SLR-SN-1

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Mathematical Physics (MSC03101)

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-SN-2

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Solid State Physics (MSC03102)

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-SN-3

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Analog and Digital Electronics (MSC03103)

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-SN-4

Seat No.	

Set P

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Classical Mechanics (MSC03108)

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-SN-6

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Quantum Mechanics (MSC03201)

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-SN-7

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Electrodynamics (MSC03202)

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-SN-8

Seat No.	

Set P

M.Sc. (Semester - II) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Statistical Physics (MSC03206)

Day & Date: Tuesday, 25-07-2023 Max. Marks: 80
Time: 11:00 AM To 02:00 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 correct alternative. **10**

1) In which thermodynamics process, there is no flow of heat between the system and its surroundings?
   a) isothermal b) isochoric
   c) isobaric d) adiabatic

2) In a micro-canonical ensemble, the system exchange.
   a) only matter b) only energy
   c) both energy and matter d) neither energy nor matter

3) It never happens that heat by itself flows from ____ body to a ____ body.
   a) cold, cold b) hot, cold
   c) cold, hot d) hot, hot

4) The equation of state for an ideal gas is represented as _____.
   a) PV = R/T b) PV = nRT
   c) P/V = R/T d) PV = RT

5) The heat or energy consumed or emitted during a phase change of a material is known as _____.
   a) latent heat b) specific heat
   c) phase heat d) none of the above

6) Entropy in thermodynamics is a measure of _____.
   a) order of system b) pressure of the system
   c) volume of system d) disorder of the system

7) The value of the universal gas constant is _____.
   a) 8.2353 b) 8.3143
   c) 8.5123 d) 8.2352

8) Phase equilibrium curve terminates at _____.
   a) boiling point b) sublimation point
   c) triple point d) critical point

9) Louisville's equation gives the rate of change in
   a) pressure b) temperature
   c) density d) volume

10) Which of the following statement is correct for the perfect black body?
   a) It can transmit entire radiation incidents on it
   b) It can absorb entire radiation incidents on it
   c) The emissive power of the black body is less than an ordinary body
   d) All the above statements are correct for the black body.

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

1) Gibb's free energy determines The relative stability of a system for transformation at constant temperature and pressure.
2) Photon, Phonon, etc. obeys the Fermi Dirac distribution function.
3) In a microcanonical ensemble both energy and mass are conserved.
4) Louisville's equation gives the rate of change in pressure.
5) The unit of mass in the S.I. unit is _____.
6) Entropy is a _____ function.

Q.2 Answer the following (any four) **16**

a) Calculate the increase in entropy when 746 gm of water is converted into vapor at 100°C. The latent heat of vaporization of water = 540 Cal/ gm.
b) How the properties of matter change near the triple point.
c) Write a note on grand canonical ensembles.
d) Explain the difference between microstates and macrostates.
e) Write a note on a PT diagram.

Q.3 Answer the following.

a) State thermodynamic potential and Maxwell's equations. **10**
b) Explain the concept of statistical equilibrium. **06**

Q.4 Answer the following.

a) Explain the 2nd order phase transition phenomenon with on example. **08**
b) Derive Ehrenfest equations. **08**

Q.5 Answer the following.

a) Give the condition for B E condensation. **10**
b) By using the Vander Waals equation at reduced states calculate the values of critical constants. **06**

Q.6 Answer the following.

a) What is the Gibbs paradox and how it is resolved? **10**
b) Write a note on black body radiations. **06**

Q.7 Answer the following.

a) Derive Clausius Clapeyron equation. **10**
b) Obtain Plank's law for black body radiation. **06**

SLR-SN-10

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Semiconductor Physics (MSC03301)

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-SN-11

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Atomic, Molecular Physics (MSC03302)

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-SN-14

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2023
PHYSICS (Materials Science)
Materials Characterization (MSC03308)

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

1) Error of measurement is the difference between _____.
   a) True value and measured value
   b) Precision and True value
   c) Measured value and Precision
   d) None of the above

2) The error caused by poor calibration of the instrument is called _____.
   a) Random error b) Systematic error
   c) Gross error d) Precision error

