Seat No.	

Set | P

M.Sc. Physics (Nano Physics) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2025
Mathematical Physics (2306101)

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 (Nano Physics) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2025
Solid State Physics (2306102)

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.

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Set P

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

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 (Nano Physics) (Semester - I) (New) (NEP CBCS)
Examination: March/April - 2025
Research Methodology in Physics (2306105)

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.

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Set P

M.Sc. Physics (Nano Physics) (Semester - II) (New) (NEP CBCS)
Examination: March/April - 2025
Quantum Mechanics (2306201)

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. (Any three). **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 (Nano Physics) (Semester - II) (New) (NEP CBCS)
Examination: March/April - 2025
Electrodynamics (2306202)

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.

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Set **P**

M.Sc. Physics (Nano Physics) (Semester - II) (New) (NEP CBCS)
Examination: March/April - 2025
Classical Mechanics (2306206)

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) $\epsilon > 1$ b) $\epsilon < 1$
   c) $\epsilon = 1$ d) $\epsilon = 0$

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

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Set P

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

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.

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Set P

M.Sc. Physics (Nano Physics) (Semester - III) (New) (NEP CBCS)
Examination: March/April - 2025
Atomic & Molecular Physics (2306302)

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.

Seat No.	

Set P

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

Day & Date: Monday, 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) Select the correct alternative. **08**

1) The material used for thin film PV cell must have _____
   a) high absorption coefficient
   b) high recombination rate
   c) high transmission coefficient
   d) none of these

2) In Dye sensitized solar cell the incident photon will _____
   a) eject the electron from dye material
   b) excite the electron from dye material
   c) both eject and excite the electron from dye material
   d) none of these

3) In pseudocapacitance, storage of electrical energy is achieved by _____
   a) Faradaic redox reaction
   b) polar material
   c) Helmholtz double layer
   d) none of these

4) In symmetric electrode supercapacitor, the capacitance of _____
   a) both electrode is same
   b) +Ve electrode is grater than -Ve electrode
   c) +Ve electrode is less than -Ve electrode
   d) can't say perfectly

5) In hydrogen-oxygen fuel cell, the by-product are _____
   a) water only b) heat only
   c) both water and heat d) none of these

6) As compared to battery the fuel cell are _____
   a) low efficient and low cost
   b) low efficient and high cost.
   c) more efficient and low cost
   d) more efficient and high cost.

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

8) Which of the following is piezoelectric material.
   a) Silicon (Si) b) Lithium tantalite ($LiTaO_3$)
   c) Silicon dioxide($Si O_2$) d) Germanium(Ge)

B) State True or False **04**

1) The band gap energy of solar cell material is about 1.1 eV. (True/False)
2) Supercapacitor can be used as battery.(True/False)
3) The output of fuel cell is AC type.(True/False)
4) Piezoelectric material can be used to generate microwave.(True/False)

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

a) Define Fill Factor and efficiency of PV cell.
b) Explain the any two advantages of thin film PV cell.
c) Explain the charge storage mechanism in double layer capacitance in supercapacitor.
d) Explain any two electrode material used in pseudocapacitor.
e) Explain the advantages of fuel cell over battery.
f) Give the anode and cathode reaction in Hydrogen-Oxygen Fuel cell.
g) Define and explain the piezoelectric effect.
h) Explain the use piezoelectric effect in generation of ultrasound.

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

a) Explain any two methods of preparation of cathodic electrode.
b) Explain the any four applications of super capacitor in detail.
c) With neat diagram explain the construction of alkaline fuel cell.
d) Explain the working of Hydrogen-Oxygen based fuel cell.

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

a) Explain the construction and working of CuInSe2 solar cell with neat diagram.
b) Explain the working of symmetric super capacitor with diagram.
c) Explain the construction and working of Hydrogen-Oxygen based fuel cell.

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

a) Explain the construction and working of dye sensitized solar cell.

b) Explain any three piezoelectric materials with their advantages and disadvantages.

c) Explain in detail any three application of piezoelectric cell.

Seat No.	

