Seat No.	

Set P

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

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

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

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

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

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

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

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

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

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

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

a) Anticommutativity b) Distributivity

c) Additivity d) Associativity

8) The rank of the zero matrix?

a) 0 b) 1

c) -1 d) The rank is undefined

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ii) Calculate the residues at each of the singular points

b) Describe Argand Diagram.

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

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

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

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

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

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

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

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

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

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

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

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Set P

M.Sc. Physics (Solid State) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2025
Solid State Physics (2307102)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SLR-ZU-3

Seat No.	

Set P

M.Sc. Physics (Solid-State physics) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2025
Analog and Digital Electronics (2307106)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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Set **P**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Seat No.	

Set P

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

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

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

Q.1 A) Choose Correct Alternative. **08**

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

2) Momentum of particle by de-Broglie relation is _____ to its wavelength.
a) inversely proportional b) directly proportional
c) in phase d) out of phase

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

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

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

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

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

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

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

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

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

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

Q.3 Answer the following. (AnyThree). **12**

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

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

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

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

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

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Set **P**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SLR-ZU-8

Seat No.	

Set P

M.Sc. Physics (Soild-State physics) (Semester - II) (New) (NEP CBCS)
Examination: March/April - 2025
Classical Mechanics (2307206)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

a) Explain
1) Gauge invariance of Lagrangian equation
2) Gyroscopic forces
b) Explain and prove the principle of least action.
c) Derive an equivalent equation for reduction to one body problem from two body problem.

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

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

Seat No.	

Set P

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

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

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

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

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

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

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

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

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

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

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

8) Electron is an example of which statistics?

a) Bose Einstein statistics b) Maxwell Boltzmann statistics

c) Fermi Dirac statistics d) None

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

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

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

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

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

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

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

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

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

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

Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - III) (New) (NEP CBCS)
Examination: March/April - 2025
Atomic & Molecular Physics (2307302)

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

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

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

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

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

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

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

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

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

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

8) Symmetric top molecules have _____.

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

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

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

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

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

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

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

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

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

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

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

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

SLR-ZU-15

Seat No.	

Set P

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

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

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

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

1) In molecular beam epitaxy (MBE), the growth rate is typically:
   a) Very fast
   b) Controlled at the atomic level
   c) Highly unpredictable
   d) Only dependent on the substrate

2) Doping in semiconductor materials is used to _____.
   a) Remove impurities
   b) Alter mechanical properties
   c) Control electrical conductivity
   d) Change the optical properties

3) The _____ diode is specifically designed to act as a voltage-dependent capacitor.
   a) Zener diode b) Varactor diode
   c) Schottky diode d) Tunnel diode

4) The primary application of a breakdown diode is in _____.
   a) Amplification circuits b) Voltage regulation
   c) Signal modulation d) Current limiting

5) Ohmic losses in a p-n junction semiconductors are primarily caused by:
   a) Depletion region capacitance
   b) Tunneling of carriers
   c) Series resistance of the material
   d) Variation in contact potential

6) _____ type of junction is commonly used in light-emitting diodes.
   a) Heterojunction b) Schottky junction
   c) Ohmic contact d) Abrupt p-n junction

7) Space charge at a junction results from _____.
   a) Neutralization of dopants
   b) Accumulation of free carriers
   c) Ionized acceptor and donor in depletion region
   d) Forward-bias voltage

8) The periodic table is arranged based on _____.
   a) Increasing atomic radius b) Increasing atomic mass
   c) Increasing atomic number d) Decreasing electronegativity

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

1) The II-VI and III-V compounds are used as semiconductors.
2) In a forward-biased p-n junction, the depletion region becomes wider.
3) Schrodinger wave equation is a fundamental equation in quantum mechanics.
4) Schottky diodes are known for their low forward voltage drop and fast switching speed.

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

a) Explain three types of solids, classified according to its atomic arrangement?
b) Define the Heisenberg Uncertainty Principle?
c) Draw cubic lattice structures for (111) and (100) planes.
d) Explain the working principle of a rectifier?
e) What are basic types of p-n junction capacitors.
f) How the switching speed of switching diode is improved?
g) Define reverse recovery transient in a diode?
h) Draw schematic diagram of rapid thermal processor.

