| Seat No. | | Set | P |

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: October/November - 2025
Mathematical Physics (2321101)

Day & Date: Wednesday, 29-10-2025 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. (MCQ) 08

1) Which of the function of complex variable $z = x + iy$ is analytic?
a) $|Z|^2$ b) $Img\ Z$
c) e^2 d) $\bar{Z}$

2) The residue of a function $f(Z) = \frac{1}{(Z-2)(Z+3)^2}$ are_____
a) $-\frac{1}{9}$ and $\frac{1}{9}$ b) $-\frac{1}{16}$ and $-\frac{1}{9}$
c) $-\frac{1}{27}$ and $-\frac{1}{5}$ d) $-\frac{1}{25}$ and $-\frac{1}{5}$

3) Which of the following sets of vectors is linearly independent?
a) $\{(2,3)\ (4,6)\}$ b) $\{(1,0)\ (0,1)\}$
c) $\{(1,2)\ (2,4)\}$ d) $\{(3,1)\ (6,2)\}$

4) Determinant of an orthogonal matrix is _____.
a) 0 b) 1
c) -1 d) Either 1 or -1

5) What is the order of the differential equation given by
$\frac{d^2y}{dx^2} + 3\frac{dy}{dx} + 2y = e^x$
a) 0 b) 1
c) 2 d) 3

6) Solution of the differential equation
$(2y - 5x + 1)dx + (5y - 2x + 3)dy = 0$ is_____.
a) $p = (y + x)^4 (y - x)^3$ b) $p = (y + x + 1)^4 (y - x + 1)^3$
c) $p = (y + x)^3(y - x)^4$ d) $p = (y + x - 1)^5(y - x + 1)^2$

7) Which function's Fourier transform results in a constant function?
a) Sine function
b) Gaussian function
c) Delta function
d) Ramp function

8) If the function $f(x)$ is odd, then which of the following is zero?
a) a_n (Cosine coefficients)
b) b_n (Sine coefficients)
c) a_0
d) nothing is zero

B) State True or False. 04
a) In the Argand diagram, the imaginary part of a complex number is represented along the y-axis
b) In a second-order homogeneous differential equation with constant coefficients, the superposition principle holds.
c) The Laplace transform of the unit step function $u(t)$ is zero.
d) Eigenvectors corresponding to repeated eigenvalues of a matrix are always linearly independent.

Q.2 Answer the following. (Any Six) 12
a) If $Z_1 = 4 + 3i$ and $Z_2 = 2 + I$ then find $Z_1 + Z_2$
b) Show that both $Z \times Z^*$ and $Z + Z^*$ are real quantity whereas $Z - Z^*$ is imaginary.
c) Show that $\{(0,1)(1,0)\}$ is a basis of $V = R^2$
d) If A is a unitary matrix, then show that A^{-1} is also unitary.
e) Find the solution to the ordinary differential equation $\frac{dy}{dx} = 3x^2 - 4x + 2$
f) Solve the differential equation $y^3 \frac{dy}{dx} + 2y + x^3 = 0$
g) Define Laplace Transform.
h) Define Fourier series.

Q.3 Answer the following. (Any Three) 12
a) Find the integrating factor of the differential equation $y\frac{dx}{dy} - x = 3y^2$
b) Consider the complex function $f(z) = \frac{z^3 - 2}{z - 1}$
   i) Determine the singular points of the function.
   ii) Calculate the residues at each of the singular points.
c) Show that the set $S = \{(2,1,0)\ (1,-1,1)\ (-1,2,1)\}$ is an orthogonal set.
d) Check whether the given function is exponential or not $f(t) = 5t + 3$.

Q.4 Answer the following. (Any Two) 12
a) Find the Laplace transform of $f(t) = e^{2t} \sin 3t$
b) Discuss the method of solving second-order non-homogeneous differential equations with constant coefficients.

c) Find the value of k in matrix $A = \begin{bmatrix} k+1 & 1 & 2 \\ 2 & k & 1 \\ 1 & -1 & k-1 \end{bmatrix}$

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

a) Solve the Residue theorem

$$\int_0^{2\pi} \frac{d\theta}{5 - 3\cos\theta + 2\sin\theta}$$

b) Find the inverse of matrix $B = \begin{bmatrix} 2 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix}$

c) Solve $\frac{d^2y}{dx^2} - 5\frac{dy}{dx} + 6y = 0$

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Set **P**

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: October/November - 2025
Solid State Physics (2321102)

Day & Date: Friday, 31-10-2025   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.
3) Draw neat labelled diagrams wherever necessary.

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

1) For intrinsic semiconductors, relation between Fermi level and intrinsic level is _____.
   a) $E_f = E_i$ b) $E_f = 2\,E_i$
   c) $E_f = E_i/2$ d) $E_f = 4\,E_i$

2) Magnetic induction (B) and magnetic field intensity (H) are related by _____.
   a) $B = H^2\mu_0$ b) $B = {\mu_0}^2 H$
   c) $B = \mu_0\mu_r H$ d) $B = \mu_0 + H$

3) Magnetic susceptibility of a magnetic material is given by, $\psi =$_____.
   a) $\mu_r - 1$ b) $\dfrac{M}{H}$

   c) $\dfrac{(\mu - \mu_0)}{\mu_0}$ d) All of these

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

5) The size of the (negative) field required to reduce the induction to zero is known as the _____.
   a) Coercivity or coercive force, Hc
   b) Retentivity
   c) Hysteresis
   d) Saturation magnetization

6) Which of the following is the essential requirement for ferromagnetism?
   a) partly filled d shells   b) partly filled f shells
   c) partly filled d or f shells   d) partly d or f shells

7) For paramagnetic materials, relative magnetic permeability (μ_r) at room temperature is nearly _____.
   a) Zero   b) 1000
   c) 1   d) 100

8) Superconductor are divided into _____ types based on magnetic properties.
   a) One   b) Two
   c) Three   d) Four

B) Fill in the blanks. 04
   1) If ψ^* is complex conjugate of wave function ψ then; $P=\psi^*\psi=|\psi|^2$ is called _____.
   2) The Langevin function, $L(a)=$_____.
   3) In ferromagnetic materials, the flux density changes, lag the changes in the magnetic field strength, this effect is called _____.
   4) The complete ejection of magnetic field lines from the interior of the superconductor during its transition into superconducting state, is called _____ effect.