Set P

M.Sc. Physics (Nanophysics) (Semester - III) (Old) (CBCS) Examination: March/April - 2025
Semiconductor Physics (MSC09301)

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.

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Seat No.	

Set P

M.Sc. Physics (Nano Physics) (Semester - III) (Old) (CBCS) Examination: March/April - 2025
Atomic and Molecular Physics (MSC09302)

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 (Nanophysics) (Semester - III) (Old) (CBCS) Examination: March/April - 2025
Functional Nanomaterials (MSC09306)

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

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

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

1) The nanofibers are created using _____ process.
a) Electrospinning b) Particle collision
c) Radiation washing d) Photosynthesis

2) Polymer has outstanding property of being _____.
a) heavy weight b) corrosive
c) light weight d) brittle

3) The expanded use of NWs in nanocomposite materials hold promise in the design of _____.
a) nonconductive films and nanoscale devices
b) conductive films and miliscale devices
c) conductive films and nanoscale devices
d) nanoconductive films and miliscale devices

4) Bucky ball is an example of _____.
a) spherical fullerence b) cylindrical fullerece
c) nanowire d) quantum dot

5) The stabilizing element in β-phase of Ti alloys is _____.
a) Al b) Mo
c) O d) N

6) The electric and optical properties of TiO_2 nanotube are strongly associated with their
a) mass, length and radius
b) mass, length and symmetry
c) mass, dimensions and symmetry
d) morphology, dimensions and symmetry

7) The strength of the polymer increases with _____ in molecular weight.
a) increase b) decrease
c) no change d) slightly decrease

8) At room temperature, the polymer is formed the then it is _____.

a) brittle
b) viscofluid state
c) amorphous
d) rubbery

9) The curing process of thermoset is completely _____.

a) reversible
b) irreversible
c) adiabatic
d) isothermal

10) The TNT array is an expected material for _____.

a) hydrogen splitting from oil
b) hydrogen splitting from air
c) hydrogen splitting from film
d) hydrogen splitting from water

B) Fill in the blanks OR True or false: **06**

a) Quantum dots have two dimensions.
b) The range of identical Temperature for synthesis of MOF is 500° C to 600° C.
c) Carbon atom can form four covalent bonds.
d) Bucky ball is an example of _____.
e) The electrospinning process can be adjusted to control fibre diameter by varying electric filed strength and polymer solution concentration.
f) The layer-by layer assembly of oppositely charged polyelectrolytes originated in the early.

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

a) Write a brief note on the structural characteristics of Titanium Oxide nanotube arrays.
b) What are the fundamental materials used in polymer nanocomposites? Discuss their significance.
c) List and explain the properties of polymer nanocomposites
d) Discuss the biomedical applications of quantum dots.

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

a) What is polymerization? Discuss the process of emulsion polymerization in detail.
b) Provide a detailed explanation of the arc discharge and arc melting techniques for synthesizing boron nitride nanotubes.

Q.4 Answer the following **16**

a) Elaborate on the process of electrospinning for nanofiber production.
b) Describe the synthesis of semiconductor nanocrystals using organic solvents.

Q.5 Answer the following **16**

a) Discuss the critical parameters in the electrospinning process for nanofibers, and explain four key parameters in detail.

b) Highlight the structural applications of nanocomposite fibers.

Q.6 Answer the following **16**

a) Explain the electrochemical anodization method for fabricating TiO_2 nanotube arrays, focusing on the first-generation synthesis process.

b) Write a brief overview of the fabrication methods for polymer nanocomposites.

Q.7 Answer the following **16**

a) Define Metal-Organic Frameworks (MOFs) and discuss their advantages and limitations.

b) Explain the Laver-by-Layer (LBL) assembly technique using. semiconductor nanoparticles and nanowires.

Seat No.	

