Seat No.	

Set | P

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2025
Mathematical Physics (2321101)

Day & Date: Thursday, 15-May-2025 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 A) Choose correct alternative. **08**

1) Which of the following is NOT an algebraic operation in complex numbers?
a) Addition b) Exponential
c) Multiplication d) Division

2) Cauchy's Integral Theorem states that:
a) The integral of a function along a closed contour is zero
b) The integral of a function along a closed contour is nonzero
c) The integral of a function along a contour depends on the contour itself
d) The integral of a function along a contour is infinity

3) The Fourier transform of a Gaussian distribution in the time domain results in a:
a) Gaussian distribution in the frequency domain
b) Sine function in the frequency domain
c) Cosine function in the frequency domain
d) Delta function in the frequency domain

4) In the Fourier series representation of a square wave, the coefficients corresponding to odd harmonics are:
a) Zero b) Non-zero
c) Constant d) Negative

5) The number of arbitrary constants in the general solution of differential equation of second order is ____.
a) 1 b) 0
c) 2 d) 4

6) The non-zero Particular Integral can be found out for _____ differential equation.
a) Homogeneous b) Non-Homogeneous
c) Second order Homogeneous d) None of these

7) In Hilbert space, which property does the inner product satisfy?

a) Anticommutativity b) Distributivity

c) Additivity d) Associativity

8) The rank of the zero matrix?

a) 0 b) 1

c) -1 d) The rank is undefined

B) Write True or False. **04**

a) A set of functions is a complete orthogonal set if any function in the set can be expressed as a linear combination of the others.

b) The Wronskian of a set of solutions to a second-order homogeneous equation with constant coefficients is always zero.

c) Cauchy's Integral Formula expresses the value of a function at a point in terms of its contour integral.

d) The Fourier series expansion of a square wave contain only cosine terms.

Q.2 Answer the following question (Any Six) **12**

a) Show that given matrix is unitary matrix $A = \begin{bmatrix} i & 0 \\ 0 & 1 \end{bmatrix}$

b) Find the Norms of given equation $f(t) = t + 2$

c) Define De-Moivre's theorem by exponential function.

d) Solve $f(z) = \frac{\sin z}{z}$

e) Solve $4\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + y = 0$

f) Find $L(te^{2t})$

g) Define in a_0, a_n *and* b_n in Fourier series.

h) Find, the Residue of $f(z) = \frac{z^2}{Z^2+a^2}$

Q.3 Answer the following question (Any Three) **12**

a) Consider the function $f(z) = \oint \frac{e^z}{Z^2-2Z+2}\, dz$

i) Determine the singular points of $f(z)$.

ii) Calculate the residues at each of the singular points

b) Describe Argand Diagram.

c) Determine linear independence of following Set $S = \{(1,-1,2),(1,-2,1),(1,1,4)$

d) Solve $9\frac{d^2y}{dx^2} + 12\frac{dy}{dx} + 29y = 0$

Q.4 Answer the following question (Any Two) **12**

a) Solve the differential equation $\frac{dy}{dx} + ycotx = \cos x$

b) Evaluate the integral $f(z) = \oint \frac{\sin(z)}{Z^2+4}\, dz$ where, C is the circle $|Z| = 3$ traversed counterclockwise.

c) Determine whether the following in R^3 is linearly independent.

$\{(1,-2,1),(2,1,1),(7,-4,1)\}$

Q.5 Answer the following (Any Two) **12**

a) Find $L(te^{-2t}\sin 2t \sin 3t)$

b) Solve $\frac{d^2y}{dx^2} - 10\frac{dy}{dx} + 25y + 0$

c) Find the inverse of a matrix $A = \begin{bmatrix} 7 & 2 & 1 \\ 0 & 3 & -1 \\ -3 & 4 & -2 \end{bmatrix}$

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M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2025
Solid State Physics (2321102)

Day & Date: Saturday, 17-May-2025 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 A) Choose correct alternative. **08**

1) The Bloch theorem is crucial for understanding_____
a) Dielectric properties b) Band structure in solids
c) Superconductivity d) Paramagnetism

2) The Meissner effect demonstrates_____
a) Perfect diamagnetism in superconductors
b) Magnetic susceptibility in ferrites
c) Curie-Weiss behavior in paramagnetism
d) None of the above

3) The Neel temperature is associated with ____.
a) Superconductivity b) Antiferromagnetism
c) Ferrimagnetism d) Ferroelectricity

4) Which type of polarization is due to the distortion of the electron cloud?
a) Ionic b) Orientational
c) Electronic d) Dielectric

5) The Kronig-Penney model explains:
a) The energy gap in semiconductors
b) Susceptibility in magnetic materials
c) Polarization mechanisms
d) None of the above

6) Superconductivity is destroyed at ____.
a) Low temperatures b) High magnetic fields
c) Room temperature d) Low pressures

7) Ferrimagnetic materials are characterized by ____.
a) Equal and opposite spins b) Unequal opposing spins
c) Random spin alignment d) None of the above

8) The Clausius-Mossotti equation relates
a) Magnetic permeability and susceptibility
b) Polarizability and dielectric constant
c) Electrical conductivity and temperature
d) None of the above

B) Fill in the blanks: **04**
a) The energy bands in solids arise due to the ____ potential.
b) Superconductors exhibit perfect diamagnetism due to the ____ effect.
c) Antiferromagnetic materials have a critical temperature called the ____.
d) The ____ equation is used to calculate the internal field in a dielectric.

Q.2 Answer the following (Any Six). **12**
a) Explain the motion of electrons according to band theory.
b) Discuss the significance of the Meissner effect in superconductors.
c) What is the Curie point?
d) Explain the electronic polarization in dielectrics.
e) Write about the energy gap in semiconductors.
f) Differentiate between Type I and Type II superconductors.
g) Classify the magnetic materials.
h) Explain the Bloch wall.

Q.3 Answer the following (Any Three). **12**
a) Derive the London equations in superconductivity.
b) Describe the electrical conductivity in metals.
c) Write about the Langevin theory of paramagnetism.
d) Discuss the Brillouin zones.

Q.4 Answer the following (Any Two). **12**
a) Derive the Clausius-Mossotti equation.
b) Explain the dipole theory of ferroelectricity.
c) Write a note on saturation magnetization and its temperature dependence.

Q.5 Answer the following (Any Two). **12**
a) Describe the Josephson effect and its applications.
b) Discuss the thermodynamics of superconductors.
c) Write a detailed note on ferrimagnetic materials.

