

Seat No.	
----------	--

**M.Sc. (Semester - I) (New) (NEP CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Mathematical Physics (2306101)**

Day & Date: Friday, 10-05-2024  
 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) Function  $f(Z) = 1 + \frac{1}{\sqrt{Z}}$  of a complex variable  $Z$  is \_\_\_\_\_.
  - a) has a simple pole at  $Z = 0$
  - b) has a branch cut from  $Z = 0$  to  $Z = \infty$  along real axis
  - c) is finite at all points inside a unit circle centred at origin
  - d) has a branch point at  $Z = 0$
- 2) The integral of  $Z$  along upper half of circle  $|Z| = 1$  from  $Z = -1$  to  $Z = 1$  is \_\_\_\_\_.
  - a)  $-i\pi$
  - b)  $i\pi$
  - c)  $2\pi i$
  - d)  $-2\pi i$
- 3) What is the dimensionality of the vector space spanned by the vector  $\{(1,0,0) (0,1,0) (0,0,1)\}$  \_\_\_\_\_.
  - a) 1
  - b) 2
  - c) 4
  - d) 3
- 4) What is the dimensionality of the vector space of  $3 \times 3$  matrices?
  - a) 6
  - b) 9
  - c) 12
  - d) 3
- 5) If the characteristic equation  $ar^2 + br + C = 0$  has complex roots, what type of solution do we expect?
  - a) Real and Distinct
  - b) Real and repeated
  - c) Complex conjugate
  - d) Imaginary
- 6) Which principle is allowed to solve non-homogeneous linear differential equation by adding the solutions of its homogeneous counterpart & particular solution?
  - a) Superposition principal
  - b) Homogeneous principle
  - c) Integration principal
  - d) Differential principal
- 7) Which theorem states that any periodic function can be represented as an infinite sum of sines and cosines of varying frequencies?
  - a) Laplace's Theorem
  - b) Fourier's Theorem
  - c) Parseval's Theorem
  - d) Fourier-Mellin Transform
- 8) The Fourier series expansion of a sawtooth wave contains \_\_\_\_\_.
  - a) Only cosine terms
  - b) Only sine terms
  - c) Both cosine and sine terms
  - d) Only complex exponential terms

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

- 1) Parseval's theorem relates the power of a signal to its frequency-domain representation.
- 2) Analytic functions are necessarily harmonic functions.
- 3) The dimensionality of a Hilbert space can be infinite.
- 4) A second-order homogeneous equation with constant coefficients always has exponential solutions.

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

a) Find the complex conjugate of the following equations

i)  $Z_1 = 2 + 3i$

ii)  $Z_2 = -5 - 2i$

b) Find the  $n^{\text{th}}$  root of the following number  $Z = 8i$

c) Find the general solution of the given differential equation

$$\frac{d^2y}{dt^2} - 3\frac{dy}{dt} + 2y = 5e^{2t}$$

d) Find the general solution of the given differential equation

$$\frac{d^2y}{dt^2} + 4\frac{dy}{dt} = 0$$

e) Determine whether the vectors  $V_1 = (1,2,3)$  and  $V_2 = (2,4,6)$  are linearly independent.

f) State Fourier theorem and briefly explain its significance in signal processing.

g) Define the Laplace transform of a function  $f(t)$  and explain its significance in solving the differential equations.

h) Find the inverse of the matrix  $A = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$

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

a) State and Explain Cauchy's residue theorem in detail.

b) Prove that  $I - A$  is invertible, where  $I$  is identity matrix and a square matrix  $A^2 = A$ .

c) Find the Laplace transform of  $f(s)$  for the given function  $f(t) = e^{-t}$  for  $t \geq 0$ .

d) State and prove superposition principle.

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

a) Determine the general solution of given non-homogeneous differential equation  $y'' + 3y' + 2y = 4x$

b) Evaluate the integral  $f(z) = \oint_C \frac{\cos(z)}{z^2+4} dz$  where  $C$  is the semicircle in the upper half plane centred at origin with radius  $R$  &  $R > 2$ .

c) Find the eigen values and eigen vectors of the matrix  $A = \begin{bmatrix} 2 & 1 & 0 \\ 1 & 2 & 1 \\ 0 & 1 & 2 \end{bmatrix}$

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

- a) Evaluate the integral  $f(z) = \oint \frac{\sin(z)}{z^2+4} dz$  where,  $C$  is the circle  $|z| = 3$  traversed counterclockwise.
- b) i) Compute the Fourier series of the function  $f(x) = x$  over the interval  $-\pi \leq x \leq \pi$ .
- ii) Determine the first three nonzero terms of the Fourier series for the sawtooth wave  $g(x)$ , which has period  $2\pi$  and is defined as follows:

$$g(x) = \begin{cases} x & \text{for } -\pi \leq x < 0 \\ x - 2\pi & \text{for } 0 < x < \pi \end{cases}$$

- c) Find the inverse of the matrix  $A = \begin{vmatrix} 2 & 1 & -1 \\ 1 & 0 & 2 \\ -3 & 2 & 1 \end{vmatrix}$  and verify  $A \times A^{-1} = I$

Seat No.	
----------	--

**M.Sc. (Semester - I) (New) (NEP CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Solid State Physics (2306102)**

Day & Date: Monday, 13-05-2024  
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