Set P

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

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) Select the correct alternative. **08**

1) For the material having band gap energy more than 5eV, act as _____.
a) super conductor b) conductor
c) insulator d) semiconductor

2) The Gunn diode is made from _____.
a) only N-type material
b) only P-type material
c) P-type and N-type material
d) N-type semiconductor and metal

3) Switching speed of Schottky diode is _____ ordinary diode.
a) less than b) greater than
c) equal to d) none of these

4) Which of the following semiconductor device is bidirectional?
a) SCR b) LASCR
c) UJT d) TRIAC

5) Reverse breakdown voltage of SCR depends upon _____.
a) voltage between anode & cathode
b) voltage between gate & cathode
c) gate current
d) temperature of SCR

6) The momentum of electron changes in _____ semiconductor material, when it jumps from conduction band to valence band.
a) indirect band gap b) direct band gap
c) P-type d) N-type

7) The Fermi energy level is _____ in N-type semiconductor.
a) near the conduction band
b) near the valence band
c) at the center of forbidden gap
d) inside the valence band

8) Diffusion current in semiconductor is depends upon _____.
a) temperature of semiconductor
b) applied voltage to semiconductor
c) neither a or b
d) both a & b

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

1) Drift current in semiconductor depends upon applied voltage.
2) Photon energy less than band gap energy produces electron-hole pair.
3) Schottky diode is used in very high frequency rectifier.
4) Photodiode works in reverse bias.

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

a) Explain the indirect band gap semiconductor.
b) Write a note on the conductivity of N-type semiconductor.
c) Explain the drift current in semiconductor.
d) Write a note on photoluminescence.
e) Explain the direct recombination of electron hole pair.
f) Write a note on diffusion of carries.
g) Explain the thermionic emission.
h) Write a note on LASCR.

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

a) Explain the effect of doping on the mobility of electron in N-type semiconductor.
b) Explain the diffusion and drift current.
c) Give the construction and working of Gunn diode.
d) Explain the forward characteristics of SCR.

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

a) Derive the equation for conductivity of semiconductor.
b) Explain the transport theory of Schottky barrier.
c) Give the construction and working of TRIAC.

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

a) Derive an expression for barrier height between metal & semiconductor contact.
b) Explain the steady state carrier generation and derive the necessary expression.
c) Explain the forward and reverse characteristics of SCR.

Seat No.	

Set P

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

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 the correct alternative. **08**

1) A neutron is composed of which combination of quarks?
a) uuu b) ddd
c) udd d) uud

2) Which fundamental force is responsible for beta decay?
a) Electromagnetic b) Weak
c) Strong d) Gravitational

3) Conservation of linear momentum in nuclear reactions is maintained due to:
a) Symmetry of space
b) Absence of friction
c) Presence of external field
d) Internal energy loss

4) Which particle does not belong to the group of fundamental fermions?
a) Electron neutrino b) Tauon
c) Gluon d) Electron

5) In a particle-antiparticle annihilation process, the energy released equals:
a) The kinetic energy of the particles
b) The binding energy of the nucleus
c) Twice the rest mass energy of one particle
d) The difference in potential energy

6) Which is a limitation of semiconductor detectors in nuclear physics experiments?
a) They are very expensive
b) Poor resolution
c) Must be operated in vacuum
d) Sensitive to radiation damage

7) A scintillation counter typically uses which crystal for gamma ray detection?

a) Lithium fluoride b) Cesium iodide
c) Sodium iodide d) Barium sulfate

8) The kinetic energy gained by a particle in a cyclotron depends on:

a) Its charge and frequency
b) Magnetic field and radius squared
c) Radius and mass only
d) Frequency and time only

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

1) The energy required to disassemble a nucleus into its nucleons is known as _____
2) The nuclear model explaining the nucleus as a charged liquid drop is attributed to _____
3) Beta decay involves the transition between two isobars. True/False
4) The parity operator has eigenvalues +1 and -1. True/False

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

a) Define Q-value in nuclear reactions?
b) What are the characteristics of short-range nuclear forces?
c) Explain the two salient features of the liquid drop model.
d) Define the spin-orbit coupling in nuclei.
e) Define radioactivity.
f) Describe any one of the fundamental characteristics of atomic nuclei such as size, mass, shape, spin, and binding energy.
g) List various types of nuclear reactions.
h) What is a scintillation counter?