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Set P

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2025
Analog and Digital Electronics (2321106)

Day & Date: Monday, 19-May-2025 Max. Marks: 60
Time: 03:00 AM To 05:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 A) Choose correct alternative. **08**

1) If a signal passing through a gate is inhibited by sending a LOW into one of the inputs, and the output is HIGH, the gate is a(n):
   a) AND b) NAND
   c) NOR d) OR

2) Which of the following is true about microprocessors?
   a) It has an internal memory
   b) It has interfacing circuits
   c) It contains ALU, CU, and registers
   d) It uses Harvard architecture

3) What is a shift register that will accept a parallel input, or a bidirectional serial load and internal shift features, called?
   a) tristate b) end around
   c) universal d) conversion

4) The output of an AND gate with three inputs. A, B, and C, is HIGH when _____.
   a) A = 1, B=1, C=0 b) A=0, B=0, C=0
   c) A=1, B=1, C=1 d) A=1, B=0, C=1

5) An ideal operational amplifier has _____.
   a) infinite output impedance b) zero input impedance
   c) infinite bandwidth d) All of the above

6) A series dissipative regulator is an example of a _____.
   a) linear regulator b) switching regulator
   c) shunt regulator d) dc-to-dc converter

7) The output of a NOR gate is HIGH if _____.
   a) all inputs are HIGH b) any input is HIGH
   c) any input is LOW d) all inputs are LOW

8) Which of the following logical operations is represented by the + sign in Boolean algebra?
   a) inversion b) AND
   c) OR d) Complementation

B) Fill in the blanks or Write True/False. **04**

1) The output voltage of a voltage buffer is _____ with the input voltage.
2) Op-amp circuits are used in _____ voltmeters.
3) A microprocessor with the necessary support circuits will include at least two memory ICs: ROM or EPROM, and a RAM. True/ False
4) Programs written for the 8080A must have slight modifications to run on the 8085A.True/False

Q.2 Answer the following. (Any Six) **12**

a) Define the term common mode rejection ratio.
b) What are the operations performed by ALU of 8085.
c) What is instrumentation amplifier.
d) Define slew rate.
e) What is Input bias current.
f) Define voltage regulator.
g) What is opcode fetch cycle.
h) Define differential gain related to a differential amplifier

Q.3 Answer the following. (Any Three) **12**

a) Draw the circuit diagram of an Op-amp based Wein bridge oscillator?
b) List the Software and Hardware interrupts of 8085?
c) Describe some of the characteristics of practical Op-amp?
d) Show the logic diagram of SR flip-flop with four NAND gate?

Q.4 Answer the following. (Any Two) **12**

a) What is switching regulator? What are the types of switching regulator? Explain them in details with suitable figure?
b) Draw the circuit of summing amplifier using inverting amplifier configuration.
Write an equation for the output voltage for this circuit
c) Explain briefly about bus structure of 8085.

Q.5 Answer the following. (Any Two) **12**

a) What is comparator? How it can be used to produce a square -wave at the output from a Sine-wave?
b) Draw and explain the architecture of 8085 microprocessor.
c) Explain the difference between combinational & Sequential circuits.

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M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2025
Research Methodology in Physics (2321105)

Day & Date: Saturday, 24-May-2025 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 A) Choose the correct alternative. **08**

1) The main problem in questionnaire is _____.
a) Accessible to Diverse Respondent
b) Greater Anonymity
c) Shows an inability of respondent to provide information
d) None of these

2) UV-V is spectroscopy cannot analyze compounds that _____ with light.
a) don't interact b) interact
c) merge d) none of the above

3) By selecting laser operating conditions, control over microstructure is _____.
a) possible b) impossible
c) not defined d) both a) and b)

4) In DC sputtering, _____ bias is applied to the target material.
a) Negative b) Positive
c) No d) All of the above

5) Resistive thermal deposition can deposit materials with low _____ points.
a) boiling b) decimal
c) melting d) none of the above

6) HRTEM provides _____ images.
a) medium resolution b) poor resolution
c) low resolution d) high resolution

7) Qualitative methods are probably the oldest of all the scientific techniques, the method of Qualitative research is _____.
a) Questionnaire b) Attitude Scales
c) Depth Interview d) Observation

8) Electronic interview can be conducted by _____.
a) Telephonic b) Fax
c) Personal d) All of the above

B) Fill in the blanks OR write True / False: **04**

1) In PLD, kinetic energies of ablated particles are high enough to promote surface diffusion. (True/False)
2) In thermal evaporation, films in the thickness range of angstroms to microns are obtained. (True/False)
3) _____ sampling is a probability sampling method.
4) In _____ sputtering, magnets behind cathode trap electrons.

Q.2 Answer the following. (Any Six) **12**

a) What are the applications of UV-Vis Spectroscopy?
b) State the physical conditions of DC and RF sputtering.
c) Define Quantitative research method.
d) State the various tools for data analysis.
e) Draw the neat labeled diagram of electrodeposition method.
f) What are the applications of FTIR Spectroscopy.
g) Enlist the Data Processing strategies.
h) Write the applications of Pulsed Laser Deposition.

Q.3 Answer the following. (Any Three) **12**

a) Write a note on Patents.
b) Draw the neat labeled diagram of HRTEM instrument.
c) Define physical and chemical vapour deposition.
d) Write a note on Applied Vs. Fundamental research methods.

Q.4 Answer the following. (Any Two) **12**

a) Explain different techniques and methods of good sampling.
b) Write in detail about the concept of Chemical Bath Deposition.
c) Write in detail about the construction and working of SEM.

Q.5 Answer the following. (Any Two) **12**

a) Write a note on Review of Literature.
b) What is Research Methodology? What are the requisites for Good Scientific Research?
c) Explain the construction and working of Fourier Transform Infrared Spectroscopy.

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Set P

M.Sc. Physics (Material Science) (Semester - II) (New) (NEP CBCS)
Examination: March/April - 2025
Quantum Mechanics (2321201)

Day & Date: Wednesday, 14-May-2025 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to right indicate full marks.

Q.1 A) Choose correct alternative. **08**

1) Raising operator is defined as _____.
a) $L_x + iL_y$ b) $L_x - iL_y$
c) $iL_z - iL_y$ d) $iL_x - iL_z$

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

4) If Ψ_a and Ψ_b are said to be orthogonal to each other, then which of the following is true.
a) $\langle \Psi_a | \Psi_b \rangle = 1$ b) $\langle \Psi_a | \Psi_b \rangle = \infty$
c) $\langle \Psi_a | \Psi_b \rangle = \sqrt{1/2}$ d) $\langle \Psi_a | \Psi_b \rangle = 0$

5) The commutation relation between $[x, P_x]$ and $[\partial/\partial x, x]$ is _____.
a) $i\hbar, 0$ b) $0, i\hbar$
c) $-i\hbar, 1$ d) $i\hbar, 1$

6) The eigen value of L^2 is _____.
a) $l(l+1)\hbar^2$ b) $l(l-1)\hbar$
c) $l(l^2+1)\hbar^2$ d) $l(l+1)\hbar$

7) The minimum energy of particle confined to one dimensional rigid box is by substituting n equal to _____.
a) one b) zero
c) half d) two

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

B) Fill in the blanks OR write true/false. **04**

1) Inner product of bra and ket in Quantum Mechanics is always 1. (True/False)
2) Probability density is always positive. (True/False)
3) For a free particle the potential energy $V(x) =$ _____.
4) The linear momentum operator is given by _____.

