

Seat No.	
----------	--

Set	P
-----	---

M.Sc. Physics (Solid State) (Semester - I) (New) (NEP CBCS)
Examination: October/November - 2025
Mathematical Physics (2307101)

Day & Date: Wednesday, 29-10-2025
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

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

Q.1 A) Choose correct alternative. (MCQ)

08

1) Which of the function of complex variable $z = x + iy$ is analytic?

- a) $|Z|^2$ b) $\text{Im}g Z$
 c) e^z d) $\bar{Z}$

2) The residue of a function $f(Z) = \frac{1}{(Z-2)(Z+3)^2}$ are_____

- a) $-\frac{1}{9}$ and $\frac{1}{9}$ b) $-\frac{1}{16}$ and $-\frac{1}{9}$
 c) $-\frac{1}{27}$ and $-\frac{1}{5}$ d) $-\frac{1}{25}$ and $-\frac{1}{5}$

3) Which of the following sets of vectors is linearly independent?

- a) $\{(2,3) (4,6)\}$ b) $\{(1,0) (0,1)\}$
 c) $\{(1,2) (2,4)\}$ d) $\{(3,1) (6,2)\}$

4) Determinant of an orthogonal matrix is _____.

- a) 0 b) 1
 c) -1 d) Either 1 or -1

5) What is the order of the differential equation given by

$$\frac{d^2y}{dx^2} + 3\frac{dy}{dx} + 2y = e^x$$

- a) 0 b) 1
 c) 2 d) 3

6) Solution of the differential equation

$$(2y - 5x + 1)dx + (5y - 2x + 3)dy = 0 \text{ is } \underline{\hspace{2cm}}.$$

- a) $p = (y + x)^4 (y - x)^3$ b) $p = (y + x + 1)^4 (y - x + 1)^3$
 c) $p = (y + x)^3 (y - x)^4$ d) $p = (y + x - 1)^5 (y - x + 1)^2$

- 7) Which function's Fourier transform results in a constant function?
- a) Sine function b) Gaussian function
c) Delta function d) Ramp function
- 8) If the function $f(x)$ is odd, then which of the following is zero?
- a) a_n (Cosine coefficients)
b) b_n (Sine coefficients)
c) a_0
d) nothing is zero

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

- a) In the Argand diagram, the imaginary part of a complex number is represented along the y-axis
- b) In a second-order homogeneous differential equation with constant coefficients, the superposition principle holds.
- c) The Laplace transform of the unit step function $u(t)$ is zero.
- d) Eigenvectors corresponding to repeated eigenvalues of a matrix are always linearly independent.

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

- a) If $Z_1 = 4 + 3i$ and $Z_2 = 2 + i$ then find $Z_1 + Z_2$
- b) Show that both $Z \times Z^*$ and $Z + Z^*$ are real quantity whereas $Z - Z^*$ is imaginary.
- c) Show that $\{(0,1)(1,0)\}$ is a basis of $V = R^2$
- d) If A is a unitary matrix, then show that A^{-1} is also unitary.
- e) Find the solution to the ordinary differential equation $\frac{dy}{dx} = 3x^2 - 4x + 2$
- f) Solve the differential equation $y^3 \frac{dy}{dx} + 2y + x^3 = 0$
- g) Define Laplace Transform.
- h) Define Fourier series.

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

- a) Find the integrating factor of the differential equation $y \frac{dx}{dy} - x = 3y^2$
- b) Consider the complex function $f(z) = \frac{z^3 - 2}{z - 1}$
- i) Determine the singular points of the function.
- ii) Calculate the residues at each of the singular points.
- c) Show that the set $S = \{(2,1,0) (1, -1,1) (-1,2,1)\}$ is an orthogonal set.
- d) Check whether the given function is exponential or not $f(t) = 5t + 3$.

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

- a) Find the Laplace transform of $f(t) = e^{2t} \sin 3t$
- b) Discuss the method of solving second-order non-homogeneous differential equations with constant coefficients.

- c) Find the value of k in matrix $A = \begin{bmatrix} k+1 & 1 & 2 \\ 2 & k & 1 \\ 1 & -1 & k-1 \end{bmatrix}$

Q.5 Answer the following. (Any Two)

12

- a) Solve the Residue theorem

$$\int_0^{2\pi} \frac{d\theta}{5-3\cos\theta+2\sin\theta}$$

- b) Find the inverse of matrix $B = \begin{bmatrix} 2 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix}$

- c) Solve $\frac{d^2y}{dx^2} - 5\frac{dy}{dx} + 6y = 0$

**Seat
No.**

Set	P
-----	---

Max. Marks: 60

08

- Page 1 of 2

- 7) For paramagnetic materials, relative magnetic permeability (μ_r) at room temperature is nearly _____.
a) Zero b) 1000
c) 1 d) 100
- 8) Superconductor are divided into _____ types based on magnetic properties.
a) One b) Two
c) Three d) Four

B) Fill in the blanks.

04

- 1) If ψ^* is complex conjugate of wave function ψ then; $P=\psi^* \psi=|\psi|^2$ is called _____.
- 2) The Langevin function, $L(a)=$ _____.
- 3) In ferromagnetic materials, the flux density changes, lag the changes in the magnetic field strength, this effect is called _____.
- 4) The complete ejection of magnetic field lines from the interior of the superconductor during its transition into superconducting state, is called _____ effect.

Q.2 Answer the following. (Any Six)

12

- a) What is Dirac delta function?
- b) What is Fermi level (E_F)?
- c) What are diamagnetic materials?
- d) State curie law.
- e) Define coercive force.
- f) Give the relation between magnetic susceptibility, magnetization, and magnetic field.
- g) Define critical/ transition temperature of a superconductor?
- h) What is London penetration depth?