3) On which factor does the average kinetic energy of gas molecules depend?
   a) Nature of the gas b) Temperature
   c) Volume d) Mass

4) What is the average velocity of the molecules of an ideal gas?
   a) Infinity b) Constant
   c) Unstable d) Zero

5) X-ray diffractometers are not used to identify the physical properties of which of the following?
   a) Metals b) Liquids
   c) Polymeric materials d) Solids

6) X-ray diffractometers provide _____ information about the compounds present in a solid sample.
   a) Quantitative b) Qualitative
   c) Quantitative and qualitative d) Either quantitative or qualitative

7) Which of the following parameters can't be found with Hall Effect?
   a) Polarity b) Conductivity
   c) Carrier concentration d) Area of the device

8) In the Hall Effect, the electric field is in X direction and the velocity is in Y direction. What is the direction of the magnetic field?
   a) X b) Y
   c) Z d) XY plane

9) Beer Lambert's law gives the relation between which of the following?
   a) Reflected radiation and concentration
   b) Scattered radiation and concentration
   c) Energy absorption and concentration
   d) Energy absorption and reflected radiation

10) In which of the following ways, absorption is related to transmittance?
   a) Absorption is the logarithm of transmittance
   b) Absorption is the reciprocal of transmittance
   c) Absorption is the negative logarithm of transmittance
   d) Absorption is a multiple of transmittance

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

1) A system will be error free if we remove all systematic error.
2) Zero error is an indication of instrumental error.
3) The degree of freedom of a triatomic gas is 6.
4) When certain geometric requirements are met, X-rays scattered from a crystalline solid can constructively interfere with each other and produce a diffracted beam.
5) In Hall Effect, the electric field applied is parallel to both current and magnetic field.
6) Absorbance has no unit

Q.2 Answer the following **16**

a) Describe the methods of temperature measurements.
b) State the postulates of kinetic theory of gases.
c) How are X-rays generated and detected?
d) State and derive Beer Lambert law.

Q.3 Answer the following

a) Explain the methods of sample preparation. **08**
b) Describe the necessity of vacuum during the material characterization. **08**

Q.4 Answer the following

a) Describe the Laue method for single crystal structural analysis. **08**
b) Describe Hall effect in semiconductors. **08**

Q.5 Answer the following

a) Describe the resonance techniques and their necessity. **08**
b) Explain the application of UV- Visible absorption spectroscopy in the determination of band gap of semiconductors. **08**

Q.6 Answer the following

a) Explain the functioning of a vacuum pump. **08**
b) Describe the factors affecting the intensity in powder XRD. **08**

Q.7 Answer the following **08**

a) What are the defects in semiconductors? Explain how are they measured. **08**
b) What is a spectrometer? Explain its working and applications.

SLR-SN-15

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Semiconductor Devices (MSC03401)

Day & Date: Monday, 10-07-2023 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) CMOS is popular due to _____.
   a) Low noise immunity
   b) High power consumption
   c) Low power consumption
   d) High power dissipation

2) _____ devices are not a unipolar device
   a) DE-MOSFET b) MOSFET
   c) JFET d) BJT

3) The condition $h\upsilon > E_g$ causes _____ of light semiconductor.
   a) Absorption b) Transmission
   c) Reflection d) Modulation

4) A negative gate voltage to n - channel MOSFET causes _____ of carriers.
   a) Depletion b) Enhancement
   c) Saturation d) Induction

5) A potential well is created in p - semiconductor by applying ____ in CCD memory device to store charge.
   a) positive potential b) negative potential
   b) square negative pulse d) sinusoidal pulse

6) The output of LASER is _____.
   a) Polychromatic b) non – coherent
   c) Dispersed d) Monochromatic

7) Energy required to move electron from Fermi level to outside the metal is called as _____.
   a) Barrier b) work function
   c) Depletion d) dielectric constant

8) The switching ON behavior of SCR is based on _____.
   a) Regenerative b) Breakdown
   c) Blocking d) Etching

