Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: March/April – 2026
Mathematical Physics (2321101)

Day & Date: Friday, 17-04-2026 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) Function $f(Z) = \frac{1}{z}$ has a _____.
   a) Branch point b) Simple pole at $z = 0$
   c) Essential singularity d) Removable singularity

2) The integral of $1/Z$ along the circle $|Z| = 1$ is _____.
   a) 0 b) $i\pi$
   c) $2\pi i$ d) $-2\pi i$

3) The dimensionality of vector space spanned by $\{(1,0,0), (0,1,0), (0,0,1)\}$ _____.
   a) 1 b) 2
   c) 3 d) 4

4) The dimensionality of all 2×2 matrices is _____.
   a) 4 b) 9
   c) 12 d) 3

5) The general solution of $\frac{dy}{dx} = ky$ is _____.
   a) $y = C^{e^{kx}}$ b) $y = kx + C$
   c) $y = Cx^k$ d) $y = c + kx$

6) If the roots of characteristic equation are complex, then the solution is _____.
   a) Real and distinct b) Real and repeated
   c) Complex conjugate d) Imaginary

7) The Fourier series of a square wave contains _____.
   a) Only sine terms b) Only cosine terms
   c) Both sine and cosine d) Constant terms only

8) The coefficient a_n in a Fourier series represents _____.
   a) Average (DC) value of the function
   b) Maximum amplitude
   c) Frequency
   d) Phase angle

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

a) Analytic functions automatically satisfy Laplace's equation and are therefore harmonic.
b) Parseval's theorem relates the total energy (or power) of a signal in the time domain to that in the frequency domain.
c) Linearly dependent vectors can form a basis for a vector space.
d) A second-order homogeneous differential equation with constant coefficients always has exponential-type solutions.

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

a) Find the complex conjugate of the following equations.
   i) $Z_1 = -4 + 7i$
   ii) $Z_2 = 3 - 6i$

b) Find the cube root of the following number $Z = 8i$

c) Find the general solution of the given differential equation.

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 6y = 12e^{-2t}$$

d) Find the general solution of the given differential equation

$$\frac{d^2y}{dt^2} - 9y = 0$$

e) Determine whether the vectors $V_1 = (1,0,2)$ and $V_2 = (0,1,3)$ are linearly independent.

f) State Fourier theorem and briefly explain its significance in signal processing.

g) Define the Laplace transform of a function $f(t)$ and explain its significance.

h) Find the inverse of the matrix $A = \begin{bmatrix} 3 & 2 \\ 1 & 4 \end{bmatrix}$

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

a) State and Explain Cauchy's theorem in detail.

b) Let $A = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$, show $A^2 = A$ but $I - A = 0$ is invertible.

c) Find the Laplace transform of $f(t) = te^{-2t}$ for $t \geq 0$.

d) State and prove superposition principle.

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

a) Find the general solution of $y'' - y' - 6y = 3e^{2x}$

b) Evaluate the integral $f(z) = \oint \frac{\cos(Z)}{Z^2+1} dz$

c) Find the eigen values and eigen vectors of the matrix

$$A = \begin{vmatrix} 3 & -1 & 0 \\ -1 & 3 & -1 \\ 0 & -1 & 3 \end{vmatrix}$$

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

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

b) Compute the Fourier series of the function $f(x) = x^2$ on the interval $-\pi \leq x \leq \pi$ period 2π

c) Find the inverse of the matrix $B = \begin{vmatrix} 1 & 2 & 3 \\ 0 & 1 & 4 \\ 5 & 6 & 0 \end{vmatrix}$ and verify $B \times B^{-} = I$

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - I) (New)
(NEP CBCS) Examination: March/April - 2026
Solid State Physics (2321102)

Day & Date: Monday, 20-04-2026 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) The Bloch theorem describes the wavefunction of an electron in a _____.
   a) Free space b) Periodic potential
   c) Random potential d) Infinite potential well

2) In the Kronig-Penney model, allowed energy bands arise due to:
   a) Discrete energy levels of atoms
   b) Periodic potential in the crystal lattice
   c) Random scattering centres
   d) Magnetic field applied to the crystal

3) Paramagnetic susceptibility follows which temperature dependence?
   a) Curie Law b) Curie-Weiss Law
   c) Debye Law d) Pauli's Law

4) Clausius-Masotti relation is used to relate: _____.
   a) Magnetic susceptibility and field
   b) Polarization and electric field
   c) Dielectric constant and polarizability
   d) Magnetization and current density

5) Weiss molecular field theory explains: _____.
   a) Diamagnetism b) Ferromagnetism
   c) Superconductivity d) Dielectric polarization

6) The energy gap in a superconductor: _____.
   a) Is zero below Tc
   b) Increases with temperature
   c) Decreases with temperature and vanishes at Tc
   d) Remains constant with temperature

7) Type II superconductors are characterized by _____.
   a) Single critical magnetic field
   b) Two critical magnetic fields, Hc_1 and HC_2
   c) No Meissner effect
   d) Infinite critical temperature

8) Bloch wall is associated with _____.
   a) Superconducting current
   b) Magnetic domain boundaries
   c) Electron energy bands
   d) Dielectric polarization

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

1) In intrinsic semiconductors, the number of electrons equals the number of _____.
2) The Meissner effect shows that superconductors are perfect __.
3) True/False: Langevin theory of paramagnetism assumes quantum mechanical treatment of magnetic moments.
4) The exchange interaction between spins is responsible for _____ ordering in ferromagnets.

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

a) State Bloch theorem.
b) Write the distinction between metals, insulators, and semiconductors based on band theory.
c) Explain about DC conductivity of metals.
d) Write a short note on Brillouin zones.
e) State Clausius-Mossotti equation.
f) Write Curie law for paramagnetic susceptibility.
g) Define Neel temperature.
h) What is London penetration depth?

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

a) Explain Kronig-Penney model and formation of energy bands.
b) Derive expression for internal field in dielectrics.
c) Explain ferromagnetic domains and anisotropy energy.
d) Discuss Meissner effect and its significance in superconductors.

