **16**

a) What are different types of an optical spectrometer? Explain any one in detail with neat diagram.
b) What is the AFM? Obtain the equation of force curves,

Q.4 Answer the following **16**

a) What are secondary and backscattered electrons? Explain SEM in detail with neat diagram.
b) What is the principle of TEM? Explain the construction and working of TEM with neat diagram.

Q.5 Answer the following **16**

a) Explain high resolution solid state NMR methods in detail.
b) What is resonance condition in EPR and NMR? Explain principle and working of EPR in detail.

Q.6 Answer the following **16**

a) What is cross polarization? Explain CP-MAS experiment in detail.
b) What is electron diffraction? Obtain Bragg's condition of diffraction.

Q.7 Answer the following **16**

a) What is the principle of diffraction of light? Obtain Rayleigh criteria of diffraction.
b) What is the principle of STM? Explain construction and working of STM with diagram.

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Seat No.	

Set P

M.Sc. (Semester - IV) (Old) (CBCS) Examination: Oct/Nov-2022
PHYSICS (NANOPHYSICS)
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) Fill in the blanks by choosing correct alternatives given below. **10**

1) What does MOSFET Stands for?
   a) Metal oxide Semiconductor Field Effect Transistor
   b) Metal oxidized Silicon based Field Effect Transistor
   c) Metal oxidized Silicon based Force Effect Transistor
   d) Metal oxidized Silicon Field Equivalent Transistor

2) What type of a device is MOSFET?
   a) Current-controlled
   b) Voltage-controlled
   c) Voltage-controlled current source
   d) Voltage-controlled voltage source

3) What is the full form of LASER?
   a) Light Absorbent and Stimulated Emission of Radiations
   b) Light Absorbing Solar Energy Resource
   c) Light Amplification of Stimulated Emission of Radiations
   d) Light Amplification of Singular Emission of Radiations

4) CMOS stands for _____.
   a) Complementary Metal Oxide Semiconductor
   b) Commutative Metal Oxide Semiconductor
   c) Cosmopolitan MOS
   d) Customize MOS

5) An ideal power diode much have _____.
   a) low forward current carrying capacity
   b) large reverse breakdown voltage
   c) high ohmic junction resistance
   d) high reverse recovery time

6) Which of the following scientist discovered Schottky diode?
   a) Walter H Schottky b) James Schottky
   c) Richard d) Daniel Schottky

7) What does LED stand for?
   a) Light Emitting Display b) Low Energy Display
   c) Light Emitting Diode d) Light Emitting Detector

8) The device whose symbol is seen to be two SCR's inverse parallel connected is: _____.
   a) Triac Switch b) Silicon unilateral switch
   c) Mid-point gate thyristor d) Silicon unidirectional diac

9) The most significant advantage of CCD is _____.
   a) Low density b) high density
   c) Low Gain d) high Gain

10) The gunn effect is also known as _____.
   a) Transient avalanche effect
   b) Auto electronic effect
   c) Transfer transient effect
   d) Transferred electron effect

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

1) A CCD memory require a very small area.
   a) True b) False
2) The most commonly used materials for gunn diodes is GaAs.
   a) True b) False
3) The charge coupled device discovered in _____ by the Bell telephone laboratories.
4) An SCR is sometimes called _____.
5) Schottky diode consist of _____ semiconductor junction.
6) A photoconductive cell is used for low frequency application.
   a) True b) False

Q.2 Answer the following **16**

a) Write short notes on MIS Structure.
b) What is the transferred electron effect?
c) Write short notes on avalanche characteristics.
d) Explain the term threshold current density.

Q.3 Answer the following **16**

a) Explain the current flow mechanism in MS junction.
b) Discuss the characteristics of DIACs and TRIACs.

Q.4 Answer the following **16**

a) Write the difference between LED and LASER.
b) Explain the charge transfer mechanisms of CCD.

Q.5 Answer the following **16**

a) Discuss the frequency responses of Gunn devices.
b) Discuss special characteristics of CMOS devices.

Q.6 Answer the following **16**

a) Discuss the various materials for semiconductor LASER.
b) Discuss characteristics of Power diode.

Q.7 Answer the following **16**

a) Draw the circuit diagram of Solar cell and explain I-V characteristics.
b) Explain the depletion node of operation in MOSFET.