9) Anode voltage must be _____ V, if gate voltage is 0.3 V to switch on programmable unijunction transistor.
   a) 1.0 b) 0.3
   c) 0.8 d) 0.5

10) Sum of α_1 and α_2 must be _____ for SCR to become ON.
   a) zero b) unity
   c) half d) infinity

B) State True or False/Fill gaps. **06**

1) VLSI use CCDs for memory.
2) Forward blocking state in SCR is due to forward biased J1 junction.
3) Minimum current above which SCR becomes ON is holding.
4) Light emission is not possible in Si due to its _____
5) The barrier height of M – S contact is the difference between metal work function of semiconductor _____.
6) The drift of stable domains in TEDs is attainable in _____ loaded circuits.

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

a) LED
b) CMOS devices
c) Digital IC
d) DIACs

Q.3 a) Describe MOS structure with emphasis on accumulation, depletion & inversion modes with band diagrams. **10**
b) Elucidate Depletion type MOSFET. **06**

Q.4 a) Describe p-i-n diode with doping profile and electric field distribution. **10**
b) LASCR **06**

Q.5 a) Explain GaAs Gun Oscillator modes with, **10**
i) space charge accumulation
ii) Quenched domain mode
iii) Delayed domain mode.
b) Explain the periodic oscillating behavior of n- GaAs Gunn diode. **06**

Q.6 a) Describe the operating principle of photodiode based on multilayer hetrojunction with band diagrams and IV characteristics. **10**
b) What is Semiconductor Laser diode? Discuss the mechanism of stimulated emission of light in GaAs laser diode. **06**

Q.7 a) What is solar cell? Derive an expression for open circuit voltage and short circuit current. **10**
b) Explain quantum efficiency and response speed of solar cell. **06**

SLR-SN-16

Seat No.		Set	P

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Nuclear and Particle Physics (MSC03402)

Day & Date: Wednesday, 12-07-2023 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) Choose the correct alternative. **10**

1) The ratio will be _____, Where, R is the mean nuclear radius.
   a) 0.8 b) 0.4
   c) 1.25 d) 8

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

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

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

5) All the nucleii's available in nature are _____.
   a) Spherical shape and are symmetric
   b) Some are spherical, some ellipsoid shape
   c) All are ellipsoid shape
   d) No definite shape

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

7) The height of potential barrier faced by an alpha-particle inside the nucleus is _____.
   a) 27.87 MeV b) 27.87 KeV
   c) 27.87 GeV d) 27.87 eV

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

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

10) The average binding energy per nucleon of nucleus is _____.
[Given: neutron mass m_n= 1.008665 u, proton mass m_p=1.007825 u, where 1 u = 931.5 MeV/c^2]
   a) 5.60 MeV b) 21.4 MeV
   c) 8.5 MeV d) 36 MeV

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

1) Nuclear density is constant for all nuclei.
2) Nucleon-nucleon forces are spin dependent forces.
3) Leptons are the only elementary particles that experiences all four fundamental forces of nature.
4) Baryons consist of three quark and Mesons consist of one quark and anti-quark.
5) Electron capture is one of the modes of beta decay process.
6) In radioactivity, after one half-life, activity of a radioactive substance reduces to half.

Q.2 Answer the following **16**

a) A sample of an ancient wooden sculpture piece gives 5 count/min/g of carbon due to ^{14}C present in it. If freshly cut wooden piece gives 16 counts/min, what is the age of sculpture? [Given Half-life of ^{14}C=5760 years]

b) Explain the working and basic principle of semiconductor detector. Draw neat schematic figure to mention each component of the counter.

c) Explain the gamma decay, internal conversion and internal pair conversion of gamma decay process.

d) Draw the Meson octate, identify the particles in it along with their quark structures, charges and spins.