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

a) Derive expression for paramagnetic susceptibility using Langevin theory.
b) Explain Weiss theory of ferromagnetism and obtain Curie-Weiss law.
c) Explain BCS theory of superconductivity.

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

a) Derive London equation and obtain London penetration depth.
b) Explain exchange integral and its role in ferromagnetism.
c) Discuss the thermodynamics of superconductivity.

SLR-PN-3

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: March/April – 2026
Analog and Digital Electronics (2321106)

Day & Date: Wednesday, 22-04-2026 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 output resistance of a practical op-amp is: _____.
   a) High b) Low
   c) Infinite d) Zero

2) In an astable multivibrator, the output waveform is: _____.
   a) Square wave b) Sine wave
   c) Triangle wave d) DC

3) The 8085 instruction “MVI A, 32H” uses which addressing mode?
   a) Immediate b) Direct
   c) Register d) Indirect

4) A NOT gate is also called: _____.
   a) Inverter b) Buffer
   c) AND gate d) OR gate

5) An Non- inverting amplifier produces an output that is: _____.
   a) In phase with input b) 180° out of phase
   c) 90° out of phase d) Zero

6) The main advantage of negative feedback in op-amps is: _____.
   a) Increase gain b) Reduce bandwidth
   c) Stabilize gain d) Decrease input resistance

7) A multiplexer is used to: _____.
   a) Combine signals b) Amplify signals
   c) Compare signals d) Filter signals

8) A D Flip-Flop stores data on _____.
   a) Rising edge of clock b) Falling edge of clock
   c) Both edges d) Level triggered

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

1) The gain of an open-loop op-amp is usually _____.
2) True/False: The output of an inverting integrator decreases when the input voltage is positive.
3) True/False: JK master-slave flip-flop eliminates the race-around condition.
4) Multiplexer is used to _____ signals.

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

a) Draw the AC equivalent circuit of a differential amplifier.
b) Explain the concept of negative feedback in op-amps.
c) State the advantages of synchronous counters over asynchronous counters.
d) Define input bias current and offset current.
e) List various applications of op-amp.
f) Write the truth table of D Flip-Flop.
g) Explain the concept of voltage series feedback.
h) Write an assembly language program for 8085 to subtraction of two 4-bit numbers.

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

a) Explain the voltage follower and its applications.
b) Draw and explain instrumentation amplifier using op-amps.
c) Explain operation of Astable multivibrator using op-amp.
d) Describe DC analysis of an differential amplifier.

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

a) Explain the working of phase shift oscillator using op-amp.
b) Explain the architecture of 8085 microprocessor.
c) Design a differentiator circuit using op-amp.

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

a) Explain the working of JK Flip-Flop with truth table.
b) Write short notes on Wein bridge oscillator.
c) Write an Assembly Language program for 8085 to multiply two 4-bit numbers.

SLR-PN-4

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: March/April – 2026
Elements of Materials Science (2321107)

Day & Date: Wednesday, 22-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

1) The material which absorbs the transmission of visible light is termed as _____.
   a) Opaque b) Translucent
   c) Transparent d) None of the above

2) The forces exerted between the atoms/molecules are _____ in nature and depend on the electronic structure.
   a) Electrostatic b) Electrodynamic
   c) Ionic d) Electromagnetic

3) _____ is the process of increase in the electrical conductivity of a semiconducting material, when a radiation falls on the material.
   a) Photodetectivity b) Photoconductivity
   c) Specific detectivity d) All the above

4) The degree of freedom when ice, water and water vapour co-exist in equilibrium is _____.
   a) 1 b) triple point
   c) zero d) -1

5) Due to the cross-linking of polymer chain, the strength of the polymer increases while its _____ decreases.
   a) photodetectivity b) conductivity
   c) elasticity d) plasticity

6) _____ are organic materials prepared by polymerization reactions in which small molecules are chemically combined into long chain molecules or 3D structures.
   a) Ceramic b) Metals
   c) Alloys d) Polymers

7) The unit of flux J is _____.
   a) atoms m^{-2} s^{-1} b) atoms m^{2} s^{-1}
   c) moles m^{-3} s^{-1} d) All of above

8) The linear polymers are held together by weak _____ forces.
   a) ionic b) metallic
   c) van der Waals d) covalent

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

1) The amorphous solids have no regular structure (no directional property) and hence they are known as isotropic substances.
2) The nanoparticles with particle size of nearly 1-100 nm.
3) Responsivity is defined as the ratio of the electrical output to the radiation input.
4) The unit of the diffusion coefficient D is $m^2 s^{-1}$.

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

a) Explain skin depth.
b) What are the primary bonds?
c) What is degree of polymerization?
d) How can luminescence be classified?
e) What is the degree of freedom of a system of two components when the number of phases is one?
f) What are semiconducting materials?
g) What is the phase rule?
h) What are the key characterization techniques for nanostructured materials?

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

a) What chemical techniques are used for the synthesis of nanophase materials? Describe any two of these in short.
b) Explain Kirkendall effect.
c) Discuss interaction of light with matter.
d) Explain the difference between crystalline and non-crystalline (amorphous) solids.

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

a) What is principle of luminescence? Explain classification of luminescence.
b) What are the types of Engineered materials? Discuss in short. What are the application of engineering materials?
c) What are nanostructured or nanophase materials, and what are their important properties and applications?

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

a) What are ceramics, and how are ceramics classified into different categories?
b) What is the photoconductivity? What are the characteristics of photoconductive materials?
c) What are secondary bonds, and what are the different types of these bonds?

Seat No.	

