SLR-SV-1

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANOPHYSICS)
Mathematical Physics (MSC09101)

Day & Date: Wednesday, 19-07-2023 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) Choose correct alternatives. **10**

1) A point at which a Function $f(z)$ is not analytic is known as a _____ or singularity of the Function.
   a) Scalar point b) Singular point
   c) Non - Singular d) None of these

2) In Cauchy's Residue theorem $\oint_{\Gamma} f(z)dz =$ _____.
   a) $2\pi i \sum_{j=1}^{n} a - 1 z_j$ b) $2\pi i$
   c) $2\pi i \sum_{j=1}^{n}$ d) $2\pi i \sum_{j=1}^{n} a + 1\, z_j$

3) In complex variable theory $\int_c f(z)/dz$ is called a _____ of $f(z)$ along the contour c from $Z_0\ to\ Z'$.
   a) Contour integral b) Residue
   c) Contour d) None of these

4) What are the eigen value of $\begin{pmatrix} 1 & -i \\ i & 1 \end{pmatrix}$?
   a) Both are 0 b) 0 and 1
   c) 0 and -1 d) 0 and 2

5) If A, B and C are non-zero Hermitian operator which of the following relations must be false?
   a) $[\,A, B\,] = C$ b) $AB + BA = C$
   c) $A\,B\,A = C$ d) $A + B = C$

6) Which of the following is on even function of t?
   a) $t^2 - 4t$ b) $t^3 + 6$
   c) t^2 d) $\sin(2t) + 3t$

7) The degree of $x\frac{d^2y}{dx^2} + \sin\frac{dy}{dx} = 0$ is _____.
   a) 1 b) 2
   c) 3 d) Not defined

8) A square matrix, conjugate transpose of which coincide with the matrix itself is called _____.
   a) Unitary b) Hermitian
   c) Orthogonal d) Skew Hermitian

9) Laplace transform of $f(t)$ is defined for _____.
   a) +ve value of t b) -ve value of t
   c) Both +ve & -ve value of t d) None of these

10) A square matrix A is idempotent if _____.
   a) $A' = A$ b) $A' = -A$
   c) $A^2 = A$ d) $A^2 = A^2$

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

1) A square matrix is called orthogonal if $A = A^{-1}$.
2) The function $|\bar{z}|^2$ is not analytic at any point.
3) $x\frac{\partial u}{\partial x} + t\frac{\partial u}{\partial t} = 2u$ is an ordinary differential equation
4) The Function $y = 0$ is always a solution to a linear homogeneous ordinary differential equation.
5) If $y(x)$ is solution to an n[th] order ODE and contain arbitrary constant, then it must be the general solution to the ODE.
6) In matrix with 9 elements then the possible ordered pair are (3,3) (1,9) (9,1)

Q.2 Answer the following **16**

a) Show that any square matrix can be expressed as the sum of two matrices, one symmetric and the other antisymmetric.

b) Solve $\left(1 + e^{x/y}\right)dx + e^{x/y}(1 - x/y)dy = 0$

c) Find the poles of $f(z) = \frac{\sin(z-a)}{(z-a)4}$

d) Verify that :
$A = \frac{1}{3}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ -2 & 2 & -1 \end{bmatrix}$ is orthogonal

Q.3 Answer the following.

a) Show that the transformation **08**
$y_1 = 2x_1 + x_2 + x_3, \quad y_2 = x_1 + x_2 + 2x_3, \quad y_3 = x_1 - 2x_3$ is regular, write down the inverse transformation.

b) Expand the function in square wave $f(x) = 0;\ -\pi \le x \le 0$ **08**
$f(x) = h;\ 0 \le x \le \pi$ Fourier series

Q.4 Answer the following.

a) Show that the eigen value of Hermitian matrix are real. **08**

b) Evaluate the integral $\int_0^{2\pi} \frac{d\theta}{5 - 3\cos\theta}$ **08**

Q.5 Answer the following.

a) Explain Gaussian distribution function with example. **08**

b) Explain the first order linear differential equation. **08**

Q.6 Answer the following.

a) Use Residue calculus to evaluate the following integral. **08**
$\int_0^{2\pi} \frac{1}{5 - 4\sin\theta}\, d\theta$

b) Solve $y'' - 2y' + y = 2\cos x$ by use of successive integration. **08**

Q.7 Answer the following.

a)	Explain the details of Parseval Theorem.	**08**
b)	Explain Laplace transform of Derivatives.	**08**

SLR-SV-2

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANO PHYSICS)
Solid State Physics (MSC09102)

Day & Date: Thursday, 20-07-2023 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) Packing fraction of BCC is _____.
   a) 74% b) 68%
   c) 52% d) 58%

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

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

4) What is relative permittivity?
   a) Equal to the absolute permittivity
   b) Ratio of actual permittivity to absolute permittivity
   c) Ratio of absolute permittivity to actual permittivity
   d) Equal to the actual permittivity

5) Which crystal structure has the maximum packing fraction?
   a) BCC b) HCP
   c) FCC d) both FCC and HCP

6) The superconducting state is perfect _____ in nature.
   a) Diamagnetic b) Paramagnetic
   c) Ferromagnetic d) None of these

7) Below transition temperature, the London penetration depth.
   a) Almost constant b) Increases exponentially
   c) Decreases exponentially d) None

8) Which one of the following is an application for a hall effect sensor?
   a) Position sensing b) DC transformer
   c) Automatic fuel level indicator d) All of these

9) Phonon is Quantum of _____.
   a) Longitudinal wave b) Elastic wave
   c) Transverse wave d) Electromagnetic wave

10) Why is water used in automobiles as a coolant?
   a) It is not toxic to the environment
   b) It has a high specific heat capacity
   c) It has a high lubricating property which in turn keeps the engine cool by reducing friction
   d) It is available in abundance

B) Write True or False **06**

1) Rectifier rectifies internal resistance.
2) Fermi energy level in the case of a p-type semiconductor is close to the conduction band.
3) Superconductor is ferromagnetic.
4) X-rays are more visible than lasers.
5) For type I superconductors, the surface energy is always positive.
6) Insulators have a negative temperature coefficient of resistance.