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

a) Describe the molecular beam epitaxy (MBE) in detail.
b) Write a note on diamond lattice structure.
c) Explain the periodic table with the help of quantum numbers.
d) Describe the varactor diode with its applications.

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

a) Describe the Vapor- Phase Epitaxy in detail.
b) Explain the photolithography in semiconductor device fabrication.
c) Explain the graded junction with its forward and reverse characteristics.

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

a) Discuss the depletion capacitance of p-n junction
b) Derive an expression for the total energy of the electron in the n^{th} orbit in atomic spectra using Bohr's model.
c) Derive an expression for Schrodinger's time independent equation in three dimensions.

Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - III) (Old) (CBCS) Examination: March/April - 2025
Semiconductor Physics (MSC10301)

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

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

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

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

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

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

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

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

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

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

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

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

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

a) Growth b) Nucleation

c) atomic bonding d) Clusters

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

a) Lower Potential Energy b) Local Potential Energy

c) Liquid Phase Epitaxy d) Laser phase Epitaxy

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

a) Volume Phase Epitaxy b) Vapor Phase Epitaxy

c) Variable Potential Energy d) Vapor Pressure Energy

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

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

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

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

b) Discuss electrical conductivity and mobility in a semiconductor.

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

d) How trapping of charges carries occurs in semiconductors?

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

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

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

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

a) Discuss bonding forces in semiconductors.

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

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

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

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

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

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

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

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

a) Write a note on Fermi level pining.

b) Explain Czochralski and liquid encapsulation techniques.

Seat No.	

Set **P**

M.Sc. Physics (Solid State) (Semester - III) (Old) (CBCS) Examination: March/April - 2025
Atomic and Molecular Physics (MSC10302)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - III) (Old) (CBCS) Examination: March/April - 2025
Experimental Techniques for Physics (MSC10307)

Day & Date: Monday, 19-May-2025 Max. Marks: 80
Time: 11:00 AM To 02:00 PM

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

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

1) The _____ is a type of electrical transformer used for measuring linear displacement.
   a) Inductive transducer
   b) linear variable differential transformer
   c) Capacitive transducer
   d) Resistive transducers

2) Resistance of an electrical conductor is _____.
   a) $C = \varepsilon 0\ \varepsilon r\ A/d$ b) $R = \rho I/A$
   c) $R = I/\ A\rho$ d) $R = \rho A/I$

3) LED is a PN junction diode under _____ biased.
   a) forward
   b) reversed
   c) both forward as well as reverse
   d) not any

4) Laser action is found in _____ semiconductors.
   a) direct band gap b) indirect band gap
   c) germanium d) silicon

5) The intensity of Bragg peak observed in XRD pattern is depends on _____.
   a) Charge on X-ray
   b) Net Charge of the material
   c) Atomic scattering factor and atomic density of a given plane
   d) Structure factor

6) For a given gas at sufficiently low pressures, the thermal conductivity _____ with pressure.
   a) decreases
   b) increases
   c) remains constant
   d) first decreases then increases

7) The Thermogravimetric analysis measures the change in _____ with temperature.
   a) entropy b) enthalpy
   c) thermal conductivity d) mass

8) In electromagnetic spectrum, the infrared region is located between the _____.
   a) Visible and ultraviolet regions
   b) Visible and microwave region
   c) Visible and x-ray regions
   d) Visible and γ-ray regions

9) The CMRR of an in-amp will be around _____.
   a) 50dB b) 100dB
   c) 120dB d) 200dB

10) Four probe method is used to measure _____ of semiconductor.
   a) thermal conductivity b) specific heat
   c) thermal diffusivity d) electrical resistivity

B) Write true/false. **06**

1) In SEM, convex lens is used for focussing electrons.
2) The X-ray diffraction is based upon Bragg's equation.
3) Raman lines are weak.
4) when a molecule absorbs infrared radiation then molecule vibrate slower.
5) The differential scanning calorimetry technique is used to measure specific heat with temperature.
6) The He-Ne laser is considered as gas laser.

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

a) Explain the working of getter ion pump.
b) State various signals generated in SEM when electrons interact with sample.
c) What is sensor. Discuss different types of sensors.
d) Explain the working of LCR meter.

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

a) Explain in details construction and working of transmission electron microscopy.
b) What is shielding. Discuss types of shielding

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

a) Explain the working of Pirani guage.
b) Explain the working of linear variable differential transformer LVDT.