Set **P**

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS) Examination: March/April - 2026 Research Methodology in Physics (2321105)

Day & Date: Friday, 24-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

1) In UV-visible spectroscopy, the concentration of the analyte can be determined using _____.
   a) Ohm's law b) Beer-Lambart's law
   c) Lenz's law d) Faraday's law

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) Gathering knowledge for knowledge's sake is termed _____ research.
   a) basic b) applied
   c) quantitative d) experimental

4) A critical literature review is for _____.
   a) analytical exploration b) comparative evaluation
   c) identification of patterns d) all of these

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) global filament

7) Research in common parlance refers to a search for _____.
   a) knowledge b) goods
   c) peace d) skills

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 or False. **04**

1) Physicists must adhere to ethical guidelines when conducting research. (True/ False)
2) Applied research aims at finding a solution for an immediate problem facing a society. (True/ False)
3) Research methodology is a way to systematically solve the research problem. (True/ False)
4) Radiofrequency sputtering can sputter insulating materials. (True/ False)

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

a) Define research.
b) Write use of web in research.
c) Draw the neat labelled schematic diagram of scanning tunneling microscope.
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) Explain Fourier transform infrared spectroscopy with neat labelled diagram.
b) Explain in detail construction and working of Magnetron Sputtering.
c) Explain the concept data interpretation in research.
d) Write a note on meaning and importance of research.

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

a) Explain data analysis in research with statistical tools.
b) Explain in detail spray pyrolysis deposition technique.
c) Explain in details types of research.

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

a) Explain transmission electron microscope with neat labelled diagram.
b) Explain in detail ion beam sputtering technique of deposition.
c) Write detailed note on atomic force microscopy.

Seat No.	

Set **P**

M.Sc. Physics (Material Science) (Semester - II) (New) (NEP CBCS)
Examination: March/April - 2026
Quantum Mechanics (2321201)

Day & Date: Thursday, 16-04-2026 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) What are the eigenvalues for z component of angular momentum operator L_z?
   a) $L_z = m\hbar$ b) $L_z = \hbar^2\pi m$
   c) $L_z = m\hbar^2$ d) $L_z = 0$

2) The Energy levels are proportional to _____.
   a) n b) n^{-1}
   c) n^2 d) n^{-2}

3) The Schrodinger wave equation is a mathematical expression describing _____.
   a) energy of the electron b) momentum of the electron
   c) position of the electron d) All of the above

4) What is the meaning of a Hermitian operator?
   a) An operator that yields complex eigenvalues
   b) Another name for the Hamiltonian operator
   c) An operator that yields real eigenvalues
   d) An operator that gives an average value over space and time

5) The operator $\hat{A}$ acts linearly on the functions f_1 and f_1. Applying it on $f_1 + f_2$ does which of the following?
   a) $\hat{A}\,(f_1 + f_2) = \hat{A}f_1 + \hat{A}\,f_2$
   b) $\hat{A}\,(f_1 + f_2) = \hat{A}f_1 - \hat{A}\,f_2$
   c) $\hat{A}\,(f_1 + f_2) = \hat{A}f_1 + \hat{A}\,f_2 + \hat{A}f_1f_2$
   d) $\hat{A}\,(f_1 + f_2) = \hat{A}f_1 + \hat{A}\,f_2 - \hat{A}f_1f_2$

6) According to de-Broglie relation, momentum of particle is _____ to its wavelength.
   a) inversely proportional b) directly proportional
   c) in phase d) out of phase

7) Energy operator is equal to _____.
   a) $i\hbar\partial/\partial t$ b) $-i\hbar\partial/\partial t$
   c) $i\hbar\partial/\partial x$ d) $-i\hbar\partial/\partial x$

8) The continuity equation is given by _____.
   a) $\partial\rho/\partial t + \partial j/\partial x = 0$ b) $\partial\rho/\partial t - \partial j/\partial x = 0$
   c) $\partial j/\partial t + \partial\rho/\partial x = 0$ d) $\partial j/\partial t - \partial\rho/\partial x = 0$

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

1) For 3-D system, the Schrödinger equation changes. (Ture/False)
2) Inner product of Bra and Ket in Quantum mechanics is always 1. (True/False)
3) The operator equation is _____.
4) If Ψ_a and Ψ_b are said to be orthogonal to each other, then _____.

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

a) What does the Schrödinger wave equation demonstrate?
b) Write about the black body radiation.
c) What are the physical significances of Dirac's bra-ket notations?
d) What is meant by group velocity of wave?
e) Write in short about Compton scattering.
f) Which quantity is said to be degenerate when $H\Psi_n = E_n\Psi_n$?
g) What is meant by scalar product?
h) Write the difference between span and basis.

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

a) Explain the Heisenberg uncertainty principle.
b) What are the raising and lowering operators?
c) Define the different postulate of Quantum mechanics.
d) Prove that eigen function of Hermitian operator with different eigen values are orthogonal to each other.

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

a) Explain in detail about eigen value and eigen function?
b) Describe the Pauli spin matrices.
c) What are Ehrenfest's theorems? Prove any one of them.

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

a) Write down the co-ordinate and momentum representation.
b) Define the continuity equation. Deduce it.
c) Write in detail about Schrodinger time independent wave equation.

SLR-PN-7

Seat No.		Set	P

M.Sc. Physics (Materials Science) (Sem - II) (New) (NEP CBCS)
Examination: March/April – 2026
Electrodynamics (2321202)

Day & Date: Saturday, 18-04-2026 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 skin effect is a phenomenon observed in _____.
a) Insulators b) Dielectrics
c) Conductors d) Semiconductors

2) What is the unit of electric flux?
a) V/m b) N/m
c) V*m d) N/Coulomb

3) In Maxwell equation $\nabla \times \mathrm{H} = \mathrm{J} + \partial \mathrm{D} / \partial \mathrm{t}, \mathrm{J}$ is _____.
a) Electric flux density b) Magnetic flux density
c) Surface current density d) No physical quantity

4) Divergence of the curl of any vector field is always _____.
a) 0 b) 1
c) Infinite d) can't possible

5) Lorentz electric force has direction _____.
a) similar to electric field b) opposite to electric field
c) scalar quantity d) None of these

6) If a charge is placed outside a closed surface, flux due to that charge inside the surface will be _____.
a) Positive
b) May be positive or negative, depending on the nature of the charge
c) Negative
d) Zero

7) The amount of force exerted on a unit positive charge in an electric field is known as _____.
a) Electric field intensity b) Electric flux
c) Electric potential d) Electric lines of force

8) The direction of electric field created by a negative charge is _____.
   a) Directed outwards
   b) Directed towards the charge
   c) Maybe outwards or towards the charge
   d) Circular in shape

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

1) When curl of a path is zero, the field is said to be conservative. True / False.
2) An electric generator works on the principle of electromagnetic induction. True /False.
3) Coulomb's Law is valid for any distance between the particles. True /False
4) Force on a charge 'q' moving with a velocity 'v' in a magnetic field is given by F = qvB. True /False

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

a) State the Gauss law.
b) Define 'electric flux'.
c) State Coulomb's law.
d) Define Electrostatic force.
e) Define electric flux density.
f) Define current density.
g) State Ampere's law.
h) State Biot-Savart law

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

a) State the boundary condition for an electrostatic field $\overline{E}$.
b) Write a note on Dipole moment of continuous charge distribution.
c) Explain potential due to surface charge.
d) Write a short on Energy stored in electric field.

