Seat No.	

Set P

M.Sc. Physics (Nanophysics) (Semester - I) (New) (NEP CBCS)
Examination: October/November - 2025
Mathematical Physics (2306101)

Day & Date: Wednesday, 29-10-2025 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. (MCQ) **08**

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

a) $|Z|^2$ b) $Img\ Z$

c) e^2 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

$(2y - 5x + 1)dx + (5y - 2x + 3)dy = 0$ is_____.

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

M.Sc. Physics (Nanophysics) (Semester - I) (New) (NEP CBCS)
Examination: October/November - 2025
Solid State Physics (2306102)

Day & Date: Friday, 31-10-2025 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.
3) Draw neat labelled diagrams wherever necessary.

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

1) For intrinsic semiconductors, relation between Fermi level and intrinsic level is _____.
   a) $E_f = E_i$ b) $E_f = 2\,E_i$
   c) $E_f = E_i/2$ d) $E_f = 4\,E_i$

2) Magnetic induction (B) and magnetic field intensity (H) are related by _____.
   a) $B = H^2\mu_0$ b) $B = {\mu_0}^2 H$
   c) $B = \mu_0\mu_r H$ d) $B = \mu_0 + H$

3) Magnetic susceptibility of a magnetic material is given by, ψ=_____.
   a) $\mu_r - 1$ b) $\frac{M}{H}$
   c) $\frac{(\mu - \mu_0)}{\mu_0}$ d) All of these

4) Susceptibility of ferromagnetic materials is _____.
   a) a small negative quantity
   b) small positive quantity
   c) large positive quantity
   d) large negative quantity

5) The size of the (negative) field required to reduce the induction to zero is known as the _____.
   a) Coercivity or coercive force, Hc
   b) Retentivity
   c) Hysteresis
   d) Saturation magnetization

6) Which of the following is the essential requirement for ferromagnetism?
   a) partly filled *d* shells b) partly filled *f* shells
   c) partly filled *d* or *f* shells d) partly *d* or *f* shells

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**

a) 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=8.625x10^{-5} *eV/K.)*
b) Distinguish between ionic and electronic polarization.
c) Explain Bloch wall and the domain wall energy.
d) Discuss Type I and Type II superconductors.

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

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

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

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

SLR-HV-3

Seat No.	

Set P

M.Sc. Physics (Nano physics) (Semester - I) (New) (NEP CBCS)
Examination: October/November – 2025
Analog and Digital Electronics (2306106)

Day & Date: Monday, 03-11-2025 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. (MCQ) **08**

1) Input impedance of ideal op-amp is ____.
   a) Infinite b) Zero
   c) 75Ω d) 1M Ω

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 Ri = 100 kΩ, Rf = 3 MΩ and Vi= 3 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 near circuit diagram, explain master slave JK flip flop.
c) Draw and explain instrumentation amplifier.

SLR-HV-5

Seat No.	

Set P

M.Sc. Physics (Nano physics) (Semester - I) (New) (NEP CBCS)
Examination: October/November - 2025
Research Methodology in Physics (2306105)

Day & Date: Thursday, 06-11-2025 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. (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 (Nanophysics) (Semester - II) (New) (NEP CBCS)
Examination: October/November – 2025
Quantum Mechanics (2306201)

Day & Date: Tuesday, 28-10-2025 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) 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 $\mathrm{H\Psi_n = E_n \Psi_n}$?
a) Operators b) Eigen Values
c) Eigen Functions d) All of above

3) In the rotational motion, acceleration is given by ____.
a) dθ/dt b) dω/dt
c) dv/dt d) Both (b) and (c)

4) What is the classical expression for angular momentum (L)?
a) L = I × ω b) L = r × F
c) L = F × p d) L = r × p

5) What is the quantum mechanical postulate regarding the average value <a> of an observable corresponding with an operator $A^{>}$?
a) $< a > = \int \varphi^* A^{>} \varphi d\tau$ b) $< a > = \int (\varphi)^* A^{>} \varphi^2 d\tau$
c) $< a > = \int \varphi^* \varphi d\tau$ d) $< a > = \int A^{>} d\tau$

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.

SLR-HV-7

Seat No.	