Q.2 Answer the following. (Any Six) **12**

a) Define Hamiltonian operator.
b) Write about the energy of harmonic oscillator.
c) What is the probability density?
d) Define the orthogonality and normalization.
e) Write in short about the Dirac delta function.
f) What is Compton effect?
g) What is meant by rigid box?
h) What is a complex function? Give an example.

Q.3 Answer the following. (Any three). **12**

a) State and prove Ehrenfest theorem Part II.
b) Prove that group velocity (V_g) is equal to velocity of material of particle (V).
c) Define the different postulate of Quantum mechanics.
d) Explain unitary transformation.

Q.4 Answer the following. (Any two) **12**

a) What is Schrodinger wave equation? Write in detail about Schrodinger time independent wave equation.
b) State and explain Heisenberg uncertainty principle in Quantum Mechanics with an example.
c) Discuss eigen values and eigen functions for a particle in three-dimensional infinite potential well.

Q.5 Answer the following. (Any two) **12**

a) Obtain eigen values of operators L^2 and Lz.
b) Describe the Pauli spin matrices.
c) Explain
i) Schartz's Inequality
ii) State vector
iii) Span
iv) Basis

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Set **P**

M.Sc. Physics (Material Science) (Semester - II) (New) (NEP CBCS)
Examination: March/April - 2025
Electrodynamics (2321202)

Day & Date: Friday, 16-May-2025 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 A) Choose correct alternative. **08**

1) The electrostatic energy in an electric field does not depend on which of the following?
   a) Magnitude of charges b) Permittivity
   c) Applied electric field d) Flux lines

2) If the electric potential is given, which of the following cannot be calculated?
   a) Electrostatic energy b) Electric field intensity
   c) Electric flux density d) Permittivity

3) Electric field intensity is a _____ quantity.
   a) Scalar b) Vector
   c) Both (a) and (b) d) None of the above

4) The skin effect is a phenomenon observed in _____.
   a) Insulators b) Dielectrics
   c) Conductors d) Semiconductors

5) Lorentz electric force has direction_____.
   a) Similar to electric field b) Opposite to electric field
   c) Scalar quantity d) None of these

6) Electric intensity at any point in an electric field is equal to the at that point.
   a) Electric flux b) Magnetic flux density
   c) Potential gradient d) None of the above

7) The Biot-Savart's law is a general modification of _____.
   a) Kirchhoff’s law b) Lenz's law
   c) Ampere's law d) Faraday's laws

8) The skin depth is used to find which parameter?
   a) DC resistance b) AC resistance
   c) Permittivity d) Potential

B) Write True/False. **04**

1) The work done in moving a test charge from one point to another in an equipotential surface is zero.
2) When curl of a path is zero, the field is said to be conservative.
3) In static magnetic field only magnetic dipole exist.
4) The magnetic field intensity will be zero inside a conductor.

Q.2 Answer the following. (Any Six) **12**

a) State Biot-Savart law.
b) Explain the electromagnetic force.
c) How electromagnetism works?
d) Define Poynting vector.
e) What is an electric field?
f) Write Maxwell equation derived from Faradays law.
g) What is an electromagnetic wave?
h) Define Skin effect.

Q.3 Answer the following. (Any Three) **12**

a) Explain differential form of Ampere's law.
b) Explain energy stored in electric field.
c) State the boundary condition for an electrostatic field $\bar{E}$.
d) Explain Maxwell displacement current.

Q.4 Answer the following. (Any Two) **12**

a) What is gauss law? Explain differential form of its.
b) Discuss electromagnetic plane waves in stationary medium.
c) Explain the concept of Thomson cross section.

Q.5 Answer the following. (Any Two) **12**

a) Explain boundary condition between conductor and free space.
b) State and prove Poynting theorem.
c) Explain in short radiation from a half wave antenna.

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Set **P**

M.Sc. Physics (Material Science) (Semester - II) (New) (NEP CBCS)
Examination: March/April - 2025
Classical Mechanics (2321206)

Day & Date: Tuesday, 20-May-2025 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 A) Choose correct alternative. **08**

1) _____ the constraints are independent of time.
a) Holonomic b) Non-holonomic
c) Scleronomous d) Rheonomous

2) The phase space refers to _____.
a) Position coordinates
b) Momentum coordinates
c) Both Position and Momentum coordinates
d) Cyclic coordinates

3) Which is true mathematical statement of 2nd law of Newtonian mechanics?
a) F=m/a b) F=ma
c) F=m+a d) F=m-a

4) _____ for circular orbit the value of eccentricity.
a) $\in > 1$ b) $\in < 1$
c) $\in = 1$ d) $\in = 0$

5) Newton's laws of motion are _____ under Galilean transformation.
a) Invariant b) Variant
c) changes its form d) changes its sign

6) Degrees of freedom for fly wheel _____.
a) 0 b) 1
c) 3 d) 5

7) Which of the following is true for Poisson bracket?
a) [X,Y]= [Y,X] b) [X,Y]=2[Y,X]
c) [X, Y]= -[Y,X] d) [X,X]=[Y,Y]=1

8) The generating function F1(q,Q,t) generates _____ transformation.
a) Identity b) Exchange
c) Zero d) Infinite

B) Fill in the blank OR true /False. **04**

1) The motion of the planets around the sun is the example of the motion under central force field. (True/False)
2) In Lagrange's equation, the motion of the system has been described by force. (True/False)
3) The equation of Jacobi's Identity is _____.
4) As per Kepler's third law of planetary motion, square of a time period is directly proportional to cube of a _____.

Q.2 Answer the following. (Any Six) **12**

a) Define central force and give its characteristics?
b) How to analyse the orbits?
c) What is the Jacobi integral?
d) Define the conservation of linear and angular momenta.
e) Write in short about the open system.
f) What is Euler-Lagrangian differential equation?
g) Write the condition for transformation to be canonical.
h) What is the constant of motion?

Q.3 Answer the following. (Any Three) **12**

a) Give an account about conservation of energy in case of mechanics of particles.
b) What are constraints? Explain in detail about their types with suitable examples.
c) Check whether the transformation defined as $Q=1/p$, $P=qp^2$ is canonical or not.
d) State Hamilton's variational principle and derive the Lagrange's equation of motion form it?

Q.4 Answer the following. (Any Two) **12**

a) Explain
1) Gauge invariance of Lagrangian equation
2) Gyroscopic forces

b) Explain and prove the principle of least action.
c) Derive an equivalent equation for reduction to one body problem from two body problem.