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Set P

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

Day & Date: Tuesday, 21-02-2023 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) Fill in the blanks by choosing correct alternatives given below. **10**

1) Energy equivalent of 1 a.m.u. is _____.
   a) 931 eV b) 931 KeV
   c) 931 MeV d) 931 BeV

2) The energy released per fission of U-235 is about _____.
   a) 200 eV b) 200 KeV
   c) 200 MeV d) 200 ergs

3) The conservation laws of energy and momentum _____.
   a) are valid for all situations at all levels
   b) are always obeyed at the macroscopic level, but always violated at the atomic level
   c) may be violated at the atomic level if the violation does not last too long
   d) are no longer valid at any level

4) Which one of the following is not a member of the lepton family?
   a) electron b) muon
   c) proton d) neutrino

5) When electron annihilates with a positron, the amount of energy released is equal to the _____.
   a) total rest mass of the electron and the positron
   b) rest mass of the electron
   c) rest mass of the positron
   d) binding energy of the hydrogen atom

6) Quantum chromodynamics explains the _____ among the quarks.
   a) chemical reactions b) chain reactions
   c) nuclear fission d) strong interaction

7) The radius R of a nucleus is given by _____.
   a) $R= r_oA^{-1/3}$ b) $R=r_oA^{1/3}$
   c) $R= r_oA^{-3}$ d) $R= r_oA^{3}$

8) Which of the following is the main disadvantage of semiconductor detector?
   a) Low accuracy
   b) Low sensitivity
   c) It should be maintained at low temperature
   d) High avalanche breakdown voltage

9) Scintillation detector is a large flat crystal of which of the following materials?
   a) Sodium chloride b) Sodium iodide
   c) Sodium carbonate d) Sodium sulphate

10) The maximum kinetic energy of the positive ion in the cyclotron is _____.
   a) $qBR^2/2m$ b) $q^2B^2R^2/2m$
   c) $q^2B^2R^2/m$ d) qBR/m

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

1) The strong nuclear force acts over the distance _____.
2) The liquid drop model of nucleus was developed by _____.
3) The Bethe-Weizsacker's mass formula is also called _____.
4) The splitting of the nucleus into two or more parts is called _____.
5) The exchange particle which holds the quarks together is called _____.
6) Nuclear binding energies are usually expressed in units of _____.

Q.2 Answer the following **16**

a) Explain spin-orbit interaction of nucleus.
b) What is Q-value of a nuclear reaction? Explain its significance.
c) Explain short range nuclear forces.
d) Give a short account of the liquid drop model of nucleus.

Q.3 Answer the following **16**

a) Give an account of meson theory of nuclear forces. Explain Yukawa's hypothesis.
b) Explain the conservation laws of nuclear reactions. Give an account of Nuclear fusion and Nuclear fission with examples of nuclear reactions.

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a) Explain mass, shape, size and spin of nucleus. Write a note on nuclear binding energy. Explain nuclear stability using nuclear binding energy curve.
b) What is radioactivity? Explain the laws of radioactivity. Give a short account of carbon dating.

Q.5 Answer the following **16**

a) What are Cosmic rays? Give an account of origin of Cosmic rays. Explain the properties of primary Cosmic rays.
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Q.6 Answer the following **16**

a) Give an account of Scintillation counter.
b) Give an account of elementary particles. Explain the classification of elementary particles based on symmetry.

Q.7 Answer the following **16**

a) What are Quarks? Explain the types of quarks. Give an account of CPT theorem.
b) Explain the construction and working of cyclotron. What are its disadvantages?

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Seat No.	

Set P

M.Sc. (Semester - IV) (Old) (CBCS) Examination: Oct/Nov-2022
PHYSICS (NANOPHYSICS)
Characterization 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
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Q.1 A) Choose correct alternative. **10**

1) TGA techniques is used to find _____.
   a) changes in weight b) changes in length
   c) changes in height d) none of A, B, C

2) The essential components of all SEMs are _____.
   a) electron lenses b) electron source (gun)
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4) _____ have extremely large surface area to volume ratio.
   a) Medium materials b) Bulk materials
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5) If semiconductor particles size reduces then band gap is _____.
   a) decrease b) increase
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6) _____ of nano material depend upon reflection, absorption and transmission light phenomenon.
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B) Answer the following. **06**

1) Atomic Force Microscopy has _____ resolution type.
2) NMR is used as advanced medical imaging techniques in _____.
3) 'There is plenty of room at the bottom' this quote by Richard Bradman. **(True/False)**
4) Bulk material has high surface to volume ratio. **(True/False)**
5) Which technique used to identify the elemental composition of specimen?
6) What is the discovery of W.C. Rontgen?

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

a) What is high resolution imaging in SEM?
b) What are different types of chemical sample preparation methods? Explain any one method in detail.
c) How the X-ray production takes place? Write any four application of X-ray.
d) Write a short note on Bulge test.

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

a) What are the different spectroscopic equipment? Explain UV-VIS spectroscope in detail.
b) What are the applications of nano material in medical sector?

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

a) What are the mechanical properties of nano material? Explain any two properties in detail.
b) Explain the FTIR technique in detail with neat diagram.

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

a) Explain HRTEM and find excitation wave length.
b) Explain thermal conductivity property of nano material.

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

a) What is nonlinear Kerr effect? How the optical band gap is found?
b) What is quantum yield? Obtain the relation of quantum efficiency.

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

a) Explain XRD in detail with neat diagram to study crystal structure.
b) Explain TEM in detail with neat diagram.