Q.2 Answer the following **16**

a) What is Meissner's effect?
b) Explain the BCC structure.
c) Type I and type II superconductors.
d) Direct and Indirect bandgap semiconductors.

Q.3 Answer the following

a) What is a superconductor? Write the London equations. **08**
b) Write the Clausius - Mosotti equation. **08**

Q.4 Answer the following

a) What is dielectric polarization? Give the expression for orientational polarization. **08**
b) Write about Josephson tunneling. **08**

Q.5 Answer the following

a) What is the internal field? Write the expression of the internal field. **08**
b) Explain the geometrical construction of Brillion Zones in 2D. **08**

Q.6 Answer the following

a) Write about the behavior of electrons in a periodic potential. **08**
b) What is the Hall effect? Write about the expression for the mobility of the charge carriers. **08**

Q.7 Answer the following

a) Write about the thermodynamics of a superconductor. **08**
b) Write about carrier concentration in an intrinsic semiconductor. **08**

SLR-SV-3

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANOPHYSICS)
Analog and Digital Electronics (MSC09103)

Day & Date: Friday, 21-07-2023 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) Select Correct Alternatives. **10**

1) _____ signal is used to demultiplex address/ data bus in 8085 microprocessors.
   a) RD b) WR
   c) ALE d) INTR

2) Decade counter requires _____ number of flip flops.
   a) 3 b) 5
   c) 4 d) 2

3) Symbolic address in microprocessors is recorded in the _____ field.
   a) Label b) Opcode
   c) Operand d) Comment

4) Op-Amp is _____ coupled voltage type of amplifier.
   a) AC b) DC
   c) ADC d) DAC

5) The decrease in the frequency makes the phase-shift _____ in the Wien bridge oscillator.
   a) Lead b) Lag
   c) Lead-Lag d) None of the above

6) The NOR gate output will be high if the two inputs are _____.
   a) 00 b) 01
   c) 10 d) 11

7) The output of a particular Op-amp increases 8V in 12μs. The slew rate is _____.
   a) $90\ \mathrm{V/\mu s}$ b) $0.67\ \mathrm{V/\mu s}$
   c) $1.5\ \mathrm{V/\mu s}$ d) None of these

8) The no-change conditions occur when _____ in JK flip flop.
   a) J=1, K=1 b) J=0, K=0
   c) J=1, K=0 d) J=0, K=1

9) The output impedance of Op amp is decreases due to _____ feedback.
   a) Negative b) Positive
   c) Negative + Positive d) None on these

10) The _____ gates are mainly used for checking parity of data.
   a) NOR b) NAND
   c) EX-OR d) EX-NOR

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

1) In JK flip flop race around condition arises due to _____.
2) A demultiplexer is used to perform _____ conversion.
3) In the oscillator circuit the total phase shift of the loop gain must be _____.
4) Negative feedback is used in oscillator circuits. (True/False)
5) The sawtooth waveform has a rise time many times than the fall time. (True/False)
6) An ideal operational amplifier has infinite input impedance. (True/False)

Q.2 Attempt following. **16**

a) RS Flip flop.
b) Addressing modes of 8085 microprocessor.
c) Op Amp as Comparator
d) Adjustable voltage regulators.

Q.3 a) Write an ALP with flow diagram for addition of two 8 bit numbers using 8085 Microprocessor Immediate addressing mode. **10**

b) Reduce the following logical expressions using Boolean laws: **06**
$(\overline{A}B + AB)(\overline{A}BC + ABC)$
Draw logic diagram of reduced expression.

Q.4 a) What is shift register? Draw and explain logic diagram of PIPO shift register. **10**

b) Draw and explain 8:1 multiplexer using AND gate. **06**

Q.5 a) Describe Non-inverting configuration of 3 input Op Amp as a summing. Scaling and averaging amplifier. **10**

b) Elucidate effect of negative feedback on output resistance of Op Amp. **06**

Q.6 a) Describe functional block diagram of Intel 8085 microprocessor. **10**

b) Demultiplexing of AD0- AD7 signals. **06**

Q.7 a) What is Oscillator? Describe phase shift oscillator, obtain an expression for frequency of oscillation. **10**

b) Design a phase shift oscillator for f_0=1 KHz, using IC741. **06**
(Supply voltage = $\pm$15V)

SLR-SV-4

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANOPHYSICS)
Classical Mechanics (MSC09108)

Day & Date: Saturday, 22-07-2023 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 energy of a particle of mass M and E its momentum is p, then the relation between E and P is _____.
   a) $E = \frac{P}{2M}$ b) $E = \sqrt{2PM}$
   c) $P = \sqrt{2\,ME}$ d) $P = \frac{2M}{E}$

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

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 $\epsilon = 1$, 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) [u, vw] = _____.
   a) [u, v]w + v[u, w] b) [u, w]v + [w, u]v
   c) [u, v]w + [v, w]u d) [u, v]w + v[w, u]

7) The generating function $F_1(q, Q, t)$ 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, p_j] = _____.
   a) $-\partial u/\partial p_j$ b) $\partial u/\partial q_j$
   c) $+\partial u/\partial p_j$ d) $-\partial u/\partial q_j$

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

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

1) The Poisson bracket of [u,c] = u where c is constant.
2) The areal velocity of the particle in a central force field is zero.
3) The Poisson bracket of the function with itself is zero.
4) Newtonian mechanics is based on the concept of Force.
5) In Phase space, the system is having a unique path.
6) Lagrangian is based on the function L=T+V

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

a) Write note on Rutherford's scattering.

b) The particle describes a circular orbit given by r = 2a cos θ under the influence of an attractive central force. Show that the force varies as inverse 5th power of the distance.

c) State the variational principle and derive Hamilton's canonical equations using the variational principle.

d) Explain the work-energy theorem in brief.

