Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - I) (New) (NEP CBCS)
Examination: March/April – 2026
Mathematical Physics (2307101)

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 $B \times B^{-} = I$

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Set P

M.Sc. Physics (Solid State) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2026
Solid State Physics (2307102)

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) Which of the following statement is wrong in case of a free electron?
   a) A free electron is not attached to atom or molecule
   b) A free electron contributes for conduction
   c) A free electron responds to external fields.
   d) A free electron is always bound.

2) The Bohr magneton, $\mu_B =$ _____.
   a) $\frac{e\hbar}{2m_e}$ b) $\frac{e\hbar}{2\pi m_e}$
   c) $\frac{eh}{2m_e}$ d) $\frac{e\hbar}{4\pi m_e}$

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

4) The smallest repeating unit of the lattice is called _____.
   a) unit cell b) primitive
   c) nonprimitive d) centrosymmetric

5) Well above the Curie temperature, ferromagnetic materials behave like _____ material.
   a) a diamagnetic b) a paramagnetic
   c) a ferrimagnetic d) an antiferromagnetic

6) Magnetic materials which can be readily magnetized in either direction are called _____.
   a) soft magnetic materials
   b) hard magnetic materials
   c) low hysteresis loss materials
   d) high hysteresis loss materials

7) The temperature below which certain materials are antiferromagnetic and above which they are paramagnetic is called _____ temperature.
   a) Curie b) Neel
   c) transition d) Weiss

8) Which of the following statements is wrong in case of superconductivity?
   a) A sufficiently strong magnetic field will destroy superconductivity
   b) Type I superconductor is also called as soft superconductor
   c) The electrons are ordered at temperature above critical temperature
   d) The superconducting state is an ordered state

B) Fill in the blanks. **04**

1) For Dirac delta function $\int_{-\infty}^{\infty} \delta(x)dx =$ _____.
2) Orientational polarizability (α_o) is inversely proportional to the temperature and is given by $\alpha_o =$ _____.
3) The interaction between neighboring atoms which tends align their spin is main cause for _____ magnetization in ferromagnetic substances.
4) In a superconductor the Cooper pair is a pair of two _____.

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

a) Draw energy -wavevector $(\epsilon - k)$ graph for nearly free electron.
b) Describe DC and AC electrical conductivity of metals.
c) What are ferromagnetic materials?
d) What are centrosymmetric crystals?
e) What is an inner loop in hysteresis?
f) What is saturation magnetization?
g) What are properties of superconductor?
h) Explain Isotope effect in superconductivity.

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

a) Calculate probability of occupancy for the energy level which lies 0.01 eV above the Fermi level at 27 °C. Given: Boltzmann constant, $k = 8.625 \times 10^{-5} eV/k$.
b) Discuss classification of magnetic materials.
c) What is meant by anisotropy energy in ferromagnetic materials?
d) Explain Type I and Type II superconductors.

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

a) State and prove Bloch theorem.
b) Discuss spontaneous magnetization in ferromagnetic materials.
c) What is Meissner effect in superconductors?

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

a) Explain in detail motion of electron through the solid using Kronig - Penney model.

b) Explain Langevin's theory of paramagnetism.

c) Obtain London equation in superconductivity.

SLR-PU-3

Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - I) (New) (NEP CBCS)
Examination: March/April – 2026
Analog and Digital Electronics (2307106)

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.

Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - I) (New) (NEP CBCS)
Examination: March/April – 2026
Elements of Materials Science (2307107)

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 (Solid State) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2026
Research Methodology in Physics (2307105)

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 (Solid State) (Semester - II) (New) (NEP CBCS)
Examination: March/April – 2026
Quantum Mechanics (2307201)

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) If Ψ_a and Ψ_b are orthogonal to each other, then scalar product is _____.
   a) one b) zero
   c) infinite d) Ψ_a

2) The product of a scalar with a vector gives _____.
   a) another vector b) scalar
   c) pseudo scalar d) null vector