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

a) Explain the case of reflection and transmission at a normal incidence and show that the sum of reflection coefficient (R) and transmission coefficient (T) is unity.
b) Write a note on skin depth of conductor.
c) State and prove Poynting theorem.

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

a) Write a expression for electromagnetic energy.
b) Write a expression for potential at point due to line charge.
c) State and explain in details of Gauss law.

Seat No.	

Set **P**

M.Sc. Physics (Materials Science) (Semester - II) (New)
(NEP CBCS) Examination: March/April – 2026
Classical Mechanics (2321206)

Day & Date: Tuesday, 21-04-2026 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 degree of freedom for N particles in space are _____.
   a) 2N b) 3N
   c) N d) Zero

2) Generalized coordinates _____.
   a) Depends on each other
   b) Independent on each other
   c) Necessarily spherical coordinates
   d) May be Cartesian coordinate

3) The Lagrangian function is define by _____.
   a) L= F + V b) L=T - V
   c) L = T + V d) L = F - V

4) The constraints on a bead on a uniformly rotating wire in a force free space is_____.
   a) Rheonomous b) Scleronomous
   c) a and b both d) None of these

5) Virtual work is represented as _____.
   a) $\delta W = \sum F^{e_i} \delta r_i = 0$ b) $\delta W = \sum F^{e_w} \delta r_i = 0$
   c) $W = \sum F^{e_l} r_i = 0$ d) $\delta W = \sum F^{e} i \delta r_i$

6) $\sum_i p_i q_i - L$ (Hamiltonian) is always _____.
   a) Variable b) Constant
   c) Zero d) None of these

7) Hamilton's equations are also called _____.
   a) Canonical equations b) Legendre's equations
   c) Linear equations d) None of these

8) If the total torque is zero, then _____ is conserved.
   a) angular momentum b) force
   c) linear momentum d) torque

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

1) Kepler's first law of planetary motion is also called as law of elliptical orbit. (True/False)
2) Lagrange's equations of motion are first order differential equations. (True/False)
3) The Poisson's bracket, [p, p] = _____.
4) In central force laws, if the potential energy, V = -k/r, then f = _____.

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

a) Define the constrains and their type.
b) State the Hamilton's variation principle.
c) What is generalized velocity and force?
d) Write in short about gyroscopic forces.
e) State the Kepler's first and second law.
f) Write in short about the relation between Hamiltonian (H) and Lagrangian (L).
g) Write about the resistive forces on Atwood machine.
h) Discuss the various properties of polymer materials.

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

a) Express the equation of moving body near surface of earth using Hamilton's canonical equation.
b) Differentiate between the Lagrange's and Hamilton equations of motion.
c) Elaborate about the gauge invariance.
d) Explain about the open systems with variable mass.

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

a) Prove the work-energy theorem.
b) Derive the solution of harmonic oscillator by Hamilton's - Jacobi method.
c) Derive the Euler Lagrange differential equation using variational principle.

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

a) Prove the Kepler's first law of planetary motion.
b) Write in detail on general analysis of orbits.
c) Explain about the symmetries of space and time with conservations laws.

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - III) (New) (NEP CBCS)
Examination: March/April – 2026
Statistical Physics (2321301)

Day & Date: Friday, 17-04-2026 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) According to law of thermodynamics the energy of the universe is always _____.
   a) conserved b) increasing
   c) decreasing d) zero

2) Work done by ideal gas during isothermal expansion is W = _____.
   a) S2 – S1 b) T(S2 – S1)
   c) R log (V2/V1) d) Q/T

3) Which of the following is boson?
   a) Electron b) Positron
   c) Proton d) Photon

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

5) In Bose Einstein Condensation all the particle accumulate in _____.
   a) excited state b) meta state
   c) ground state d) all exited state

6) Phase space is _____ dimensionalspace.
   a) 1 b) 2
   c) 3 d) 6

7) The first order phase transitions are accompanied by a discontinuous change in _____.
   a) Gibb's molar free energy function
   b) Internal energy
   c) Crystal symmetry
   d) None of the above

8) Sackur-tetrode formula gives the relation for _____.
   a) entropy b) enthalpy
   c) internal energy d) Gibb's energy

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

1) Electrons obey Bose Einstein Statistics.
2) Planck's radiation law can be derived using Fermi Dirac Statistics.
3) Phase equilibrium curve terminates at Critical point.
4) For the stable state of the system G i.e. Gibbs's free energy should be large.

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

a) State 1st and 2nd law of thermodynamics.
b) Distinguish between different types of ensembles.
c) Draw a neat phase diagram for one component system.
d) Explain microstates and macrostates.
e) Write conditions for thermal equilibrium.
f) Define critical point.
g) Distinguish between 1st order and 2nd order phase transition.
h) Write equation of reduced state.

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

a) Derive Clausius- Clapeyron equation for first order phase transition.
b) Obtain expression for change in entropy with change in volume.
c) Derive Ehrenfest's equation for second order phase transition.
d) Explain phase diagram using PT diagram.

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

a) State and prove Liouville's theorem.
b) What is Gibb's paradox? Flow it is resolved?
c) Using Vander Waal's equation of reduced state, calculate the values of critical constants.

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

a) Explain the second order phase transition with an example of $BaTiO_3$.
b) Derive the expression for energy fluctuation in canonical ensemble.
c) Explain in details Bose Einstein Condensation.