Q.3 Answer the following.

a) What is meant by real and pseudo forces? Give an example of each. Show that the angular acceleration is the same in fixed and rotating frames. **10**

b) State and explain the laws of conservation of linear momentum & angular momentum of a single particle system. **06**

Q.4 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) Distinguish between the configuration space and phase space. **06**

Q.5 Answer the following.

a) What is Poisson Bracket? List its properties. Explain Jacobi's identity with its proof. **10**

b) Show that the transformation $Q = 2q^{1/2}\, e^{a} \cos p$ and $P = (2q)^{1/2} e^{-a} \sin p$ is canonical. **06**

Q.6 Answer the following.

a) Explain the term differential scattering cross section and derive the formula for the same. **10**

b) Write a note on Hamilton's - Jacobi Theory. **06**

Q.7 Answer the following.

a) Show that the generating function $F = \sum q_k Q_k$ produces exchange Transformation. **10**

b) Explain the different shapes of orbits formed due to motion under a central force field. **06**

SLR-SV-6

Seat No.		Set	P

M.Sc. (Semester - II) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANOPHYSICS)
Quantum Mechanics (MSC09201)

Day & Date: Wednesday, 19-07-2023 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) Fill in the blanks by choosing correct alternative. **10**

1) If Ψ be a complex function, then $\Psi^*\Psi$ must vanish at _____.
   a) unity b) zero
   c) infinity d) finite value

2) Momentum of particle by de-Broglie relation is _____ to its wavelength.
   a) Inversely proportional b) directly proportional
   c) in phase d) out of phase

3) The energy spectrum of a particle in one-dimensional rigid box has the nature of _____
   a) infinite sequence of discrete energy levels
   b) exponentially increasing
   c) infinite sequence of equidistant energy levels
   d) exponentially decreasing

4) The eigen value of the energy of a particle in a cubical box is $11(h^2/8ma^2)$. The quantum numbers of the state are _____.
   a) (311) b) (301)
   c) (222) d) (111)

5) Potential energy of a particle in harmonic oscillator having mass m is _____.
   a) $m\omega^2x^2$ b) $(1/2)m\omega^2x^2$
   c) $mr\omega^2$ d) $(1/2)mv^2$

6) The eigen value of spin matrices are _____
   a) ±2 b) 0
   c) ± 1 d) ∞

7) The commutation relation between L^2 and L_x i.e. $[L^2, Lx]$ = _____.
   a) 0 b) 1
   c) ∞ d) 2

8) The outer product of bra and ket function is called _____ operator.
   a) state b) unitary
   c) energy d) identity

9) In operator equation $H\psi = E\psi$ the eigen function is _____.
   a) *H* b) ψ
   c) *E* d) *H* & *E*

10) Raising operator is defined as _____.

a) $L_x + iL_y$ b) $L_x - iL_y$

c) $iL_z - L_y$ d) $iL_x - iL_z$

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

1) The Heisenberg's uncertainty principle is applicable to all conjugate pair of variables. (True/False)
2) Einstein photoelectric and Compton effects are the evidence of wave nature of matter. (True/False)
3) Probability density is always positive. (True/False)
4) The magnitude of total angular momentum is _____.
5) The lowest energy of an harmonic oscillator is obtained by putting n equal to _____.
6) The energy operator is given by _____.

Q.2 Answer the following **16**

a) Find the lowest energy of an electron confined to move in a one-dimensional box of length 2 Å? Given: $m = 9.11 \times 10^{-31}\, kg,\ \hbar = 1.054 \times 10^{-34}\, J - s$

b) Explain Pauli spin matrices.

c) What is WKB method? Elaborate.

d) Describe the wave packet.

Q.3 Answer the following

a) Discuss eigen values and eigen functions for a particle in three-dimensional infinite potential well. **08**

b) Discuss wave-functions or eigen functions of linear harmonic oscillator and give their physical interpretation. **08**

Q.4 Answer the following

a) Elaborate the uncertainty relation. **08**

b) Explain Dirac's bra-ket notation. **08**

Q.5 Answer the following.

a) Write the interpretation and properties of wave function. What is admissible wave function? **08**

b) What is Ehrenfest's theorem? Prove it. **08**

Q.6 Answer the following.

a) Explain in detail about the variational and WKB methods with simple examples. **08**

b) Write down the matrices for J^2, J_x, J_y and J_z operators. **08**

Q.7 Answer the following.

a) What are equations of motion? Explain the Schrodinger, Heisenberg and Interaction pictures. **08**

b) Describe the box normalization and Dirac Delta function. **08**

SLR-SV-7

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANOPHYSICS)
Electrodynamics (MSC09202)

Day & Date: Sunday, 23-07-2023 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) Fill in the blanks by choosing correct alternatives given below. 10

1) Indicates that _____.
   a) Non-existance of magnetic dipole
   b) Non-existance of magnetic monopole
   c) Existance of magnetic monopole
   d) Existance of electric monopole

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) Faradays law shows that a changing magnetic field gives rise to _____.
   a) electric field b) magnetic force
   c) lorentz force d) none of above is correct

4) In free space the value of E, the electric field vector at any instant is _____ time the value of H, the magnetic field vector.
   a) 277 b) 577
   c) 477 d) 377

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) The energy in magnetic field is proportional to _____.
   a) Square of magnetic field b) Square root of magnetic field
   c) Square of electric field d) Square root of electric field

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

9) The vector potential is, due to _____.
   a) Charge density b) Surface charge
   c) Charge d) Current density

10) Two particles with identical charges and mass collide, there is _____.
   a) Radiation b) No radiation
   c) Retardation d) None of these

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

1) The parallel component of electric field, above and below the surface _____.
2) The angular distribution of radiation for accelerating particle is _____ direction.
3) As in electrostatics then $\mathrm{E} =$ _____.
4) In a monochromatic plane wave in free space, E and B at any instant _____.
5) The Lorentz force under electric and magnetic field is given by _____.
6) For normal incidence of EM wave at interface of two media having refractive indices $n_1 = n_2$ then _____.