Q.3 Answer the following

a) Calculate the value of proton separation energy (S_p) for (S_n) for in units of MeV. **08**
[Given M() =20.007344 u, M() =20.997651 u, M() =21.999574 u, neutron mass m_n =1.008665 u, proton mass m_p= 1.007825 u, where 1 u = 931.5 MeV/c^2]

b) Using semi-empirical mass formula, for given family of isobars, obtain the relation for most stable nuclei. **08**
[constants in semi-empirical formula: Volume term, Surface term, Coulomb term, asymmetry term, pairing term]

Q.4 Answer the following

a) Using Fermi gas model and its basic assumptions, estimate the potential depth for a nucleus. Assuming average binding energy per nucleon to be around 8.5 MeV, calculate the kinetic energy of the nucleons in the nucleus. **08**

b) Find the Q-value and the threshold for the following nuclear reaction. **08**
[Given M() =22.99097 u, M()= 19.999981 u, M() = 4.002603 u, neutron mass m_n =1.008665 u, proton mass m_p= 1.007825 u, where 1 u = 931.5 MeV/c^2]

Q.5 Answer the following

a) Write down the Schrodinger equation for deuteron (use simplest finite square well potential), i.e. n-p system with an attractive potential V(r) between them. Obtain the complete solution and draw the wavefunction inside and outside the potential well. **08**

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

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

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

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

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

Q.6 Answer the following

a) Starting with the equation of Fermi-Golden's rule, derive the Fermi expression of beta-decay. **10**

b) Show that the energy of the triplet state (S=1) is not equal to the energy of the singlet state (S=0) for deuteron bound state. **06**

Q.7 Answer the following

a) Classify different types of accelerators. Explain basic principle and describe in detail working of linear accelerator. Draw a neat schematic diagram to show each component. **10**

b) With a suitable example explain what is nuclear fission and fusion reactions. Estimate the power released in Kilo-Watt-Day for the thermal neutron induced fission reaction of to and. **06**

[Given M() =235.043922 u, M()=146.922780 u, M() = 88.926400 u. neutron mass m_n= 1.008665 u, proton mass m_p= 1.007825 u, m_e= 0.00055 u where 1 u = 931.5 MeV/c^2]

SLR-SN-17

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Physics of Nano Materials (MSC03403)

Day & Date: Friday, 14-07-2023 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) Multiple choice questions. **10**

1) The buckminsterfullerene is naturally occurring element found in _____.
   a) Earth's crust b) Smoke
   c) Soot d) Coal

2) The resolving power of a TEM is derived from_____.
   a) Electrons b) Power
   c) Specimens d) Ocular system

3) _____ is used to examine the surface composition of the materials in industries.
   a) AFM b) TEM
   c) STM d) SEM

4) _____ is used in electron microscope?
   a) Electron beams
   b) Electron beams & magnetic fields
   c) Magnetic fields
   d) Light waves

5) Degree of scattering in TEM is a function of_____.
   a) Number and mass of atoms that lie in the electron path
   b) Wavelength of electron beam used
   c) Number of atoms that lie in the electron path
   d) Mass of atoms that lie in the electron path

6) In fullerenes, the graphene sheets are linked with _____ rings.
   a) Octagonal b) Trigonal
   c) Hexagonal d) Decagonal

7) _____ is used for measuring the surface area of the nanoparticles.
   a) X-ray diffraction
   b) Brunauer-Emmett-Teller method
   c) Electrophoresis
   d) Spectrometry

8) _____ is a technique to separate nanoparticles by size during characterization.
   a) Spectrometry b) Electrophoresis
   c) Centrifugation d) None of the above

9) _____ operate like a single electron transistor.
   a) Quantum wells b) Quantum dots
   c) Quantum wires d) Quantum rings

10) The cathode of TEM consists of _____.
   a) Tungsten wire b) Iron filament
   c) Bulb d) Gold wire

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

1) Electron Microscope can give a magnification up to_____.
2) _____ is an instrument for imaging surfaces at the atomic level.
3) _____ are used in lasers.
4) Quantum dots are theoretically described as a zero-dimensional entity.
5) The electrons in SEM are reflected through metal-coated surfaces.
6) Schottky defect is a Line defect.