Set P

M.Sc. Physics (Nano Physics) (Sem - II) (New) (NEP CBCS)
Examination: October/November - 2025
Electrodynamics (2306202)

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 $\mathrm{E} = \lambda/(2\pi\varepsilon\mathrm{h}).\mathrm{aN}$. (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 $\bar{E}$.

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.

Seat No.		Set	P

M.Sc. Physics (Nanophysics) (Semester - II) (New) (NEP CBCS)
Examination: October/November – 2025
Classical Mechanics (2306206)

Day & Date: Saturday, 01-11-2025 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 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) $F - MV$
   c) $W - MV$ d) $F + \dot{M}U$

8) The Jacobi integral of the system is equal to ____.
   a) $\Sigma\, p_j\, \dot{q}_j - L$ b) T+V
   c) $\Sigma\, \dot{P}_j\, q_j - L$ 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, arial velocity is constant. (True/False)
3) An angular momentum is conserved in the absence of external torque. (True/False)
4) The fundamental Poisson's brackets are varying 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.

Seat No.	

Set **P**

M.Sc. Physics (Nanophysics) (Semester - III) (New) (NEP CBCS)
Examination: October/November - 2025
Statistical Physics (2306301)

Day & Date: Wednesday, 29-10-2025 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) 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 2^{nd} 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 weekly 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.

SLR-HV-11

Seat No.	

Set P

M.Sc. Physics (Nano physics) (Semester - III) (New) (NEP CBCS)
Examination: October/November - 2025
Atomic and Molecular Physics (2306302)

Day & Date: Friday, 31-10-2025 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) 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, ml 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 II 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.

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Set P

M.Sc. Physics (Nanophysics) (Semester - III) (New) (NEP CBCS)
Examination: October/November – 2025
Energy Harvesting Devices (2306308)

Day & Date: Monday, 03-11-2025 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) Select the correct alternative. **08**

1) Piezoelectric cell can be used as _____.
   a) Transducer b) Amplifier
   c) Capacitor d) Oscillator

2) Which of the following materials exhibits pseudo capacitance?
   a) Silicon
   b) Copper
   c) RuO_2 (Ruthenium dioxide)
   d) Aluminum

3) In hydrogen-oxygen fuel cells, the by-product are ____.
   a) water only b) heat only
   c) both water and heat d) none of these

4) The standard emf of the hydrogen - oxygen fuel cell is _____.
   a) 0.58 V b) 2.54 V
   c) 3.96 V d) 1.23 V

5) Piezoelectric crystal produces _____.
   a) Low voltage b) medium voltage
   c) high voltage d) Zero voltage

6) The main disadvantage of silicon solar cells is: ____.
   a) Low efficiency
   b) High manufacturing cost
   c) High toxicity of materials
   d) Degradation of performance with time

7) The typical operating voltage range of a super capacitor is: ____.
   a) 0-1 V b) 5-10 V
   c) 2-3 V d) 0-2 V

8) Dye-sensitized solar cells (DSSCs) used mainly for material as the photoanode?
   a) Si b) TiO_2
   c) $CuInSe_2$ d) CdS

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

1) Piezoelectric material can be used to generate Microwave. (True/False)
2) The output of fuel cell is AC type. (True/False)
3) Photovoltaic (PV) cells convert sunlight directly into electricity. (True/False)
4) Supercapacitors are ideal for applications requiring long-term energy storage. (True/False)

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

a) Define and explain the piezoelectric effect.
b) Define and explain Hybrid supercapacitor.
c) Define Fill Factor and efficiency of PV cell.
d) Explain the advantages of fuel cell over battery.
e) Explain the p- n junction solar cell.
f) Elucidate Cds / Cu2s solar cell.
g) Give the anode and cathode reaction in Hydrogen-Oxygen Fuel cell.
h) Explain the charge storage mechanism in double layer capacitance in super capacitor.

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

a) Explain the working of Hydrogen-Oxygen based fuel cell.
b) write note on photo electrochemical cell.
c) Explain the any four applications of super capacitor in detail.
d) Explain symmetric & asymmetric super capacitor configurations.

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

a) Explain the construction and working of Hydrogen-Oxygen based.
b) With neat diagram explain the construction of alkaline fuel cell.
c) Explain the construction and working of dye sensitized solar cell.