Q.2 Answer the following **16**

a) Write the Maxwell's equations in integral form.
b) Define and explain Biot-Savart law.
c) State and prove Gauss's law.
d) Prove that magnetic force do no work on particle.

Q.3 Answer the following

a) Show that vector potential for dipole is $\mathrm{A_{dip}} = \frac{\mu_0}{4\pi} \frac{\mathrm{m} \times \hat{\mathrm{r}}}{\mathrm{r}^2}$. **10**

b) Derive and show that the electric field is the gradient of a scalar potential. **06**

Q.4 Answer the following

a) Solve for static magnetic field. **10**
b) Discuss magneto static boundary conditions in detail. **06**

Q.5 Answer the following

a) State and prove Poyntings theorem. **08**
b) Explain skin effect and skin depth. **08**

Q.6 Answer the following

a) Obtain the Fresnel's relation for the polarization perpendicular to the plane of incidence. **08**
b) Obtain plane wave equation of electromagnetic field in vacuum. **08**

Q.7 Answer the following

a) What is radiation from half wave antenna and explain it. **08**
b) Explain the concept of radiation damping. **08**

SLR-SV-8

Set No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANOPHYSICS)
Statistical Physics (MSC09206)

Day & Date: Tuesday, 25-07-2023 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) The first law of thermodynamics is conservation of _____.
   a) Momentum b) Pressure
   c) Temperature d) Energy

2) The device which converts heat into mechanical work is _____.
   a) Motor b) Generator
   c) Energy converter d) Heat engine

3) Maxwell-Boltzmann law is for the _____.
   a) Indistinguishable particles
   b) Distinguishable particles
   c) Particles with half integral spin
   d) Particles-with integral spin

4) Fermi-Dirac statistics cannot be applied to _____.
   a) Electrons b) Photons
   c) Fermions d) Protons

5) Bosons have symmetrical wave functions. They do not obey _____.
   a) Aufbau Principal
   b) Pauli's Exclusion Principal
   c) Hund's Rule of Maximum Multiplicity
   d) Heisenberg's Uncertainty Principle

6) Bose -Einstein Statistics is for the _____.
   a) Distinguishable particles
   b) Symmetrical Particles
   c) Particles with half integral spin
   d) Particles with integral Spin

7) The radiations emitted by hot bodies are called as _____.
   a) β rays b) X-rays
   c) Black body radiation d) α rays

8) Heat does not spontaneously flow from a colder body to a hotter one. Which of the following thermodynamics law states this.
   a) Second law of thermodynamics
   b) Zeroth law of thermodynamics
   c) First law of thermodynamics
   d) Third law of thermodynamics

9) The molecules of gas moving through space with some velocity possess what kind of energy?
   a) Rotational kinetic energy b) Translational energy
   c) Spin energy d) None of the above

10) The sum of all the microscopic form of energy is called _____.
   a) Total energy b) Phase energy
   c) Internal energy d) System energy

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

1) The device which converts heat into mechanical work is Heat engine.
   a) True b) False
2) The ratio of rms velocity to most probable velocity is $\sqrt{2}$: $\sqrt{3}$.
   a) True b) False
3) In micro canonical ensemble, a system A of fixed volume is in contact with a large reservoir B. Then A can exchange neither energy nor particles with B.
   a) True b) False
4) The relations between inte U rnal energy and the canonical partition function $\mathrm{Z\ is\ U\ } = \mathrm{-}\ \partial/\partial$ Tlog Z.
   a) True b) False
5) Critical temperature is defined as the highest temperature at which the gas can be liquefied by increase of pressure alone.
   a) True b) False
6) According to Debye's theory of specific heat at low temperature specific heat is proportional to T^2.
   a) True b) False

Q.2 Answer the following.

a) Define phase space and Explain concept of Gibb's Paradox. **04**
b) State and derive most probable distribution for a quantum ideal gas. **04**
c) Derive the equation for particle function in Grand Canonical Ensemble. **04**
d) Describe fluctuations in Brief and hence derive an expression for Fluctuation in Energy. **04**

Q.3 Answer the following.

a) Sate and explain Ergodic Hypothesis. **08**
b) State and Prove quantum Liouville equation. **08**

Q.4 Answer the following.

a) For an ideal Bose gas. obtain the number of particles as $N = \frac{V}{\lambda^3} g_{\frac{3}{2}}(Z) + \frac{z}{1-z}$ **08**

b) Consider N Particles of an ideal non interacting gas in a cube of volume V. Using the allowed energy levels in quantized particles in a box. Calculate the number of possible state between E and E + dE. Hence obtain an expression for the entropy of the gas. Prove that $\mathrm{PV} = \frac{2}{3}u$ for this non relativistic gas. **08**

Q.5 Answer the following.

a) Derive an expression for internal energy in thermodynamics properties of microcanonical ensemble. Show the relation between τ and T. **08**
b) State and explain Two fluid model for liquid He and Describe the Thermo-Mechanical effect of it. **08**

Q.6 Answer the following.

a)	State and Derive the expression for Boltzmann Transport equation.	**08**
b)	Explain the concept of ensemble average and discuss the concept at stationary ensemble.	**08**

Q.7 Answer the following.