**Instructions:** 1) All questions are compulsory.  
 2) The figure to right indicate full marks.

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

**08**

- 1) Which of the following is a property of a superconductor?
  - a) Perfect diamagnetism
  - b) High electrical resistance
  - c) Low electrical conductivity
  - d) non-zero resistivity
- 2) What happens to the free electrons when an electric field is applied?
  - a) They move randomly and collide with each other
  - b) They move in the direction of the field
  - c) They remain stable
  - d) They move in the direction opposite to that of the field
- 3) Dielectrics which show spontaneous polarization are called as \_\_\_\_\_.
  - a) Pyroelectric
  - b) Piezoelectric
  - c) Ferroelectric
  - d) Centrosymmetric
- 4) According to Curie-Wiess's law \_\_\_\_\_.
  - a)  $\chi = C/(T - \theta)$
  - b)  $\chi = C/(T + \theta)$
  - c)  $\chi = C/(\theta - T)$
  - d)  $\chi = C/T\theta$
- 5) The magnetic lines of force cannot penetrate the body of a superconductor, a phenomenon known as \_\_\_\_\_.
  - a) Isotopic effect
  - b) BCS theory
  - c) Meissner's effect
  - d) London theory
- 6) In which of the following the magnetic moments align themselves parallel to each other?
  - a) Paramagnetic material
  - b) Ferromagnetic material
  - c) Ferrimagnetic material
  - d) Diamagnetic material
- 7) The amount of energy required to raise the substance of 1 kg by 1°C is called \_\_\_\_\_.
  - a) specific entropy
  - b) specific heat capacity
  - c) sensible heat
  - d) latent heat
- 8) Polarization that possess positive and negative ions when an electric field is not applied is termed as \_\_\_\_\_.
  - a) Electrical
  - b) Magnetic
  - c) Ionic
  - d) orientation

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

**04**

- 1) The fermi energy level for extrinsic 'n' type semiconductors lies \_\_\_\_\_.
- 2) The temperature at which the conductivity of a material becomes infinite is called \_\_\_\_\_.
- 3) Weber is the unit of magnetic flux.
- 4) In a good conductor, the energy gap between the conduction band and the balance band is wide.

- Q.2 Answer the following. (Any Six). 12**
- a) What is heat capacity?
  - b) Define diamagnetic materials.
  - c) Write a short note on the Bloch wall.
  - d) Define Neel temperature.
  - e) What is the isotope effect?
  - f) What is ionic polarization?
  - g) State the concept of ferroelectricity.
  - h) State Curie-Weiss's law?
- Q.3 Answer the following (Any Three) 12**
- a) Write a note on BCS theory.
  - b) Difference between diamagnetic and paramagnetic.
  - c) Explain Brillouin zones in 2-D.
  - d) Write a note on the orientation polarization.
- Q.4 Answer the following (Any Two) 12**
- a) Explain the Clausius - Mossotti equation.
  - b) Explain the motion of electrons in 1-D.
  - c) Explain Meissner's effect.
- Q.5 Answer the following (Any Two) 12**
- a) Explain the Kronig-Penny model.
  - b) Write a note on London penetration depth.
  - c) Explain Weiss's theory in detail.

Seat No.	
----------	--

**M.Sc. (Semester - I) (New) (NEP CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Analog and Digital Electronics (2306106)**

Day & Date: Wednesday, 15-05-2024  
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

**Instructions:** 1) All Questions are compulsory.  
 2) Figure to right indicate full marks.

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

**08**

- 1) The basic SR flip-flop can be constructed by cross coupling by using which of the gates \_\_\_\_\_.
  - a) AND or OR gate
  - b) XOR or XNOR gate
  - c) NOR or NAND gate
  - d) AND or NOR gate
- 2) In JK flip-flop "no change" condition appear when \_\_\_\_\_.
  - a)  $J = 1, K = 1$
  - b)  $J = 0, K = 0$
  - c)  $J = 1, K = 0$
  - d) None of these
- 3) Which is the 16-bit register for 8085 microprocessors \_\_\_\_\_.
  - a) Stack pointer
  - b) Accumulator
  - c) Register B
  - d) Register C
- 4) The feedback path in an op-amp integrator consists of \_\_\_\_\_.
  - a) A resistor
  - b) A capacitor
  - c) A resistor and capacitor in series
  - d) A resistor and capacitor in parallel
- 5) Multiplexure has \_\_\_\_\_.
  - a) Many Input and one output
  - b) One input many output
  - c) Many Input and many out put
  - d) One input and one output
- 6) The op-amp comparator circuit uses \_\_\_\_\_.
  - a) Positive feedback
  - b) Negative feedback
  - c) Regenerative feedback
  - d) No feedback
- 7) Op- amp is a \_\_\_\_\_ type of amplifier.
  - a) Current
  - b) Voltage
  - c) Power
  - d) Resistance
- 8) An XOR gate can be used for \_\_\_\_\_.
  - a) Inverter and non-inverter
  - b) Only inverter
  - c) Only non-inverter
  - d) None of the above

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

**04**

- 1) In an instrumentation amplifier, the output voltage is based on the \_\_\_\_\_ times a scale Factor.
- 2) The output voltage of a voltage buffer is \_\_\_\_\_ with the input voltage.
- 3) The voltage gain of a voltage buffer is \_\_\_\_\_.
- 4) The data in stack is called \_\_\_\_\_.

- Q.2 Answer the following. (Any Six) 12**
- a) List the allowed register pairs of 8085.
  - b) Define CMRR frequency response.
  - c) What is microprocessor? Give the power supply & clock frequency of 8085.
  - d) Draw AND gate with truth table.
  - e) Define Input offset voltage.
  - f) Define Multiplexer.
  - g) State the principle of phase shift oscillator.
  - h) Define Voltage follower.
- Q.3 Answer the following. (Any Three) 12**
- a) Explain Multiplexers and Demultiplexers.
  - b) Explain Inverting and Non inverting amplifier.
  - c) Write a note on Demorgan's Theorem.
  - d) Write in details of Integrator and Differentiator.
- Q.4 Answer the following. (Any Two) 12**
- a) Draw and explain Integrator using 741 Op Amp.
  - b) What is multivibrator? Explain the difference between the three types of multivibrators.
  - c) Draw and explain 8:1 Multiplexers.
- Q.5 Answer the following. (Any Two) 12**
- a) Draw and explain memory write cycle of 8085 microprocessor.
  - b) Explain in details of instrumentation amplifier.
  - c) Define Oscillators? Explain their types.