Q.2 Answer the following. (Any Six) 12
   a) What is Dirac delta function?
   b) What is Fermi level (E_F)?
   c) What are diamagnetic materials?
   d) State curie law.
   e) Define coercive force.
   f) Give the relation between magnetic susceptibility, magnetization, and magnetic field.
   g) Define critical/ transition temperature of a superconductor?
   h) What is London penetration depth?

Q.3 Answer the following. (Any Three) 12
   a) What is the probability of an electron being thermally excited to conduction band in intrinsic silicon at 27 °C. The band gap energy of Si is 1.12 eV. (Given: Boltzmann constant, $k=8.625\times10^{-5}$ eV/K.)
   b) Distinguish between ionic and electronic polarization.
   c) Explain Bloch wall and the domain wall energy.
   d) Discuss Type I and Type II superconductors.

Q.4 Answer the following. (Any Two) 12
   a) How are Brillouin zones in three dimensions constructed?
   b) Write a note on hysteresis.
   c) Discuss isotope effect in superconductors.

Q.5 Answer the following. (Any Two) 12
   a) Discuss motion of an electron in one-dimension based on band theory.
   b) Derive Clausius-Mosotti relation.
   c) Write a short note on BCS Theory.

Seat No.

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS) Examination: October/November – 2025
Analog and Digital Electronics (2321106)

Day & Date: Monday, 03-11-2025   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. (MCQ)   **08**

1) Input impedance of ideal op-amp is ____.
   a) Infinite   b) Zero
   c) 75Ω d) $1M\,\Omega$

2) ____ is used for Mod-2 addition.
   a) XOR-gate   b) OR-gate
   c) Full adder   d) Half adder

3) ____ is a circuit with one input and many outputs.
   a) Multiplexer   b) Demultiplexer
   c) Decoder   d) Encoder

4) In J-K flip-flop, when J=1 and K=1, it is possible to ____ the flip-flop.
   a) Set   b) Reset
   c) Toggle   d) Forbidden

5) Stack pointer holds ____.
   a) 16 bit address   b) 16 bit data
   c) 8 bit address   d) 8 bit data

6) Find the output voltage of inverting amplifier with Ri = 100 kΩ, Rf = 3 MΩ and Vi= 3 mV.
   a) 90 mV   b) 120mV
   c) 200mV   d) 210mV

7) Unity gain voltage follower is also called as ____.
   a) Comparator   b) Schmitt trigger
   c) Buffer   d) Zero crossing detector

8) Intel 8085 microprocessor has ____ bit size of data bus.
   a) 8 bit   b) 16 bit
   c) both a & b   d) 32 bit

B) **Fill in the blanks OR Write true/false:** 04
1) A phase shift oscillator uses RC network.   True / False
2) The output stage of an op-amp usually a ____.
3) In 808 microprocessors, accumulator register used as a working area in CPU.   True / False
4) Master slave flip is also referred to as Pulse triggered flip-flop. True / False

Q.2 **Answer the following. (Any Six)** 12
a) What do you mean by an encoder?
b) What is ALU?
c) List the five addressing modes of 8085 microprocessor.
d) What is dynamic shift register?
e) What is differential amplifier?
f) Explain difference between Encoder and Decoder.
g) Define the term CMRR.
h) What is Demultiplexer?

Q.3 **Answer the following. (Any Three)** 12
a) Write the features of 8085 microprocessor.
b) Give comparison between inverting and non-inverting configuration of an operational amplifier.
c) Describe 4 bit D flip-flop with timing diagram.
d) Explain the concept of virtual ground in Op-amp.

Q.4 **Answer the following. (Any Two)** 12
a) Draw and explain functional block diagram of 8085 microprocessor.
b) Draw and explain 16:1 Multiplexer.
c) Draw and explain Phase shift Oscillator using Op-amp. Obtain an expression for frequency.

Q.5 **Answer the following. (Any Two)** 12
a) What is multivibrator? Explain the difference between three types of multivibrators.
b) With a near circuit diagram, explain master slave JK flip flop.
c) Draw and explain instrumentation amplifier.

Seat No.	

Set P

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: October/November – 2025
Elements of Materials Science (2321107)

Day & Date: Monday, 03-11-2025   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) _____ structure can be studied by naked eye.
   a) Macro   b) Micro
   c) Nano   d) Crystal

2) Most of the ceramics have ____ structures, which are formed by the chemical reactions between the non-metallic and metallic elements.
   a) Crystalline   b) non-crystalline
   c) Amorphous   d) polycrystalline

3) _____ is defined as the ratio of the electrical output to the radiation input.
   a) Responsivity   b) Noise equivalent power
   c) Specific detectivity   d) None of the above

4) The degree of freedom, when FCC iron and BCC iron co-exist in equilibrium, are _____.
   a) 2   b) 1
   c) 0   d) -1

5) The atoms are arranged in a periodic manner and are hence known as _____ materials.
   a) amorphous   b) polycrystalline
   c) crystalline   d) single crystal

6) In a single-component system, the maximum number of phases that can coexist in equilibrium is _____ .
   a) 2   b) 3
   c) 4   d) 5

7) The nanoparticles with particle size of nearly _____ nm.
   a) 1-1000   b) 1-10
   c) 1-100   d) Less than 1000 nm

8) The transparent materials will _____ the incident light with absorption and reflection.
  a) refract
  b) transmit
  c) scatter
  d) none of the above

B) Fill in the blanks OR Write True/False.   **04**
  1) Refraction takes place when light does not pass into the material rather the light bounces at the surface of the material.
  2) The unit of the diffusion coefficient D is $m^2 \, s^{-1}$.
  3) The linear polymers are held together by weak van der Waals forces.
  4) The crystalline solids have directional properties and are also known as anisotropic substances

Q.2 Answer the following. (Any Six)   **12**
  a) What is degree of polymerization?
  b) What is principle of luminescence?
  c) What are crystalline solids?
  d) Discuss the various properties of polymer materials.
  e) What is the phase rule?
  f) What is Tauc Law?
  g) What are the various applications of engineering materials?
  h) What is the Ficks second law of diffusion?