a)	Derive the equipartition theorem.	**08**
b)	Derive an expression for partition function of ideal gas in canonical ensemble.	**08**

SLR-SV-10

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANOPHYSICS)
Semiconductor Physics (MSC09301)

Day & Date: Monday, 10-07-2023 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 alternatives. **10**

1) P-type semiconductor the Fermi energy level is ____.
   a) Near the conduction band b) Near the valance band
   c) at the center d) not available

2) In semiconductors the motion of the charge carrier under the influence of the _____ is called as drift.
   a) electric field b) magnetic field
   c) gravitational field d) None of these

3) In intrinsic semiconductor the Fermi energy level is _____.
   a) Near the conduction band b) Near the valance band
   c) At the center d) Not available

4) The depletion region is created by _____.
   a) Ionization b) Diffusion
   c) Recombination d) All of these

5) Molecular Beam Epitaxy is a _____ process.
   a) Physical vapor deposition
   b) Chemical vapor deposition
   c) Chemical bath deposition
   d) Hydrothermal deposition

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

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

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

9) The conductivity of a sample due to excess carriers created by phonon vibration is called _____.
   a) Thermal conductivity b) Electrical conductivity
   c) Photoconductivity d) None of these

10) At the absolute zero temperature (−273° C), an intrinsic semiconductor has _____
   a) A few free electrons b) Many Holes
   c) No holes or free electrons d) Many free electrons

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

1) if σ is the conductivity, the relation between the electric field E and the current density J in a conducting medium is ____.
2) Liquid-phase epitaxy (LPE) uses _____ to grow crystals on a substrate.
3) In Czochralski crystal growth process, the material is heated up to _____.
4) In a semiconductor, the energy gap between the valence band and conduction band is about 1eV. (True/False)
5) Electron-hole pairs are produced by Thermal energy. (True/False)
6) Ohm's law is not obeyed by Insulator. (True/False)

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

a) Optical absorption
b) Effective mass of an electron
c) Hydrothermal process
d) Fermi level pinning

Q.3 a) Describes variation of energy bands with alloy composition with suitable example. **10**

b) Elucidate effective mass of an electron. **06**

Q.4 a) What is Luminescence? Describe different type of Luminescence with example. **10**

b) A 0.5 μm thick sample of Indium (In) is illuminated with monochromatic light of $h\upsilon$=1.5eV. The absorption coefficient $10^4 cm^{-1}$. The power incident on the sample in 15mW. Find the total energy absorbed by the sample per second (J/sec). **06**

Q.5 a) Explain MS structure with band diagram. Explain current flow mechanism in MS junction. **10**

b) Show the equilibrium energy band diagram for a metal to an p-type semiconductor where **06**
   1) $\Phi M < \Phi S$ and
   2) $\Phi M > \Phi S$

Q.6 a) Describe crystal growth by Czochralski method. **10**

b) Explain Chemical vapor deposit with suitable example. **06**

Q.7 a) Describe crystal growth by Molecular Beam Epitaxy. **10**

b) Explain vapor phase epitaxy. **06**

SLR-SV-11

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANOPHYSICS)
Atomic and Molecular Physics (MSC09302)

Day & Date: Tuesday, 11-07-2023 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 $L-S$ coupling scheme, the terms arising from two non-equivalent p –electrons are _____.
   a) ^3S, ^1P, ^3P, ^1D, ^3D b) ^1S, ^3S, ^1P, ^1D
   c) ^1S, ^3S, ^3P, ^3D d) ^1S, ^3S, ^1P, ^3P, ^1D, ^3D

2) The spectral term separation ΔT is expressed in terms of cm^{-1} which is caused due to spin-orbit interaction is related to the atomic number Z by _____
   a) Z^4 b) Z^3
   c) Z^{-4} d) Z^{-1}

3) The total number of 'd' electrons in Fe^{2+} (Atomic No. of Fe is 26) is NOT equal to that of the total number of _____.
   a) p – electrons in Ne (Atomic No. 10)
   b) d – electrons in Fe atom
   c) p – electrons in Cl^- ion (Atomic no. of Cl is 17)
   d) s – electrons of Mg (Atomic no. of Mg is 12)

4) The outer electronic configuration of Mn^{2+} is $3d^5 4s^0$. By employing the Hund's rules of $L-S$ coupling the ground state of Mn^{2+} is characterized by the spectroscopic term _____.
   a) $^6S_{5/2}$ b) $^2D_{5/2}$
   c) $^2F_{5/2}$ d) $^6H_{5/2}$

5) At 0 K, the vibrational energy of a molecule is_____
   a) 0 b) $\hbar\omega$
   c) $\hbar\omega/2$ d) $\hbar\omega/3$

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) $2^1P_1 \longrightarrow 2^1S_0$
   c) $3^3P_{0,1,2} \longrightarrow 2^3S_1$ 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 $A1$ $(Z = 13)$ 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 8201 Å.
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 Lande's g-factor for $^7G_1$ is ½. – (True/False)
5) There are 9 bands observed in the IR spectrum of water due to fundamental vibrations. – (True/ False)
6) The Raman shift is expressed in cm^{-1}. – (True/False)

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

a) Deduce the ground state term symbol for sodium (Z = 11). Why sodium exhibit doublets of yellow color. With neat labelled diagram explain the Zeeman effect for sodium atom when it is placed in weak magnetic field.

b) Using Hund's rules, find the ground-state term symbol for
   1) fluorine (Z = 9)
   2) titanium (Z = 22)
   3) Nickel (Z = 28)
   4) magnesium (Z=12)

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 KCI 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 KC1 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

a) 1) Discuss the basic foundation behind the magnetic spin resonance spectroscopy Techniques? **08**
2) Differentiate between nuclear magnetic resonance and electron paramagnetic resonance spectroscopic techniques.
3) 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.
4) If the observed chemical shift of a proton is 200 Hz from tetramethyl silane $(CH_3)_4Si$ and instrument frequency is 60 MHz, what is the chemical shift in terms of δ? Express it in τ value.

b) 1) Explain Raman effect and origin of Raman spectroscopy with the help of energy level diagram. Why anti-Stokes lines are less intense than Stokes line. **08**

2) In a linear molecule the Raman shift of the first Stokes/anti-Stokes line from the exciting one is 6B cm^{-1} whereas separation between adjacent lines is 4B cm^{-1}. why?