Q.5 Answer the following. (Any Two) **12**

a) Elaborate the differences between Classical Mechanics and Quantum Mechanics.
b) Apply the Hamilton's equations to derive the equations of motion for simple pendulum and linear harmonic oscillator.
c) Write short note on
1) Artificial Satellite
2) Rutherford scattering

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Set P

M.Sc. Physics (Material Science) (Semester - III) (New) (NEP CBCS)
Examination: March/April - 2025
Statistical Physics (2321301)

Day & Date: Thursday, 15-May-2025 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

Instructions: 1) All questions are compulsory.
2) Figure to the right indicate full marks.

Q.1 A) Choose correct alternative. **08**

1) First and second law of thermodynamics are related by the relation
a) dU=TdS-VdP b) dU=TdS+PdV
c) dU=PdV-TdS d) dU=TdS-PdV

2) Helmholtz function is the amount of useful work done by a thermodynamic system at constant ____.
a) pressure
b) temperature and volume
c) temperature and pressure
d) pressure and volume

3) "At absolute zero the entropy of pure crystal is zero" is the statement of which law of thermodynamics?
a) First law b) Second law
c) Third law d) Fourth law

4) In a grand canonical ensemble, a system A of fixed volume is in contact with a large reservoir B. Then ____.
a) A can exchange neither energy nor particles with B
b) A can exchange only energy with B
c) A can exchange both energy and particles with B
d) A can exchange only particles with B

5) In which process the pressure of the system remains constant?
a) isothermal process b) isobaric process
c) isometric process d) isochoric process

6) In Maxwell relations, $(\partial \mathrm{T}/\,\partial \mathrm{V})s = ?$
a) $-(\partial \mathrm{V}/\,\partial S)_{\mathrm{T}}$ b) $-(\partial \mathrm{P}/\,\partial S)_{\mathrm{V}}$
c) $(\partial S/\,\partial \mathrm{P})_{\mathrm{T}}$ d) $(\partial S/\,\partial \mathrm{V})_{\mathrm{T}}$

7) What does occur at a critical point in critical phenomenon?
a) phase transition b) symmetry breaking
c) universality d) scaling laws

8) Electron is an example of which statistics?

a) Bose Einstein statistics b) Maxwell Boltzmann statistics

c) Fermi Dirac statistics d) None

B) Fill in the blanks OR write true/false: **04**

1) Entropy and temperature are the canonical pair. (True/False)
2) During a phase change, the temperature of a substance remains constant. (True/False)
3) The average K.E. of a harmonic oscillator is ____.
4) In BE statistics particles have ____ spin.

Q.2 Answer the following question (Any Six). **12**

a) Which physical quantity remains constant during the process of phase transition?
b) Write one example of first order phase transition.
c) Name the statistics obeyed by photon and electron.
d) What is thermodynamic potential?
e) Write about statistical ensemble.
f) What is phase space?
g) What is the entropy of system?

Q.3 Answer the following (Any Three). **12**

a) Write a note on chemical potential.
b) Discuss about the thermodynamic system.
c) Write about the condition for phase equilibrium.
d) Write a note on probability calculation.

Q.4 Answer the following (Any Two). **12**

a) Write a note of Black body radiation and Planck distribution.
b) Draw and discuss the diagram of an oscillator in phase space.
c) Define and explain the laws of thermodynamics with examples.

Q.5 Answer the following (Any Two). **12**

a) State and discuss the Ehrenfest equations.
b) Write in detail about the Maxwell-Boltzmann statistics.
c) Explain about the statistical ensembles and their types.

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Set P

M.Sc. Physics (Material Science) (Semester - III) (New) (NEP CBCS)
Examination: March/April - 2025
Atomic & Molecular Physics (2321302)

Day & Date: Saturday, 17-May-2025 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 A) Choose correct alternative. **08**

1) The singlet system of helium for S = 0 is called ____.
a) Para-helium b) a positively helium ion
c) Ortho-helium d) a negatively helium ion

2) Which of the following cannot be conserved during Raman scattering?
a) Total Energy b) Momentum
c) Kinetic Energy d) Electronic Energy

3) Transition of an electron from various s levels to lowest p level gives____
a) sharp series b) principle series
c) diffuse series d) fundamental series

4) In case of LS coupling l_1= 1, l_2 = 2, then J = ____.
a) 1,2,3,4 b) 0,1,2,3
c) 2,3,4 d) 0,1,2,3,4

5) With increasing quantum number, energy difference between adjacent levels in atoms ____.
a) decreases b) increases
c) remain constant d) zero

6) Atomic spectra is an example of ____
a) line spectra b) continuous spectra
c) band spectra d) both a and b

7) The orientation of atomic orbitals depends on their ____.
a) Spin quantum number
b) Magnetic quantum number
c) Azimuthal quantum number
d) Principal quantum number

8) Symmetric top molecules have _____.

a) $I_A=I_B=I_C$ b) $I_A=I_B\neq I_C$

c) $I_A\neq I_B=I_C$ d) $I_A=O$, $I_B\neq I_C$

B) Write true/false. **04**

1) Splitting of spectral lines in an atom in presence electric field is called Stark effect. (True/False)
2) If Q value of nuclear reaction is positive the reaction is Exothermic. (True/False)
3) Spin angular momentum depends on s. (True/False)
4) The electronic spectra are observed in far IR region. (True/False)

Q.2 Answer the following (Any Six). **12**

a) What are the quantum states of an electron in an atom?
b) Define interaction energy of an atom.
c) Write about the Paschen back effect.
d) Define covalent interaction.
e) What is meant by diatomic molecule?
f) Define dissociation energy.
g) Write about the binding energy of an atom.

Q.3 Answer the following (Any Three) **12**

a) Write in brief on two valence electron spectra.
b) Discuss about origin of spectral line.
c) State and explain Pauli's Exclusion Principle.
d) Write a note on the vibrating diatomic molecule.

Q.4 Answer the following (Any Two) **12**

a) Write in detail about the jj coupling.
b) Discuss about the X-ray and Auger transition.
c) Write a note on Raman spectra.

Q.5 Answer the following (Any Two). **12**

a) What is hyperfine structure? Elaborate.
b) Explain in detail about anharmonic oscillator.
c) Discuss in detail about the spectrum of a non-rigid rotator.