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

a) Discuss various method used for obtaining low temperature.

b) Explain the working of oil diffusion pump.

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

a) Explain the working of X-ray diffraction method for the analysis of crystal structure.

b) Explain the working of atomic force microscopy with suitable diagram.

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

a) What is Ruby Laser? Explain the working of Ruby Laser with suitable diagram.

b) Explain the working principle of differential scanning calorimetry (DSC).

Seat No.	

Set P

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

Day & Date: Wednesday, 14-May-2025 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

1) For an electron, the sum of the probability of occupancy and non-occupancy of an energy level is _____.
a) 1 b) 0.5
c) less than 1 d) greater than 1

2) When a piece of pure silicon is doped with indium, then _____.
a) The doped silicon piece will become n-type semiconductor
b) The doped silicon piece will become p-type semiconductor
c) The conductivity of the doped silicon piece will remain the same
d) The resistivity of the doped silicon piece will increase

3) How much should be minimum energy of the photon in joule that can be absorbed by semiconductor having band gap of 1 eV?
a) 2 joule b) 1.6×10^{-19} joule
c) 3.2×10^{-19} joule d) 0.8×10^{-19} joule

4) In the case of direct recombination, the excess carriers' decay _____.
a) at exactly the same rate as the minority carriers.
b) at a less rate as the minority carriers.
c) at a greater rate than the minority carriers.
d) at a double rate as the minority carriers.

5) A Schottky diode is a _____ diode with a low forward voltage drop and a very fast switching speed.
a) p-n junction b) n-p junction
c) metal-semiconductor d) M-I-S

6) A metal is heated to a sufficient temperature, to enable the free electrons to come out of its surface. This type of emission is called _____.
a) High field emission b) Secondary emission
c) Photoelectric emission d) Thermionic emission

7) Which of the following semiconductor devices converts optical energy into electrical energy?
   a) solar cells
   b) photodiodes and solar cells
   c) light-emitting diodes (LEDs)
   d) Silicon Controlled Rectifier (SCR)

8) The minimum input current that can turn on a thyristor is called the _____.
   a) Holding current
   b) Breakover current
   c) Trigger current
   d) low-current drop-out

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

1) Even at elevated temperature, the Fermi level lies at the middle of the band gap for intrinsic materials. (True/False)
2) A semiconductor with a band gap of about 2 eV wide, allows only long wavelengths (infrared) and the red part of the visible spectrum to transmit through it. (True/False)
3) In a dynamic equilibrium, there is no continual diffusion of electrons from the n to the p side (and holes from p to n). (True/False)
4) The _____ is a bidirectional device.

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

a) The probability of occupancy of an energy level is 0.6. Calculate the probability of non-occupancy of the same energy level.
b) What are Indirect semiconductor materials?
c) How does the trapping of charge carriers occur in semiconductors?
d) Distinguish between drift and diffusion currents.
e) What is a depletion Layer?
f) What is Schottky barrier?
g) A Silicon solar cell has an open-circuit voltage; V_{oc} = 0.8 V, a short-circuit current; I_{sc} = 100 x 10^{-3} A, maximum voltage; V_m = 0.5 V and maximum current; I_m = 80 x 10^{-3} A. Calculate the fill factor of the solar cell.
h) Define the efficiency of a solar cell

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

a) Write a note on the effective mass of an electron/hole.
b) Discuss intrinsic and extrinsic materials.
c) Explain Optical absorption in semiconductors.
d) Discuss the Diffusion and Drift of carriers and built-in fields that occur in the semiconductor.

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

a) Effects of temperature and doping on mobility.
b) Discuss the Forward characteristics and reverse characteristics of the Schottky barrier.
c) Explain the principle, working, and characteristics of a light-emitting diode (LED).

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

a) Derive the continuity equation.

b) Write a note on Gunn diode.

c) Write a note on a Solar Cell.

Seat No.	