3) With which type of spectroscopy would one observe the pure rotational spectrum of H_2? If the bond length of H_2 is 0.07417 nm, what would be the spacing of the first three lines in the spectrum?

Q.4 Answer the following

a) 1) 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. **08**

2) 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. ($\mu_b = 9.2740 \times 10^{-24} J/T$)

3) Nitrogen ($Z = 7$) has three electrons in the $2p$ level (in addition to two electrons each in the $1s$ and $2s$ levels),

i) Consistent with the Pauli principle, what is the maximum possible value of the total Ms of all seven electrons?

ii) List the quantum numbers of the three $2p$ electrons that result in the largest total Ms.

iii) If the electrons in the $2p$ level occupy states that maximize Ms, what would be the maximum possible value for the total M_L?

iv) What would be the maximum possible total M_L if the three $2p$ electrons were in states that did not maximize Ms?

b) Distinguish conceptually between the splitting of fine structured spectral lines under the action of external weak (< 0.1 T) and high (> 1 T) magnetic field strength. An atom with the states $^2G_{9/2}$ and $^2H_{11/2}$ is placed in a weak (< 0.1 T) magnetic field. Draw the energy levels and indicate the possible allowed transitions between the two states with π and σ components. **08**

Q.5 Answer the following.

a) 1) Discuss the vibrational-rotational spectra of a diatomic molecule by showing P, Q and R branches with proper selection rules, **08**

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

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

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

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

b) Certain atom with two valence electrons is subjected to very strong magnetic field strength of the order of > 10 T. Draw the energy levels and indicate the possible allowed transitions between $^3S_1 \leftarrow {}^3P_{0,1,2}$ transitions in that atom. Justify the phenomenon of Paschen-Back effect by considering magnetic interaction energy i.e. ΔE as well as selection rules. **08**

Q.6 Answer the following.

a) Write down the allowed spectral terms for Germanium (Z = 32) and Oxygen (Z= 8) atoms in their normal and first excited state and by applying selection rules explain the emission spectra of Germanium (Z = 32) and Oxygen (Z= 8) (Consider Pauli's Exclusion Principle). **08**

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) **08**

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.

a) Based on molecular orbital (MO) concept explain the nature of bond order and stability for O_2, O_2^+, O_2^- and O_2^{--} molecules. Also, explain the magnetic nature of each molecule. Why valence bond (VB) approach fails to explain the paramagnetic nature for O_2 and B_2 molecules, while molecular orbital approach explains the paramagnetic nature for O_2 and B_2 molecules. **08**

b) 1) 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. **08**

2) What do you mean fine structure? With neat labelled diagram discuss the fine structure of doublets for

i) $^2P_{1/2}$ and $^2P_{3/2}$ and

ii) $^2D_{3/2}$ and $^2D_{5/2}$ states with justification based on magnitude of ΔT_{ls}.

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

SLR-SV-12

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANOPHYSICS)
Functional Nanomaterials (MSC09306)

Day & Date: Wednesday, 12-07-2023 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) The electrospinning process can be adjusted to control the fiber diameter by varying _____ and polymer concentration.
   a) magnetic & electric field strength
   b) magnetic field strength
   c) electric field strength
   d) none of these

2) Which of the following electrolyte used in synthesis of second generation TiO_2 nanotubes array.
   a) polar organic electrolyte
   b) non-polar organic electrolyte
   c) acidic fluoride based electrolyte
   d) buffered electrolytic

3) The size of nanoparticles is between _____ nm.
   a) 100 to 1000 b) 0.1 to 10
   c) 1 to 100 d) 0.01 to 1

4) In nanowire, the motion of electron is continued _____ direction.
   a) One b) Two
   c) Three d) all of above

5) The creating of nanoscale materials by chemically or physically breaking down the larger materials is known as _____approach in nanotechnology.
   a) top-down b) bottom-up
   c) bottom-down d) top-up

6) Which of the following regarding Born nitride is correct?
   a) Its structure is similar to diamond in which both B and N are SP^2 hybridized.
   b) Its structure is similar to graphite in which both B and N are SP^2 hybridized.
   c) BN possess linear structure
   d) BN is ionic, hence non-directional in nature.

7) Quantum dots are _____ in nature.
   a) Inorganic b) Organic
   c) Biologic d) Metallic

8) Which of the following quantum dot is used in the biomedical application?
   a) LEDs b) Solar cells
   c) Qubits d) medical imaging

9) What is the aspect ratio?
   a) Length to diameter ratio b) Length to depth ratio
   c) Depth to length ratio d) Diameter to length

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

B) State true or false **06**

1) The structure BN tube is similar to graphite.
2) Sol-gel process is top-down method of synthesis of nanoparticles.
3) The motion of electron confined in 3-D in quantum dots.
4) Nano indentation is an effective technique for probing electrical properties of nano tubes.
5) The relation for crystal growth rate is $dr/dt = D(C_b - C_i) \,/\, rd_m$.
6) Nano wire is an example of 2-D nano material.

Q.2 Answer the following **16**

a) Write down the advantages and disadvantages of metal oxide frameworks.
b) What are the applications of TiO_2 nanotube array?
c) Discuss the applications of quantum dots in biomedicine.
d) Write note on ball milling synthesis method of Boron Nitride nanotubes.