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - III) (New) (NEP CBCS)
Examination: March/April - 2025
Physics of Nanomaterials (2321307)

Day & Date: Monday, 19-May-2025 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 A) Choose the correct alternative. (MCQ) **08**

1) Which of the following is a bottom-up technique for nanostructure fabrication?
   a) Sputtering b) Ball milling
   c) Polyol route d) Photolithography

2) The primary effect of quantum confinement in semiconductor nanostructures is:_____
   a) Reduced bandgap
   b) Increased optical absorption
   c) Reduced electron mobility
   d) Decreased surface energy

3) Raman Spectroscopy is primarily used for: _____
   a) Measuring electrical conductivity
   b) Identifying chemical bonds and vibrational modes
   c) Measuring the absorption spectra
   d) Determining the density of states

4) Which of the following processes can be used for thin film deposition?
   a) Poling
   b) Rapid solidification
   c) Molecular beam epitaxy
   d) Colloidal precipitation

5) Hopping conduction is most likely to occur in:
   a) Semiconductors b) Insulators
   c) Metals d) Thin films

6) The phenomenon of electroluminescence is best observed in:_____
   a) Organic light-emitting diodes
   b) Fluorescent materials
   c) Metal nanoparticles
   d) Insulating materials

7) Field-enhanced thermionic emission is related to:_____
   a) Tunnelling b) Schottky effect
   c) Poole-Frenkel effect d) Hopping conduction

8) Which technique uses a focused laser to transfer material onto a substrate?
   a) Sputtering
   b) Pulsed Laser Deposition
   c) Physical Vapor Deposition
   d) Chemical Vapor Deposition

B) Fill in the blanks OR write true/false **04**

1) Ball milling is a top-down approach to the fabrication of nanostructures. (True/False)
2) Excitons are formed when an electron and hole pair bind together.(True/False)
3) Rapid solidification is a bottom-up technique. (True/False)
4) Raman spectroscopy is used to study the electronic structure of carbon nanotubes. (True/False)

Q.2 Answer the following (Any Six) **12**

a) Define quantum confinement in nanomaterials.
b) What are exciton and its role in nanostructures?
c) What is the significance of Raman spectroscopy in studying nanomaterials?
d) Differentiate between photoluminescence and fluorescence.
e) What is the Schottky effect?
f) Describe the principle of Field-Enhanced Thermionic Emission.
g) Explain the basic concept of lithography in nanofabrication.
h) What is the purpose of colloidal precipitation in nanoparticle synthesis?

Q.3 Answer the following (Any Three) **12**

a) Explain bottom-up techniques and provide examples.
b) Discuss the Poole-Frenkel effect and its significance in materials science.
c) Describe the process and applications of Physical Vapor Deposition (PVD).
d) Explain plasmonic resonance in metallic nanoparticles and its applications.

Q.4 Answer the following (Any Two) **12**

a) Discuss the top-down fabrication techniques in nanotechnology.

b) Describe the synthesis and applications of carbon nanotubes.

c) Explain the different types of luminescence observed in nanomaterials and their significance.

Q.5 Answer the following (Any two) **12**

a) Compare quantum dots with bulk semiconductors regarding electronic and optical properties.

b) Explain the hopping conduction mechanism in low-dimensional systems.

c) Discuss the electrical conduction mechanisms in insulators and compare them to those of metals.

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - III) (Old) (CBCS)
Examination: March/April - 2025
Semiconductor Physics (MSC03301)

Day & Date: Thursday, 15-May-2025 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

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

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

1) At 0 K the Fermi-Dirac distribution function takes _____.
a) the exponential form b) the simple rectangular form
c) the linear form d) the circular form

2) For a semiconductor in thermal equilibrium _____.
a) the intrinsic level E_i is in the valence band
b) the intrinsic level E_i is near the valence band edge
c) the intrinsic level E_i is at the middle of the band gap
d) the intrinsic level E_i is near the conduction band edge

3) In semiconductors, the Fermi function $f(E)$ is symmetrical about ____.
a) Fermi level E_F b) conduction band edge Ec
c) valence band edge Ev d) conduction band (C.B.)

4) A semiconductor absorbs photons with energies _____.
a) Smaller than band gap energy only
b) equal to the band gap energy only
c) equal to the band gap or larger
d) equal to the band gap or smaller

5) When trapping is present in the material:
a) $\tau_n \neq \tau_p$ b) $\tau_n = \tau_p$
c) $\tau_n = 0$ d) $\tau_p = 0$

6) To get _____ the junction must be constructed so that there is either no barrier between the metal and the semiconductor, or any barrier that is present is so thin that charge carriers readily tunnel through it.
a) an ohmic contact
b) a rectifying
c) both an ohmic contact and a rectifying
d) clipper

7) If $(a+b)$ is period of potential, then for such periodic potential; $V(x)$ = _____.

a) $V[x+(a+b)]$ b) $V[x/(a+b)]$

c) $V[x+(a-b)]$ d) $V[x*(a+b)]$

8) _____ is initial process that occurs in the formation of a crystal.

a) Growth b) Nucleation

c) atomic bonding d) Clusters

9) In case of crystal growth process the term LPE means _____.

a) Lower Potential Energy b) Local Potential Energy

c) Liquid Phase Epitaxy d) Laser phase Epitaxy

10) In case of crystal growth process the abbreviation VPE means _____.

a) Volume Phase Epitaxy b) Vapor Phase Epitaxy

c) Variable Potential Energy d) Vapor Pressure Energy

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

1) The high-field excitation of electrons into the indirect minima leads to the _____ effect.
2) Semiconductor silicon (Si) has band gape energy; E_g = _____ eV.
3) Drift of charge carriers in a semiconductor is caused by _____.
4) The particle inside a box in a finite potential well can never be at rest, as it will violate _____ Uncertainty Principle.
5) The inverse effective-mass tensor is a symmetric tensor of the _____ rank.
6) The crystal growth technique MBE means _____.

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

a) Calculate the probability of an electron being thermally excited to an energy level which is 0.01 eV above the Fermi level. (Given: the Boltzmann constant, $k = 8.625 \times 10^{-5}$ eV/K, temperature, $T = 300\ K$ and value of exponent base, $e = 2.71$).

b) Discuss electrical conductivity and mobility in a semiconductor.

c) Calculate band gap energy of a semiconductor germanium (Ge), in electron volt, if it absorbs a photon of wavelength 1.77 micro meters.

d) How trapping of charges carries occurs in semiconductors?

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

a) Write a note on "group velocity of electrons." Obtain necessary expression.

b) Describe in detail nucleation and growth theory of crystal growth process.

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

a) Discuss bonding forces in semiconductors.

b) Discuss in detail formation energies of liquid nuclei and crystalline nuclei.

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

a) Write a note on direct and indirect band gap materials.

b) Explain how electric field is Built up by diffusion and drift of carries in the in semiconductor.

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

a) Discuss in detail “The Haynes-Shockley Experiment.”

b) Describe dynamics of electrons and holes inside a semiconductor.

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

a) Write a note on Fermi level pining.

b) Explain Czochralski and liquid encapsulation techniques.

Seat No.	