Q.3 Answer the following. (Any Three)

12

- What is the probability of an electron being thermally excited to conduction band in intrinsic silicon at 27 °C. The band gap energy of Si is 1.12 eV. (Given: Boltzmann constant, $k=8.625 \times 10^{-5}$ eV/K.)
- Distinguish between ionic and electronic polarization.
- Explain Bloch wall and the domain wall energy.
- Discuss Type I and Type II superconductors.

Q.4 Answer the following. (Any Two)

12

- How are Brillouin zones in three dimensions constructed?
- Write a note on hysteresis.
- Discuss isotope effect in superconductors.

Q.5 Answer the following. (Any Two)

12

- Discuss motion of an electron in one-dimension based on band theory.
- Derive Clausius-Mosotti relation.
- Write a short note on BCS Theory.

Seat No.	
----------	--

Set

P

M.Sc. Physics (Solid State) (Semester - I) (New) (NEP CBCS)
Examination: October/November – 2025
Analog and Digital Electronics (2307106)

Day & Date: Monday, 03-11-2025
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

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

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

- 1) Input impedance of ideal op-amp is _____.
 a) Infinite b) Zero
 c) 75Ω d) $1M\Omega$
- 2) _____ is used for Mod-2 addition.
 a) XOR-gate b) OR-gate
 c) Full adder d) Half adder
- 3) _____ is a circuit with one input and many outputs.
 a) Multiplexer b) Demultiplexer
 c) Decoder d) Encoder
- 4) In J-K flip-flop, when $J=1$ and $K=1$, it is possible to _____ the flip-flop.
 a) Set b) Reset
 c) Toggle d) Forbidden
- 5) Stack pointer holds _____.
 a) 16 bit address b) 16 bit data
 c) 8 bit address d) 8 bit data
- 6) Find the output voltage of inverting amplifier with $R_i = 100\text{ k}\Omega$, $R_f = 3\text{ M}\Omega$ and $V_i = 3\text{ mV}$.
 a) 90 mV b) 120mV
 c) 200mV d) 210mV
- 7) Unity gain voltage follower is also called as _____.
 a) Comparator b) Schmitt trigger
 c) Buffer d) Zero crossing detector
- 8) Intel 8085 microprocessor has _____ bit size of data bus.
 a) 8 bit b) 16 bit
 c) both a & b d) 32 bit

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

- 1) A phase shift oscillator uses RC network. True / False
- 2) The output stage of an op-amp usually a ____.
- 3) In 808 microprocessors, accumulator register used as a working area in CPU. True / False
- 4) Master slave flip is also referred to as Pulse triggered flip-flop. True / False

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

- a) What do you mean by an encoder?
- b) What is ALU?
- c) List the five addressing modes of 8085 microprocessor.
- d) What is dynamic shift register?
- e) What is differential amplifier?
- f) Explain difference between Encoder and Decoder.
- g) Define the term CMRR.
- h) What is Demultiplexer?

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

- a) Write the features of 8085 microprocessor.
- b) Give comparison between inverting and non-inverting configuration of an operational amplifier.
- c) Describe 4 bit D flip-flop with timing diagram.
- d) Explain the concept of virtual ground in Op-amp.

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

- a) Draw and explain functional block diagram of 8085 microprocessor.
- b) Draw and explain 16:1 Multiplexer.
- c) Draw and explain Phase shift Oscillator using Op-amp. Obtain an expression for frequency.

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

- a) What is multivibrator? Explain the difference between three types of multivibrators.
- b) With a neat circuit diagram, explain master slave JK flip flop.
- c) Draw and explain instrumentation amplifier.

Seat No.	
----------	--

M.Sc. Physics (Solid State) (Semester - I) (New) (NEP CBCS)
Examination: October/November - 2025
Research Methodology in Physics (2307105)

Day & Date: Thursday, 06-11-2025
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

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

Q.1 A) Choose correct alternative. (MCQ)

08

- 1) Gathering knowledge for knowledge's sake is termed ____ research.
 - a) Basic
 - b) Applied
 - c) Quantitative
 - d) Experimental
- 2) Identifying gap areas in research are for _____.
 - a) exploration of uncharted terrain
 - b) addressing unanswered queries
 - c) resolution of conflicting findings
 - d) all of these
- 3) Physical vapor deposition is the process where ____ material to be deposited is physically converted to phase.
 - a) solid, vapor
 - b) gas, gas
 - c) vapor, liquid
 - d) solid, liquid
- 4) ____ refers to the closeness of a measurement or observation to the true or accepted value.
 - a) Precision
 - b) Accuracy
 - c) Average
 - d) Prediction
- 5) The principle on which electrodeposition method works is _____.
 - a) electrolysis
 - b) evaporation
 - c) gel formation
 - d) none of these
- 6) ____ is used as the source of infrared light.
 - a) Tungsten filament
 - b) Mercury lamp
 - c) Diode laser
 - d) globar filament
- 7) Direct current sputtering is suitable for depositing _____.
 - a) insulating materials
 - b) conducting materials
 - c) dielectric materials
 - d) polymers

8) Atomic force microscopy measures _____ between the probe tip and the sample surface.

- | | |
|----------------------|----------------|
| a) length | b) pressure |
| c) interaction force | d) temperature |

B) Write true/false.