Seat No.	
-------------	--

**M.Sc. (Semester - I) (New) (NEP CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Research Methodology in Physics (2306105)**

Day & Date: Friday, 17-05-2024  
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

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

**Q.1 A) Choose the correct alternatives from the options.**

**08**

- 1) Research is \_\_\_\_\_.
  - a) Searching again and again
  - b) Finding solution to any problem
  - c) Working in a scientific way to search for truth of any problem
  - d) None of above
- 2) Electronic interview can be conducted by \_\_\_\_\_.
  - a) Telephonic
  - b) Fax
  - c) Personal
  - d) All of the above
- 3) In DC sputtering, \_\_\_\_\_ bias is applied to the target material.
  - a) Negative
  - b) Positive
  - c) No
  - d) All of the above
- 4) E-beam evaporation transfers \_\_\_\_\_ and precise metal coatings.
  - a) Non-uniform
  - b) Pure
  - c) Impure
  - d) All of the above
- 5) 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
- 6) Resistive thermal deposition can deposit materials with low \_\_\_\_\_ points.
  - a) boiling
  - b) decimal
  - c) melting
  - d) None of the above
- 7) The most common scales used in research are \_\_\_\_\_.
  - a) Nominal
  - b) Ratio
  - c) Ordinal
  - d) All of the above
- 8) HRTEM provides \_\_\_\_\_ images.
  - a) medium resolution
  - b) poor resolution
  - c) low resolution
  - d) high resolution



- B) Fill in the blanks OR Write True or False: 04**
- 1) In \_\_\_\_\_ sputtering, magnets behind cathode trap electrons.
  - 2) In PLD, kinetic energies of ablated particles are high enough to promote surface diffusion. (True/False)
  - 3) \_\_\_\_\_ sampling is a probability sampling method.
  - 4) Hypothesis must be conceptually clear. (True/False)
- Q.2 Answer the following. (Any Six) 12**
- a) State the physical conditions of Ion beam sputtering.
  - b) What is the necessity of defining the research problem?
  - c) Write the significance of HRTEM over SEM and TEM techniques.
  - d) What is empirical research method?
  - e) State the parameters affecting the deposition by chemical bath method.
  - f) State the various tools for data analysis.
  - g) Draw the neat labeled diagram of electrodeposition method.
  - h) What are secondary sources of literature review?
- Q.3 Answer the following. (Any Three) 12**
- a) Write a note on Applied Vs. Fundamental research methods.
  - b) Draw the neat labeled diagram of HRTEM instrument.
  - c) Write a note on Patents.
  - d) Write in brief about Sol-gel technique.
- Q.4 Answer the following. (Any Two) 12**
- a) Elaborate the mechanism of Magnetron Sputtering.
  - b) Explain steps/process in scientific Research.
  - c) Write in detail about the construction and working of SEM.
- Q.5 Answer the following. (Any Two) 12**
- a) What is sampling? Explain essentials of good Sampling?
  - b) Explain the construction and working of Fourier Transform Infrared Spectroscopy.
  - c) What is Research Methodology? What are the requisites for Good Scientific Research?

Seat No.	
-------------	--

Set **P**

**M.Sc. (Semester - I) (Old) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Mathematical Physics (MSC09101)**

Day & Date: Friday, 10-05-2024  
 Time: 03:00 AM To 06:00 PM

Max. Marks: 80

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

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

- 1) Function  $f(Z) = 1 + \frac{1}{\sqrt{Z}}$  of a complex variable  $Z$  is \_\_\_\_\_.
  - a) has a simple pole at  $Z = 0$
  - b) has a branch cut from  $Z = 0$  to  $Z = \infty$  along real axis
  - c) is finite at all points inside a unit circle centred at origin
  - d) has a branch point at  $Z = 0$
- 2) The integral of  $Z$  along upper half of circle  $|Z| = 1$  from  $Z = -1$  to  $Z = 1$  is \_\_\_\_\_.
  - a)  $-i\pi$
  - b)  $i\pi$
  - c)  $2\pi i$
  - d)  $-2\pi i$
- 3) What is the dimensionality of the vector space spanned by the vector  $\{(1,0,0) (0,1,0) (0,0,1)\}$  \_\_\_\_\_.
  - a) 1
  - b) 2
  - c) 4
  - d) 3
- 4) What is the dimensionality of the vector space of  $3 \times 3$  matrices?
  - a) 6
  - b) 9
  - c) 12
  - d) 3
- 5) If the characteristic equation  $ar^2 + br + C = 0$  has complex roots, what type of solution do we expect?
  - a) Real and Distinct
  - b) Real and repeated
  - c) Complex conjugate
  - d) Imaginary
- 6) Which principle is allowed to solve non-homogeneous linear differential equation by adding the solutions of its homogeneous counterpart & particular solution?
  - a) Superposition principal
  - b) Homogeneous principle
  - c) Integration principal
  - d) Differential principal
- 7) Which theorem states that any periodic function can be represented as an infinite sum of sines and cosines of varying frequencies?
  - a) Laplace's Theorem
  - b) Fourier's Theorem
  - c) Parseval's Theorem
  - d) Fourier-Mellin Transform