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

a) Explain any three piezoelectric materials with their advantages and disadvantages.
b) Explain principle & working of proton exchange membrane in fuel cell.
c) Describe principle, working and materials for DSSC solar cell.

Seat No.	

Set **P**

M.Sc. Physics (Nanophysics) (Semester - III) (New) (NEP CBCS)
Examination: October/November - 2025
Semiconductor Physics (2306309)

Day & Date: Monday, 03-11-2025 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 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) Development
   b) Etching
   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**

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

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

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

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

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

SLR-HV-16

Seat No.	

Set P

M.Sc. Physics (Nanophysics) (Semester - IV) (New) (NEP CBCS)
Examination: October/November – 2025
Physics of Semiconductor Devices (2306401)

Day & Date: Tuesday, 28-10-2025 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. (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.

SLR-HV-17

Seat No.	

Set P

M.Sc. Physics (Nanophysics) (Semester - IV) (New) (NEP CBCS)
Examination: October/November - 2025
Nuclear and Particle Physics (2306402)

Day & Date: Thursday, 30-10-2025 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. (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.

SLR-HV-20

Seat No.	

Set P

M.Sc. Physics (Nanophysics) (Semester - IV) (New) (NEP CBCS)
Examination: October/November - 2025
Nanomaterials Characterization Techniques (2306407)

Day & Date: Saturday, 01-11-2025 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. (MCQ) **08**

1) _____ of transition take place in UV - vis Spectroscopy.
   a) Rotation b) Vibrational
   c) Electronic d) All of the above

2) The nanoscale involves the range from approximately _____.
   a) 1 nm to 10 nm b) 1 nm to 100 nm
   c) 1 nm to 1000 nm d) 1 nm to 0.001 nm

3) AFM is primarily used to study _____.
   a) Optical properties
   b) Surface morphology
   c) Elemental composition
   d) Thermal stability

4) TEM stands for _____.
   a) Total Electron Mapping
   b) Transmission Electron Microscopy
   c) Thermoelectric Microscopy
   d) Tunneling Energy Measurement

5) XRD is most commonly used to study _____.
   a) Thermal degradation b) Crystal structure
   c) Chemical bonding d) Electron emission

6) Which technique can help analyze the nonlinear Kerr effect?
   a) UV-Vis spectroscopy b) Photoluminescence
   c) Optical spectroscopy d) TGA
   .

7) STM can only be used with samples that are _____.
   a) Insulators b) Transparent
   c) Conductive d) Magnetic

8) Which of the following cannot provide 3D surface morphology?
   a) SEM b) AFM
   c) STM d) FTIR

B) Fill in the blanks OR write True or False. **04**

a) STM requires the sample to be an insulator. (T/F)
b) Sample preparation for TEM is more complex than SEM.(T/F)
c) Photoluminescence studies are not applicable for semiconductor nanomaterials. (T/F)
d) Bulge test is used for surface area analysis. (T/F)

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

a) What is Poisson's Ratio?
b) Define Young's modulus.
c) What is meant by the optical band gap?
d) What is bulge test?
e) What is the principal of AFM?
f) What is the purpose of energy analyzers in XPS?
g) What is TGA?
h) Mention two advantages of TEM.

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

a) Write a short note on the applications of AFM.
b) Differentiate between FTIR and Raman spectroscopy.
c) Discuss thermal conductivity in nanomaterials.
d) Explain sampling depth in XPS.

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

a) Explain the construction and working of TEM with neat diagram.
b) Write a note on Nanolithographic techniques.
c) Explain the procedure of surface area measurement for nanoparticles and its importance.

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

a) Explain the principle of Raman spectroscope and write its applications?
b) Describes the instrumentation and working of FTIR spectrometer.
c) Explain Optical Spectroscopy of Metal Nanoparticles.

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Set **P**

M.Sc. Physics (Nanophysics) (Semester - IV) (New/Old) (CBCS)
Examination: October/November - 2025
Semiconductor Devices (MSC09401)

Day & Date: Tuesday, 28-10-2025 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. 1 and 2 are compulsory.
2) Attempt any three from Q. 3 to Q. 7.
3) Figures to the right indicate full marks.