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

a) Quantum confinement effect
b) Postulates of the Drude Model
c) Image formation in an electron microscope
d) Single Electron Transistor

Q.3 Answer the following.

a) Describe principle and operation of SEM. **10**
b) Explain the difference between field-enhanced thermionic emission and field-assisted thermionic emission. **06**

Q.4 Answer the following.

a) Describe the Molecular Beam Epitaxy technique for the synthesis of nanoparticles. **10**
b) Explain the mechanism of electron transport in semiconductors. **06**

Q.5 Answer the following.

a) What is Fullerene? Describe the bonding and structure of carbon buckminsterfullerene. **10**
b) Why does the band gap of nanomaterials increase with size reduction? **06**

Q.6 Answer the following.

a) What is luminescence? Discuss various types luminescence. **10**
b) Explain the principle and process of lithography. **06**

Q.7 Answer the following.

a) Give an account of core-shell in quantum dot. **10**
b) Write a note on Carbon Nanotubes. **06**

SLR-SN-18

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS (MATERIALS SCIENCE)
Advanced Techniques of Materials Characterization (MSC03406)

Day & Date: Sunday, 16-07-2023 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Attempt five questions.
2) Q (1) and Q (2) are compulsory.
3) Attempt any three from Q.3 to Q. 7.

Q.1 A) Multiple choice questions. **10**

1) _____ types of waves have the long wavelength?
   a) Radio waves b) X-ray
   c) Microwaves d) UV

2) _____ technique is used to determination of surface area.
   a) SEM b) TEM
   c) BET d) None of the above

3) NMR is the study of absorption of _____ by nuclei in a magnetic field?
   a) Radioactive radiation
   b) IR radiation
   c) Radio frequency radiation
   d) Microwaves

4) In SEM, once an electron beam hits a sample, the sample ejects _____.
   a) electrons and x-rays
   b) positrons and gamma rays
   c) anti-electrons and ultraviolet rays
   d) neutrinos and radio waves

5) The energy of the back scattered electrons in SEM is _____ that of secondary electrons.
   a) Equal to b) Less than
   c) Greater than d) None of these

6) Energy of the electromagnetic radiation is decreases with _____.
   a) Increasing wavelength b) Decreasing wavelength
   c) Both a) and b) d) None of the above

7) _____ technique is suitable for function group detection.
   a) FTIR b) UV -VIS Spectroscopy
   c) XRD d) NMR

8) XPS working is based on the principle of _____.
   a) Photovoltaic effect b) Lamberts law
   c) Photoelectric effect d) None of these

9) ____ is the capability of the optical instrument to distinguish between two adjacent points.
   a) Magnification b) Resolving power
   c) Ionization d) Emulsification

10) Fluorescence occurs within _____.
   a) 10^{-5} s b) 10^{-5} ms
   c) 10^{-5} μs d) 10^{-5} ns

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

1) Electron microscope is much more powerful than _____.
2) Usually quantum structures are _____.
3) Range of Visible light's wavelength is between _____.
4) Radio waves are considered to be the lowest energy form of Electromagnetic radiation. (True/False)
5) Light waves are used in electron microscope. (True/False)
6) Magnification is the capacity to distinguish between two adjacent points. (True/False)

Q.2 Attempt the following. **16**

a) Nano Lithographic technique
b) Raman scattering
c) Depth Profiling?
d) Operating mode of AFM

Q.3 Answer the following.

a) What do you mean by surface? What are different probes used for surface characterization? What is order of vacuum required to record the XPS spectra and why? **10**

b) Explain principle and working of Selective Area Electron Diffraction (SEAD). **06**

Q.4 Answer the following.

a) Describe principle, instrumentation and working of Scanning Electron Microscope with neat labelled diagram. **10**

b) Explain in detail difference between SEM and TEM. **06**

Q.5 Answer the following.

a) Describe qualitative and quantitive analysis of Auger electron spectrum with example. **10**

b) Explain applications of NMR spectroscopy. **06**

Q.6 Answer the following.

a) Describe bright field and dark field images in TEM. How do they are formed? **10**

b) Explain Magic Angle Spinning (MAS). **06**

Q.7 Answer the following.

a) Describe classical and quantum approach used to understand Raman Spectroscopy. **10**

b) Explain the necessity of high-resolution NMR spectrometer for solid samples. **06**