- 8) The Fourier series expansion of a sawtooth wave contains \_\_\_\_\_.
  - a) Only cosine terms
  - b) Only sine terms
  - c) Both cosine and sine terms
  - d) Only complex exponential terms
- 9) Determinant of orthogonal matrix is \_\_\_\_\_.
  - a) 0
  - b) 1
  - c) -1
  - d) It can be real or Imaginary
- 10) Which function's Fourier transform results in a constant function?
  - a) Box function
  - b) Exponential function
  - c) Delta function
  - d) Rectangular function

**B) Write True/False.**

06

- 1) Parseval's theorem relates the power of a signal to its frequency-domain representation.
- 2) Analytic functions are necessarily harmonic functions.
- 3) The dimensionality of a Hilbert space can be infinite.
- 4) A second-order homogeneous equation with constant coefficients always has exponential solutions.
- 5) In the Argand diagram, the real part of a complex number is represented along the y-axis.
- 6) In a first-order homogeneous equation with variable coefficients, the superposition principle holds.

**Q.2 Answer the following.**

16

- a) State and Explain Cauchy's residue theorem in detail.
- b) Prove that  $I = A$  is invertible, where  $I$  is identity matrix and a square matrix  $A^2 = A$ .
- c) Find the Laplace transform of  $f(s)$  for the given function  $f(t) = e^{-t}$  for  $t \geq 0$ .
- d) State and prove superposition principle.

**Q.3 Answer the following.**

16

- a) Determine the general solution of given non-homogeneous differential equation  $Y'' + 3y' + 2y = 4x$
- b) Evaluate the integral  $f(z) = \oint_C \frac{\cos(z)}{z^2+4} dz$  where  $C$  is the semicircle in the upper half plane centred at origin with radius  $R$  &  $R > 2$ .

**Q.4 Answer the following.**

16

- a) Find the eigen values and eigen vectors of the matrix  $A = \begin{vmatrix} 2 & 1 & 0 \\ 1 & 2 & 1 \\ 0 & 1 & 2 \end{vmatrix}$
- b) Find the inverse of the matrix  $A = \begin{vmatrix} 2 & 1 & -1 \\ 1 & 0 & 2 \\ -3 & 2 & 1 \end{vmatrix}$  and verify  $A \times A^{-1} = I$ .

**Q.5 Answer the following.**

16

- a) Evaluate the integral  $\oint_C (z) = \oint \frac{\sin(z)}{z^2+4} dz$  where,  $C$  is the circle  $|Z| = 3$  traversed counterclockwise.
- b) 1) Compute the Fourier series of the function  $f(x) = x$  over the interval  $-\pi \leq x \leq \pi$ .
- 2) Determine the first three nonzero terms of the Fourier series for the sawtooth wave  $g(x)$ , which has period  $2\pi$  and is defined as follows:
- $$g(x) = \begin{cases} x & \text{for } -\pi \leq x < 0 \\ x - 2\pi & \text{for } 0 \leq x < \pi \end{cases}$$

**Q.6 Answer the following.**

16

- a) Solve  $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 2 \cos x$  using successive integration method.
- b) Discuss the second order non-homogeneous linear differential equation with constant coefficient.

**Q.7 Answer the following.**

16

- a) Expand the Fourier series for full wave rectifier
- $$f(x) = \begin{cases} \sin x; & (0 \leq x < \pi) \\ -\sin x; & (-\pi \leq x \leq 0) \end{cases}$$

- b) Find the Laplace transform of

$$f(t) \begin{cases} \sin t & 0 < t < \pi \\ 0 & t > \pi \end{cases}$$

Seat No.	
----------	--

**M.Sc. (Semester - I) (Old) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Solid State Physics (MSC09102)**

Day & Date: Monday, 13-05-2024  
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- 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 the correct alternative. 10**

- 1) In the case of a superconductor, at  $T_c$  conductance becomes \_\_\_\_\_.
  - a) Zero
  - b) Finite
  - c) Infinite
  - d) None of the above
- 2) Induced electric dipole moment is directly proportional to \_\_\_\_\_.
  - a)  $E$
  - b)  $E^2$
  - c)  $E^3$
  - d)  $E^{1/2}$
- 3) Number of tetrad axis in simple cubic system are \_\_\_\_\_.
  - a) 2
  - b) 3
  - c) 4
  - d) 8
- 4) According to mass action law, product of hole and electron concentration is equal to \_\_\_\_\_ of intrinsic concentration.
  - a) Square
  - b)  $1/2$
  - c)  $1/3$
  - d)  $1/4$
- 5) Miller indices of crystal plane which intercepts at (2a, 3b, c) are \_\_\_\_\_.
  - a) (3,3,6)
  - b) (1,2,3)
  - c) (2,1,6)
  - d) (3,2,1)
- 6) \_\_\_\_\_ metals are generally not superconductors.
  - a) Divalent
  - b) Monovalent
  - c) Trivalent
  - d) A and b
- 7) Reciprocal lattice vector  $G =$  \_\_\_\_\_.
  - a)  $K' - K$
  - b)  $K - K'$
  - c)  $K' + K$
  - d)  $(K' + K)^2$
- 8) The electronic polarizability  $\alpha_e$  of a monoatomic gas is \_\_\_\_\_.
  - a)  $4\pi\epsilon_0$
  - b)  $4\pi\epsilon_0 R$
  - c)  $4\pi\epsilon_0 R^3$
  - d)  $4\pi\epsilon_0^{-2}$
- 9) The effective mass of localized electrons depends on \_\_\_\_\_.
  - a)  $(d^2E/dK)$
  - b)  $(dE/dK)$
  - c)  $(d^2E/d^2K)^{-2}$
  - d)  $(d^2E/d^2K)^{-1}$
- 10) The coordination number of HCP is \_\_\_\_\_.
  - a) Two
  - b) Four
  - c) Six
  - d) Twelve

