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**M.Sc. Physics (Condensed Matter) (Semester - I) (CBCS) Examination:
March/April - 2025
Mathematical Physics (MSC04101)**

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

Max. Marks: 60

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 $4 \frac{d^2 y}{dx^2} + 4 \frac{dy}{dx} + y = 0$
- 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 $f(z) = \oint \frac{e^z}{z^2 - 2z + 2} dz$
- Determine the singular points of $f(z)$.
 - 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 $9 \frac{d^2 y}{dx^2} + 12 \frac{dy}{dx} + 29y = 0$

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

- a) Solve the differential equation $\frac{dy}{dx} + y \cot x = \cos x$
- 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 $\mathbb{R}^3$ 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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**M.Sc. Physics (Condensed Matter) (Semester - I) (CBCS) Examination:
March/April - 2025
Solid State Physics (MSC04102)**

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

Max. Marks: 60

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
- Magnetic permeability and susceptibility
 - Polarizability and dielectric constant
 - Electrical conductivity and temperature
 - None of the above

B) Fill in the blanks:

04

- The energy bands in solids arise due to the _____ potential.
- Superconductors exhibit perfect diamagnetism due to the _____ effect.
- Antiferromagnetic materials have a critical temperature called the _____.
- The _____ equation is used to calculate the internal field in a dielectric.

Q.2 Answer the following (Any Six).

12

- Explain the motion of electrons according to band theory.
- Discuss the significance of the Meissner effect in superconductors.
- What is the Curie point?
- Explain the electronic polarization in dielectrics.
- Write about the energy gap in semiconductors.
- Differentiate between Type I and Type II superconductors.
- Classify the magnetic materials.
- Explain the Bloch wall.

Q.3 Answer the following (Any Three).

12

- Derive the London equations in superconductivity.
- Describe the electrical conductivity in metals.
- Write about the Langevin theory of paramagnetism.
- Discuss the Brillouin zones.

Q.4 Answer the following (Any Two).

12

- Derive the Clausius-Mossotti equation.
- Explain the dipole theory of ferroelectricity.
- Write a note on saturation magnetization and its temperature dependence.

Q.5 Answer the following (Any Two).

12

- Describe the Josephson effect and its applications.
- Discuss the thermodynamics of superconductors.
- Write a detailed note on ferrimagnetic materials.

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**M.Sc. Physics (Condensed Matter) (Semester - I) (CBCS) Examination:
March/April - 2025
Analog and Digital Electronics (MSC04103)**

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

Max. Marks: 60

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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M.Sc. Physics (Condensed Matter Physics) (Semester - II) (CBCS)
Examination: March/April - 2025
Quantum Mechanics (MSC04201)

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

Max. Marks: 60

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

Q.1 A) Choose correct alternative.

08

- [illegible]

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 $V(x) = \underline{\hspace{2cm}}$.
- 4) The linear momentum operator is given by $\underline{\hspace{2cm}}$.

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 L_z .
- b) Describe the Pauli spin matrices.
- c) Explain
 - i) Schartz's Inequality
 - ii) State vector
 - iii) Span
 - iv) Basis

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**M.Sc. Physics (Condensed Matter) (Semester - II) (CBCS) Examination:
March/April - 2025
Electrodynamics (MSC04202)**

Day & Date: Friday, 16-May-2025
Time: 11:00 AM To 02:00 PM

Max. Marks: 60

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 $\vec{E}$.
- 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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M.Sc. Physics (Condensed Matter) (Semester - III) (New) (NEP CBCS)
Examination: March/April - 2025
Semiconductor Physics (MSC04301)

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

Max. Marks: 60

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, $(\partial T / \partial V)_S = ?$
 - a) $-(\partial V / \partial S)_T$
 - b) $-(\partial P / \partial S)_V$
 - c) $(\partial S / \partial P)_T$
 - d) $(\partial S / \partial V)_T$
- 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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M.Sc. Physics (Condensed Matter) (Semester - III) (New) (CBCS)
Examination: March/April - 2025
Atomic & Molecular Physics (MSC04302)

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

Max. Marks: 60

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

Q.1 A) Choose correct alternative.

08

- The singlet system of helium for $S = 0$ is called _____.
 - Para-helium
 - a positively helium ion
 - Ortho-helium
 - a negatively helium ion
- Which of the following cannot be conserved during Raman scattering?
 - Total Energy
 - Momentum
 - Kinetic Energy
 - Electronic Energy
- Transition of an electron from various s levels to lowest p level gives _____.
 - sharp series
 - principle series
 - diffuse series
 - fundamental series
- In case of LS coupling $I_1 = 1$, $I_2 = 2$, then $J =$ _____.
 - 1,2,3,4
 - 0,1,2,3
 - 2,3,4
 - 0,1,2,3,4
- With increasing quantum number, energy difference between adjacent levels in atoms _____.
 - decreases
 - increases
 - remain constant
 - zero
- Atomic spectra is an example of _____.
 - line spectra
 - continuous spectra
 - band spectra
 - both a and b
- The orientation of atomic orbitals depends on their _____.
 - Spin quantum number
 - Magnetic quantum number
 - Azimuthal quantum number
 - 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) $I_A = 0, I_B \neq I_C$

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.