3) The uncertainty relation cannot hold for the following pairs _____.
   a) position and momentum
   b) energy and time
   c) linear momentum and angle
   d) angular momentum and angle

4) Which of the following is an even function?
   i) $|x| - 1$ ii) $-x^2 + 2$
   iii) $\cos x$ iv) $\frac{1}{x^2}$
   a) i) & ii) b) ii) & iii)
   c) iii) & iv) d) All of these

5) Energy of a particle which is moving in one-dimensional rigid box is proportional to _____.
   a) square of length of box
   b) reciprocal of square of length of box
   c) length of box
   d) reciprocal of length of box

6) The total energy operator or Hamiltonian operator is given by $\hat{H} =$ _____.
   a) $\frac{\hat{p}^2}{2m}$ b) $V(x)$
   c) $\frac{\hat{p}^2}{2m} + V(x)$ d) $\frac{\hat{p}^2}{2m} - V(x)$

7) The spin matrix $\chi = \begin{pmatrix} a \\ b \end{pmatrix} =$ _____.

a) $a\chi_+ + b\chi_-$ b) $a\chi_+ + b\chi_+$

c) $a\chi_- - b\chi_-$ d) $a\chi_- + b\chi_-$

8) Spin has _____ eigen states.

a) $\frac{1}{2}$ b) 1

c) 4 d) 2

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

1) For each vector ψ, there must exist a zero vector such that: $\psi + 0 = 0 + \psi = 0$ (True/False)
2) If two observables represented by the operators A and B can be measured simultaneously, then, $[A, B] = 0$ (True/False)
3) The separation between two successive energy levels in linear harmonic oscillator is _____.
4) For any matrix 'A', in matrix algebra, $A^\dagger A = 1$. (True/False)

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

a) What is an operator?
b) Differentiate span and basis.
c) Calculate the eigenvalue of the operator $\frac{d^2}{dx^2}$ for the eigenfunction, $y = e^{2x}$.
d) What is meant by expectation value?
e) Ground state energy of a particle confined in one dimensional potential box is 9 eV.
Calculate the energy of the particle in the second excited state.
f) Write boundary conditions for square well potential.
g) Compute $\psi^\dagger . \psi$; if $\psi^\dagger = [c_\alpha^* \quad c_\beta^*]$ and $\psi = \begin{bmatrix} c_\alpha \\ c_\beta \end{bmatrix}$
h) What is Spinor or spin matrix?

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

a) Discuss operator algebra.
b) Derive the continuity equation.
c) A wave function $\psi(x)$ is given by $\psi(x) = A \sin\left(\frac{n\pi}{L}x\right)$. Find the value of A using the normalization condition. where $0 < x < L$
d) Explain Variational Methods of Approximation.

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

a) What is Dirac's bra-ket notations?
b) Discuss operators in quantum mechanics.
c) Discuss the harmonic oscillator by the operator method.

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

a) State and explain ‘Heisenberg’s uncertainty principle.’

b) Obtain Schrodinger’s wave equation for a square well potential and obtain its solution.

c) Describe the Pauli spin matrices.

Seat No.	

Set **P**

M.Sc. Physics (Solid State) (Sem - II) (New) (NEP CBCS)
Examination: March/April – 2026
Electrodynamics (2307202)

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 Biot-Savart law gives the magnetic field due to _____.
   a) Point charge b) Dipole moment
   c) Current element d) Magnetic flux

2) In an electromagnetic wave, the direction of magnetic field induction $B^{\rightarrow}$ is _____.
   a) parallel to electric field $E^{\rightarrow}$
   b) perpendicular to electric field $E^{\rightarrow}$
   c) random
   d) none of the above

3) Lienard-Wiechert potentials are associated with: ____.
   a) Static charges b) Moving charges
   c) Magnetic monopoles d) Neutral particles