SLR-PN-11

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - III) (New) (NEP CBCS)
Examination: March/April - 2026
Atomic and Molecular Physics (2321302)

Day & Date: Monday, 20-04-2026 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) In the context of selection rules, which of the following changes is allowed for an electric dipole transition?
   a) $\Delta 1 = 0$ b) $\Delta s = 1$
   c) $\Delta j = 0, \pm 1$ d) $\Delta ml = 2$

2) The probability of finding an electron in an atom is described by _____.
   a) Schrodinger equation
   b) Heisenberg uncertainty principle
   c) Pauli exclusion principle
   d) Quantum tunneling

3) Which effect demonstrates the particle nature of photons?
   a) Stark effect b) Zeeman effect
   c) Compton effect d) Doppler effect

4) The strong field Stark effect in hydrogen results in energy splitting that is _____.
   a) Linear with electric field strength
   b) Quadratic with electric field strength
   c) Independent of electric field strength
   d) Magnetic field dependent

5) In an anharmonic oscillator, the energy levels are _____.
   a) Equidistant
   b) Non equidistant, higher energy levels spaced further apart
   c) Completely degenerate
   d) Discrete and equally spaced

6) Which of the following types of interaction is responsible for the attraction between molecules in a gas?
   a) Ionic interaction b) Covalent bonding
   c) Van der Waals forces d) Electrostatic force

7) Nuclear magnetic resonance (NMR) is primarily used to study _____.
   a) Electron spin transitions b) Nuclear spin transitions
   c) Rotational energy levels d) Molecular dissociation

8) Born Oppenheimer approximation is useful because it allows the separation of _____.
   a) Electronic and nuclear motions in molecules
   b) Nuclear spin and electron spin
   c) Vibrational and rotational spectra
   d) Chemical and physical properties

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

1) The azimuthal quantum number l determines the spin orientation of the electron.
2) The Stark effect can be observed in atoms exposed to an external magnetic field.
3) Spherical top molecules have identical moments of inertia along all axes.
4) In anharmonic oscillator the vibrational energy levels are non-equidistant.

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

a) What is the magnetic quantum number, and what does it signify about an electron's orbital?
b) Describe the relationship between electron spin and magnetic moment.
c) Explain the Paschen Back effect for two electron systems.
d) State the Stark effect for a hydrogen atom.
e) What is the spectrum of a nonrigid rotator?
f) Explain its significance in rotational spectra.
g) Explain the origin of hyperfine structure in atomic spectra?
h) What is the Born Oppenheimer approximation.

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

a) Discuss the principle behind the chemical shift and its role in identifying functional groups in molecules.
b) Discuss the classification of molecules into linear, symmetric tops, spherical tops, and asymmetric tops with example.
c) Describe the significance of electron spin in creating magnetic moments.
d) Explain the molecular interactions of covalent, ionic, and Van der Waals interactions and how these forces influence the behavior of molecules?

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

a) Describe the experimental setup to observe the Compton shift and how this effect provides evidence for the quantization of electromagnetic radiation.

b) Explain the relativistic corrections of hydrogen atom and discuss the Dirac equation with concept of spin-orbit interaction.

c) Describe the Frank-Condon principle and its significance in understanding the electronic transitions in molecule.

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

a) Explain the concept of quantum numbers and their significance in determining the energy and wavefunction of an electron in an atom. Discuss how each quantum number (n, 1, m, s) affects the atomic orbitals?

b) What is Born - Oppenheimer approximation? Explain how it is allow the separation of electronic and nuclear motion in molecule.

c) Explain in detail the techniques and instrumentation of microwave spectroscopy.

Seat No.	

Set **P**

M.Sc. Physics (Material Science) (Semester - III) (New)
(NEP CBCS) Examination: March/April – 2026
Microcontrollers & Interfacing (2321306)

Day & Date: Wednesday, 22-04-2026 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 8051 microcontroller is a _____ bit microcontroller.
   a) 4-bit b) 8-bit
   c) 16-bit d) 32-bit

2) The total number of I/O pins in 8051 is _____.
   a) 16 b) 32
   c) 40 d) 8

3) The Program Counter (PC) in 8051 is of _____ bits.
   a) 8 b) 16
   c) 32 d) 64

4) PSW stands for _____.
   a) Program Status Word b) Port Status Word
   c) Peripheral Status Word d) Program Start Word

5) Which register is used for serial communication in 8051?
   a) SP b) DPTR
   c) SBUF d) P1

6) The clock frequency of standard 8051 is _____.
   a) 1 MHz b) 12 MHz
   c) 16 MHz d) 20 MHz

7) Which instruction is used to jump to subroutine?
   a) SJMP b) LJMP
   c) ACALL d) NOP

8) Which motor rotates in discrete steps?
   a) DC motor b) Servo motor
   c) Stepper motor d) Induction motor

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

1) 8051 has 4 I/O ports named P0 to P3. (True/False)
2) Timer 0 and Timer 1 are available in 8051. (True/False)
3) The accumulator is an 8-bit register used in arithmetic operations. (True/False)
4) DAC0808 converts digital signals into _____ signals.

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

a) List features of 8051 microcontroller.
b) Draw and label the pin diagram of 8051.
c) Define PSW and explain its bits.
d) What is the function of the accumulator?
e) List different addressing modes of 8051.
f) Write a short note on interrupts.
g) Define interrupt and its types.
h) Write syntax of a simple LED blinking program in Embedded C.

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

a) Explain memory organization of 8051 with a neat diagram.
b) Write an assembly language program to add two 8-bit numbers.
c) Explain timers and counters in 8051.
d) Write an Embedded C program for serial communication.

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

a) Explain architecture of 8051 in detail.
b) Describe interrupt structure and priorities.
c) Write a program (in assembly or C) to transfer “YES” serially at specific baud rate.

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

a) Explain interfacing of LCD with 8051.
b) Write an Assembly language program to interface DC to microcontroller 8051.
c) Explain working of ADC0804 with neat diagram and interfacing steps.

Seat No.	