04

- 1) Research methodology is a way to systematically solve the research problem. (True/ False)
- 2) Applied research aims at finding a solution for an immediate problem facing a society. (True/False)
- 3) UV-V is spectroscopy measures the absorbance of light in the infrared region of the electromagnetic spectrum. (True/False)
- 4) The pyrolysis means the formation of chemical compounds. (True/ False)

Q.2 Answer the following. (Any Six)

12

- a) What is peer review process?
- b) Write examples of primary and secondary sources of literature.
- c) Draw the neat labelled schematic diagram of atomic force microscopy.
- d) Write the advantages and disadvantages of UV-visible spectroscopy.
- e) What is the importance of literature review in research?
- f) Write the names of tools used in research for data collection.
- g) What are the types of sputtering?
- h) Write the advantages of electrodeposition method.

Q.3 Answer the following. (Any Three)

12

- a) Write a note on meaning and importance of research.
- b) Explain the concept data interpretation in research.
- c) Explain transmission electron microscope with neat labelled diagram.
- d) Explain in detail construction and working of e-beam evaporation.

Q.4 Answer the following. (Any Two)

12

- a) Explain in details types of research.
- b) Explain in detail spray pyrolysis deposition technique.
- c) Explain different sampling methods involved in research.

Q.5 Answer the following. (Any Two)

12

- a) Explain scanning electron microscope with neat labelled diagram.
- b) Write detailed note on Fourier transform infrared spectroscopy.
- c) Explain in detail radio frequency sputtering technique of deposition.

Seat No.	
----------	--

Set **P**

M.Sc. Physics (Solid State) (Semester - II) (New) (NEP CBCS)
Examination: October/November – 2025
Quantum Mechanics (2307201)

Day & Date: Tuesday, 28-10-2025
 Time: 11:00 AM To 01:30 PM

Max. Marks: 60

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

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

- 1) If the mass of an electron is m_e and mass of the nucleus is m_n , what is the reduced mass μ of the electron-nucleus system?
 - a) $\mu = m_e + m_n^2$
 - b) $\mu = m_e m_n^2$
 - c) $\mu = (m_e + m_n) / m_e m_n$
 - d) $\mu = m_e m_n / (m_e + m_n)$
- 2) Which quantity is said to be degenerate when $H\Psi_n = E_n\Psi_n$?
 - a) Operators
 - b) Eigen Values
 - c) Eigen Functions
 - d) All of above
- 3) In the rotational motion, acceleration is given by _____.
 - a) $d\theta/dt$
 - b) $d\omega/dt$
 - c) dv/dt
 - d) Both (b) and (c)
- 4) What is the classical expression for angular momentum (L)?
 - a) $L = I \times \omega$
 - b) $L = r \times F$
 - c) $L = F \times p$
 - d) $L = r \times p$
- 5) What is the quantum mechanical postulate regarding the average value $\langle a \rangle$ of an observable corresponding with an operator A ?
 - a) $\langle a \rangle = \int \psi^* A \psi d\tau$
 - b) $\langle a \rangle = \int (\psi)^* A^> \psi^2 d\tau$
 - c) $\langle a \rangle = \int \psi^* \psi d\tau$
 - d) $\langle a \rangle = \int A^> d\tau$
- 6) Probability density is always _____.
 - a) Positive
 - b) Negative
 - c) Infinite
 - d) All of above
- 7) Diffraction and interference are the evidence of _____ of matter.
 - a) wave nature
 - b) particle nature
 - c) both a & b
 - d) None of above
- 8) If Ψ be a complex function, then $\Psi^*\Psi$ must vanish at _____.
 - a) unity
 - b) zero
 - c) infinity
 - d) finite value

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

- 1) Total Energy is quantized but not angular momentum of the quantum particle. (True/False)
- 2) The Heisenberg's uncertainty principle is applicable to all conjugate pair of variables. (True/False)
- 3) Raising operator is defined as _____.
- 4) The corresponding values of wave functions (Ψ) are called _____ functions.

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

- a) What is the physical significance of the Schrodinger wave function?
- b) Write the difference between span and basis.
- c) What is meant by expectation value?
- d) Write about the commutation relation.
- e) Define spin angular momentum.
- f) Define Photoelectric effect.
- g) What is the lowering operator?
- h) What is a complex function? Give an example.

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

- a) Write a note on stationary states.
- b) Explain the unitary transformation.
- c) Express the continuity equation.
- d) Describe the Pauli spin matrices.

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

- a) Write the interpretation and properties of wave function. What is admissible wave function?
- b) Describe the box normalization and Dirac Delta function.
- c) Obtain Schrodinger's wave equation for Hydrogen atom in terms of spherical polar coordinates, express its radial and angular parts.

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

- a) Discuss wave-functions of linear harmonic oscillator and give their physical interpretation.
- b) Obtain the eigen values and eigen functions for a particle in three-dimensional infinite potential well.
- c) Define the Hermitian operator. Show that eigen values of Hermitian operator are real in nature.