4) The Poynting's vector *S* of an electromagnetic wave is _____.
   a) $S =^{\rightarrow} E^{\rightarrow\rightarrow} \times H^{\rightarrow}$ b) $S^{\rightarrow\rightarrow} =^{\rightarrow} E^{\rightarrow\rightarrow} \times B^{\rightarrow}$
   c) $S = E^{\rightarrow}/B^{\rightarrow}$ d) $S = E^{\rightarrow}/H^{\rightarrow}$

5) In a stationary medium, EM wave propagation depends on: __.
   a) Mass
   b) Charge
   c) Permittivity and permeability
   d) Conductivity

6) The total power radiated by an oscillating dipole is _____to _____ power of frequency.
   a) Proportional, fourth
   b) Inversely proportional, fourth
   c) Inversely proportional, third
   d) Proportional, third

7) _____ of the following laws do not form a Maxwell equation.
   a) Planck's law b) Gauss's Law
   c) Faraday's law d) Ampere's Law

8) Poynting's vector S gives _____.
   a) Energy transported per unit area per second
   b) Energy stored per unit volume
   c) Flux of field
   d) Electromagnetic Momentum contained per unit volume

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

1) The electrostatic potential energy of a system depends on the configuration of charges. (True/False)
2) Reflection coefficient can be greater than one. (True/False)
3) In equipotential surface, potential is different everywhere. (True/False)
4) Divergence theorem is based on Gauss law. (True/False)

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

a) State and write expression for Biot-Savart law.
b) What is the meaning of divergence of electric field?
c) What are the scalar and vector potentials?
d) State and write expression for Faraday's law.
e) Define skin depth.
f) Define magnetic dipole.
g) Define electromagnetic wave.
h) What is D'Alembertian operator?

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

a) Explain Maxwell's equations in differential form in free space.
b) Write a note on energy stored in electric and magnetic fields.
c) Write a note on Lorentz's and Coulomb's gauges.
d) Explain radiation from a half wave antenna.

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

a) Derive an expression for differential form of Gauss's law.
b) Derive an expression for Lienard-Wiechert potentials of a point charge.
c) Derive the expressions for reflection and refraction of electromagnetic waves at plane boundaries for normal incidence.

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

a) State and prove Poynting's theorem.
b) Derive an expression for differential form of Ampere's law.
c) Discuss the interaction energy between two current loops and derive an expression for the force between them.

Seat No.	

Set **P**

M.Sc. Physics (Solid State) (Semester - II) (New) (NEP CBCS)
Examination: March/April – 2026
Classical Mechanics (2307206)

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) According to Hamilton's principle, the action integral for monogenic, conservative system should produce _____ value.
   a) one b) Zero
   c) minus one d) Extremum

2) The configuration space involves _____.
   a) 2N dimensions b) 3N dimensions
   c) 6N dimensions d) 4N dimensions

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

4) The gyroscopic forces are _____ in nature.
   a) conservative b) non-conservative
   c) pseudo d) not exist

5) In central force laws, if the potential energy, V = -k/r, then ____.
   a) $f= -k/r^2$ b) $f= k/r^2$
   c) f= k/r d) f= -k/r

6) The Poisson's bracket, [q, q] = _____.
   a) p b) Q
   c) 0 d) Q

7) The square of the period of revolution of a planet around the sun is proportional to _____.
   a) cube root of the semi major axis of the ellipse
   b) cube root of the semi minor axis of the ellipse
   c) cube of the semi minor axis of the ellipse
   d) cube of the semi major axis of the ellipse

8) If the transformation is canonical, the Poisson's bracket has _____ when evaluated with respect to any canonical set of variables.
   a) same value b) different value
   c) zero value d) no value

B) Write true/false **04**

1) An angular momentum is conserved in the absence of external force. (True/False)
2) The constraints expressed as equations of coordinates are called holonomic constraints. (True/False)
3) The fundamental Poisson's brackets are varying under canonical transformation. (True/ False)
4) In δ variation, both position and time coordinate at the end points, are held fixed. (True/False)

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

a) Prove linear momentum is conserved for a system of particles.
b) Write two advantages of Lagrangian formulation over Newtonian formulation.
c) Define scleronomic and rheonomic constraints.
d) What are the generalized coordinates?
e) State Hamilton's principle and write its expression.
f) Define Poisson's bracket and write its expression.
g) What are the gyroscopic forces?
h) How many forms of generating function? Write it.