Set **P**

M.Sc. Physics (Materials Science) (Semester - III) (New) (NEP CBCS)
Examination: March/April – 2026
Physics of Nanomaterials (2321307)

Day & Date: Wednesday, 22-04-2026 Max. Marks: 60
Time: 11:00 AM To 01:30 PM

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

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

1) Density of states in a 0-D system is _____.
   a) Constant
   b) Step-like
   c) Delta function-like discrete levels
   d) Parabolic

2) Exciton is _____.
   a) Free electron in the conduction band
   b) Bound state of electron and hole
   c) Lattice vibration quantum
   d) Impurity level

3) A single-walled carbon nanotube consists of _____.
   a) A rolled graphene sheet forming one cylinder
   b) Many concentric graphene cylinders
   c) Fullerene cages
   d) Amorphous carbon

4) Raman spectroscopy of CNTs gives information about _____.
   a) Tube diameter and vibrational modes
   b) Magnetic properties
   c) Electron transport
   d) Work function

5) The top-down approach involves _____.
   a) Chemical self-assembly
   b) Lithography and etching
   c) Sol-gel process
   d) Colloidal precipitation

6) Surface plasmon resonance is associated with _____.
   a) Collective oscillation of electrons at the surface
   b) Vibration of lattice ions
   c) Magnetic spin alignment
   d) Exciton recombination

7) According to the Drude model, electrical conductivity σ is _____.
   a) Independent of electron density
   b) Proportional to mean free path and electron density
   c) Inversely proportional to relaxation time
   d) Zero for metals

8) Poole-Frenkel effect describes _____.
   a) Quantum confinement
   b) Field-assisted emission of electrons from traps
   c) Surface plasmon resonance
   d) Phonon scattering

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

1) In quantum wells, carriers are confined in _____ dimension(s).
2) True/False: Multi-walled carbon nanotubes consist of a single graphene cylinder.
3) Colloidal precipitation is a _____ (top-down/bottom-up) approach.
4) True/False: Surface plasmon resonance frequency is independent of nanoparticle size.

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

a) Define quantum nanostructure and give one example.
b) Write an expression for the density of states in a 3D system.
c) List two applications of quantum dots.
d) Give one difference between single-walled and multi-walled CNTs.
e) Mention two top-down synthesis techniques.
f) State Beer-Lambert's law.
g) Define thermionic emission.
h) Write a short note on hopping conduction.

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

a) Explain partial confinement and its effect on the density of states.
b) Describe fabrication steps of nanoelectromechanical systems (NEMS).
c) Explain Raman and IR spectroscopic signatures of CNTs.
d) Discuss the effect of particle size on SPR peak position and width.

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

a) Explain top-down and bottom-up approaches with examples and advantages/limitations.
b) Derive Beer-Lambert law for absorption in nanomaterials.
c) Discuss electron transport in low-dimensional systems (0D,1D, 2D).

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

a) Describe Poole-Frenkel and Schottky emission mechanisms with diagrams.
b) Explain the pulsed laser deposition method for nanomaterial synthesis with a schematic.
c) Describe photoluminescence and electroluminescence phenomena with examples of nanomaterial-based devices.

Seat No.	

Set **P**

M.Sc. Physics (Materials Science) (Semester - III) (New)
(NEP CBCS) Examination: March/April - 2026
Semiconductor Physics (2321309)

Day & Date: Wednesday, 22-04-2026 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 crystal growth technique that allows atomic level control is _____.
   a) CVD b) MBE
   c) Floating zone d) Czochralski

2) Compared to a p-n junction diode, a Schottky diode has _____.
   a) Higher forward voltage drop
   b) Slower switching speed
   c) Lower forward voltage drop
   d) Wider depletion region

3) Which of the following is NOT a dopant for silicon?
   a) Phosphorus b) Arsenic
   c) Boron d) Copper

4) Electron tunneling through a potential barrier is possible because ___.
   a) Electrons have zero mass
   b) Energy is always conserved classically
   c) The wavefunction decays exponentially inside the barrier
   d) Barrier height becomes zero

5) The key use of Zener diode is _____.
   a) Amplification b) Voltage regulation
   c) Current amplification d) Oscillation generation

6) In an abrupt p-n junction under reverse bias, the depletion width ____.
   a) Increases with applied reverse voltage
   b) Is independent of voltage
   c) Decreases linearly with voltage
   d) Becomes zero

7) Space charge in a junction is formed by _____.
   a) Neutral atoms b) Ionized dopants
   c) Free electrons d) Holes only

8) The periodic table is arranged according to _____.
   a) Atomic number b) Atomic mass
   b) Group number d) Atomic radius

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

1) Schottky diodes exhibit fast switching speed.
2) Zener breakdown occurs mainly due to quantum mechanical tunneling.
3) Photolithography is used to grow crystals.
4) In equilibrium, the Fermi level remains constant throughout a p-n junction.

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

a) Why is silicon the dominant semiconductor material?
b) Draw cubic lattice diagrams for (111) and (001) planes.
c) Explain rectification principle of p-n junction diode.
d) Describe the types of junction capacitances.
e) What is a Schottky barrier?
f) Explain the Bohr postulates.
g) Explain the purpose of rapid thermal processing.
h) What is the uncertainty principle?

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

a) Describe crystal lattice types with diagrams.
b) Explain ion implantation process and its merits.
c) Give review of quantum numbers.
d) Discuss Zener breakdown and avalanche breakdown mechanisms in p-n junctions.

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

a) Explain photolithography steps in device fabrication.
b) Explain the diamond lattice and its importance in electronics.
c) Explain graded junction characteristics.

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

a) Explain MBE in detail and its advantages.
b) Derive energy of electron in Bohr’s nth orbit.
c) Derive Schrodinger’s equation in 1-D potential well.