Seat No.	
----------	--

M.Sc. Physics (Solid State) (Semester - II) (New) (NEP CBCS)
Examination: October/November - 2025
Electrodynamics (2307202)

Day & Date: Thursday, 30-10-2025

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. (MCQ)**08**

- 1) 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
- 2) Electric field intensity is a _____ quantity.
 a) Scalar b) Vector
 c) Both (a) and (b) d) None of the above
- 3) Lorentz electric force has direction _____.
 a) Similar to electric field b) Opposite to electric field
 c) Scalar quantity d) None of these
- 4) 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
- 5) The lines of force due to charged particles are _____.
 a) always straight b) always curved
 c) sometimes curved d) None of these
- 6) In a capacitor the electric charge is stored in _____.
 a) metal plates b) dielectric
 c) both (a) and (b) d) None of the above
- 7) Divergence theorem is based on _____.
 a) Gauss law b) Stoke's law
 c) Ampere law d) Lenz law
- 8) The Gaussian surface for a point charge will be _____.
 a) Cube b) Cylinder
 c) Sphere d) Cuboid

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

- 1) In static magnetic field only, magnetic dipole exists. (True/ False)
- 2) The magnetic field intensity will be zero inside a conductor. (True/ False)
- 3) Electric field of an infinitely long conductor of charge density λ , is given by $E = \lambda/(2\pi\epsilon h)$. aN. (True/ False)
- 4) The work done in moving a test charge from one point to another in an equipotential surface is zero. (True/ False)

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

- a) Define Skin depth.
- b) What is an electric field?
- c) Write Maxwell equation derived from Faraday's law.
- d) State Coulombs law.
- e) Define Poynting vector.
- f) Define Boundary condition.
- g) Define electromagnetic force.
- h) State Biot-Savart law.

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

- a) Explain Maxwell displacement current.
- b) Discuss energy stored in magnetic field.
- c) Express the term potential due to point charge.
- d) State the boundary condition for an electrostatic field $\vec{E}$.

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

- a) Discuss in details of radiation from a half wave antenna.
- b) Explain the electromagnetic plane waves in stationary medium.
- c) What is Gauss law? Explain differential form of its.

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

- a) Explain boundary condition between conductor and free space.
- b) Write a note on radiation damping.
- c) State and prove Poynting theorem.

Set	P
-----	---

M.Sc. Physics (Solid State) (Semester - II) (New) (NEP CBCS)
Examination: October/November – 2025
Classical Mechanics (2307206)

Day & Date: Saturday, 01-11-2025
Time: 11:00 AM To 01:30 PM

Max. Marks: 60

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

Q.1 A) Choose correct alternative. (MCQ)

08

- 1) The number of independent variables for a free particle in space are _____.
 - a) Zero
 - b) One
 - c) Two
 - d) Three
- 2) In Lagrange's equation if there are N number of particles then the generalized coordinates are _____.
 - a) $n = N - k$
 - b) $n = 3N - k$
 - c) $n = 3N$
 - d) $n = 3N + k$
- 3) _____ constraints are time dependent.
 - a) Holonomic
 - b) Non-Holonomic
 - c) Scleronomous
 - d) Rheonomous
- 4) Total virtual work done on N-particle system is _____.
 - a) Zero
 - b) Maximum
 - c) Minimum
 - d) None
- 5) Lagrange's equation are written as _____.
 - a) $d/dt [\partial L / \partial \dot{q}_j] - \partial L / \partial q_j = 0$
 - b) $\partial L / \partial q_j = 0$
 - c) $d/dt [\partial L / \partial q_j] = 0$
 - d) $d/dt [\partial L / \partial q_j] - \partial L / \partial \dot{q}_j = 0$
- 6) Hamilton's principle is also called _____.
 - a) Principle of least action
 - b) Generalized Principle
 - c) Both a and b
 - d) None of these
- 7) The rate of momentum change of an open system is equal to _____.
 - a) $T + \dot{M}U$
 - b) $F - \dot{M}V$
 - c) $W - \dot{M}V$
 - d) $F + \dot{M}U$
- 8) The Jacobi integral of the system is equal to _____.
 - a) $\sum p_j \dot{q}_j - L$
 - b) $T+V$
 - c) $\sum \dot{p}_j q_j - L$
 - d) None of these

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

- 1) Hamilton's canonical equations of motion are second order differential equations. (True/False)
- 2) According to Kepler's second law, areal velocity is constant. (True/False)
- 3) Angular momentum is conserved in the absence of external torque. (True/False)
- 4) The fundamental Poisson's brackets are invariant under canonical transformation. (True/ False)

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

- a) Write about the generalized coordinates.
- b) Define the central force.
- c) What is integral of motion?
- d) Show that linear momentum is conserved for a particle.
- e) What is an artificial satellite?
- f) Write about the constant of motion.
- g) Define the Poisson's bracket.
- h) Write the condition for transformation to be canonical.

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

- a) Explain about the open systems with variable mass.
- b) Prove Kepler's second law of planetary motion.
- c) Derive the Lagrange's equation of motion for a conservative system.
- d) Explain about the Hamilton-Jacobi theory.

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

- a) Deduce the Lagrange's equation of motion from Hamilton's principle.
- b) Derive the equation of compound pendulum using Hamilton's equation of motion.
- c) Express the reduced mass from two-body problem into equivalent one body.

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

- a) Explain about the canonical transformation and deduce the condition for transformation to be canonical.
- b) Derive the Hamilton's canonical equations in terms of Poisson's bracket.
- c) Prove the principle of least action.