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

a) State and prove work-energy theorem.
b) Explain the characteristics of the conservative central force.
c) Explain any four properties of Poisson's brackets.
d) Deduce Lagrange's equation of motion from Hamilton's principle.

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

a) Explain the Guage invariance in Lagrangian formulation.
b) State and derive the expression for the Kepler's first law.
c) Deduce Euler-Lagrange's differential equation using variational technique.

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

a) Derive Hamilton's canonical equations of motion in terms of Poisson's brackets.
b) Explain the principle of least action and prove it.
c) Derive an expression for reduction of two body problem in to equivalent one body problem with its special case of $m_1 >> m_2$.

Seat No.	

Set **P**

M.Sc. Physics (Solid State) (Semester - III) (New) (NEP CBCS)
Examination: March/April – 2026
Statistical Physics (2307301)

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-PU-11

Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - III) (New) (NEP CBCS)
Examination: March/April - 2026
Atomic and Molecular Physics (2307302)

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 (Solid State) (Semester - III) (New)
(NEP CBCS) Examination: March/April - 2026
Semiconductor Physics (2307309)

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.

Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - IV) (New) (NEP CBCS)
Examination: March/April - 2026
Physics of Semiconductor Devices (2307401)

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 the correct alternative. (MCQ) **08**

1) Germanium has a band gap of _____ eV.
   a) 1.12 b) 0.66
   c) 5.6 d) 10

2) The two classes of semiconductor energy bands are _____.
   a) direct and indirect b) direct and individual
   c) indirect and individual d) direct and imaginary

3) How much should be minimum energy of the photon in joule that can be absorbed by semiconductor having band gap of 1.6 eV?
   a) 2 joule b) 1.6×10^{-19} joule
   c) 3.2×10^{-19} joule d) 2.56×10^{-19} joule

4) For optical absorption, the energy of the impinging photon _____.
   a) $hv < E_g$ b) $hv = \frac{E_g}{2}$
   c) $hv \geq E_g$ d) $hv = \frac{E_g}{5}$

5) Normally, the junction area of a Schottky diode is small therefore, the junction capacitance is _____.
   a) large b) ideally infinite
   c) very large d) small

6) In thermionic emission _____.
   a) A very strong electric field is applied to the metal
   b) A metal is heated to a sufficiently high temperature
   c) Light of a certain frequency is made to fall on the metal surface
   d) electrons are emitted from a metal surface due to bombardment by high-speed electrons

7) After the SCR is fired, it will remain ON until its current drops below _____ current.
   a) holding b) transient
   c) latch d) maximum

8) A thyristor can be used as _____.
   a) A resistor
   b) An amplifier
   c) A switch
   d) A power source

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

1) For pure germanium or silicon, the Fermi level lies at the middle of the band gap, even at elevated temperatures. (True/False)
2) In a semiconductor, lattice scattering varies directly with the temperature, while impurity scattering varies inversely with the temperature. (True/False)
3) Holes flow from the high to low Fermi level regions.
4) A triac is generally considered most sensitive in _____ quadrant.

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

a) The probability of non-occupancy of an energy level is 0.4. Calculate the sum of the probability of occupancy and non-occupancy of the same energy level.
b) What are Direct band gap materials?
c) Mention different types of luminescence.
d) What is an electron capture?
e) What is Schottky barrier?
f) What is the work function of a metal?
g) A Silicon solar cell has an open-circuit voltage; $V_{oc} = 0.8\,V$, a short-circuit current; $I_{sc} = 100 \times 10^{-3}\,A$, maximum voltage; $V_m = 0.5\,V$ and maximum current; $I_m = 80 \times 10^{-3} A$. Calculate the ideal power of the solar cell.
h) What are power devices?