Q.3 Answer the following. (Any Three)   **12**
  a) How are optical materials classified?
  b) i) A copper wire has a diameter of 0.9 mm. Determine the resistance of 30 cm wire. Given that resistivity is $1.7 \times 10^{-9} \, \Omega$ m.
    ii) Calculate the resistivity of a metal with conductivity, $\sigma = 6.0 \times 10^7$ S/m.
  c) What are the degrees of freedom of a system of two components when the number of phases is one, two, and three?
  d) What are the key characterization techniques for nanostructured materials?

Q.4 Answer the following. (Any Two)   **12**
  a) Explain physical and chemical techniques for synthesis of nanophase materials
  b) Provide a brief discussion on how engineering materials are classified.
  c) What are excitons and traps? Provide a brief explanation and highlight the properties of excitons.

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

    a) What are primary (interatomic) bonds, and what are the different types of these bonds?

    b) Explain the different optical properties of materials.

    c) What are ceramics? What are the different structures of the ceramic compounds? Explain with neat sketches and examples. Explain properties of ceramics

Seat No.

M.Sc. Physics (Material Science) (Semester - I) (New) (NEP CBCS)
Examination: October/November - 2025
Research Methodology in Physics (2321105)

Day & Date: Thursday, 06-11-2025   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. (MCQ)   08

1) Gathering knowledge for knowledge's sake is termed _____ research.
a) Basic   b) Applied
c) Quantitative   d) Experimental

2) Identifying gap areas in research are for _____.
a) exploration of uncharted terrain
b) addressing unanswered queries
c) resolution of conflicting findings
d) all of these

3) Physical vapor deposition is the process where _____ material to be deposited is physically converted to phase.
a) solid, vapor   b) gas, gas
c) vapor, liquid   d) solid, liquid

4) _____ refers to the closeness of a measurement or observation to the true or accepted value.
a) Precision   b) Accuracy
c) Average   d) Prediction

5) The principle on which electrodeposition method works is _____.
a) electrolysis   b) evaporation
c) gel formation   d) none of these

6) _____ is used as the source of infrared light.
a) Tungsten filament   b) Mercury lamp
c) Diode laser   d) globar filament

7) Direct current sputtering is suitable for depositing _____.
a) insulating materials   b) conducting materials
c) dielectric materials   d) polymers

8) Atomic force microscopy measures ____ between the probe tip and the sample surface.
   a) length   b) pressure
   c) interaction force   d) temperature

B) Write true/false.   **04**
   1) Research methodology is a way to systematically solve the research problem. (True/ False)
   2) Applied research aims at finding a solution for an immediate problem facing a society. (True/False)
   3) UV-V is spectroscopy measures the absorbance of light in the infrared region of the electromagnetic spectrum. (True/False)
   4) The pyrolysis means the formation of chemical compounds. (True/ False)

Q.2 Answer the following. (Any Six)   **12**
   a) What is peer review process?
   b) Write examples of primary and secondary sources of literature.
   c) Draw the neat labelled schematic diagram of atomic force microscopy.
   d) Write the advantages and disadvantages of UV-visible spectroscopy.
   e) What is the importance of literature review in research?
   f) Write the names of tools used in research for data collection.
   g) What are the types of sputtering?
   h) Write the advantages of electrodeposition method.

Q.3 Answer the following. (Any Three)   **12**
   a) Write a note on meaning and importance of research.
   b) Explain the concept data interpretation in research.
   c) Explain transmission electron microscope with neat labelled diagram.
   d) Explain in detail construction and working of e-beam evaporation.

Q.4 Answer the following. (Any Two)   **12**
   a) Explain in details types of research.
   b) Explain in detail spray pyrolysis deposition technique.
   c) Explain different sampling methods involved in research.

Q.5 Answer the following. (Any Two)   **12**
   a) Explain scanning electron microscope with neat labelled diagram.
   b) Write detailed note on Fourier transform infrared spectroscopy.
   c) Explain in detail radio frequency sputtering technique of deposition.

Seat No.		Set	P

M.Sc. Physics (Material Science) (Semester - II) (New) (NEP CBCS) Examination: October/November – 2025 Quantum Mechanics (2321201)

Day & Date: Tuesday, 28-10-2025 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. (MCQ) 08

1) If the mass of an electron is m_e and mass of the nucleus is m_n, what is the reduced mass μ of the electron-nucleus system?
a) $\mu = m_e + m_n{}^2$
b) $\mu = m_e m_n{}^2$
c) $\mu = (m_e + m_n)/m_e m_n$
d) $\mu = m_e m_n/(m_e + m_n)$

2) Which quantity is said to be degenerate when $H\Psi_n = E_n \Psi_n$?
a) Operators
b) Eigen Values
c) Eigen Functions
d) All of above

3) In the rotational motion, acceleration is given by ____.
a) $d\theta/dt$
b) $d\omega/dt$
c) dv/dt
d) Both (b) and (c)

4) What is the classical expression for angular momentum (L)?
a) $L = I \times \omega$
b) $L = r \times F$
c) $L = F \times p$
d) $L = r \times p$

5) What is the quantum mechanical postulate regarding the average value <a> of an observable corresponding with an operator $A^>$?
a) $<a> = \int \varphi^* A^> \varphi d\tau$
b) $<a> = \int (\varphi)^* A^> \varphi^2 d\tau$
c) $<a> = \int \varphi^* \varphi d\tau$
d) $<a> = \int A^> d\tau$

6) Probability density is always ____.
a) Positive
b) Negative
c) Infinite
d) All of above

7) Diffraction and interference are the evidence of ____ of matter.
a) wave nature
b) particle nature
c) both a & b
d) None of above

8) If Ψ be a complex function, then $\Psi^*\Psi$ must vanish at ____.
a) unity
b) zero
c) infinity
d) finite value

B) Fill in the blanks OR Write True/False 04
1) Total Energy is quantized but not angular momentum of the quantum particle. (True/False)
2) The Heisenberg's uncertainty principle is applicable to all conjugate pair of variables. (True/False)
3) Raising operator is defined as ____.
4) The corresponding values of wave functions (Ψ) are called ____ functions.