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

a) Explain the laws governing it. What is meant by radiocarbon dating?
b) Compare nuclear fission and fusion with suitable examples.
c) Explain nuclear binding energy and relate it with nuclear stability.
d) Discuss the meson exchange theory.

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

a) Describe the working and applications of a scintillation counter.
b) Discuss the elementary particles.
c) Define quarks. Mention the six types and their properties.

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

a) Discuss their source and properties of primary cosmic rays.
b) Describe the structure and functioning of a synchrotron.
c) Explain CPT symmetry and its implications in particle physics.

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Seat No.	

Set P

M.Sc. Physics (Nano Physics) (Semester - IV) (New) (NEP CBCS)
Examination: March/April - 2025
Nanomaterials Characterization Techniques (2306407)

Day & Date: Tuesday, 20-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 alternatives: **08**

1) Which technique provides high-resolution imaging of nanomaterials?
a) UV- VIS Spectroscopy b) SEM
c) FTIR d) TGA

2) Which instrument is used to study vibrational modes in materials?
a) XRD b) FTIR
c) TEM d) AFM

3) Raman spectroscopy is based on_____.
a) Infrared absorption
b) Scanning probe interaction
c) Inelastic scattering of photons
d) UV-Vis transmission

4) Young's modulus characterizes _____.
a) Mechanical stiffness b) Magnetic behavior
c) Electrical properties d) Surface area

5) Poisson ratio is associated with _____.
a) Optical absorption b) Deformation mechanics
c) Surface potential d) Spectral shifts

6) XPS is primarily used for _____.
a) Electrical resistance measurement
b) Elemental and chemical analysis
c) Thermal expansion
d) Optical band gap analysis

7) Which of the following is a non-optical spectroscopic technique?
a) UV-VIS b) RAMAN
c) FTIR d) XRD

8) TGA is used to analyze _____.
a) Thermal stability b) Optical absorption
c) Electrical conductivity d) Structural defects

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

1) EDAX is used for elemental analysis in microscopy. (T/F)
2) Photoluminescence is used to analyze optical band gap. (T/F)
3) XPS works well at atmospheric pressure. (T/F)
4) AFM can image both conductive and non-conductive samples. (T/F).

Q.2 Write short answers. (Any Six) **12**

a) What is photoluminescence?
b) Define Young's modulus.
c) What is meant by the optical band gap?
d) What is Bragg's condition of diffraction?
e) Mention any two spectroscopic techniques used for nanomaterials.
f) What is the purpose of energy analyzers in XPS?
g) What is TGA?
h) What are the defects observed in nanomaterials?

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

a) What are the properties of X-ray?
b) List any four differences between SEM and TEM...
c) Explain the concept of core-level splitting.
d) Discuss the importance of surface area measurement techniques

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

a) Describe the principle and use of Dual Polarization Interferometry (DPI).
b) Write a note on Raman spectroscopy.
c) Describe the working principle and instrumentation of XPS

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

a) Explain construction and working of STM with diagram
b) Explain principal and working of EDAX.
c) Discuss the limitations of microscopy techniques in nanomaterial analysis

Seat No.	

Set P

M.Sc. Physics (Nano Physics) (Semester - IV) (New/Old) (CBCS)
Examination: March/April - 2025
Semiconductor Devices (MSC09401)

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 the correct alternative. **10**

1) In a heterojunction LASER, _____ materials are present.
a) n-type b) p-type
c) both (a) and (b) d) only n-type

2) When a _____ voltage is applied to the gate, the NMOS will conduct.
a) breakdown b) low
c) high d) both (a) and (b)

3) After biasing MIS structure, in case of accumulation, there is _____ of majority charge carriers.
a) addition b) removal
c) both (a) and (b) d) none of these

4) Flat-Band refers to the biasing condition in which there is _____ voltage drop.
a) little b) no
c) not defined d) all of these

5) When the current can be conducted in both directions of the MS contact, the contact is defined as the _____ contact.
a) Rectifying b) Ohmic
c) Resistive d) none of these