Set	P
-----	---

M.Sc. Physics (Solid State) (Semester - III) (New) (NEP CBCS)
Examination: October/November - 2025
Statistical Physics (2307301)

Day & Date: Wednesday, 29-10-2025
Time: 11:00 AM To 01:30 PM

Max. Marks: 60

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

Q.1 A) Choose correct alternative. (MCQ)

08

- 1) Gibbs 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
- 2) The relation $TdS = ?$
a) $C_v dT - T(\partial P/\partial S)_v.dV$ b) $C_v dT + T(\partial P/\partial S)_v.dV$
c) $C_v dT + T(\partial P/\partial T)_v.dV$ d) $C_v dT + T(\partial V/\partial S)_v.dV$
- 3) In which statistics particles are distinguishable?
a) Bose Einstein statistics b) Maxwell Boltzmann statistics
c) Fermi Dirac statistics d) All of the above
- 4) What is critical point?
a) The point at which a substance transitions from solid to liquid
b) The point at which phase transitions occur
c) The point at which phase transitions are complete
d) The point at which a substance transitions from liquid to gas
- 5) In Maxwell relations, $(\partial T/\partial P)_S = ?$
a) $(\partial V/\partial S)_P$ b) $(\partial S/\partial V)_T$
c) $-(\partial S/\partial P)_T$ d) $(\partial S/\partial P)_T$
- 6) Photon is an example of which statistics?
a) Bose Einstein statistics b) Maxwell Boltzmann statistics
c) Fermi Dirac statistics d) None
- 7) Which law of thermodynamics is directional one?
a) second law b) zeroth law
c) third law d) first law
- 8) When no change in temperature between system and its surrounding, the equilibrium is called?
a) Chemical b) Mechanical
c) Thermal d) All

B) write true/false**04**

- 1) Spin of particles in FD statistics is odd half integer. (True/False)
- 2) Electron do not condense even into the lowest energy state. (True/False)
- 3) Pressure is an example of qualitative property. (True/False)
- 4) Refrigerator is an example of 2nd law of thermodynamics. (True/False)

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

- a) Define Ideal fermi gas.
- b) What is the free energy?
- c) What is meant by specific heat?
- d) What is chemical potential?
- e) Write about phase equilibria.
- f) What is thermal equilibrium.
- g) Define probability.
- h) What is the entropy of system?

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

- a) Explain the postulate of equal prior probability.
- b) What do you mean by Gibb's paradox?
- c) Discuss about the weakly and strongly degenerate gas.
- d) Write a note on Maxwell Boltzmann distribution.

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

- a) State and write about the laws of thermodynamics.
- b) What is Clausius-Clayperon equation? Express it.
- c) Write in detail about the Fermi-Dirac and Bose-Einstein statistics.

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

- a) What is meant by phase transition? Write in detail about its type.
- b) Write in detail about the thermodynamic potential and Maxwell's relation.
- c) Write a note on Liouville's theorem.

Seat No.	
-------------	--

Set P

M.Sc. Physics (Solid State) (Semester - III) (New) (NEP CBCS)
Examination: October/November - 2025
Atomic and Molecular Physics (2307302)

Day & Date: Friday, 31-10-2025
 Time: 11:00 AM To 01:30 PM

Max. Marks: 60

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

Q.1 A) Choose correct alternative. (MCQ)

08

- 1) When a helium atom loses an electron, it becomes _____.
 a) an alpha particle b) a positively helium ion
 c) a proton d) a negatively helium ion
- 2) The reduced mass of a diatomic molecule as a rigid rotator is _____.
 a) $(m_1+m_2)/(m_1.m_2)$ b) $(m_1.m_2)/(m_1-m_2)$
 c) $m_2/(1+m_2/m_1)$ d) $m_1/(1+m_2/m_1)$
- 3) Two electron spectra always show _____.
 a) Singlet and doublets b) singlet and triplets
 c) doublets and triplets d) all of these
- 4) In Raman spectroscopy, the radiation lies in the _____.
 a) Microwave Region b) X-ray Region
 c) UV Region d) Visible Region
- 5) Electrons in the atom are held in the atom due to _____.
 a) Coulombs force b) Nuclear force
 c) Atomic force d) Both a and b
- 6) "An electron can never be found inside nucleus", this statement is according to _____.
 a) Heisenberg uncertainty principle
 b) Bernoulli's equation
 c) Bohrs model
 d) Both a and b
- 7) Ionization energy of hydrogen atom in ground state is _____.
 a) 13.5 J b) 13.6 eV
 c) 14 eV d) 13.6 MeV
- 8) Orbital angular momentum depends on _____.
 a) l b) n and l
 c) n and m d) m and s

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

- 1) The principal quantum number determines the orientation and energy of the orbital. (True/False)
- 2) The Nuclear magnetic resonance (NMR), spectrum of a molecule, is observed in radio frequency range. (True/False)
- 3) For $l=2$, m_l has _____ Possible values.
- 4) Hyperfine structure is due to _____ interaction of valence electrons.

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

- a) What is meant by inner shell vacancy?
- b) Define ll and ss coupling in an atom.
- c) Write about asymmetric top molecule.
- d) Define magnetic quantum numbers.
- e) Define atomic spectra.
- f) Write about the various series arising from electronic transition.
- g) Write about the binding energy of an atom
- h) Write about the Paschen back effect

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

- a) Explain about strong field stark effect in hydrogen.
- b) State and discuss the Paschen back effect of two electrons.
- c) Write in brief on one valence electron spectra.
- d) Write a note on dissociation energy and dissociation product.

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

- a) What is LS coupling? Elaborate.
- b) Write a note on instrumentation of microwave spectroscopy.
- c) Discuss about the intensity rules for Zeeman effect.

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

- a) What is electron spin resonance? Explain.
- b) Write in detail about different quantum numbers of an electron in an atom.
- c) Explain about the rotational spectrum of molecule.