Q.2 Answer the following. (Any Six) 12
a) What is the physical significance of the Schrodinger wave function?
b) Write the difference between span and basis.
c) What is meant by expectation value?
d) Write about the commutation relation.
e) Define spin angular momentum.
f) Define Photoelectric effect.
g) What is the lowering operator?
h) What is a complex function? Give an example.

Q.3 Answer the following. (Any Three) 12
a) Write a note on stationary states.
b) Explain the unitary transformation.
c) Express the continuity equation.
d) Describe the Pauli spin matrices.

Q.4 Answer the following. (Any Two) 12
a) Write the interpretation and properties of wave function. What is admissible wave function?
b) Describe the box normalization and Dirac Delta function.
c) Obtain Schrodinger's wave equation for Hydrogen atom in terms of spherical polar coordinates, express its radial and angular parts.

Q.5 Answer the following. (Any Two) 12
a) Discuss wave-functions of linear harmonic oscillator and give their physical interpretation.
b) Obtain the eigen values and eigen functions for a particle in three-dimensional infinite potential well.
c) Define the Hermitian operator. Show that eigen values of Hermitian operator are real in nature.

Seat No.	

M.Sc. Physics (Material Science) (Semester - II) (New) (NEP CBCS)
Examination: October/November - 2025
Electrodynamics (2321202)

Day & Date: Thursday, 30-10-2025   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. (MCQ)   08

1) 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

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

3) Lorentz electric force has direction ____.
   a) Similar to electric field   b) Opposite to electric field
   c) Scalar quantity   d) None of these

4) 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

5) The lines of force due to charged particles are ____.
   a) always straight   b) always curved
   c) sometimes curved   d) None of these

6) In a capacitor the electric charge is stored in ____.
   a) metal plates   b) dielectric
   c) both (a) and (b)   d) None of the above

7) Divergence theorem is based on _____.
   a) Gauss law   b) Stoke's law
   c) Ampere law   d) Lenz law

8) The Gaussian surface for a point charge will be ____.
   a) Cube   b) Cylinder
   c) Sphere   d) Cuboid

B) Fill in the blanks OR Write True /False: 04
1) In static magnetic field only, magnetic dipole exists. (True/ False)
2) The magnetic field intensity will be zero inside a conductor. (True/ False)
3) Electric field of an infinitely long conductor of charge density λ, is given by $E = \lambda/(2\pi\varepsilon h).\, aN$. (True/ False)
4) The work done in moving a test charge from one point to another in an equipotential surface is zero. (True/ False)

Q.2 Answer the following. (Any Six) 12
a) Define Skin depth.
b) What is an electric field?
c) Write Maxwell equation derived from Faraday's law.
d) State Coulombs law.
e) Define Poynting vector.
f) Define Boundary condition.
g) Define electromagnetic force.
h) State Biot-Savart law.

Q.3 Answer the following. (Any Three) 12
a) Explain Maxwell displacement current.
b) Discuss energy stored in magnetic field.
c) Express the term potential due to point charge.
d) State the boundary condition for an electrostatic field $\bar{E}$.

Q.4 Answer the following. (Any Two) 12
a) Discuss in details of radiation from a half wave antenna.
b) Explain the electromagnetic plane waves in stationary medium.
c) What is Gauss law? Explain differential form of its.

Q.5 Answer the following. (Any Two) 12
a) Explain boundary condition between conductor and free space.
b) Write a note on radiation damping.
c) State and prove Poynting theorem.

Seat No.		**Set**	**P**

**M.Sc. Physics (Material Science) (Semester - II) (New) (NEP CBCS)
Examination: October/November – 2025
Classical Mechanics (2321206)**

Day & Date: Saturday, 01-11-2025   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. (MCQ)   **08**

1) The number of independent variables for a free particle in space are _____.
   a) Zero   b) One
   c) Two   d) Three

2) In Lagrange's equation if there are N number of particles then the generalized coordinates are _____.
   a) $n = N - k$ b) $n = 3N - k$
   c) $n = 3N$ d) $n = 3N + k$

3) _____ constraints are time dependent.
   a) Holonomic   b) Non-Holonomic
   c) Scleronomous   d) Rheonomous

4) Total virtual work done on N-particle system is _____.
   a) Zero   b) Maximum
   c) Minimum   d) None

5) Lagrange's equation are written as _____.
   a) $d/dt\,[\,\partial L/\partial \dot{q}_j] - \partial L/\partial q_j = 0$
   b) $\partial L/\partial q_j = 0$
   c) $d/dt\,[\,\partial L/\partial q_j] = 0$
   d) $d/dt\,[\,\partial L/\partial q_j] - \partial L/\partial \dot{q}_j = 0$

6) Hamilton's principle is also called _____.
   a) Principle of least action   b) Generalized Principle
   c) Both a and b   d) None of these

7) The rate of momentum change of an open system is equal to _____.
   a) $T + \dot{M}U$ b) $F - MV$
   c) $W - MV$ d) $F + \dot{M}U$

8) The Jacobi integral of the system is equal to _____.
   a) $\Sigma\, p_j\, \dot{q}_j - L$ b) T+V
   c) $\Sigma\, \dot{P}_j\, q_j - L$ d) None of these

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

1) Hamilton's canonical equations of motion are second order differential equations. (True/False)
2) According to Kepler's second law, arial velocity is constant. (True/False)
3) An angular momentum is conserved in the absence of external torque. (True/False)
4) The fundamental Poisson's brackets are varying under canonical transformation. (True/ False)

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

a) Write about the generalized coordinates.
b) Define the central force.
c) What is integral of motion?
d) Show that linear momentum is conserved for a particle.
e) What is an artificial satellite?
f) Write about the constant of motion.
g) Define the Poisson's bracket.
h) Write the condition for transformation to be canonical.

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

a) Explain about the open systems with variable mass.
b) Prove Kepler's second law of planetary motion.
c) Derive the Lagrange's equation of motion for a conservative system.
d) Explain about the Hamilton-Jacobi theory.

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

a) Deduce the Lagrange's equation of motion from Hamilton's principle.
b) Derive the equation of compound pendulum using Hamilton's equation of motion.
c) Express the reduced mass from two-body problem into equivalent one body.

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

a) Explain about the canonical transformation and deduce the condition for transformation to be canonical.
b) Derive the Hamilton's canonical equations in terms of Poisson's bracket.
c) Prove the principle of least action.