6) The point in the gate voltage sweep, when significant current begins to flow is called as _____.
a) cut-off voltage b) contact potential
c) threshold voltage d) all of these

7) The readout circuits of CCD perform a _____ conversion.
a) parallel to series b) series to parallel
c) parallel to parallel d) all of these

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

9) To increase fringing field, CCD gate length needs to be _____.
a) reduced b) enhanced
c) unchanged d) all of these

10) The negative differential resistance is the concept explained by _____ theory.
a) RWH b) Hall effect
c) quantum confinement d) both (b) and (c)

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

1) NMOS works faster than PMOS. (True False)
2) Fermi-level pinning is lowered potentially by the insulator layer at the metal-semiconductor junction. (True/False)
3) A higher electron energy is represented by the higher position in the energy band diagram. (True/False)
4) When the SCR is turned from forward blocking to forward conduction state is called as _____.
5) Photodiodes operate after _____ biasing.
6) The number of photoelectrons produced divided by the number of impinging photons is called as _____.

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

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

Q.3 Answer the following question

a) Elaborate the IV characteristics of solar cell. Deduce an expression for quantum efficiency of solar cell. **08**
b) Elaborate in detail about the charge trapping concept in MOSFET. **08**

Q.4 Answer the following question

a) What are light emitting diodes? Explain the principle of construction and working of LEDs. **08**
b) Explain in brief about dv/dt and di/dt characteristics of SCR. **08**

Q.5 Answer the following question

a) What are Schottky diodes? Give the detailed explanation of working mechanism in Schottky diode. **08**
b) Explain the concept of flat band condition? Give the detailed explanation of basic equations flat band condition. **08**

Q.6 Answer the following question

a) Elaborate in detail about the basic construction and charge transfer mechanism in two phase CCD. **08**

b) Write in detail about LSA mode of operation. **08**

Q.7 Answer the following question

a) Give detailed explanation about the construction and working of p-n junction LASER. **08**

b) What are Photoconductors? Write in brief about photocurrent gain. **08**

Seat No.	

Set **P**

M.Sc. Physics (Nanophysics) (Semester - IV) (New/Old) (CBCS)
Examination: March/April - 2025
Nuclear and Particle Physics (MSC09402)

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 the correct alternative. **10**

1) The binding energy per nucleon is highest for which of the following elements?
   a) Helium b) Iron
   c) Uranium d) Hydrogen

2) The theory explaining alpha decay is based on which phenomenon?
   a) Quantum tunnelling
   b) Gravitational force
   c) Electromagnetic interaction
   d) Thermal diffusion

3) The quark composition of a proton is: _____.
   a) uuu b) uud
   c) udd d) ddu

4) Which nuclear model considers the nucleus as a drop of incompressible nuclear fluid?
   a) Shell model b) Fermi gas model
   c) Liquid drop model d) Superconductivity model

5) The primary component of cosmic rays is: _____.
   a) Electrons b) Neutrons
   c) Protons d) Gamma rays

6) Yukawa's theory describes nuclear forces as mediated by which type of particle?
   a) Electron b) Neutrino
   c) Meson d) Photon

7) The half-life of a radioactive substance is the time taken for its activity to: _____.
   a) Reduce to zero b) Double
   c) Reduce to half d) Become constant

8) Magic numbers are associated with which nuclear property?
   a) Nuclear spin b) Nuclear stability
   c) Decay constant d) Isotopic mass

9) The conservation law not obeyed in weak interactions is: _____.
   a) Charge conservation b) Parity conservation
   c) Energy conservation d) Baryon number conservation

10) A synchrotron is used to: _____.
   a) Accelerate particles in a straight line
   b) Detect cosmic rays
   c) Accelerate particles in a circular path
   d) Measure binding energy

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

1) The energy released during nuclear fusion is due to the conversion of _____ into energy.
2) The shell model explains the concept of _____ numbers for stable nuclei.
3) In beta decay, a neutron converts into a _____ and emits a beta particle and an antineutrino.
4) Cosmic rays are primarily composed of heavy nuclei. True/False
5) The binding energy per nucleon decreases for elements heavier than iron. True/False
6) Alpha particles have higher penetration power than beta particles. True/False:

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

a) Explain the concept of nuclear binding energy and its relation to nuclear stability.
b) Describe the liquid drop model and its applications in predicting nuclear masses.
c) What is Yukawa's hypothesis of nuclear forces? Explain the role of mesons.
d) Discuss the process of radioactive dating and its applications.