Set **P**

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

Day & Date: Friday, 16-May-2025 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

1) Nuclei having same number of neutrons are called _____.
a) isobars b) isotopes
c) isotones d) isomers

2) The series that contain magic numbers is _____.
a) 2, 8, 20, 28, 50 b) 2, 8, 18, 28, 50
c) 2, 8, 10, 28, 50, 82 d) 8, 18, 20, 28

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) $2nS$ d) S^{2n}

5) If Q value of nuclear reaction is positive the reaction is _____.
a) exoergic b) endothermic
c) endoergic d) direct reaction

6) The inverse process of the stripping reaction is _____ reaction.
a) compound b) clipping
c) fusion d) pickup

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

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

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

1) High binding energy means more stability of the nucleus. (True/False)
2) Gravitational interaction is of greater strength than electromagnetic interaction. (True/False)
3) The electric quadrupole moment is negative; shape of the nuclei is oblate. (True/False)
4) The Rutherford scattering experiment may not be called a nuclear reaction. (True/False)

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

a) Write a note on composition of nucleus.
b) Write the series of magic numbers.
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) Write fission reaction upon bombarding a neutron on uranium.
f) What is elastic and inelastic scattering?
g) What is convenient unit of nuclear cross section and convert it into SI system?
h) What is the name of hypothetical particle exchanged in the gravitational interaction?

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

a) Explain meson theory of nuclear force.
b) Give detailed account on liquid drop model.
c) Explain the nuclear fusion with the example of the Sun.
d) Write a note on linear accelerators.

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

a) Explain in detail alpha, beta and gamma decay.
b) How shell model explained the existence of all magic numbers with the help of different nuclear potentials?
c) Give detailed account on cosmic rays and explain how geomagnetic-latitude effect on distribution of cosmic rays.

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

a) Explain any six conservation law s of nuclear reactions.
b) Give detailed account on nuclear forces and its properties.
c) Explain idea of quantum chromo dynamics and different types of quarks charge.

Seat No.	

Set P

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

Day & Date: Tuesday, 20-May-2025 Max. Marks: 60
Time: 03:00 PM To 05:30 PM

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

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

1) Rayleigh's criterion is used to determine _____.
a) Magnification b) Resolution limit
c) Depth of field d) Contrast

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) Which technique is based on the photoelectric effect?
a) SEM b) XPS
c) STM d) AFM

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

5) What does Bragg's condition describe in electron diffraction?
a) Absorption of electrons
b) Refraction of electrons
c) Interference of electrons
d) Diffraction of electrons

6) What is the primary reason for using ultra-high vacuum (UHV) in surface analysis?
a) Enhance conductivity b) Improve thermal stability
c) Prevent surface contamination d) Increase resolution

7) The intensity of anti-Stokes lines is _____ than Stokes lines.
a) Higher b) Lower
c) Equal d) Zero

8) AFM is commonly used for imaging _____.

a) In vacuum only
b) In air and liquid environments
c) Using transmitted electrons
d) In biological samples only

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

1) Fluorescence microscopy uses ultraviolet light to excite the sample.
2) The principle of TEM involves the use of transmitted electrons to form an image.
3) Angle-resolved XPS is not useful for thin films.
4) Ultra-High Vacuum (UHV) is not necessary in surface characterization to minimize interactions with residual gases.

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

a) Define Numerical Aperture and its significance in optical microscopy.
b) What is the purpose of apertures in TEM?
c) What is the role of magnetic lenses in an electron microscope?
d) Define Bragg's condition.
e) Write two applications of STM.
f) What is the principle of Phase Contrast Microscopy?
g) Define the Raman Effect.
h) What is the basic principle of FTIR spectroscopy?

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

a) Describe the common defects found in optical lenses?
b) Compare advantages of electron microscopy over light microscopy.
c) Explain how electron focusing is achieved using magnetic fields.
d) Describe the principle of electron tunneling in STM.

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

a) Explain the instrumentation and working principle of FTIR spectroscopy with a diagram.
b) Describe the complete instrumentation of XPS, including X-ray source, vacuum system, and energy analyser.
c) Explain the construction and working of Confocal Microscopy.

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

a) Explain principle, instrumentation and working of atomic force microscope (AFM).
b) Describe the implementation of Scanning Tunneling Microscopy in instruments,
c) Describe the principle and operation of Scanning Electron Microscope (SEM).

Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - IV) (New/Old) (CBCS)
Examination: March/April - 2025
Semiconductor Devices (MSC10401)

Day & Date: Wednesday, 14-May-2025 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

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

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

1) A semiconductor has forbidden band gap of 1 eV. Its band gap in joule will be _____.
a) $1.12 \times 10^{-23} J$ b) $1.12 \times 10^{-19} J$
c) $1.6 \times 10^{-19} J$ d) $1.28 \times 10^{-11} J$

2) The main advantage of CMOS is its _____.
a) High power rating b) Small-signal operation
c) Switching capability d) Low power consumption

3) The voltage that turns on the EMOS device is _____.
a) Gate-source cutoff voltage b) Pinchoff voltage
c) Threshold voltage d) Knee voltage

4) A four-layer diode is sometimes called a _____.
a) Unijunction transistor b) Diac
c) pnpn diode d) Switch

5) Which of the following is not a bidirectional thyristor?
a) SUS b) DIAC
c) TRIAC d) SBS

6) The basic of CCD is the dynamic storage and withdrawal of charge in a series of _____.
a) MOS resistor b) MOS capacitors
c) MOS inductors d) MOS diode

7) Phototransistor is same as npn transistor with unconnected _____.
a) base b) emitter
c) collector d) substrate

8) In CCD, the time required to fill the well thermally is called the _____ time.
a) transit b) thermal relaxation
c) on d) off

9) Transferred electron effect is the transfer of conduction electrons from a _____.
a) high mobility valley to low mobility
b) low mobility valley to high mobility
c) high mobility valley to high mobility
d) low mobility valley to low mobility

10) TED possesses the properties of _____.
a) positive differential resistance
b) positive differential capacitance
c) negative differential resistance
d) negative differential capacitance

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

1) In a semiconductor, the process whereby particles flow from a region of high concentration to a region of low concentration is called _____.
2) Punch-through (PT) and nonpunch-through (NPT) are two versions of _____.
3) The full form of semiconductor triggering device PUT is _____.
4) In PIN diode, P stands for _____.
5) In PIN diode, N stands for _____.
6) The PIN diode comprises a semiconductor diode having _____ (number of) layers.

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

a) The data sheet for the MOSFET shows $I_{D(on)} = 3mA$ and $V_{DS(on)} = 10V$. If $V_{DD} = 25V$, select the value of R_D that the MOSFET to operate at the specified Q point.

b) Explain MS contact and Schottky diode.

c) In Fig.: Triac Problem, the switch is closed. If the triac has fired, what is the approximate current through the 22 Ω resister.
[Given $V = 99\ V$]

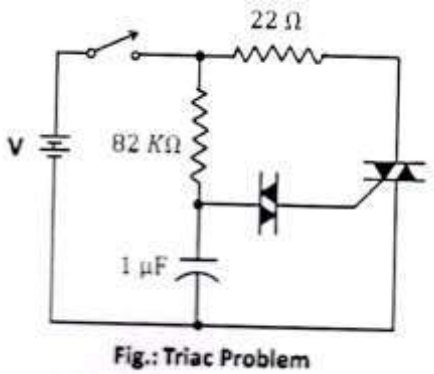

Fig.: Triac Problem

d) Draw energy band diagram for p-type semiconductor showing Fermi level (E_F), work function (E_w), electron affinity, (χ) and band gap (E_g).

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

a) Explain construction of P-i-n diode.

b) Describe quantum well heterostructures.

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

a) Write basic equations in flat-band condition. Explain meaning of the terms involved.

b) What is p-i-n diode? Discuss its characteristics.

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

a) Describe depletion and enhancement type MOS FETS.

b) Write a short note on two transistor analogy of SCR.

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

a) Explain construction & characteristics of TRIACs.

b) What is CCD? Explain three phase CCD.

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

a) Explain charge storage, surface potential under depletion and mechanism of charge transfer in CCD.

b) Explain current voltage characteristics of solar cell.

Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - IV) (New/Old) (CBCS)
Examination: March/April - 2025
Nuclear and Particle Physics (MSC10402)

Day & Date: Friday, 16-May-2025 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

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

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

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

2) The mode of a disintegration of a compound nucleus depends only on _____.
a) Its energy b) angular momentum
c) Parity d) all of these

3) The electric quadrupole moment is positive; shape of the nuclei is _____.
a) Oblate b) Prolate
c) Spherical d) All of these

4) The isotope of carbon, used for radiocarbon dating is _____.
a) $^{12}_{6}C$ b) $^{14}_{6}C$
c) $^{13}_{6}C$ d) $^{16}_{6}C$

5) One of the series that contain a magic number is _____.
a) 2, 8, 20, 28, 50 b) 2, 8, 18, 28, 50
c) 2, 8, 10, 28, 50, 82 d) 8, 18, 20, 28

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

7) Nuclei having same number of neutrons are called _____.
a) isobars b) isotopes
c) isotones d) isomers

8) Probability of occurrence of nuclear reaction is described by the _____.
a) projectile b) target
c) effective cross section d) yield

9) 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

10) The doubly magic nuclei (Z and N both magic numbers) are particularly _____ bound.
a) tightly b) weakly
c) unstable d) not

B) Write True or False. **06**

1) The radius of a nucleus is typically on the order of 10^{-15} to 10^{-14} m.
2) Parity can provide information about the nuclear structure.
3) Cosmic rays are high-energy particles that originate from sources beyond our solar system.
4) Stripping reaction can be explained by single particle model.
5) Nuclei with nucleons having a magic number are rare in nature.
6) If Q value of nuclear reaction is positive the reaction is endothermic.

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

a) Explain the concepts binding energy and nuclear stability.
b) Explain CPT conservation.
c) Write a note on collective model of the nucleus.
d) Write a note on nuclear fusion.

Q.3 Answer the following.

a) Derive the expression for Bethe-Weizsacker mass formula and discuss its an application. **10**
b) State Yukawa's hypothesis and explain the Yukawa interaction. **06**

Q.4 Answer the following.

a) Explain in detail nuclear scattering cross section determinations. **10**
b) Write a note on types of nuclear reactions. **06**

Q.5 Answer the following.

a) What are magic numbers? Flow does the shell model explain the existence of magic numbers and other nuclear properties? **10**
b) Explain the liquid drop model of the nucleus **06**

Q.6 Answer the following.

a) What is radioactivity? State law of radioactive decay and derive the expression for the decay rate of the sample. **10**
b) Give detailed account on radioactive dating and radioactive series. **06**

Q.7 Answer the following.

a) Explain linear accelerator and scintillation detector with neat labelled diagram. **10**
b) Write a note on primary and secondary cosmic rays. **06**

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Seat No.	

Set P

M.Sc. Physics (Solid State) (Semester - IV) (New/Old) (CBCS)
Examination: March/April - 2025
Thin Film Physics and Technology (MSC10403)

Day & Date: Tuesday, 20-May-2025 Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. No1 & 2 are compulsory.
2) Attempt any three questions from Q. No 3 to Q .No 7
3) Figures to the right indicate full marks.

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

1) If the kinetic energy of an incident atom is _____ than the energy of desorption, thermal accommodation is easily attained.
a) greater b) equal
c) less d) no any relationship

2) In RF sputtering, the _____ frequency is used for RF power supply equipment.
a) 13.56 Hz b) 13.56 K Hz
c) 13.56 MHz d) 13.56 GHz

3) Spray pyrolysis is an example of _____ phase synthesis
a) solid b) liquid
c) gas d) Plasma

4) The expression 4 σ /D denotes the _____ in the crystallite.
a) interface area b) interface volume
c) internal pressure d) internal volume

5) The working electrode in electrodeposition is _____.
a) Cathode
b) Anode
c) both Cathode and Anode
d) neither cathode nor anode

6) Which gas is used in PVD ?
a) Ammonia b) CO2
c) Hydrogen d) Argon

7) Thickness of the thin films is in between _____.
a) 1 nm to 1000 nm b) 1000 nm to 2000 nm
c) 2000 nm to 3000nm d) 3000nm to 4000nm

8) The reaction SiH4(g) + O2 (g) = SiO_2 (g) + $2H_2$(g) gives the deposition of _____.

a) *Silicon oxynitride*
b) *Silicon Nitride*
c) Silicon Dioxide
d) Silicon Dinitride

9) In MOS devices, _____ serves as a gate electrode material.

a) Polysilicon
b) Silicon dioxide
c) Silicon nitride
d) Silicon dinitride

10) _____can be produced by reacting dichlorosilane and ammonia at temperature between 700°C and 800°C.