- B) Fill in the blanks OR Write True or False. 06**
- 1) The coordination number of the body-centered cubic crystal structure is \_\_\_\_\_.
  - 2) At \_\_\_\_\_ temperature materials show transition from normal to superconducting state.
  - 3) Induced electric dipole moment is inversely proportional to electric field  $E$ . (T/F)
  - 4) Crystalline solids are anisotropic. (T/F)
  - 5) The relation between electronic polarizability and induced electric dipole moment is given by  $\mu_e = \alpha_e \cdot E$ . (T/F)
  - 6) Brillouin zones are represented on the EK curve. (T/F)

- Q.2 Answer the following (Any Four) 16**
- a) Define packing fraction.
  - b) Concept of Cooper pair
  - c) What is electronic polarization?
  - d) What is penetration depth?
  - e) Calculate the electronic polarization of isolated Se atom of atomic radius 0.18nm. Given  $\epsilon_0 = 8.854 \times 10^{-12} F/m$

- Q.3 Answer the following. 10**
- a) Discuss the Meissner effect in detail. 10
  - b) Distinguish direct and indirect band gap semiconductors. 06

- Q.4 Answer the following. 10**
- a) Give the expression for interplanar spacing (d). 10
  - b) For simple cubic structure, calculate the number of atoms per square mm for the atomic planes (010), (110) and (111). 06

- Q.5 Answer the following. 08**
- a) Explain the Kronig-Penney model. 08
  - b) Write about Ionic polarization. 08

- Q.6 Answer the following. 10**
- a) Give the expression for the concentration of electrons in the conduction band of Intrinsic semiconductors. 10
  - b) Explain the concept of Brillouin zones. 06

- Q.7 Answer the following. 10**
- a) Explain BCC and FCC Crystal structures. 10
  - b) Explain the defects in solids. 06



- B) Fill in the blanks OR Write true/false** **06**
- 1) A phase shift oscillator uses LC network. (True/False)
  - 2) The output stage of an op-amp usually a \_\_\_\_\_.
  - 3) In \_\_\_\_\_ microprocessor, accumulator register used as a working area in CPU
  - 4) Master slave flip is also referred to as Pulse -triggered flip-flop. (True/False)
  - 5) Can an encoder be called a multiplexer? (True/False)
  - 6) Voltage when applied at two inputs of Op-amp to get 0 V of output is called Output offset voltage. (True/False)

- Q.2 Answer the following** **16**
- a) Explain the concept of virtual ground in op. amp.
  - b) State De Morgan's theorems with logical diagrams.
  - c) Explain dual input balance output differential amplifier.
  - d) Explain why open loop op-amp configurations are not used in linear applications.

- Q.3 Answer the following.**
- a) Write the features of 8085 microprocessor. **06**
  - b) Explain with neat circuit diagram Wein bridge oscillator. **10**

- Q.4 Answer the following.**
- a) Draw and explain functional block diagram of 8085 microprocessor. **08**
  - b) What is Demultiplexer? Explain 1:8 Demultiplexer. **08**

- Q.5 Answer the following.**
- a) Draw logic diagram and truth table of RS flip flop and explain its working. **08**
  - b) Draw and explain the block diagram of op.amp. **08**

- Q.6 Answer the following.**
- a) Explain summing amplifier using differential configuration. **08**
  - b) Describe 4 bit D flip-flop with timing diagram. **08**

- Q.7 Answer the following.**
- a) Draw and explain Phase shift Oscillator using op. amp. Obtain an expression for its frequency. **08**
  - b) Write an assembly language program to add two 8bit numbers. **08**



Seat No.	
----------	--

**M.Sc. (Semester - I) (Old) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Classical Mechanics (MSC09108)**

Day & Date: Friday, 17-05-2024  
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- 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) A particle moving with constant velocity along a straight path parallel to +X axis is said to possess \_\_\_\_\_.
  - a) linear momentum and angular momentum about given origin
  - b) angular acceleration
  - c) only linear momentum but not angular momentum about given origin
  - d) nothing
- 2) In Galilean transformation, time in both the frames under consideration is treated as \_\_\_\_\_.
  - a) absolute
  - b) relative
  - c) some times absolute and some times relative
  - d) variant
- 3) If the condition of the constraint is expressed as  $f(r_1, r_2, r_3, r_4 \dots, t) = 0$  then it is known as \_\_\_\_\_.
  - a) Holonomic, Rheonomous constraint
  - b) Holonomic, Scleronomous constraint
  - c) Non-holonomic, Rheonomous constraint
  - d) Non-holonomic, Scleronomous constraint
- 4) As per Kepler's third law of planetary motion, square of a time period is directly proportional to cube of a \_\_\_\_\_.
  - a) semi-minor axis
  - b) semi-major axis
  - c) diameter of a orbit
  - d) average diameter of a orbit
- 5) The Rutherford scattering cross section  $\sigma(\theta)$  varies \_\_\_\_\_ with \_\_\_\_\_ where  $\theta$  is the scattering angle
  - a) directly,  $\text{cosec}^4\left(\frac{\theta}{2}\right)$
  - b) inversely,  $\text{cosec}^4\left(\frac{\theta}{2}\right)$
  - c) directly,  $\text{cosec}^2\left(\frac{\theta}{2}\right)$
  - d) inversely,  $\text{cosec}^2\left(\frac{\theta}{2}\right)$
- 6) Action is the integral product of \_\_\_\_\_.
  - a) generalized momentum and velocity
  - b) generalized momentum and force
  - c) generalized momentum and co-ordinate
  - d) none of these