Set **P**

M.Sc. Physics (Material Science) (Semester - III) (Old) (CBCS)
Examination: March/April - 2025
Atomic and Molecular Physics (MSC03302)

Day & Date: Saturday, 17-May-2025 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

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

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

1) Which interaction causes the splitting of spectral lines due to the interaction between the orbital motion of an electron and its spin?
a) Zeeman effect
b) Stark effect
c) Fine structure
d) Lamb shift

2) The fine structure of hydrogen atom includes which of the following corrections?
a) Relativistic correction
b) Spin-orbit interaction
c) Lamb shift
d) All of the above

3) What principle states that no two electrons in an atom can have the same set of four quantum numbers?
a) Hund's rule
b) Pauli exclusion principle
c) Aufbau principle
d) Heisenberg uncertainty principle

4) What does the term "fine structure spectra" refer to in atomic physics?
a) Splitting of spectral lines due to the presence of an external electric field
b) Splitting of spectral lines due to the presence of an external magnetic field
c) Detailed splitting of spectral lines into closely spaced components
d) Spectral lines emitted in the X-ray region of the electromagnetic spectrum

5) What does the term "hyperfine structure spectra" refer to?
   a) Splitting of spectral lines into closely spaced components due to nuclear spin
   b) Splitting of spectral lines due to the presence of an external electric field
   c) Detailed splitting of spectral lines into closely spaced components
   d) Spectral lines emitted in the infrared region of the electromagnetic spectrum

6) Which theory describes how atomic orbitals combine to form molecular orbitals in a molecule?
   a) Valence bond theory
   b) Molecular orbital theory
   c) Hybridization theory
   d) Electron affinity theory

7) Which type of bonding involves the attraction between temporary dipoles in molecules?
   a) Covalent bonding
   b) Ionic bonding
   c) Metallic bonding
   d) Van der Waals bonding

8) What principle states that the intensity of spectral lines in electronic transitions is proportional to the overlap of initial and final vibrational wavefunctions?
   a) Morse oscillator principle
   b) Frank-Condon principle
   c) Born-Oppenheimer principle
   d) Rigid rotor principle

9) What are the group theoretical selection rules used for in infrared and Raman spectroscopy?
   a) Determining the intensity of spectral lines
   b) Predicting the positions of spectral lines
   c) Identifying the presence of certain functional groups in molecules
   d) Assigning the molecular weight of the molecule

10) In electronic spectroscopy, what information can be obtained about molecular structure?
   a) Molecular polarizability
   b) Molecular vibrations
   c) Molecular rotations
   d) Energy levels and electronic transactions

Q.1 B) State whether true or false: **06**

   a) Microwave spectroscopy is primarily used for the determination of electronic structures in molecules.
   b) Rotational Raman spectroscopy is a technique used to determine the rotational levels of molecules by measuring the intensity of Raman-scattered light as a function of frequency.
   c) Hybridization theory primarily depends on the electronegativity of atoms involved in bond formation.
   d) Van der Waals bonding involves the attraction between permanent dipoles in molecules.

e) Relativistic corrections for energy levels of the hydrogen atom become significant only for very high atomic numbers.
f) The Pauli exclusion principle states that no two electrons in an atom can have the same set of quantum numbers.

Q.2 Write short answers. **16**

a) Describe L-S coupling and j-j coupling for describing the coupling of electron spin and orbital angular momentum in atoms.
b) Discuss the concept of fine structure spectra in atomic physics.
c) Discuss the concept of hybridization in the context of molecular orbitals and provide an example of a molecule with sp^3 hybridization.
d) Describe the group theoretical selection rules for infrared and Raman transitions in molecular vibrations.

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

a) Explain the concept of atomic and molecular polarizability. Discuss how polarizability influences the interaction of molecules with electromagnetic radiation in various spectroscopic techniques.
b) Explain the principles of Raman spectroscopy for vibrational level determination.

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

a) Explain the rotational levels in diatomic and polyatomic molecules, including the Born-Oppenheimer approximation and selection rules for rotational transitions.
b) Explain the concept of hybridization in molecules with its types of hybrid orbitals formed.

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

a) Explain the concept of the exchange effect in two-electron spectra & discuss how the interaction between electrons leads to additional spectral features which influences the observed spectrum.
b) Describe the principles of nuclear magnetic resonance (NMR) spectroscopy and electron spin resonance (ESR).

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

a) Explain the vibration-rotation spectra and the significance of P, Q, and R branches.
b) Explain the electronic spectra of diatomic molecules, emphasizing the Frank- Condon principle.

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

a) Explain Stem and Garlach Experiment and derive the expression for separation of an atom inside non-homogeneous magnetic field.
b) Explain Paschen-Back effect for 2S-2P transition.

SLR-ZN-20

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - III) (Old) (CBCS)
Examination: March/April - 2025
Materials Characterization (MSC03308)

Day & Date: Monday, 19-May-2025 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) SI unit of thermal conductivity is given as _____
a) WmK^{-1} b) $Wm^{-1}k^{-1}$
c) Wm^2K d) Wm^2k^2

2) The representation of Beer Lambert's law is given as A = abc. If 'A' represents absorption, 'b' represents distance and 'c' represents concentration, what does 'a' represent?
a) Intensity b) Transmittance
c) Absorptivity d) Admittance

3) 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

4) There are ____ main components in all spectrometers.
a) Three b) Five
c) Two d) Ten

5) By multiplying pumping speed by pressure at which that pumping speed occurs, we get a measure called as ____
a) vapour pressure b) Throughput
c) Density d) normal flow

6) The ____ is a mathematical function describing amplitude and phase of a wave diffracted from crystal lattice.
a) diffraction factor b) atomic factor
c) intensity factor d) structure factor

7) In Hall effect, ____ is exerted on the charge carriers.
a) Lorentz force b) Centripetal force
c) Mechanical force d) All of these

8) Radio waves have the ____ wavelength in the electromagnetic spectrum.
a) Longest b) Shortest
c) both (a) and (b) d) none of these

9) In four probe method, voltage is read across ____ inner probes.
a) Four b) Three
c) Two d) both (b) and (c)

10) DTA stands for ____.
a) Distribution Thermal Analysis
b) Destructive Thermal Analysis
c) Dimensional Thermal Analysis
d) Differential Thermal Analysis

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

a) Thermogravimetric analysis is used for measuring thermal stability. (True/False)
b) The oil in Rotary pump doesn't provide seal between rotor and pump ring. (True/False)
c) Gamma rays have the shortest wavelength in the electromagnetic spectrum. (True/False)
d) In a cubic lattice, all the angles are equal to ____ degrees.
e) In semiconductors having positive Hall coefficient, ____ are majority carriers.
f) Refractive index has ____ unit.

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

a) What are the different factors affecting the intensity in Powder X-ray Diffraction?
b) State the various Resonance techniques and mention their necessities in short.
c) Draw the neat labelled diagram showing construction of UV-Vis absorption spectroscopy.
d) State the postulates of kinetic theory of gases.

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

a) Describe in detail about absorption, refection and transmission in materials.
b) Explain in detail about the working principle of Roots pump.

Q.4 Answer the following **16**

a) What is a spectrometer? Explain its working and applications

b) Elaborate the basic principle of electrical transport in metals and semiconductors.