Seat No.

M.Sc. Physics (Material Science) (Semester - III) (New) (NEP CBCS)
Examination: October/November - 2025
Statistical Physics (2321301)

Day & Date: Wednesday, 29-10-2025　　　　　　　　　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. (MCQ)　　　　　　　　　　08

1) Gibbs 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

2) The relation TdS = ?
　　a)　$C_v\, dT-T(\partial P/\partial S)_v.dV$　　b)　$C_v\, dT+T(\partial P/\partial S)_v.dV$
　　c)　$C_v\, dT+T(\partial P/\partial T)_v.dV$　　d)　$C_v\, dT+T(\partial V/\partial S)_v.dV$

3) In which statistics particles are distinguishable?
　　a)　Bose Einstein statistics　　b)　Maxwell Boltzmann statistics
　　c)　Fermi Dirac statistics　　　d)　All of the above

4) What is critical point?
　　a)　The point at which a substance transitions from solid to liquid
　　b)　The point at which phase transitions occur
　　c)　The point at which phase transitions are complete
　　d)　The point at which a substance transitions from liquid to gas

5) In Maxwell relations, $(\partial T/\partial P)s$ = ?
　　a)　$(\partial V/\partial S)_P$　　　　　　b)　$(\partial S/\partial V)_T$
　　c)　$-(\partial S/\partial P)_T$　　　　　d)　$(\partial S/\partial P)_T$

6) Photon is an example of which statistics?
　　a)　Bose Einstein statistics　　b)　Maxwell Boltzmann statistics
　　c)　Fermi Dirac statistics　　　d)　None

7) Which law of thermodynamics is directional one?
　　a)　second law　　　　　　　　b)　zeroth law
　　c)　third law　　　　　　　　　d)　first law

8) When no change in temperature between system and its surrounding, the equilibrium is called?
　　a)　Chemical　　　　　　　　　b)　Mechanical
　　c)　Thermal　　　　　　　　　　d)　All

B) write true/false 04

1) Spin of particles in FD statistics is odd half integer. (True/False)
2) Electron do not condense even into the lowest energy state. (True/False)
3) Pressure is an example of qualitative property. (True/False)
4) Refrigerator is an example of 2nd law of thermodynamics. (True/False)

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

a) Define Ideal fermi gas.
b) What is the free energy?
c) What is meant by specific heat?
d) What is chemical potential?
e) Write about phase equilibria.
f) What is thermal equilibrium.
g) Define probability.
h) What is the entropy of system?

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

a) Explain the postulate of equal prior probability.
b) What do you mean by Gibb's paradox?
c) Discuss about the weekly and strongly degenerate gas.
d) Write a note on Maxwell Boltzmann distribution.

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

a) State and write about the laws of thermodynamics.
b) What is Clausius-Clayperon equation? Express it.
c) Write in detail about the Fermi-Dirac and Bose-Einstein statistics.

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

a) What is meant by phase transition? Write in detail about its type.
b) Write in detail about the thermodynamic potential and Maxwell's relation.
c) Write a note on Liouville's theorem.

Seat No.		Set	P

M.Sc. Physics (Material Science) (Semester - III) (New) (NEP CBCS)
Examination: October/November - 2025
Atomic and Molecular Physics (2321302)

Day & Date: Friday, 31-10-2025   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. (MCQ)   08

1) When a helium atom loses an electron, it becomes _____.
   a) an alpha particle   b) a positively helium ion
   c) a proton   d) a negatively helium ion

2) The reduced mass of a diatomic molecule as a rigid rotator is _____.
   a) $(m_1+m_2)/(m_1.m_2)$ b) $(m_1.m_2)/(m_1-m_2)$
   c) $m_2/(1+m_2/m_1)$ d) $m_1/(1+m_2/m_1)$

3) Two electron spectra always show _____.
   a) Singlet and doublets   b) singlet and triplets
   c) doublets and triplets   d) all of these

4) In Raman spectroscopy, the radiation lies in the _____.
   a) Microwave Region   b) X-ray Region
   c) UV Region   d) Visible Region

5) Electrons in the atom are held in the atom due to _____.
   a) Coulombs force   b) Nuclear force
   c) Atomic force   d) Both a and b

6) "An electron can never be found inside nucleus", this statement is according to ____.
   a) Heisenberg uncertainty principle
   b) Bernoulli's equation
   c) Bohrs model
   d) Both a and b

7) Ionization energy of hydrogen atom in ground state is _____.
   a) 13.5 J   b) 13.6 eV
   c) 14 eV   d) 13.6 MeV

8) Orbital angular momentum depends on _____.
   a) l b) n and l
   c) n and m   d) m and s

B) Fill in the blanks OR write true/false **04**
1) The principal quantum number determines the orientation and energy of the orbital. (True/False)
2) The Nuclear magnetic resonance (NMR), spectrum of a molecule, is observed in radio frequency range. (True/False)
3) For l=2, ml has _____ Possible values.
4) Hyperfine structure is due to _____ interaction of valence electrons.

Q.2 Answer the following. (Any Six) **12**
a) What is meant by inner shell vacancy?
b) Define ll and ss coupling in an atom.
c) Write about asymmetric top molecule.
d) Define magnetic quantum numbers.
e) Define atomic spectra.
f) Write about the various series arising from electronic transition.
g) Write about the binding energy of an atom
h) Write about the Paschen back effect

Q.3 Answer the following. (Any Three) **12**
a) Explain about strong field stark effect in hydrogen.
b) State and discuss the Paschen back effect of two electrons.
c) Write in brief on one valence electron spectra.
d) Write a note on dissociation energy and dissociation product.

Q.4 Answer the following. (Any Two) **12**
a) What is LS coupling? Elaborate.
b) Write a note on instrumentation of microwave spectroscopy.
c) Discuss about the intensity rules for Zeeman effect.

Q.5 Answer the following. (Any Two) **12**
a) What is electron spin resonance? Explain.
b) Write in detail about different quantum numbers of an electron in an atom.
c) Explain about the rotational spectrum of molecule.