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

1) In the case of accumulation, there occurs _____ of majority charge carriers, after biasing MIS structure.
   a) addition b) removal
   c) both (a) and (b) d) none of these

2) The biasing condition in which there is _____ voltage drop is called as Flat-Band condition.
   a) little b) no
   c) not defined d) All of these

3) _____ conversion is performed by the readout circuits in CCD.
   a) parallel to series b) series to parallel
   c) parallel to parallel d) All of these

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

5) If there is conduction of current 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) In the gate voltage sweep, the point at which a significant current begins to flow is called as _____.
   a) cut-off voltage b) contact potential
   c) threshold voltage d) All of these

7) CCD gate length should be _____ in order to increase fringing field.
   a) reduced b) enhanced
   c) unchanged d) All of these

8) The theory explaining the concept of negative differential resistance is _____.
   a) RWH b) Hall effect
   c) quantum confinement d) both (b) and (c)

9) 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

10) The NMOS will start conducting when a _____ voltage is applied to the gate.
   a) breakdown b) low
   c) high d) both (a) and (b)

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

1) Turning the SCR from forward blocking to forward conduction state is called as _____.
2) _____ is defined as the number of photoelectrons produced divided by the number of impinging photons.
3) Photodiodes operate under _____ bias.
4) The insulator layer at the metal-semiconductor junction can potentially lower the Fermi-level pinning. (True/False)
5) NMOS are considered to be faster than PMOS. (True/False)
6) A higher position in the energy band diagram represents a higher electron energy. (True/False)

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

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

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

a) Explain in detail about the construction and working of p-n junction LASER.
b) What is a photoconductor? Write in short about photocurrent gain.

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

a) What is a Schottky diode? Explain in detail about basic mechanism of Schottky diode.
b) What is a flat band condition? What are the basic equations in flat band conditions?

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

a) Describe IV characteristics of solar cell. Derive an expression for quantum efficiency of solar cell.
b) Explain in detail about charge trapping in MOSFET.

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

a) What are light emitting diodes? Elaborate the construction and working principles of LEDs.

b) Write in short about dv/dt and di/dt characteristics of SCR.

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

a) Explain in detail about basic construction and charge transfer mechanism in two phase CCD.

b) Explain in brief about LSA mode of operation.

Seat No.	

Set **P**

M.Sc. Physics (Nanophysics) (Sem - IV) (New/Old) (CBCS)
Examination: October/November - 2025
Nuclear and Particle Physics (MSC09402)

Day & Date: Thursday, 30-10-2025 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

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

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

1) The spin of a proton is _____
   a) 0 b) 1
   c) ½ d) 3/2

2) Which of the following particles is not involved in the strong nuclear force?
   a) Proton b) Neutron
   c) Electron d) Pion

3) In a radioactive decay series, the daughter nucleus is more stable if it has _____
   a) A higher binding energy per nucleon
   b) A lower atomic number
   c) A longer half-life
   d) A higher atomic mass

4) The magic numbers predicted by the nuclear shell model include _____
   a) 4, 12, 20 b) 2, 6, 14
   c) 8, 20, 50 d) 16, 28, 54

5) The interaction responsible for beta decay is the _____
   a) Electromagnetic force
   b) Weak nuclear force
   c) Strong nuclear force
   d) Gravitational force

6) The energy required to remove a proton from the nucleus is known as _____
   a) Ionization energy
   b) Binding energy
   c) Proton Separation energy
   d) Fission energy

7) Cosmic rays were first discovered by _____
   a) J. J. Thomson b) Victor Hess
   c) Albert Einstein d) Enrico Fermi

8) A meson is made up of _____
   a) Two quarks
   b) Three quarks
   c) One quark and one gluon
   d) A lepton and a quark

9) Which of the following accelerators uses both magnetic and electric fields to accelerate particles?
   a) Synchrotron b) Linear accelerator
   c) Bubble chamber d) Scintillation counter

10) The main purpose of the Large Hadron Collider (LHC) is to study _____
   a) Nuclear fusion
   b) Particle interactions at high energies
   c) Solar radiation
   d) Radioactive decay

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

1) The_____ force is responsible for holding protons and neutrons together in a nucleus.
2) The element with atomic number 82 (Lead) is _____ in most of its isotopic forms.
3) In gamma decay, there is no change in the atomic umber or _____ of the nucleus.
4) The weak force has a longer range than the electromagnetic force. (True/False)
5) A cyclotron is used to accelerate neutral particles. (True/False)
6) The half-life of a radioactive isotope is affected by temperature. (True/False)

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

a) What are the quantum numbers associated with nucleons in a nucleus? Explain their significance.
b) Discuss the theory of beta decay and the role of neutrinos in the process.
c) Explain the concept of nuclear reaction cross-sections and how they are measured.
d) Describe the Gell-Mann-Nishijima scheme for particle classification.