Q.5 Answer the following **16**

a) Explain the working of a Rotary Oil pump.

b) Describe the technique of measurement of band gap in solids using Photoluminescence spectroscopy.

Q.6 Answer the following **16**

a) Explain the Four probe method for conductivity measurement.

b) Using the kinetic theory of gases, obtain an expression for the relation between total kinetic energy, pressure, and volume of the gas.

Q.7 Answer the following **16**

a) Explain the methods of sample preparation.

b) Describe in detail about the Hall effect in semiconductors.

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - IV) (New/Old) (CBCS)
Examination: March/April - 2025
Semiconductor Devices (MSC03401)

Day & Date: Wednesday, 14-May-2025 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) Figures to the right indicate full marks.

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

1) In a heterojunction LASER, _____ materials are present.
a) n-type b) p-type
c) both (a) and (b) d) only n-type

2) When a _____ voltage is applied to the gate, the NMOS will conduct.
a) breakdown b) low
c) high d) both (a) and (b)

3) After biasing MIS structure, in case of accumulation, there is _____ of majority charge carriers.
a) addition b) removal
c) both (a) and (b) d) none of these

4) Flat-Band refers to the biasing condition in which there is _____ voltage drop.
a) little b) no
c) not defined d) all of these

5) When the current can be conducted in both directions of the MS contact, the contact is defined as the _____ contact.
a) Rectifying b) Ohmic
c) Resistive d) none of these

6) The point in the gate voltage sweep, when significant current begins to flow is called as _____.
a) cut-off voltage b) contact potential
c) threshold voltage d) all of these

7) The readout circuits of CCD perform a _____ conversion.
a) parallel to series b) series to parallel
c) parallel to parallel d) all of these

8) Dark charge is defined as the number of charge electrons that leaks into a pixel during the exposure time in the _____ of light.
a) absence b) presence
c) not defined d) both (a) and (b)

9) To increase fringing field, CCD gate length needs to be _____.
a) reduced b) enhanced
c) unchanged d) all of these

10) The negative differential resistance is the concept explained by _____ theory.
a) RWH b) Hall effect
c) quantum confinement d) both (b) and (c)

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

1) NMOS works faster than PMOS. (True False)
2) Fermi-level pinning is lowered potentially by the insulator layer at the metal-semiconductor junction. (True/False)
3) A higher electron energy is represented by the higher position in the energy band diagram. (True/False)
4) When the SCR is turned from forward blocking to forward conduction state is called as _____.
5) Photodiodes operate after _____ biasing.
6) The number of photoelectrons produced divided by the number of impinging photons is called as _____.

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

a) Write in brief about concept of the dark current.
b) Draw a neat labelled diagram showing construction of Gunn diode.
c) Write the difference between in depletion and enhancement MOSFET.
d) Draw a labelled diagram showing construction of Solar Cell.

Q.3 Answer the following question

a) Elaborate the IV characteristics of solar cell. Deduce an expression for quantum efficiency of solar cell. **08**
b) Elaborate in detail about the charge trapping concept in MOSFET. **08**

Q.4 Answer the following question

a) What are light emitting diodes? Explain the principle of construction and working of LEDs. **08**
b) Explain in brief about dv/dt and di/dt characteristics of SCR. **08**

Q.5 Answer the following question

a) What are Schottky diodes? Give the detailed explanation of working mechanism in Schottky diode. **08**
b) Explain the concept of flat band condition? Give the detailed explanation of basic equations flat band condition. **08**

Q.6 Answer the following question

a) Elaborate in detail about the basic construction and charge transfer mechanism in two phase CCD. **08**

b) Write in detail about LSA mode of operation. **08**

Q.7 Answer the following question

a) Give detailed explanation about the construction and working of p-n junction LASER. **08**

b) What are Photoconductors? Write in brief about photocurrent gain. **08**

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - IV) (New/Old) (CBCS)
Examination: March/April - 2025
Nuclear and Particle Physics (MSC03402)

Day & Date: Friday, 16-May-2025 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) Figures to the right indicate full marks.

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

1) The binding energy per nucleon is highest for which of the following elements?
   a) Helium b) Iron
   c) Uranium d) Hydrogen

2) The theory explaining alpha decay is based on which phenomenon?
   a) Quantum tunnelling
   b) Gravitational force
   c) Electromagnetic interaction
   d) Thermal diffusion

3) The quark composition of a proton is: _____.
   a) uuu b) uud
   c) udd d) ddu

4) Which nuclear model considers the nucleus as a drop of incompressible nuclear fluid?
   a) Shell model b) Fermi gas model
   c) Liquid drop model d) Superconductivity model

5) The primary component of cosmic rays is: _____.
   a) Electrons b) Neutrons
   c) Protons d) Gamma rays

6) Yukawa's theory describes nuclear forces as mediated by which type of particle?
   a) Electron b) Neutrino
   c) Meson d) Photon

7) The half-life of a radioactive substance is the time taken for its activity to: _____.
   a) Reduce to zero b) Double
   c) Reduce to half d) Become constant

8) Magic numbers are associated with which nuclear property?
   a) Nuclear spin b) Nuclear stability
   c) Decay constant d) Isotopic mass

9) The conservation law not obeyed in weak interactions is: _____.
   a) Charge conservation b) Parity conservation
   c) Energy conservation d) Baryon number conservation

10) A synchrotron is used to: _____.
   a) Accelerate particles in a straight line
   b) Detect cosmic rays
   c) Accelerate particles in a circular path
   d) Measure binding energy

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

1) The energy released during nuclear fusion is due to the conversion of _____ into energy.
2) The shell model explains the concept of _____ numbers for stable nuclei.
3) In beta decay, a neutron converts into a _____ and emits a beta particle and an antineutrino.
4) Cosmic rays are primarily composed of heavy nuclei. True/False
5) The binding energy per nucleon decreases for elements heavier than iron. True/False
6) Alpha particles have higher penetration power than beta particles. True/False:

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

a) Explain the concept of nuclear binding energy and its relation to nuclear stability.
b) Describe the liquid drop model and its applications in predicting nuclear masses.
c) What is Yukawa's hypothesis of nuclear forces? Explain the role of mesons.
d) Discuss the process of radioactive dating and its applications.

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

a) Explain the Fermi gas model and how it applies to the nucleus.
b) Describe the shell model of the nucleus with an emphasis on the spin-orbit interaction.

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

a) Derive the Breit-Wigner formula for nuclear resonance reactions.
b) Discuss the theory of alpha decay and the concept of quantum tunnelling.

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

a) Classify elementary particles based on their interactions. Explain with examples.

b) What are cosmic rays? Discuss their origin and effects on the Earth's atmosphere.

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

a) Explain nuclear fission and fusion with suitable examples.

b) Describe the functioning of a cyclotron and its application in nuclear physics.

Q.7 Answer the following **16**

a) Discuss the conservation laws in nuclear reactions with examples.

b) Explain the working principle of scintillation detectors and their applications.