Seat No.		Set	P

M.Sc. Physics (Material Science) (Semester - III) (New) (NEP CBCS) Examination: October/November - 2025
Microcontrollers and Interfacing (2321306)

Day & Date: Monday, 03-11-2025   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. (MCQ)   **08**

1) A microcontroller at-least should consist of _____.
    a) RAM, ROM, I/O ports and timers
    b) CPU, RAM, I/O ports and timers
    c) CPU, RAM, ROM, I/O ports and timers
    d) CPU, ROM, I/O ports and timers

2) Why microcontrollers are not called general purpose computers?
    a) because they have built in RAM and ROM
    b) because they design to perform dedicated task
    c) because they are cheap
    d) because they consume low power

3) Which of the following task swapping method is a better choice in the embedded systems design?
    a) time slice
    b) RMS
    c) cooperative multitasking
    d) pre-emptive

4) How many bytes of bit addressable memory is present in 8051 based microcontrollers?
    a) 8 bytes   b) 32 bytes
    c) 16 bytes   d) 128 bytes

5) Which instruction is used to check the status of a single bit?
    a) MOV A,P0   b) ADD A,#05H
    c) JNB PO.0, label   d) CLR P0.05H

6) What is the file extension that is loaded in a microcontroller for executing any instruction?
    a) .doc   b) .c
    c) .txt   d) .hex

7) The last statement of the source program should be
    a) Stop   b) Return
    c) OP   d) End

8) Which of the following is the basic function of a timer?
   a) it can control the compare, capture mode
   b) it provided a time delay
   c) it can act as a counter
   d) all of the mentioned

B) Fill in the blanks OR write true/false **04**
   1) Different instruction sets must make up for the various members of the 8051 family. True/False
   2) Device pins XTAL1 and XTAL2 for the 8051 are used for connections to an external oscillator or crystal. True/False
   3) 8051 series has _____ 16 bit registers.
   4) _____ devices are specifically being used for converting serial to parallel and from parallel to serial respectively.

Q.2 Answer the following (Any Six) **12**
   a) What are the uses of accumulator register.
   b) What is the memory size of sbit in embedded C.
   c) List the interrupt source in 8051.
   d) What is the notion for right shift in embedded C?
   e) What is mean by SP and PC in 8051 microcontrollers.
   f) Define program Counter.
   g) List the various registers used in 8051.
   h) What is stack pointer in 8051 microcontroller.

Q.3 Answer the following (Any Three) **12**
   a) Name the special functions registers available in 8051.
   b) Explain the role of CALL and subroutine starting from F000h (without overlapping)
   c) What is the microcontroller and what are its applications.
   d) Write a program to load three numbers into Accumulator and send them to port 1

Q.4 Answer the following (Any Two) **12**
   a) Using a block diagram, explain the features of the 8051 microcontroller
   b) Write a program the 8051 in C to receive bytes of data serially and put them in Pl. Set the baud rate at 9600, 8-bit, and 1 Stop bit.
   c) Discuss the logical instruction of 8051 microcontroller

Q.5 Answer the following (Any Two) **12**
   a) Draw and explain pin configuration of 8051.
   b) Explain the interfacing of 8051 microcontroller to ADC 0804
   c) Explain serial communication in 8051 microcontroller.

Seat No.

M.Sc. Physics (Material Science) (Semester - III) (New) (NEP CBCS) Examination: October/November – 2025
Physics of Nanomaterials (2321307)

Day & Date: Monday, 03-11-2025   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.
              3) Draw neat diagrams wherever necessary.

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

1) Density of states in 3D varies with energy as _____.
   a) $\propto E^0$ b) $\propto E^{1/2}$
   c) $\propto E$ d) $\propto E^2$

2) Quantum confinement increases the bandgap because_____.
   a) Coulomb repulsion decreases
   b) Electron energy levels shift upward
   c) Phonon scattering increases
   d) Effective mass decreases

3) Multiwalled carbon nanotubes consist of ____.
   a) Single graphene cylinder
   b) Many concentric graphene cylinders
   c) Amorphous carbon chains
   d) Fullerene-like clusters

4) Raman spectroscopy of CNTs shows ____.
   a) G-band and RBM modes
   b) D-band only
   c) Absorption edge shift
   d) PL peak shift

5) Pulsed laser deposition is an example of ____.
   a) Chemical route
   b) Mechanical route
   c) Physical vapor deposition
   d) Electrochemical route

6) Photoluminescence intensity is generally higher for ____.
   a) Bulk material
   b) Nanocrystals due to quantum confinement
   c) Amorphous material
   d) Doped insulators

7) In the Drude model, electrical conductivity $\sigma =$
   a) $ne2\,\tau\,/m$
   b) Ne/m
   c) $e2n/h$
   d) Mn/τ

8) Poole-Frenkel effect is observed in _____.
   a) Metals at low temperature
   b) Insulators with traps
   c) Superconductors
   d) CNTs under high current

B) Fill in the blanks/ Write True or False.   **04**
1) The energy levels in a 2D quantum well are quantized in _____ direction(s).
2) True/False: Exciton binding energy is lower in nanostructures compared to bulk.
3) Ball milling is a _____ approach to nanomaterial synthesis.
4) True/False: Surface plasmon resonance is independent of the dielectric environment.

Q.2 Answer the following. (Any Six)   **12**
  a) Define quantum confinement and give its significance.
  b) Explain the density of states for 1D, 2D, and 3D systems (only expressions).
  c) Mention any two applications of quantum dots.
  d) Explain the difference between SWCNT and MWCNT.
  e) Write two advantages of the bottom-up approach over the top-down approach.
  f) State Clausius-Mossotti equation (no derivation).
  g) Give two applications of MEMS/NEMS.
  h) Explain the principle of photoluminescence.

Q.3 Answer the following. (Any Three)   **12**
  a) Derive an expression for the density of states in a 2D system.
  b) Explain Raman spectroscopy for the characterization of carbon nanotubes.
  c) Describe pulsed laser deposition with a neat schematic.
  d) Explain photoluminescence and electroluminescence with suitable examples.

Q.4 Answer the following. (Any Two)   **12**
  a) Discuss fabrication techniques for nanodevices using lithography.
  b) Explain the Drude model of electrical conductivity and its limitations.
  c) Describe various polarization mechanisms in dielectrics.