- 7) Identify the correct equation for Jacobi's Identity \_\_\_\_\_.
- $[[p, q], r] + [[p, r], q] + [[q, r], p] = 0$
  - $[[q, q], r] + [[p, r], q] + [[q, r], p] = 0$
  - $[[p, q], r] + [[p, r], q] + [[r, q], p] = 0$
  - $[[p, q], r] + [[r, p], q] + [[q, r], p] = 0$
- 8) Choose the correct equation for Hamiltonian \_\_\_\_\_.
- $H = p_i q' i - L$
  - $H = p_i q' i + L$
  - $H = p_i q_i + L$
  - $H = p_i q_i - L$
- 9) The Lagrangian of the system gives \_\_\_\_\_ of the system.
- difference in kinetic and potential energy
  - addition of kinetic and potential energy
  - power
  - rate of change of energy
- 10) The phase space is \_\_\_\_\_ dimensional space.
- 3N
  - 2N
  - N
  - 6N

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

- The transformation is canonical if  $pdq - PdQ$  is an exact differential. (True/False)
- In a simple pendulum ( $\theta$ ) is the generalized co-ordinate. (True/False)
- Under Galilean transformation the inertial mass remains invariant. (True/False)
- Hamiltonian; H is the function of \_\_\_\_\_.
- Kepler's second law tells about \_\_\_\_\_.
- A rigid body moving freely in space has the degrees of freedom \_\_\_\_\_.

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

- Explain in detail about the constraints and their classification.
- Check whether the transformation defined as  $Q=1/p, P=q^2$  is canonical or not.
- Write a note on Poisson brackets and their properties.
- State Hamilton's variational principle and derive the Lagrange's equation of motion from it

**Q.3 Answer the following.**

- Prove the laws of linear and angular momentum for a system of particles. **08**
- Explain **08**
  - Symmetries and laws of conservation
  - Jacobi integral

**Q.4 Answer the following.**

- What are generalized co-ordinates? Express the D'Alembert's principle. **08**
- What are the Kepler's laws of planetary motion? Derive the equation for Kepler's first law. **08**

**Q.5 Answer the following.**

- Express the Hamilton's canonical equations of motion and deduce them from variational principle. **08**
- Apply the Hamilton's equations to derive the equations of motion for simple pendulum and linear harmonic oscillator. **08**

**Q.6 Answer the following.**

- a) What is canonical transformation? Discuss the exact differential condition to show that the transformation is to be canonical. **08**
- b) Write about invariance under Galileon Transformation. **08**

**Q.7 Answer the following.**

- a) i) Derive the equations of motion for a particle moving near surface of earth. **08**
- ii) Show that the shortest distance between two points is a straight line.
- b) Explain and prove the principle of least action. **08**

Seat No.	
-------------	--

Set **P**

**M.Sc. (Semester - II) (New) (NEP CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Quantum Mechanics (2306201)**

Day &amp; Date: Thursday, 09-05-2024

Max. Marks: 60

Time: 11:00 AM To 01:30 PM

- Instructions:** 1) All Question are compulsory.  
 2) Figure to right indicate full marks.  
 3) Draw neat labelled diagrams wherever necessary.

**Q.1 A) Choose the correct alternatives from the options.****08**

- 1) Kets are represented by \_\_\_\_\_.
  - a) row vectors
  - b) column vectors
  - c) square matrices
  - d) both row and column vectors
- 2) For commutativity of,  $|\alpha\rangle$  and  $|\beta\rangle$ ,  $|\alpha\rangle + |\beta\rangle =$  \_\_\_\_\_.
  - a)  $|\alpha\rangle - |\beta\rangle$
  - b)  $|\alpha\rangle/|\beta\rangle$
  - c)  $|\alpha\rangle * |\beta\rangle$
  - d)  $|\beta\rangle + |\alpha\rangle$
- 3) The product of a scalar with a vector gives \_\_\_\_\_.
  - a) another vector
  - b) scalar
  - c) pseudo scalar
  - d) null vector
- 4) The uncertainty relation cannot hold for the following pairs \_\_\_\_\_.
  - a) position and momentum
  - b) energy and time
  - c) linear momentum and angle
  - d) angular momentum and angle
- 5) The minimum energy of particle confined to one dimensional rigid box is obtained by substituting  $n$  equal to \_\_\_\_\_.
  - a) one
  - b) zero
  - c) half
  - d) two
- 6) The Momentum operator is given by \_\_\_\_\_.
  - a)  $\frac{\hbar}{i} \frac{d^2}{dx^2}$
  - b)  $\frac{\hbar}{i} \frac{d}{dx}$
  - c)  $i\hbar \frac{d}{dx}$
  - d)  $-i\hbar \frac{d}{dt}$
- 7) In operator equation  $H\psi = E\psi$  the eigen function is \_\_\_\_\_.
  - a)  $H$
  - b)  $\psi$
  - c)  $E$
  - d)  $H \& E$
- 8) Which of the following is adjoint of matrix  $\begin{bmatrix} 2 & 3 \\ 1 & 4 \end{bmatrix}$ ?
  - a)  $\begin{bmatrix} -2 & 3 \\ -1 & 4 \end{bmatrix}$
  - b)  $\begin{bmatrix} 2 & -3 \\ -1 & 4 \end{bmatrix}$
  - c)  $\begin{bmatrix} -2 & 3 \\ 1 & -4 \end{bmatrix}$
  - d)  $\begin{bmatrix} 4 & -3 \\ -1 & 2 \end{bmatrix}$

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

- 1) If  $\Psi_a$  and  $\Psi_b$  are orthogonal to each other, then  $\langle \Psi_a | \Psi_b \rangle = \underline{\hspace{2cm}}$ .
- 2) The operator  $\frac{\partial^2}{\partial x^2}$  has the eigen value corresponding to an eigen function  $\psi = \sin \alpha x$  as  $\underline{\hspace{2cm}}$ .
- 3) The value of  $[L_y, L_z] = \underline{\hspace{2cm}}$ .
- 4) Hermitian operators are represented by matrices that are equal to their  $\underline{\hspace{2cm}}$ .