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - IV) (New/Old) (CBCS)
Examination: March/April - 2025
Physics of Nano Materials (MSC03403)

Day & Date: Tuesday, 20-May-2025 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) Select the correct alternative. **10**

1) In bottom-up approach the building blocks can be _____.
a) atoms b) clusters
c) molecules d) all above

2) The surface area to volume ratio of a sphere with radius 30 nm is _____.
a) 10^8 b) 10^6
c) 10^7 d) 10^9

3) If the size of the metal nanoparticles decreases then the position of the SPR peak exhibits _____.
a) blue shift b) no shift
c) red shift d) none of the above

4) Similar to the bulk material, boron nitride nanotubes have a band gap _____.
a) ~ 4.5 eV b) ~ 5 eV
c) ~ 5.5 eV d) none of the above

5) The contrast transfer function frequently referred to in _____ imaging.
a) TEM b) HRTEM
c) SEM d) FESEM

6) The temperature below red heat, thermionic emission from uncharged bodies is chiefly _____.
a) positive b) negative
c) constant d) all of above

7) The conductivity expression in Arrehenious type thermally activated conduction can be given by the relation _____.
a) $\sigma = \sigma_0 \exp(E_a/kT)$ b) $\sigma = -\sigma_0 \exp(E_a/kT)$
c) $\sigma = \sigma_0 \exp(-E_a/kT)$ d) all of above

8) If an electron is confined in limited space, then the allowed energy states are _____.

a) continuous b) limited
c) discrete d) none of the above

9) DC sputtering cannot be used for deposition of _____.

a) Metal b) Oxide
c) Alloys d) All above

10) For emission of the electrons from the metal surface the minimum required energy is _____.

a) work function of the metal
b) kinetic energy of the electron
c) binding energy of the electron
d) None of the above

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

1) The estimated tensile strength of CNT is _____.
2) At present the highest resolution of HRTEM realised is _____.
3) In SEM the morphology of the sample is achieved with the help of _____.
4) STM is based on the concept of quantum tunnelling.
5) The SPR is observed for insulator nanoparticles.
6) AFM use feedback to regulate the current on the sample.

Q.2 Write short notes on. **16**

a) Nanobiometric
b) Molecular machines
c) Assumptions of Free Electron model.
d) Surface Plasmon resonance (SPR)

Q.3 **a)** Describe principle and operation of TEM. **10**
b) Why is spatial resolution of STM better than AFM? **06**

Q.4 **a)** Describe various process involved in the synthesis of metal oxides by sol-gel method. **10**
b) Advantages of chemical method of synthesis of nanomaterials. **06**

Q.5 **a)** Give an account of Top-down vs. Bottom-up techniques of nanofabrication. **10**
b) Explain the basic difference between a PVD and CVD process. **06**

Q.6 **a)** Derive the AC electrical conductivity of a metal according to Drude model. Explain the inadequacies of Drude model. **10**
b) Explain how endo-fullerenes can be used as one-dimensional metal-semiconductor junctions. **06**

Q.7	**a)**	What is a carbon nanotube? Explain types of carbon nanotubes.	**10**
	b)	Give an account of Template-assisted synthesis of nano-wires/rods.	**06**

Seat No.	

Set **P**

M.Sc. Physics (Material Science) (Semester - IV) (New/Old) (CBCS)
Examination: March/April - 2025
Advanced Techniques of Materials Characterization (MSC03406)

Day & Date: Thursday, 22-May-2025 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

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

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

1) Raman spectroscopy is based on ____.
a) Elastic scattering b) Inelastic scattering
c) Both a) and b) d) None of the above

2) Which type of spectroscopy relies on the scattering of light by molecules?
a) Raman spectroscopy b) FTIR spectroscopy
c) UV-Vis spectroscopy d) NMR spectroscopy

3) 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

4) What is the typical size range of nanoparticles?
a) 1 to 100 millimeters b) 1 to 100 micrometers
c) 1 to 100 nanometers d) 1 to 100 picometers

5) TEM images have much higher resolution than images from light Microscopes because ____.
a) TEM is much greater in size than light microscope
b) Electrons traveling as waves have wavelengths much shorter than visible light
c) TEM can achieve greater magnification
d) The fluorescent screen of TEM can generate high-resolution images

6) Raman effect is a scattering of ____.
a) Atoms b) Molecules
c) Protons d) Photons

7) Which of the following lines is most intense?
a) Stokes lines b) Rayleigh-scattered lines
c) Anti-strokes lines d) All have the same intensity

8) ____ technique is used for the determination of surface area.

a) SEM b) TEM
c) BET d) None of these

9) Which of the following is one of the most commonly used anode materials?

a) Carbon b) Tungsten
c) Magnesium d) Cesium

10) In FTIR spectroscopy, what is the function of an Attenuated Total Reflection (ATR) accessory?

a) To increase the intensity of the infrared beam
b) To reduce sample heating during analysis
c) To improve the resolution of the instrument
d) To enhance the interaction between the sample and the infrared beam

B) True and False: **06**

1) The intensity of the infrared radiation absorbed by a sample is directly proportional to the concentration of the sample.
2) In electron spectroscopy neutron beam is used for the analysis of the sample.
3) X-ray Photoelectron Spectroscopy (XPS) can be used to determine the elemental composition of a sample's surface.
4) In scanning electron microscopy, an image is formed by using secondary electrons.
5) The resolution of an optical microscope can be improved by increasing the magnification alone.
6) In Transmission Electron Microscopy (TEM), the sample must be extremely thin to allow electrons to pass through it.

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

a) Explain the principle of diffraction of light in optical microscopy. Discuss the significance of the Airy disc in determining resolution.
b) Discuss the limitations of light microscopy and the advantages of electron microscopy.
c) Explain the principle of diffraction of light and the Braggs diffraction condition.
d) Discuss the applications of Raman spectroscopy in various fields.

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

a) Discuss the spectral analysis in XPS, including core level splitting, line widths, and methods for elemental analysis.
b) Define resolution and magnification in optical microscopy. Describe Rayleigh's criteria for resolution.

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

a) Write in detail schematic of complete SEM.

b) Explain the concept of wavelength of electrons and its significance in electron microscopy. Discuss the theoretical resolving power of electron microscopes

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

a) Write about different types of optical microscopes.

b) Explain the process of energy analysis in XPS, including energy analyzers and X-ray sources. Discuss sample selection, preparation, and charging effects.

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

a) Discuss the basic setup and operational principles of Transmission Electron Microscopy (TEM), including electron diffraction and image formation.

b) Explain the classical and quantum theories of the Raman effect. Discuss the rotational and vibrational structure of Raman spectra with examples.

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

a) Compare and contrast Raman spectroscopy and FTIR spectroscopy in terms of their principles, strengths, and limitations.

b) Outline the components of the optical column in an electron microscope and explain the function of magnetic lenses.