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

a) Explain the Fermi gas model and how it applies to the nucleus.
b) Describe the shell model of the nucleus with an emphasis on the spin-orbit interaction.

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

a) Derive the Breit-Wigner formula for nuclear resonance reactions.
b) Discuss the theory of alpha decay and the concept of quantum tunnelling.

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

a) Classify elementary particles based on their interactions. Explain with examples.

b) What are cosmic rays? Discuss their origin and effects on the Earth's atmosphere.

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

a) Explain nuclear fission and fusion with suitable examples.

b) Describe the functioning of a cyclotron and its application in nuclear physics.

Q.7 Answer the following **16**

a) Discuss the conservation laws in nuclear reactions with examples.

b) Explain the working principle of scintillation detectors and their applications.

SLR-ZV-28

Seat No.

Set P

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

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

Instructions: 1) Question 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) Fill in the blanks by choosing correct alternatives given below: 10

1) The main function of the energy analyzer in XPS is to ____.
a) Measure the energy of emitted X-rays
b) Detect surface roughness
c) Analyze the energy of photoelectrons
d) Generate electron beams

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

3) Resolving power of a microscope is a function of ____.
a) Wavelength of light used
b) Numerical aperture of lens system
c) Refractive index
d) Wavelength of light used and numerical aperture of lens system

4) Where do we obtain the magnified image of the specimen in SEM?
a) Cathode ray tube b) Phosphorescent screen
c) Anode d) Scanning generator

5) Selective Area Electron Diffraction (SAED) in TEM is primarily used to _____.
a) Image large areas of the sample
b) Analyze crystalline structure at specific locations
c) Increase magnification
d) Detect elemental composition

6) NMR spectroscopy is used for determining structure in which of the following materials?
a) Radioactive materials b) Insoluble chemical compounds
c) Liquids d) Gases

7) Which of the following sensor is used in ESR spectrometer?
a) Hall-effect sensor b) Load cell
c) Strain gauge d) Bourdon gauge

8) Electron Microscope can give a magnification up to ____.
a) 400,000X b) 100,000X
c) 15000X d) 100X

9) Which of the following components are used to generate X-rays?
a) Meyer tube b) West tube
c) Anger tube d) Coolidge tube

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

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

1) TEM and SEM are the same microscopy techniques.
2) AES is limited when it comes to very high-resolution studies.
3) The cathode in the Coolidge tube is kept in an inclined manner.
4) Ion etching techniques provides the depth profiling from the surface.
5) Electron spectroscopy is based on the ionization phenomenon.
6) In basic ESR spectrometer, the cavity length is adjustable.

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

a) Explain Magnification in SEM
b) What are the applications of Raman Spectroscopy?
c) Write a short note on Optical microscope
d) What is nano material and nano technology?

Q.3 Answer the following:

a) What is EPR? Write the different applications of EPR. **10**
b) Write a note on Rayleigh Criteria. **06**

Q.4 Answer the following:

a) What are different types of an optical spectrometer? Explain any one in detail with neat diagram. **10**
b) Write a short note on SEE. **06**

Q.5 Answer the following:

a) What is principal, construction and working of Scanning electron microscope? **10**
b) What are the properties of X-ray? **06**

Q.6 Answer the following:

a) Explain in details of image formation in Scanning Tunnelling Microscopy (STM). **10**

b) Write a short note on AFM. **06**

Q.7 Answer the following:

a) What are different types of sample preparation methods? **10**

b) What is resonance condition in ESR and NMR? **06**