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

    a)   Explain the quantum confinement effect on the bandgap with a diagram.

    b)   Discuss various conduction mechanisms in insulators and semiconductors.

    c)   Explain the synthesis of nanomaterials by ball milling and the polyol method

Seat No.		Set	**P**

M.Sc. Physics (Material Science) (Semester - III) (New) (NEP CBCS)
Examination: October/November – 2025
Energy Harvesting Devices (2321308)

Day & Date: Monday, 03-11-2025   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) Piezoelectric cell can be used as _____.
    a) Transducer   b) Amplifier
    c) Capacitor   d) Oscillator

2) Which of the following materials exhibits pseudo capacitance?
    a) Silicon
    b) Copper
    c) RuO_2 (Ruthenium dioxide)
    d) Aluminum

3) In hydrogen-oxygen fuel cells, the by-product are ____.
    a) water only   b) heat only
    c) both water and heat   d) none of these

4) The standard emf of the hydrogen - oxygen fuel cell is _____.
    a) 0.58 V   b) 2.54 V
    c) 3.96 V   d) 1.23 V

5) Piezoelectric crystal produces _____.
    a) Low voltage   b) medium voltage
    c) high voltage   d) Zero voltage

6) The main disadvantage of silicon solar cells is: ____.
    a) Low efficiency
    b) High manufacturing cost
    c) High toxicity of materials
    d) Degradation of performance with time

7) The typical operating voltage range of a super capacitor is: ____.
    a) 0-1 V   b) 5-10 V
    c) 2-3 V   d) 0-2 V

8) Dye-sensitized solar cells (DSSCs) used mainly for material as the photoanode?
    a) Si   b) TiO_2
    c) $CuInSe_2$ d) CdS

B) State True/ False.   **04**
1) Piezoelectric material can be used to generate Microwave. (True/False)
2) The output of fuel cell is AC type. (True/False)
3) Photovoltaic (PV) cells convert sunlight directly into electricity. (True/False)
4) Supercapacitors are ideal for applications requiring long-term energy storage. (True/False)

Q.2 Answer the following. (Any Six)   **12**
a) Define and explain the piezoelectric effect.
b) Define and explain Hybrid supercapacitor.
c) Define Fill Factor and efficiency of PV cell.
d) Explain the advantages of fuel cell over battery.
e) Explain the p- n junction solar cell.
f) Elucidate Cds / Cu2s solar cell.
g) Give the anode and cathode reaction in Hydrogen-Oxygen Fuel cell.
h) Explain the charge storage mechanism in double layer capacitance in super capacitor.

Q.3 Answer the following. (Any Three)   **12**
a) Explain the working of Hydrogen-Oxygen based fuel cell.
b) write note on photo electrochemical cell.
c) Explain the any four applications of super capacitor in detail.
d) Explain symmetric & asymmetric super capacitor configurations.

Q.4 Answer the following. (Any Two)   **12**
a) Explain the construction and working of Hydrogen-Oxygen based.
b) With neat diagram explain the construction of alkaline fuel cell.
c) Explain the construction and working of dye sensitized solar cell.

Q.5 Answer the following. (Any Two)   **12**
a) Explain any three piezoelectric materials with their advantages and disadvantages.
b) Explain principle & working of proton exchange membrane in fuel cell.
c) Describe principle, working and materials for DSSC solar cell.

Seat No.

M.Sc. Physics (Material Science) (Semester - IV) (New) (NEP CBCS) Examination: October/November – 2025
Physics of Semiconductor Devices (2321401)

Day & Date: Tuesday, 28-10-2025   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. (MCQ)   **08**

1) The $M - S$ structure forms ____ barrier.
- a) Schottky
- b) Read
- c) Ohmic
- d) Non - Ohmic

2) The theory explaining the concept of negative differential resistance is ____.
- a) RWH
- b) Hall effect
- c) quantum confinement
- d) both (b) and (c)

3) In a case of heterojunction LASER, ____ types of materials are present.
- a) n-type
- b) p-type
- c) both (a) and (b)
- d) only n-type

4) LEDs fabricated with GaAs emit ____ wavelength.
- a) far ultraviolet
- b) ultraviolet
- c) visible
- d) infrared

5) Hall Effect is used to measure ____.
- a) majority carrier concentration
- b) mobility
- c) drift current
- d) All of these

6) Photodetector ____ optical signal.
- a) reflects
- b) detects
- c) modulate
- d) amplify

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

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

B) Fill in the blanks OR Write True/False. 04
1) Photodiodes operate under _____ bias.
2) Pulsed laser can deliver very _____ power.
3) LASER convert electrical energy to optical energy. (True/False)
4) A higher position in the energy band diagram represents a higher electron energy. (True/False)

Q.2 Answer the following. (Any Six) 12
a) What is Effective Mass of Electron?
b) What is meant by Fermi level?
c) What is Band diagram of Extrinsic semiconductor?
d) What is meant by Electroluminescence?
e) What is Schottky effect?
f) What are the types of Thyristors?
g) What are Turn ON methods of SCR?
h) What is meant by LDR?

Q.3 Answer the following. (Any Three) 12
a) Write in detail about the variation of energy bands with alloy composition.
b) Explain the Radiative and non-radiative transitions.
c) Explain the behavior of electrons and holes in quantum wells.
d) Explain the conditions of an Ideal MIS Diode.

Q.4 Answer the following. (Any Two) 12
a) What is solar cell? Obtain an expression for open circuit voltage and short circuit current.
b) Give a brief account of quantum efficiency and response speed of solar cell.
c) Explain Principal and working of Photodiode device.

Q.5 Answer the following. (Any Two) 12
a) Explain the energy band diagram of Metal-Semiconductor Contact (n-type case).
b) Explain the working of the Rectifying Contacts.
c) Write in detail about Heterostructure LASER.