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Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - IV) (New) (NEP CBCS)
Examination: March/April – 2026
Physics of Semiconductor Devices (2321401)

Day & Date: Thursday, 16-04-2026 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) Two valley model of TEDs based on GaAs is proposed by _____.
   a) BSC b) RWH
   c) BBS d) NWH

2) LEDs fabricated with GaAs emit _____ wavelength.
   a) far ultra violet b) visible
   c) ultraviolet d) infrared

3) Photodetector _____ optical signal.
   a) reflects b) modulate
   c) detects d) amplify

4) The M - S structure forms _____ barrier.
   a) Schottky b) Ohmic
   c) Read d) non - ohmic

5) $(\alpha_1 + \alpha_2)$ approaches _____ when the SCR devices are at forward breakdown.
   a) 100 b) ∞
   c) 1000 d) 1

6) A TRIAC is used where the transfer of large _____ is involved.
   a) power b) electron transfer
   c) voltage transfer d) charge transfer

7) Light emission is not possible in Si due to its _____.
   a) direct band gap b) indirect band gap
   c) high mobility d) doping

8) The energy required to move an electron at the fermi level to the vacuum outside is called as _____.
   a) Activation energy b) Fermi energy
   c) Work function d) Conductivity

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

1) The condition $hv > E_g$ causes ____ of light semiconductor.
2) The maxima of the valence band and the minima of conduction band occur for different values of momentum in _____ semiconductor.
3) If current can be conducted in both directions of the MS contact, the contact is Ohmic.
4) The effective mass is inverse function of the curvature of the E-K diagram.

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

a) What is the meaning of Optical Absorption?
b) What is Fermi level?
c) Write about the band diagram of Intrinsic semiconductor.
d) What is Photoluminescence?
e) What is the Transferred Electron Effect?
f) State the types of Thyristors.
g) What are Turn OFF methods of SCR?
h) Write about Photodiode.

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

a) Explain in detail about the carrier concentration at equilibrium.
b) Explain in detail about Direct and Indirect Transitions.
c) Elaborate the Effects of Metal work function in MIS diode.
d) Write in detail about Photoconductor device.

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

a) What is solar cell? Derive an expression for open circuit voltage and short circuit current.
b) Explain quantum efficiency and response speed of solar cell.
c) Explain in brief Operating modes of Gunn diode.

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

a) Explain the energy band diagram of Metal-Semiconductor junction. (p-type case)
b) Explain the concept of Thermionic emission.
c) Elaborate the principle and operation of Light Emming Diodes.

Seat No.	

Set P

M.SC. Physics (Material Science) (Semester - IV) (New)
(NEP CBCS) Examination: March/April - 2026
Nuclear and Particle Physics (2321402)

Day & Date: Saturday, 18-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

1) A stripping reaction is an example of ____.
   a) Direct interaction b) Compound nucleus decay
   c) Elastic scattering d) Photo-disintegration

2) The threshold energy for an endoergic reaction is ____.
   a) Zero
   b) The minimum energy required for the reaction to occur
   c) The Q-value
   d) Always 1 MeV

3) The maximum possible scattering cross-section at resonance is ___.
   a) $\pi\lambda^2$ b) $4\pi\lambda^2$
   c) $\lambda^2/4\pi$ d) R^2

4) The Higgs boson is associated with: ____.
   a) Mass generation b) Electromagnetic force
   c) Strong interactions d) Parity violation

5) Which decay is allowed by weak interactions?
   a) $\Lambda^o \rightarrow p + \pi^-$ b) $\pi^o \rightarrow \gamma + \gamma$
   c) $p \rightarrow e^+ + \gamma$ d) $\mathrm{n} \rightarrow p + e^-$

6) 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

7) 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

8) 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

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

1) Neutrinos have zero rest mass. True/False
2) The nuclear force is short-ranged. True/False
3) Nuclear reactions always conserve the number of protons and neutrons. True/False
4) Strong nuclear force is charge-independent. True/False

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

a) Explain nuclear stability.
b) State the properties of nuclear force.
c) Define the concept of isospin.
d) What are direct nuclear reactions? Provide one example.
e) Describe the quark composition of a neutron.
f) Define the term "strangeness" and give an example of a strange particle.
g) State the Differentiate between leptons and hadrons.
h) Differentiate between elastic and inelastic scattering with examples.

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

a) State and Explain:
   i) Nuclear mass
   ii) Nuclear energy
b) Write a short note on:
   i) Strongest forces
   ii) Short range forces
c) Describe the optical model of nuclear reactions. How is it used to predict scattering and absorption cross-sections?
d) Discuss the liquid-drop model of the nucleus and its application in explaining nuclear fission.

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

a) Explain the quark model and its role in classifying hadrons.
b) State the nuclear size and nuclear Density.
c) Explain the concept of Binding energy.

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

a) Write a note on Nuclear Fission.
b) Explain conservative laws in nuclear reaction.
c) Discuss various types of nuclear reactions.

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Seat No.	

Set | **P**

M.Sc. Physics (Material Science) (Semester - IV) (New)
(NEP CBCS) Examination: March/April – 2026
Communication System (2321405)

Day & Date: Tuesday,21-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

1) The class of amplifier that gives maximum efficiency is: ____
   a) Class A b) Class B
   c) Class C d) Class AB

2) In FM, the frequency of carrier varies with: ___.
   a) Modulating frequency b) Amplitude
   c) Phase d) Modulating signal amplitude

3) The advantage of Delta modulation over PCM is ____.
   a) Simplicity b) Higher bandwidth
   c) Less quantization noise d) Complex hardware

4) TDMA stands for ____.
   a) Time Division Multiple Access
   b) Time Domain Modulation Access
   c) Total Data Modulation Access
   d) Time Delay Multiple Access

5) In AM, the bandwidth is ____.
   a) Equal to carrier frequency
   b) Twice the modulating frequency
   c) Sum of carrier and modulating frequency
   d) Half the modulating frequency

6) VCO is mainly used in: ____.
   a) Amplitude modulation b) Frequency modulation
   c) Pulse modulation d) Delta modulation

7) Which is a digital modulation technique?
   a) AM b) FSK
   c) FM d) PM

8) A balanced modulator suppresses: ____.
   a) Carrier b) Sidebands
   c) Both d) None

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

1) The AM detector circuit is used to _____ the modulated signal.
2) FDM stands for _____.
3) T/F: PAM is a digital modulation technique.
4) T/F: PLL can be used for FM detection.

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

a) Define modulation and demodulation.
b) What is the function of balanced modulator?
c) Draw a block diagram of an FM transmitter.
d) What is the principle of sampling theorem?
e) State the applications of TDM.
f) Draw block diagram of AM Receiver.
g) Compare simplex and duplex communication.
h) Define NRZ and RZ formats.