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

- a) Define is a linear vector space.
- b) What is Schwartz Inequality?
- c) Compute eigen values of the square matrix,  $A = \begin{bmatrix} 2 & 1 \\ 4 & 5 \end{bmatrix}$
- d) What is a Wave function ( $\psi$ )?
- e) Write boundary conditions for infinite potential well.
- f) What is a harmonic oscillator?
- g) Compute  $\psi^\dagger \cdot \psi$ ; if  $\psi^\dagger = [c_\alpha^* \ c_\beta^*]$  and  $\psi = \begin{bmatrix} c_\alpha \\ c_\beta \end{bmatrix}$
- h) What is Spinor or spin matrix?

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

- a) Discuss operator algebra.
- b) Give physical interpretation of wave function.
- c) Prove that  $[L^2, L_z] = 0$
- d) Write a note on Pauli Spin matrices.

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

- a) Derive time dependent Schrödinger's wave equation.
- b) Discuss motion of a particle in square well potential.
- c) Describe Algebra of Spin angular momenta.

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

- a) Describe Paul Dirac's bra-ket notations.
- b) State and prove Ehrenfest's theorem.
- c) Discuss Clebich Gordon Coefficient.

Seat No.	
-------------	--

**M.Sc. (Semester - II) (New) (NEP CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Electrodynamics (2306202)**

Day & Date: Saturday, 11-05-2024  
 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 the correct alternatives from the options.**

**08**

- 1) Stationary charges produce only \_\_\_\_\_ field.
 

a) Electrostatic	b) Magnetostatic
c) Both	d) None of these
  
- 2) When wave gets reflected from the surface of denser medium there is a phase change of \_\_\_\_\_.
 

a) 0°	b) 90°
c) 180°	d) 270°
  
- 3) The total power radiated by an oscillating dipole is \_\_\_\_\_ to the \_\_\_\_\_ of frequency.
 

a) Proportional, fourth	b) Inversely proportional, fourth
c) Inversely proportional, third	d) proportional, third
  
- 4) In an electromagnetic wave, the direction of magnetic field induction  $\vec{B}$  is \_\_\_\_\_.
 

a) parallel to electric field $\vec{E}$	b) perpendicular to electric field $\vec{E}$
c) random	d) None of the above
  
- 5) The Poynting's vector  $S$  of an electromagnetic wave is \_\_\_\_\_.
 

a) $\vec{S} = \vec{E} \times \vec{H}$	b) $\vec{S} = \vec{E} \times \vec{B}$
c) $\vec{S} = \vec{E} / \vec{B}$	d) $\vec{S} = \vec{E} / \vec{H}$
  
- 6) The sum of coefficient of reflection and transmission in absorption free case is \_\_\_\_\_.
 

a) 1	b) 2
c) 0.66	d) 0

- 7) Poynting's vector  $S$  gives \_\_\_\_\_.  
 a) Energy transported per unit area per second  
 b) Energy stored per unit volume  
 c) Flux of fields  
 d) Electromagnetic Momentum contained per unit volume
- 8) Which of the Maxwell's following equations is corrected based on equation of continuity \_\_\_\_\_.  
 a)  $\nabla \cdot \vec{E} = \rho/\epsilon_0$   
 b)  $\nabla \cdot \vec{B} = 0$   
 c)  $\nabla \times \vec{E} = -\partial \vec{E}/\partial t$   
 d)  $\nabla \times \vec{B} = \mu_0 J + \mu_0 \epsilon_0 \partial \vec{E}/\partial t$

**B) Write True/False.**

**04**

- 1) In equipotential surface, potential is different everywhere. (True/ False)  
 2) One of the Maxwell's equations (in free space) in differential form is as follows  $\nabla \cdot B = 0$   
 3) The direction of propagation of electromagnetic wave is  $(\vec{E} \times \vec{B})$ . (True/ False)  
 4) The equation of continuity is  $\nabla \cdot \vec{j} - \frac{\partial \rho}{\partial t} = 0$ . (True/False)

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

**12**

- a) Write Poisson's and Laplace's equations.  
 b) State Ampere's law.  
 c) State Faraday's law and write expression for it.  
 d) What are the scalar and vector potentials?  
 e) Write electromagnetic wave equations in terms of electric and magnetic fields.  
 f) Define skin depth.  
 g) What is an electric dipole?  
 h) What is radiation damping?

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

**12**

- a) State and prove Gauss's law.  
 b) Write a note on Maxwell's displacement current.  
 c) Explain the concepts: Lorentz's and Coulomb's gauges.  
 d) Explain magnetic dipole radiation.

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

**12**

- a) Derive an expression for differential form of Ampere's law.  
 b) Derive an expression for magnetic interaction between two current loops.  
 c) Derive the expressions for reflection and refraction of electromagnetic waves at plane boundaries for normal incidence.

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

**12**

- a) Derive Larmor's formula.  
 b) Derive an expression for differential form of Gauss's law.  
 c) Describe electromagnetic plane waves in stationary medium.