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

a) Discuss the variation of energy bands with alloy composition.
b) Write a note on the Fermi level.
c) Explain the direct recombination of electrons and holes.
d) Discuss steady-state carrier generation in semiconductors and quasi-Fermi levels.

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

a) Discuss carrier concentration at equilibrium.
b) Discuss thermionic emission.
c) Explain the Construction of SCR and explain its I-V characteristics.

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

a) Discuss the Diffusion and Drift of carriers and built-in fields that occur in the semiconductor.
b) Discuss the Ideal MIS diode.
c) Explain the principle and working of a Photodiode.

Seat No.	

Set **P**

M.Sc. Physics (Solid state) (Sem - IV) (New) (NEP CBCS)
Examination: March/April - 2026
Nuclear and Particle Physics (2307402)

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 correct alternative. (MCQ) 08

1) The decay constant (λ) of a radioactive sample depends on _____.
   a) the number of atoms in the sample
   b) mass number of the nucleus
   c) the half-life of the sample
   d) atomic number

2) The asymmetry term in semi empirical mass formula is due to _.
   a) Non equality of proton number Z and neutron number N
   b) Non spherical shape of nuclei
   c) Charge independence of nuclear force
   d) Non zero value of quadrupole moment of nuclei

3) The _____ have explained the magic numbers.
   a) Liquid drop model b) Fermi gas model
   c) Shell model d) All of these

4) Two-neutron separation energy is designated as ____.
   a) S_2 b) S_{2n}
   c) $_{2n}S$ d) S^{2n}

5) The particles having _____ spin quantum number are called fermions.
   a) 0 b) $\frac{1}{2}$
   c) 1 d) 2

6) When hydrogen atom loses an electron, it becomes _____.
   a) proton b) position
   c) electron d) neutron

7) The nuclear process in which one or more particles may be liberated when the target nucleus absorbs $\gamma - ray$ is called _____.
   a) photodisintegration b) photoelectric effect
   c) Compton absorption d) γ -decay

8) Cyclotrons are specially used to accelerate _____.
   a) negative ion b) positive ion
   c) neutron d) electron

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

1) The electric quadrupole moment is negative; shape of the nuclei is oblate. (True/False)
2) The Rutherford scattering experiment may not be called a nuclear reaction. (True/False)
3) Parity can provide information about the nuclear structure. (True/False)
4) Cosmic rays are low-energy particles that originate in our solar system. (True/False)

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

a) Write a note on shape and size of nucleus.
b) What is an individual particle model?
c) Why the neutron well is deeper than the proton well in nuclear potential?
d) What is the meaning of Fermi gas in Fermi gas nuclear model?
e) What is Q-value of nuclear reaction?
f) Write an example of photo disintegration reaction.
g) What is convenient unit of nuclear cross section? Convert it into SI system.
h) What is the name of exchanging particle in the electromagnetic interaction?

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

a) Explain binding energy and nuclear stability.
b) Explain Bethe-Weizsacker mass formula.
c) Explain in detail nuclear fission.
d) Write a note on synchrotron.

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

a) What is radioactivity? Explain law of radioactivity.
b) How shell model explained the existence of all magic numbers with the help of different nuclear potentials?
c) Give detailed account on origin of cosmic rays and its energy distribution.

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

a) Write detailed note on nuclear scattering cross section.
b) Give detailed account on nuclear forces and its properties.
c) Explain idea of quantum chromodynamics and different types of quarks charge.

Seat No.	

Set | P

M.Sc. Physics (Solid State) (Semester - IV) (New)
(NEP CBCS) Examination: March/April – 2026
Communication System (2307405)

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-PU-19

Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - IV) (New) (NEP CBCS)
Examination: March/April - 2026
Advanced Techniques of Materials Characterization (2307406)

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 (Solid State) (Semester - IV) (New) (NEP CBCS)
Examination: March/April – 2026
Nanomaterials Characterization Techniques (2307407)

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.