Q.3 Answer the following

a) Explain in detail Laser assisted method of Boron Nitride nanotubes. **08**
b) Write in detail electrospinning process for nanofibers. **08**

Q.4 Answer the following

a) Discuss the fabrication process of TiO_2 nanotube arrays by Electrochemical anodization with second synthesis generation. . **10**
b) What is polymerization? Explain 'In situ' process for production of PNC. **06**

Q.5 Answer the following

a) Explain in details, key processing parameters of electrospinning of nanofiber. **10**
b) Explain the basic material used for PNC in detail. **06**

Q.6 Answer the following

a) What are the applications of TiO_2 nanotubes arrays? Explain any one in details. **08**
b) Explain in detail aqueous synthesis of semiconductor nanocrystals. **08**

Q.7 Answer the following

a) Explain anodic formation of Yarns and Fabrics formation. **08**
b) Write potential applications of electrospan fabric. **08**

SLR-SV-14

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANOPHYSICS)
Semiconductor Devices (MSC09401)

Day & Date: Monday, 10-07-2023 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) The voltage at which inversion layer is formed in E-MOSFET is known as _____.
   a) Threshold voltage b) Pinch off voltage
   c) Saturation voltage d) cut off voltage

2) MOSFET is an _____ operated semiconductor device.
   a) Current b) Voltage
   c) Power d) Resistance

3) The input gate current of a FET is _____.
   a) A few micro-amperes b) A few mili-amperes
   c) A few amperes d) Negligible

4) _____ is the bidirectional device.
   a) BJT b) MOSFET
   c) SCR d) DIAC

5) In power diode, the reverse recovery time is equal to _____.
   a) $t_a + t_b$ b) $t_a - t_b$
   c) t_a / t_b d) $t_a * t_b$

6) The equivalent circuit of SCR contains _____.
   a) Two diode b) one diode and one transistor
   c) two transistors d) one diode and two transistor

7) Which of the following is a negative resistance device?
   a) LED b) Transistor
   c) Gunn diode d) TRIAC

8) The Gunn diode is made from _____ semiconductor.
   a) Silicon b) Germanium
   c) GaAs d) P-type

9) The material used for Infra-Red LED is _____.
   a) CdS b) Silicon
   c) GaP d) GaAs

10) The light emitted from _____ device is highly monochromatic.
   a) CFL Bulb b) LED
   c) filament bulb d) LASER LED

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

1) In CCD, the data is stored in capacitors as in the form of charges.
   a) True b) False
2) E-MOSFET works only in enhancement mode.
   a) True b) False
3) Photoconductors are not used as photo detectors.
   a) True b) False
4) The photon entering in photosensitive semiconductor produces _____ and _____.
5) The SCR is _____ triggered device.
6) What does CCD stands for?

Q.2 Answer the following **16**

a) Explain the nature of output characteristics curves of E-MOSFET.
b) Explain the construction power diode. How it differs from ordinary diode.
c) Explain the charge storage process in MOS capacitor.
d) What is LASER? Explain its properties.

Q.3 Answer the following **16**

a) Explain the construction and I-V characteristics of D-MOSFET.
b) What is TRIAC? Give its symbol and simplified diagram in terms of SCR. Explain its construction.

Q.4 Answer the following **16**

a) Explain with band diagram of current flow mechanism in metal and semiconductor junction.
b) Explain the surface potential in depletion region and formation of inversion layer.

Q.5 Answer the following **16**

a) What is a solar cell? Explain I-V characteristics of solar cell.
b) How many types of photo detectors available? Explain pn junction photodetector.

Q.6 Answer the following **16**

a) Explain the construction of light activated SCR.
b) Explain the working of heterojunction LASER diode.

Q.7 Answer the following

a) Explain the charge transfer mechanism in two stage CCD device. **10**
b) Draw the output I-V characteristics of SCR and explain its nature. **06**

SLR-SV-15

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination March/April-2023
PHYSICS (NANOPHYSICS)
Nuclear and Particle Physics (MSC09402)

Day & Date: Wednesday, 12-07-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Question 1and 2 are compulsory.
2) Attempt any Three from Q.3 to Q.7.
3) Figure to right indicate full marks.

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

1) What combination of quarks makes up a proton?
   a) uuu b) Uud
   c) udd d) ddd

2) The neutrino interacts with the world primarily through the _____ force.
   a) Strong b) Electromagnetic
   c) Weak d) Gravitational

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) $R = r_0 A^{-1/3}$ b) $R = r_0 A^{1/3}$
   c) $R = r_0 A^{-3}$ d) $R = r_0 A^{3}$

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) Nuclear binding energies are usually expressed in units of _____.
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) The strong nuclear force acts over the distance _____.

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

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

Q.3 Answer the following.

a) What is radioactivity? Give an account of laws of radioactivity. Explain radioactive dating. **08**

b) Explain the conservation laws of nuclear reactions. Give an account of Nuclear fusion and Nuclear fission with examples of nuclear reactions. **08**

Q.4 Answer the following.

a) Explain mass, shape, size and spin of nucleus. Write a note on nuclear binding energy. Explain nuclear stability using nuclear binding energy curve. **08**

b) Give an account of meson theory of nuclear force. Explain Yukawa's hypothesis. **08**

Q.5 Answer the following.

a) What are Cosmic rays? Give an account of origin of Cosmic rays. Explain the properties of primary Cosmic rays. **08**

b) What are particle accelerators? Explain the principle and working of Synchrotron. **08**

Q.6 Answer the following.

a) Give an account of Scintillation counter. **08**

b) Give an account of elementary particles. Explain the classification of elementary particles based on symmetry. **08**

Q.7 Answer the following.

a) What are Quarks? Explain the types of quarks. Give an account of CPT theorem. **08**

b) Explain the construction and working of cyclotron. What are its disadvantages? **08**