Seat No.		**Set**	**P**

M.Sc. Physics (Material Science) (Semester - IV) (New) (NEP CBCS)
Examination: October/November - 2025
Nuclear and Particle Physics (2321402)

Day & Date: Thursday, 30-10-2025   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. (MCQ)   08

1)   Which of the following best define nuclear forces?
   a)   The attraction between protons and neutrons
   b)   Repulsion between protons and neutrons
   c)   The attraction between protons and electrons
   d)   The attraction between electrons and neutrons

2)   Which of the following is a stable nucleus?
   a)   The nucleus with even protons and odd electrons
   b)   The nucleus with even number of protons and neutrons
   c)   The nucleus with even neutrons and odd protons
   d)   The nucleus with odd protons and neutrons

3)   Find the true statement.
   a)   Nuclear charge is dependent on the charge
   b)   The nuclear force is weaker than the electromagnetic force
   c)   The nuclear force is independent of charge
   d)   The nuclear force is weaker than the gravitational force

4)   Nuclear Organizer Regions (NOR) is found in _____.
   a)   Nuclear matrix   b)   Nucleolus
   c)   Nuclear lamina   d)   Nucleoporins

5)   Nuclear physics primarily deals with the study of: _____.
   a)   Electrons in atoms
   b)   Nucleons in atomic nuclei
   c)   Photons in electromagnetic waves
   d)   Quarks in protons

6)   The Coulomb barrier in nuclear reactions must be overcome to: _____.
   a)   Counteract electromagnetic repulsion between protons
   b)   Increase neutron absorption
   c)   Reduce gamma-ray emission
   d)   Initiate chemical reactions
.

7) The particle proposed by Yukawa to explain nuclear forces is the: ____
   a) Muon   b) Pion (π-meson)
   c) Kaon   d) Photon

8) The first artificial nuclear transmutation was achieved by Rutherford using: ____.
   a) Protons   b) Alpha particles
   c) Neutrons   d) Electrons

B) Fill in the blanks OR Write True /False   **04**
   1) The nuclear force is short-ranged. True /False
   2) Nuclear reactions always conserve the number of protons and neutrons. True /False
   3) The Q-value of an exoergic reaction is negative. True /False
   4) Neutrinos have zero rest mass. True /False

Q.2 Answer the following. (Any Six)   **12**
   a) Define a nuclear reaction and give its general notation.
   b) What are direct nuclear reactions? Provide one example.
   c) What are the properties of nuclear force?
   d) Differentiate between leptons and hadrons.
   e) How does the Higgs mechanism impart mass to particles?
   f) What exactly is nuclear binding energy?
   g) Define Nuclear stability.
   h) Explain the concept of isospin with an example.

Q.3 Answer the following. (Any Three)   **12**
   a) Write a short note on Nuclear Reaction Cross sections.
   b) Explain Strangeness and Strange Particles.
   c) Explain the role of angular momentum in nuclear reactions. How does conservation of angular momentum affect the possible outcomes of a nuclear reaction.
   d) Explain Packing fraction.

Q.4 Answer the following. (Any Two)   **12**
   a) Write a note on Binding Energy.
   b) Derive the expression for the Q-value of a nuclear reaction. Discuss how the Q-value determines whether a reaction is energetically favorable.
   c) Explain nuclear forces.

Q.5 Answer the following. (Any Two)   **12**
   a) Explain properties of nucleus.
      i) Strongest Forces.
      ii) Short range forces.
      iii) Exchange Forces.
   b) State the nuclear size and nuclear Density.
   c) Explain the quark model and its role in classifying hadrons.

Seat No.		Set	P

M.Sc. Physics (Material Science) (Semester - IV) (New/Old) (CBCS) Examination: October/November - 2025
Semiconductor Devices (MSC03401)

Day & Date: Tuesday, 28-10-2025   Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. 1 and 2 are compulsory.
      2) Attempt any three from Q. 3 to Q. 7.
      3) Figures to the right indicate full marks.

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

1) In the case of accumulation, there occurs _____ of majority charge carriers, after biasing MIS structure.
  a) addition   b) removal
  c) both (a) and (b)   d) none of these

2) The biasing condition in which there is _____ voltage drop is called as Flat-Band condition.
  a) little   b) no
  c) not defined   d) All of these

3) _____ conversion is performed by the readout circuits in CCD.
  a) parallel to series   b) series to parallel
  c) parallel to parallel   d) All of these

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

5) If there is conduction of current 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) In the gate voltage sweep, the point at which a significant current begins to flow is called as _____.
  a) cut-off voltage   b) contact potential
  c) threshold voltage   d) All of these

7) CCD gate length should be _____ in order to increase fringing field.
  a) reduced   b) enhanced
  c) unchanged   d) All of these

8) The theory explaining the concept of negative differential resistance is _____.
     a) RWH   b) Hall effect
     c) quantum confinement   d) both (b) and (c)

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

10) The NMOS will start conducting when a _____ voltage is applied to the gate.
     a) breakdown   b) low
     c) high   d) both (a) and (b)

B) Fill in the blanks or Write True/False   **06**
1) Turning the SCR from forward blocking to forward conduction state is called as _____.
2) _____ is defined as the number of photoelectrons produced divided by the number of impinging photons.
3) Photodiodes operate under _____ bias.
4) The insulator layer at the metal-semiconductor junction can potentially lower the Fermi-level pinning. (True/False)
5) NMOS are considered to be faster than PMOS. (True/False)
6) A higher position in the energy band diagram represents a higher electron energy. (True/False)

Q.2 Answer the following.   **16**
  a) Draw a neat labelled diagram showing construction of Gunn diode.
  b) Differentiate between in depletion and enhancement MOSFET.
  c) Draw a neat labelled diagram of construction of Solar Cell.
  d) Write in short about dark current.

Q.3 Answer the following.   **16**
  a) Explain in detail about the construction and working of p-n junction LASER.
  b) What is a photoconductor? Write in short about photocurrent gain.

Q.4 Answer the following.   **16**
  a) What is a Schottky diode? Explain in detail about basic mechanism of Schottky diode.
  b) What is a flat band condition? What are the basic equations in flat band conditions?

Q.5 Answer the following.   **16**
  a) Describe IV characteristics of solar cell. Derive an expression for quantum efficiency of solar cell.
  b) Explain in detail about charge trapping in MOSFET.

Q.6 **Answer the following.** 16
    a) What are light emitting diodes? Elaborate the construction and working principles of LEDs.
    b) Write in short about dv/dt and di/dt characteristics of SCR.

Q.7 **Answer the following.** 16
    a) Explain in detail about basic construction and charge transfer mechanism in two phase CCD.
    b) Explain in brief about LSA mode of operation.