Seat No.	
----------	--

Set **P**

M.Sc. Physics (Solid State) (Semester - III) (New) (NEP CBCS)
Examination: October/November - 2025
Semiconductor Physics (2307309)

Day & Date: Monday, 03-11-2025
Time: 11:00 AM To 01:30 PM

Max. Marks: 60

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

Q.1 A) Choose correct alternative. (MCQ)

08

- 1) The capacitance of a p-n junction depends primarily on: _____.
 - a) The width of the depletion region
 - b) The forward bias voltage
 - c) The type of doping used
 - d) The recombination rate of carriers
- 2) The atomic packing factor (APF) of a face-centered cubic (FCC) lattice is _____.
 - a) 0.52
 - b) 0.68
 - c) 0.74
 - d) 0.90
- 3) _____ diode is specifically designed to act as a voltage-dependent capacitor.
 - a) Zener diode
 - b) Varactor diode
 - c) Schottky diode
 - d) Tunnel diode
- 4) _____ is NOT a common dopant in silicon semiconductors.
 - a) Phosphorus
 - b) Boron
 - c) Arsenic
 - d) Copper
- 5) Ohmic losses in a p-n junction semiconductors are primarily caused by the _____.
 - a) depletion region capacitance
 - b) tunneling of carriers
 - c) series resistance of the material
 - d) Variation in contact potential
- 6) Zener breakdown occurs primarily due to: _____.
 - a) High electric fields cause tunneling of electrons
 - b) Thermal effects in the junction
 - c) Carrier recombination
 - d) Avalanche multiplication

- 7) Space charge at a junction results from _____.
a) Neutralization of dopants
b) Accumulation of free carriers
c) Ionized acceptor and donor in depletion region
d) Forward-bias voltage
- 8) _____ step in photolithography involves transferring a pattern from a mask to a wafer.
a) Exposure
b) Etching
c) Development
d) Oxidation

B) Write true or false.

04

- 1) The diamond lattice structure is a variation of the face-centered cubic (FCC) lattice.
- 2) Miller indices are used to denote planes and directions in a crystal lattice.
- 3) The diffusion is a thermal process used in IC fabrication.
- 4) Photolithography is a process used for doping the wafer.

Q.2 Answer the following (Any Six)

12

- a) Why is silicon the preferred material for semiconductor crystal growth?
- b) Draw cubic lattice structures for (111) and (001) planes.
- c) What is the working principle of a rectifier?
- d) How does the capacitance of a p-n junction vary with applied voltage?
- e) How the switching speed of switching diode is improved?
- f) Draw neat labelled band diagram of Schottky barriers.
- g) What are the key postulates of Bohr's atomic model?
- h) What is the photoelectric effect?

Q.3 Answer the following (Any Three)

12

- Explain the three types of cubic crystal lattices with diagrams.
- Describe the principle of ion implantation and its advantages in doping.
- Explain the periodic table with the help of quantum numbers.
- Describe the process of ion implantation with diagram.

Q.4 Answer the following (Any Two).

12

- Discuss the Czochralski process for single-crystal growth.
- What is diamond lattice structure? Describe its geometry and significance in materials for IC fabrication.
- Explain the varactor diode and its graded junction profile in detail.

Q.5 Answer the following (Any Two).

12

- What is breakdown? Explain the mechanisms of Zener breakdown and avalanche breakdown.
- Derive an expression for the total energy of the electron in the n^{th} orbit in atomic spectra using Bohr's model.
- Explain the rectifying contact in metal- semiconductor junction.

Seat No.	
----------	--

Set **P**

M.Sc. Physics (Solid State) (Semester - IV) (New) (NEP CBCS)
Examination: October/November – 2025
Physics of Semiconductor Devices (2307401)

Day & Date: Tuesday, 28-10-2025
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

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

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

- 1) The M – S structure forms _____ barrier.
 - a) Schottky
 - b) Read
 - c) Ohmic
 - d) Non - Ohmic
- 2) The theory explaining the concept of negative differential resistance is _____.
 - a) RWH
 - b) Hall effect
 - c) quantum confinement
 - d) both (b) and (c)
- 3) In a case of heterojunction LASER, _____ types of materials are present.
 - a) n-type
 - b) p-type
 - c) both (a) and (b)
 - d) only n-type
- 4) LEDs fabricated with GaAs emit _____ wavelength.
 - a) far ultraviolet
 - b) ultraviolet
 - c) visible
 - d) infrared
- 5) Hall Effect is used to measure _____.
 - a) majority carrier concentration
 - b) mobility
 - c) drift current
 - d) All of these
- 6) Photodetector _____ optical signal.
 - a) reflects
 - b) detects
 - c) modulate
 - d) amplify
- 7) $(\alpha_1 + \alpha_2)$ approaches _____ when the SCR devices are at forward breakdown.
 - a) 100
 - b) 1000
 - c) ∞
 - d) 1
- 8) A TRIAC is used where the transfer of large _____ is involved.
 - a) power
 - b) electron transfer
 - c) voltage transfer
 - d) charge transfer

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

- 1) Photodiodes operate under ____ bias.
- 2) Pulsed laser can deliver very ____ power.
- 3) LASER convert electrical energy to optical energy. (True/False)
- 4) A higher position in the energy band diagram represents a higher electron energy. (True/False)

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

- a) What is Effective Mass of Electron?
- b) What is meant by Fermi level?
- c) What is Band diagram of Extrinsic semiconductor?
- d) What is meant by Electroluminescence?
- e) What is Schottky effect?
- f) What are the types of Thyristors?
- g) What are Turn ON methods of SCR?
- h) What is meant by LDR?

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

- a) Write in detail about the variation of energy bands with alloy composition.
- b) Explain the Radiative and non-radiative transitions.
- c) Explain the behavior of electrons and holes in quantum wells.
- d) Explain the conditions of an Ideal MIS Diode.

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

- a) What is solar cell? Obtain an expression for open circuit voltage and short circuit current.
- b) Give a brief account of quantum efficiency and response speed of solar cell.
- c) Explain Principal and working of Photodiode device.