a) Silicon dioxide
b) Silicon nitride
d) Silicon dinitride
d) Polysilicon

B) Fill in the blanks OR Write true/false: **06**

1) CVD technique involve the use of chemical reactions of one or more volatile precursors with heated substrate.
   True/False
2) Thick film technology is used to get cheap resistors and capacitors?
   True/False
3) If Q_{dcs}» Q_s the condensation occurs without supersaturation and the coverage is high.
   True/False
4) Mirrors were first made by evaporation of metals.
   True/False
5) Thin film growth in which small nuclei are formed over the surface of substrate is called Nucleation.
   True/False
6) LASER evaporation is the process by which the source material is evaporated by using focused e -beam.
   True/False

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

a) Write advantages and disadvantages of sputtering deposition.
b) Draw neat diagram of ion assisted deposition.
c) Write a note on Miller indices.
d) Write the desired properties of the metallization required for integrated circuits.

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

a) Explain pulsed laser deposition method for depositing thin film. State its advantages and drawbacks.
b) Write a note on optical filters.

Q.4 Answer the following (Any Two). **16**

a) Discuss with neat diagram chemical bath deposition of thin films. What are its advantages and drawbacks?

b) Explain thermodynamic theory of nucleation.

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

a) Explain with neat diagram the DC Sputtering Process.

b) Explain electrical properties of metal and semiconducting thin films.

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

a) Explain Laser CVD.

b) Write a note on dielectric deposition.

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

a) Describe with neat diagram thermal evaporation by electron beam.

b) Explain with neat diagram thin film transistor and current voltage characteristics of it.

Seat No.	

Set **P**

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

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

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

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

1) What phenomenon is responsible for the limitation of resolving power in optical microscopy?
a) Reflection b) Refraction
c) Diffraction d) Absorption

2) The Airy disc is associated with which optical phenomenon?
a) Refraction b) Interference
c) Diffraction d) Absorption

3) What is the term for the minimum distance between two distinguishable points in an image?
a) Magnification b) Resolution
c) Numerical aperture d) Rayleigh criteria

4) What is the purpose of beam scanning in SEM?
a) To increase resolution b) To cover a larger /area
c) To decrease magnification d) To change the wavelength

5) What does Bragg's condition describe in electron diffraction?
a) Absorption of electrons b) Refraction of electrons
c) Interference of electrons d) Diffraction of electrons

6) In XPS, the binding energy of a photoelectron is directly related to the ____.
a) Surface roughness b) Atomic number
c) Configuration electron d) Sample thickness

7) The Zeeman interaction in NMR is related to the interaction of nuclear spins with ____.
a) Magnetic fields b) Electric fields
c) Gravitational fields d) Inertial forces

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

9) The hyperfine structure in EPR arises from the interaction between____.
a) Electrons and protons b) Electrons and electrons
c) Nuclei and electrons d) Nuclei and photons

10) In EPR, relaxation times are measures of the ____.
a) Width of the spectral lines b) Intensity of the signals
c) Magnetic field strength d) Resonance frequency

B) State true or false: **06**

1) Sample preparation is critical in AES to obtain accurate and reproducible results.
2) The principle of TEM involves the use of transmitted electrons to form an image.
3) Electron microscopes require a vacuum environment due to the interaction of electrons with air molecules.
4) Ultra-High Vacuum (UHV) is not necessary in surface characterization to minimize interactions with residual gases.
5) STM is limited by its inability to image non-conductive samples.
6) Major lens defects in optical microscopy includes spherical, chromatic aberration, and astigmatism.

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

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

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

a) Outline the components of an optical column in electron microscopy.
b) Describe the implementation of Scanning Tunneling Microscopy in instruments. Discuss the key components and their functions in achieving high-resolution imaging.

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

a) Explain Raman Spectroscopy with the help of classical and quantum approach.
b) Discuss how these innovations have improved the capabilities and applications of both XPS and AES in material science.

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

a) Explain principle, instrumentation and working of atomic force microscope (AFM).

b) Draw the schematic diagram of XPS and explain the its working of each part.

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

a) Describe the lens systems in Transmission Electron Microscope (TEM) and how to contribute the magnification and resolution of the images obtained.

b) Explain how the phase contrast and differential interference contrast techniques enhance the visibility of transparent specimens in optical microscopy.

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

a) Discuss the instrumentation, and applications of this EPR technique.

b) Explore the Zeeman interaction in the NMR signal which influences the resonance frequencies.