SLR-SV-16

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANO PHYSICS)
Characterization of Nano Materials (MSC09403)

Day & Date: Friday, 14-07-2023 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) Atomic Force Microscopy has _____ resolution type.
   a) Low b) Medium
   c) High d) zero

2) _____ has zero dimensions.
   a) Thin film b) Thin rod
   c) BCC structure d) Quantum dot

3) TEM is invented by German physicist _____.
   a) Ernst Ruska b) Chandrasekhar Raman
   c) Rontgen d) Richard Feynman

4) _____ is a technique used to identify the elemental composition of specimen.
   a) SEM b) XRD
   c) EDX d) All a, b, c

5) Raman scattering is easily understood in terms of _____ of radiations.
   a) quantum theory b) classical theory
   c) magnetic theory d) theory of relativity

6) Now a day's nano materials are used in_____.
   a) medical field b) energy sector
   c) computer technology d) All a, b, c

7) If semiconductor particles size reduces then band gap is _____.
   a) Decrease b) Increase
   c) remains constant d) becomes zero

8) Scanning electron microscopy technique used to determine _____.
   a) Frequency b) Power
   c) lattice parameters d) grain size

9) _____ 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

10) The HRTEM is important tool for nanotechnology research used to determine the _____ within materials.
   a) size of atom b) position of atoms
   c) weight of atom d) number of atoms

B) Answer the following. **06**

1) 'There is plenty of room at the bottom' this quote by Richard Feynman. Whether this sentence is true or false.
2) What is the unit of heat capacity?
3) _____ is used to measure absorption and transmittance.
4) FTIR spectrometer is based on the _____ interferometer.
5) NMR is used as advanced medical imaging techniques in _____.
6) Nano materials have extremely large surface area to volume ratio. Whether this sentence is true or false.

Q.2 Answer the following **16**

a) Draw the neat diagram of SEM and give two applications of SEM.
b) What are the types of sample preparation methods? Explain any one sample preparation method.
c) How the X-ray production takes place? Write any four properties of X-ray.
d) Write a short note on Raman Spectroscopy.

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

a) What are the mechanical properties of nano material? Explain any two in details.
b) What are the applications of nano material in energy sector?

Q.4 Answer the following **16**

a) How the nano material is applicable in medicine?
b) Explain the UV-VIS spectroscopy in detail?

Q.5 Answer the following **16**

a) Describe HRTEM with neat diagram
b) Explain thermal properties of nano material

Q.6 Answer the following **16**

a) What is quantum yield? Obtain the relation of quantum efficiency.
b) Explain TGA in detail

Q.7 Answer the following **16**

a) Explain in detail optical properties of nano material
b) Explain EDAX in detail with neat diagram

SLR-SV-17

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS (NANO PHYSICS)
Nano Material Fabrication Techniques (MSC09408)

Day & Date: Sunday, 16-07-2023 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) Select correct alternative from following. **10**

1) In _____the Vander Waals force used between tip and surface.
   a) STM b) SEM
   c) AFM d) TEM

2) Two main types of electron microscopes are_____.
   a) STM and AFM b) TEM and SEM
   c) FTIR and TEM d) STM and AFM

3) X-rays detection in SEM equipped for energy dispersive_____.
   a) Raman spectroscopy b) resonance spectroscopy
   b) X-ray spectroscopy d) none of these

4) The photon can be measured by the relation_____.
   a) $E_k = hv - E_R - E_B - \phi - \delta E$ b) $E_k = hv – E_R - E_B - \delta E$
   c) $E_k = hv + E_R + E_B + \delta E$ d) $E_k = hv + E_R + E_B + \phi + \delta E$

5) NMR Spectroscopy is used to study _____properties of matter.
   a) chemical b) physical
   c) biological d) All A, B, C

6) _____meter is equal to one nano meter.
   a) 1×10^{-9} b) 1×10^{-10}
   c) 1×10^{-8} d) none of the A, B, C

7) In atomic force microscope _____source is uses.
   a) Sodium b) mercury
   c) LASER d) LED

8) In feedback loop of AFM tube scanner controls the _____of the entire sample.
   a) Breadth b) height
   c) Depth d) all A, B, C

9) The basic task of the fluorescence microscope is to permit excitation light to irradiate the_____.
   a) specimen b) exciter filter
   c) collector lens d) all A, B, C

10) Auger electron has relative low energy then they are only emitted from the bulk specimen for the depth of_____.
   a) < 1 nm b) < 2 nm
   c) < 3 nm d) > 3 nm

B) Answer and rewrite the following. **06**

1) FESEM stands for _____.
2) Scanning probe microscopy is also known as_____.
3) The spinning magic angle is____.
4) The XPS and SEM stand for x-ray photoelectron spectroscopy and scanning electron microscopy. Whether this sentence is true or false?
5) In general AFM is used to measure topography with force probe. Whether this sentence is true or false?
6) Who discovered the X-ray?

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

1) Write a note on Rayleigh Criteria.
2) What are the limitations of STM?
3) What is qualitative and quantitative analysis in AES?
4) What are the properties of nuclear spins?

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

a) What are different types of an optical spectrometer? Explain any one in detail with neat diagram.
b) Explain SEM in detail with neat diagram.

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

a) Draw the block diagram of AFM and describe each part of microscope.
b) Explain the construction and working of TEM with neat diagram.

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

a) What is the principle of XPS? Explain construction and working of XPS with neat diagram.
b) What is resonance condition in ESR and NMR? Explain principle and working of NMR in detail.

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

a) What is CP-MAS experiment? Explain high-resolution solid-state NMR methods.
b) What is the principle of Auger electron spectroscopy? How it is used as electron energy analyzer and electron detector?

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

a) What is the principle of STM? How STM is applicable to imaging of surfaces?
b) What is EPR? Write the different applications of EPR.