Q.3 Answer the following.

a) Explain the role of the Bethe-Weizsacker formula in calculating the binding energy of a nucleus. **08**
b) Describe the Fermi gas model and its implications for nuclear stability. **08**

Q.4 Answer the following.

a) Derive the expression for Q-value in a nuclear reaction. **08**

b) Explain the mechanism of nuclear fusion in stars and its significance in energy production. **08**

Q.5 Answer the following.

a) What are quarks? Explain their properties and the concept of colour charge in quantum chromodynamics (QCD). **08**

b) Discuss the east-west asymmetry observed in cosmic ray intensity and its implications. **08**

Q.6 Answer the following.

a) Explain the principle behind semiconductor detectors used for particle detection. **08**

b) Discuss the liquid drop model and its applications in explaining nuclear fission. **08**

Q.7 Answer the following.

a) What are direct nuclear reactions? Provide examples and explain their significance in nuclear physics. **08**

b) Describe the structure and functioning of a synchrotron accelerator. **08**

Seat No.	

Set P

M.Sc. Physics (Nanophysics) (Semester - IV) (New/Old) (CBCS) Examination: October/November - 2025
Nano Material Fabrication Techniques (MSC09408)

Day & Date: Tuesday, 04-11-2025 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

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

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

1) What images are produced by a scanning electron microscope _____images.
   a) 1D b) 2D
   c) 3D d) None of these

2) Image formation in electron microscope is based on _____.
   a) column length b) electron number
   c) differential scattering d) specimen size

3) The resolving power of TEM is derived from _____.
   a) electrons b) specimens
   c) power d) ocular system

4) The secondary electrons radiated back in scanning microscopes collected by _____.
   a) specimen b) anode
   c) vacuum chamber d) cathode

5) Electron microscope can give a magnification up to _____.
   a) 400000X b) 100000X
   c) 15000X d) 100X

6) _____ is used in electron microscope.
   a) electron beams & magnetic fields
   b) magnetic fields
   c) light waves
   d) electron beams
   .

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

8) AES is the study of radiation emitted by _____.
   a) ions b) molecules
   c) atoms d) fragments

9) 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

10) Vibrational transition of molecule is related to _____.
   a) FTIR b) UV -vis Spectroscopy
   c) XRD d) NMR

B) Answer the following. **06**

1) STM stands for _____.
2) TEM & SEM are same microscopy (True/False)
3) Bulk material has high surface to volume ratio. (True/False)
4) Lithography is a commonly used bottom-up technique for nano fabrication. (True/False)
5) Who discovered the X-ray?
6) _____ is the length between 1 nm to 100 nm.

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

a) Write a note on bright field microscope.
b) Explain in detail difference between SEM and TEM.
c) What is Magic Angle Spinning (MAS)?
d) What are the limitations of STM?

Q.3 Answer the following.

a) Explain in details of Scanning Electron Microscope with schematic diagram. **10**
b) Explain principle and working of NMR Spectroscopy. **06**

Q.4 Answer the following.

a) Explain principle, instrumentation and working of TEM with neat labeled diagram. **10**
b) Draw and Explain X-ray photoelectron spectroscopy. **06**

Q.5 Answer the following.

a) Explain Contact mode, Non-contact mode in AFM. **10**
b) Explain Selective Area Electron Diffraction (SAED). **06**

Q.6 Answer the following.

a) What is quantum yield? Obtain the relation of quantum efficiency. **10**

b) What are the applications of ESR? **06**

Q.7 Answer the following.

a) Explain limitations of light microscopy and advantages of electron microscopy. **10**

b) Write a note on AES & auger transitions. **06**