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

a) Explain the working of a class B audio amplifier.
b) Compare PAM, PWM, and PPM.
c) Explain FM radio frequency band and its allocation.
d) Explain the generation and demodulation of PWM.

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

a) Draw and explain the block diagram of a low-level AM transmitter.
b) With neat labeled block diagram explain FM receiver.
c) Explain TDM with a neat diagram.

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

a) State and prove sampling theorem.
b) Differentiate between ASK, FSK, and PSK.
c) Explain the working of a transponder in satellite communication.

SLR-PN-19

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - IV) (New) (NEP CBCS)
Examination: March/April - 2026
Advanced Techniques of Materials Characterization (2321406)

Day & Date: Tuesday, 21-04-2026 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

1) Which electron type provides surface topography in SEM?
   a) Primary b) Backscattered
   c) Secondary d) Transmitted

2) The universal yield curve shows the SEE yield is maximum at ___.
   a) 1 keV b) 10 eV
   c) 100 eV d) 10 keV

3) The basic principle of FTIR spectroscopy is based on: ____.
   a) Absorption of UV light
   b) Absorption of Infrared radiation
   c) Emission of X-rays
   d) Scattering of light

4) Force vs distance curve in AFM shows: _____.
   a) Resolution limits b) Scanning speed
   c) Tip-sample interaction d) Lens strength

5) Which lens defect causes colored fringes around objects?
   a) Spherical aberration b) Astigmatism
   c) Chromatic aberration d) Coma

6) Which property of light limits the resolution of a light microscope?
   a) Intensity b) Phase
   c) Wavelength d) Frequency

7) What is the primary mode of image formation in TEM?
   a) Scattered light b) Transmission of electrons
   c) Emitted photons d) Reflected light

8) Which of the following is not an energy analyzer type used in XPS?
   a) Hemispherical analyzer b) Cylindrical mirror analyzer
   c) Quadrupole mass analyzer d) Magnetic analyzer

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

1) Phase contrast microscopy is useful for observing live, unstained cells.
2) SEM provides higher resolution than TEM.
3) Raman spectroscopy is a non-destructive technique.
4) XPS provides both qualitative and quantitative elemental analysis.

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

a) Define Numerical Aperture and its significance in optical microscopy.
b) What is the limit of resolution for a light microscope?
c) What is the role of magnetic lenses in an electron microscope?
d) Define Bragg's condition.
e) Write two applications of TEM.
f) Mention the applications of Fluorescence Microscopy.
g) What is the difference between Stokes and -Anti-Stokes lines?
h) Write any two applications of FTIR spectroscopy.

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

a) Compare advantages of electron microscopy over light microscopy.
b) Describe the principle of electron tunneling in STM?
c) What is the difference between Bright Field and Dark Field imaging in TEM?
d) Explain the principle of photoelectron emission used in XPS.

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

a) Explain the classical and quantum theory of the Raman Effect.
b) Describe the complete instrumentation of XPS, including X-ray source, vacuum system, and energy analyser.
c) Describe different types of lens defects and methods to minimize them.

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

a) Describe the operating modes of AFM (contact and non-contact).
b) Describe the implementation of Scanning Tunneling Microscopy in instruments.
c) Discuss the interpretation of FTIR spectra for the identification of functional groups.

Seat No.	

Set **P**

M.Sc. Physics (Material Science) (Semester - IV) (New) (NEP CBCS)
Examination: March/April – 2026
Nanomaterials Characterization Techniques (2321407)

Day & Date: Tuesday, 21-04-2026 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) X-rays can be deflected by _____.
   a) Electric field b) None of the field
   c) Magnetic field d) Electromagnetic field

2) Non-contact mode in AFM is typically used to ____.
   a) Avoid damaging soft samples
   b) Enhance contact force
   c) Increase scanning speed
   d) Reduce electron beam deflection

3) In XPS, ultra-high vacuum (UHV) is necessary to: ____.
   a) Increase the energy of X-rays
   b) Enhance spectral resolution
   c) Minimize sample contamination and improve accuracy
   d) Increase electron emission

4) The backscattered electrons in TEM are used primarily for _____.
   a) Surface topography analysis
   b) High-resolution imaging
   c) Chemical composition analysis
   d) Increasing electron diffraction efficiency

5) Lithography was invented by _____ in 1798.
   a) Manuel Neuer b) John Denver
   c) Billy Armstrong d) Alois Senefelder

6) AFM stands for _____.
   a) Auto focusing microscope b) Antenna focusing microscope
   c) Atomic force microscope d) None of the mentioned

7) Select the wavelength range corresponding to UV-visible region __.
   a) 2.5 μm - 1mm b) 200-800 nm
   c) 25 μm -2.5 μm d) 400-800 nm

8) FTIR is based on the absorption of ____.
   a) Visible light
   b) Ultraviolet rays
   c) Microwaves
   d) Infrared radiation

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

1) AFM can image both conductive and non-conductive samples. (T/F)
2) High-resolution imaging of nanomaterials is only possible using optical microscopes. (T/F)
3) Raman spectroscopy cannot provide information about molecular vibrations. (T/F)
4) XRD can determine the chemical composition of a sample. (T/F)

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

a) Define EDAX.
b) Mention two advantages of TEM.
c) Explain elastic and inelastic scattering.
d) What is the function of STM?
e) What is the principle of AFM?
f) What is XRD?
g) State any two limitations of SEM.
h) Define Surface Tension and its relevance in nanomaterials.

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

a) Write a short note on the applications of AFM.
b) Explain Angle Resolved XPS.
c) What is Electron Energy Analyzer.
d) Describe the working principle of STM (Scanning Tunneling Microscope).

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

a) Explain SEM in detail with neat diagram.
b) Explain the working of UV-VIS spectroscopy and its application in nanomaterials.
c) Write a note on Optical Absorption & Non Linear Kerr Effect.

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

a) Discuss the differences, advantages, and limitations of SEM and TEM.
b) Describes the instrumentation and working of FTIR spectrometer.
c) Discuss quantitative analysis and applications of XPS.