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

- a) Explain the energy band diagram of Metal-Semiconductor Contact (n-type case).
- b) Explain the working of the Rectifying Contacts.
- c) Write in detail about Heterostructure LASER.

Seat No.	
-------------	--

Set	P
-----	---

M.Sc. Physics (Solid State) (Semester - IV) (New) (NEP CBCS)
Examination: October/November - 2025
Nuclear and Particle Physics (2307402)

Day & Date: Thursday, 30-10-2025
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

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

Q.1 A) Choose correct alternative. (MCQ)

08

- 1) Which of the following best define nuclear forces?
 - a) The attraction between protons and neutrons
 - b) Repulsion between protons and neutrons
 - c) The attraction between protons and electrons
 - d) The attraction between electrons and neutrons
- 2) Which of the following is a stable nucleus?
 - a) The nucleus with even protons and odd electrons
 - b) The nucleus with even number of protons and neutrons
 - c) The nucleus with even neutrons and odd protons
 - d) The nucleus with odd protons and neutrons
- 3) Find the true statement.
 - a) Nuclear charge is dependent on the charge
 - b) The nuclear force is weaker than the electromagnetic force
 - c) The nuclear force is independent of charge
 - d) The nuclear force is weaker than the gravitational force
- 4) Nuclear Organizer Regions (NOR) is found in _____.
 - a) Nuclear matrix
 - b) Nucleolus
 - c) Nuclear lamina
 - d) Nucleoporins
- 5) Nuclear physics primarily deals with the study of: _____.
 - a) Electrons in atoms
 - b) Nucleons in atomic nuclei
 - c) Photons in electromagnetic waves
 - d) Quarks in protons
- 6) The Coulomb barrier in nuclear reactions must be overcome to: _____.
 - a) Counteract electromagnetic repulsion between protons
 - b) Increase neutron absorption
 - c) Reduce gamma-ray emission
 - d) Initiate chemical reactions

- 7) The particle proposed by Yukawa to explain nuclear forces is the: ____
- | | |
|---------|-------------------------|
| a) Muon | b) Pion (π -meson) |
| c) Kaon | d) Photon |
- 8) The first artificial nuclear transmutation was achieved by Rutherford using: ____.
- | | |
|-------------|--------------------|
| a) Protons | b) Alpha particles |
| c) Neutrons | d) Electrons |

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

- 1) The nuclear force is short-ranged. True /False
- 2) Nuclear reactions always conserve the number of protons and neutrons. True /False
- 3) The Q-value of an exoergic reaction is negative. True /False
- 4) Neutrinos have zero rest mass. True /False

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

- a) Define a nuclear reaction and give its general notation.
- b) What are direct nuclear reactions? Provide one example.
- c) What are the properties of nuclear force?
- d) Differentiate between leptons and hadrons.
- e) How does the Higgs mechanism impart mass to particles?
- f) What exactly is nuclear binding energy?
- g) Define Nuclear stability.
- h) Explain the concept of isospin with an example.

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

- a) Write a short note on Nuclear Reaction Cross sections.
- b) Explain Strangeness and Strange Particles.
- c) Explain the role of angular momentum in nuclear reactions. How does conservation of angular momentum affect the possible outcomes of a nuclear reaction.
- d) Explain Packing fraction.

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

- a) Write a note on Binding Energy.
- b) Derive the expression for the Q-value of a nuclear reaction. Discuss how the Q-value determines whether a reaction is energetically favorable.
- c) Explain nuclear forces.

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

- a) Explain properties of nucleus.
 - i) Strongest Forces.
 - ii) Short range forces.
 - iii) Exchange Forces.
- b) State the nuclear size and nuclear Density.
- c) Explain the quark model and its role in classifying hadrons.

Seat No.	
----------	--

Set **P**

M.Sc. Physics (Solid State) (Semester - IV) (New) (NEP CBCS)
Examination: October/November - 2025
Advanced Techniques of Materials Characterization (2307406)

Day & Date: Saturday, 01-11-2025
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

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

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

- 1) Which type of microscope provides a three-dimensional view of the sample?
 - a) Bright field microscope
 - b) Stereo microscope
 - c) Phase contrast microscope
 - d) Polarizing microscope
- 2) The Airy disc is associated with which optical phenomenon?
 - a) Refraction
 - b) Interference
 - c) Diffraction
 - d) Absorption
- 3) What is the term for the minimum distance between two distinguishable points in an image?
 - a) Magnification
 - b) Resolution
 - c) Numerical aperture
 - d) Rayleigh criteria
- 4) Force vs distance curve in AFM shows: _____.
 - a) Resolution limits
 - b) Scanning speed
 - c) Tip-sample interaction
 - d) Lens strength
- 5) What does Bragg's condition describe in electron diffraction?
 - a) Absorption of electrons
 - b) Refraction of electrons
 - c) Interference of electrons
 - d) Diffraction of electrons
- 6) What is the primary reason for using ultra-high vacuum (UHV) in surface analysis?
 - a) Enhance conductivity
 - b) Improve thermal stability
 - c) Prevent surface contamination
 - d) Increase resolution
- 7) In Raman spectroscopy, the lines shifted to lower frequency are called _____.
 - a) Stokes lines
 - b) Anti-Stokes lines
 - c) Rayleigh lines
 - d) Infrared lines

- 8) AFM is commonly used for imaging _____.
 a) In vacuum only
 b) In air and liquid environments
 c) Using transmitted electrons
 d) In biological samples only

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

- 1) XPS can detect all elements except hydrogen and helium.
- 2) The principle of TEM involves the use of transmitted electrons to form an image.
- 3) Pure rotational Raman spectra are observed only in non-polar molecules.
- 4) Ultra-High Vacuum (UHV) is not necessary in surface characterization to minimize interactions with residual gases.

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

- a) Define Numerical Aperture and its significance in optical microscopy.
- b) Write a short note on Rayleigh's Criterion.
- c) What is the role of magnetic lenses in an electron microscope?
- d) Define Bragg's condition.
- e) Define surface in the context of surface characterization.
- f) What is the role of the vacuum system in XPS?
- g) Define the Raman Effect.
- h) Write any two applications of Raman Spectroscopy.

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

- a) Define Numerical Aperture (NA) and its significance to determine resolving power of microscope.
- b) Compare advantages of electron microscopy over light microscopy.
- c) Explain the principle of Transmission Electron Microscopy (TEM) and the role of electron beams in imaging.
- d) Describe the principle of electron tunneling in STM.

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

- a) Explain the instrumentation and working principle of FTIR spectroscopy with a diagram.
- b) Draw the schematic diagram of XPS and explain the its working of each part.
- c) Outline the components of an optical column in electron microscopy.

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

- a) Explain principle, instrumentation and working of atomic force microscope (AFM).
- b) Describe the implementation of Scanning Tunneling Microscopy in instruments.
- c) Discuss the use of apertures, contrast mechanisms, bright/dark field imaging, and SAED in TEM.

Seat No.	
----------	--

Set **P**

M.Sc. Physics (Solid State) (Semester - IV) (New/Old) (CBCS)
Examination: October/November – 2025
Materials Characterization Techniques (MSC10406)

Day & Date: Tuesday, 04-11-2025
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

Instructions: 1) Q.No.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 alternatives.**10**

- 1) To enhance _____ is crucial in electron microscopy?
 - a) vacuum requirements b) resolution
 - c) electron wavelength d) numerical aperture
- 2) _____ is the purpose of beam scanning in SEM.
 - a) To increase resolution
 - b) To cover a larger area
 - c) To decrease magnification
 - d) To change the wavelength
- 3) What equations are commonly used to describe force curves in AFM?
 - a) Newton's equations b) Maxwell's equations
 - c) Hooke's law d) Schrodinger's equations
- 4) _____ force measures between the tip and the sample in AFM.
 - a) Magnetic b) Gravitational
 - c) Mechanical d) Van der Waals
- 5) Higher numerical aperture indicate _____.
 - a) Lower resolution b) Higher resolution
 - c) Lower magnification d) Lower wavelength
- 6) In XPS, the binding energy of a photoelectron is directly related to the _____.
 - a) Surface roughness b) Atomic number
 - c) Electron configuration d) Sample thickness
- 7) _____ microscope is used for observing live biological specimens without staining?
 - a) Bright field microscope
 - b) Fluorescence microscope
 - c) Phase contrast microscope
 - d) Polarizing light microscope

- 8) _____ is the role of the piezoelectric drive in Scanning Tunneling Microscopy.
- | | |
|--------------------------|-------------------|
| a) To generate electrons | b) To scan sample |
| c) To interpret data | d) To focus light |
- 9) _____ is a commonly used probe for surface characterization.
- | | |
|---------------|---------------|
| a) Microwaves | b) ultrasound |
| c) IR light | d) X-Ray |
- 10) Continuous wave-EPR involves the continuous _____ of the magnetic field.
- | | |
|----------------|-------------|
| a) Decrease | b) Increase |
| c) Oscillation | d) Rotation |

B) Write true / false**06**

- 1) High-resolution solid-state NMR methods does not provide detailed information about the chemical environment and structure of solid materials.
- 2) Atomic Force Microscopy (AFM) is a probe-based technique used for surface characterization.
- 3) XPS is used for qualitative and quantitative elemental analysis of a material's surface.
- 4) Ultra-High Vacuum (UHV) is required in surface characterization techniques to minimize interactions with residual gases.
- 5) The CP-MAS experiment in NMR involves transferring polarization from one nucleus to another, enhances sensitivity and resolution.
- 6) STM is limited by its inability to image non-conductive samples.

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

- a) Why is ultra-high vacuum (UHV) essential in surface analysis techniques and Describe its significance of maintaining a vacuum.
- b) Discuss advantages and disadvantages of Transmission Electron Microscope (TEM).
- c) Explain the major lens defects in optical microscopy.
- d) Describe the concept of Magic-Angle Spinning (MAS).

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

- a) Describe the functioning of magnetic lenses in electron microscopes.
- b) Explore the Zeeman interaction in NMR signal which influences resonance frequencies.

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

- a) Explain quantitative analysis using Auger Electron Spectroscopy and Discuss the factors influences on accuracy of quantitative results.
- b) Discuss the instrumentation, experimental conditions, and applications of EPR technique.

- Q.5 Answer the following. 16**
- a) Explain principle, instrumentation and working of atomic force microscope.
 - b) Explore principle, construction and working of XPS.
- Q.6 Answer the following. 16**
- a) Explain the detailed schematic of a Transmission Electron Microscope (TEM) and functions of each component, emphasizing the pathway of electrons from source to image formation.
 - b) Explain construction and working of confocal microscopy in detail.
- Q.7 Answer the following. 16**
- a) Compare Contact and Non-contact modes of Atomic Force Microscopy and Discuss the advantages and limitations of each mode in image formation.
 - b) Explain in detailed schematic representation of a complete SEM setup, highlighting the key components and their functions.