Seat No.	
-------------	--

**M.Sc. (Semester - II) (New) (NEP CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Classical Mechanics (2306206)**

Day & Date: Tuesday, 14-05-2024  
 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 the correct alternatives from the options.**

**08**

- 1) The gyroscopic forces are \_\_\_\_\_ in nature.
  - a) conservative
  - b) non-conservative
  - c) pseudo
  - d) not exist
- 2) If the total force is zero, then \_\_\_\_\_ is conserved.
  - a) angular momentum
  - b) force
  - c) linear momentum
  - d) torque
- 3) The square of the period of revolution of a planet around the sun is proportional to \_\_\_\_\_.
  - a) cube root of the semi major axis of the ellipse
  - b) cube root of the semi minor axis of the ellipse
  - c) cube of the semi minor axis of the ellipse
  - d) cube of the semi major axis of the ellipse
- 4) In central force laws, if the potential energy,  $V = -k/r$ , then \_\_\_\_\_.
  - a)  $f = -k/r^2$
  - b)  $f = k/r^2$
  - c)  $f = k/r$
  - d)  $f = -k/r$
- 5) If coordinates  $q_j$  in Lagrangian are cyclic, then  $\frac{\partial H}{\partial q_j}$  is equal to \_\_\_\_\_.
  - a) 1
  - b) 2
  - c) -1
  - d) 0
- 6) The configuration space involves \_\_\_\_\_.
  - a) 2N dimensions
  - b) 3N dimensions
  - c) 6N dimensions
  - d) 4N dimensions
- 7) The Poisson's bracket,  $[q, q] =$  \_\_\_\_\_.
  - a) p
  - b) q
  - c) 0
  - d) Q
- 8) The Kronecker delta,  $\delta_{ik} = 1$  for \_\_\_\_\_.
  - a)  $i = k$
  - b)  $i \neq k$
  - c) not depends on  $i$  and  $k$
  - d) depends on  $i$  and  $k$



- B) Write True/False.** **04**
- 1) The equations of constraints containing the time as an explicit variable are called rheonomous constraints. (True/ False)
  - 2) In  $\delta$  variation, both position and time coordinates at the end points, are not fixed. (True/ False)
  - 3) The fundamental Poisson's brackets are invariant under canonical transformation. (True/ False)
  - 4) An angular momentum is conserved in the absence of external torque. (True/ False)
- Q.2 Answer the following. (Any Six)** **12**
- a) What are the gyroscopic forces?
  - b) Prove linear momentum is conserved for a particle.
  - c) What are the degrees of freedom?
  - d) What are the generalized coordinates?
  - e) State Hamilton's principle and write its expression.
  - f) What is configuration space?
  - g) How many forms of generating function? Write it.
  - h) Define Poisson's bracket and write its expression.
- Q.3 Answer the following (Any Three)** **12**
- a) State and prove work-energy theorem.
  - b) Derive an expression for reduction of two body problem in to equivalent one body problem.
  - c) Deduce Lagrange's equation of motion from Hamilton's principle.
  - d) Explain any four properties of Poisson's brackets.
- Q.4 Answer the following (Any Two)** **12**
- a) Derive the equation of motion for the system with variable mass.
  - b) Explain general features of the orbit with effective potential energy curve.
  - c) Deduce Euler-Lagrange's differential equation using variational technique.
- Q.5 Answer the following (Any Two)** **12**
- a) Derive an expression for Kepler's first law of planetary motion.
  - b) Explain the principle of least action and prove it.
  - c) Derive Hamilton's canonical equations of motion in terms of Poisson's brackets.

Seat  
No.

**M.Sc. (Semester - II) (Old) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Quantum Mechanics (MSC09201)**

Day & Date: Thursday, 09-05-2024  
 Time: 11:00 AM To 02:00 PM

Max. Marks: 80

- 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 the correct alternative from the options.****10**

- 1) An electron, a neutron, an alpha particle and tennis ball are, moving at the same speed. Which one of them has the greatest de Broglie Wavelength?
  - a) Neutron
  - b) Electron
  - c) Tennis ball
  - d) Alpha particle
- 2) Consider an electron in a ring of constant potential energy. Let  $C$  be the length of circumference of the ring. Since wave functions must be single valued, then  $\psi(x) = \underline{\hspace{2cm}}$ .
  - a)  $\psi\left(x + \frac{C}{4}\right)$
  - b)  $\psi\left(x + \frac{C}{2}\right)$
  - c)  $\psi(x + C)$
  - d)  $\psi\left(x + \frac{3C}{4}\right)$
- 3) Which of the following relation is true for wavelength of De Broglie waves?
  - a)  $\lambda = \frac{h}{p}$
  - b)  $\lambda = \frac{p}{h}$
  - c)  $\lambda = \frac{1}{\sqrt{ph}}$
  - d)  $\lambda = \frac{p}{m}$
- 4) The number of electrons circulating about the positively charged nucleus in hydrogen like atom is \_\_\_\_\_.
  - a) negligible
  - b) equal to the number of protons in the nucleus
  - c) equal to mass number
  - d) one
- 5) The zero-point energy of a particle in 3-dimensional box is \_\_\_\_\_.
  - a) equal to that for a one-dimensional box.
  - b) double that for a one-dimensional box.
  - c) three times that for a one-dimensional box.
  - d) nine times that for a one-dimensional box.
- 6) If electron 1 is placed at definite point in space, then the potential energy of electron 1 in the field of electron 2 is given by \_\_\_\_\_.
  - a)  $V_1 = \int \frac{\phi_1^2(1)}{r_{12}} d\tau_1$
  - b)  $V_1 = \int \frac{\phi_1^2(1)}{r_{12}} d\tau_2$
  - c)  $V_1 = \int \frac{\phi_2^2(2)}{r_{12}} d\tau_1$
  - d)  $V_1 = \int \frac{\phi_2^2(2)}{r_{12}} d\tau_2$



**Q.6 Answer the following.**

**16**

- a) Obtain Total wave function of hydrogen- like atom.
- b) Discuss wave function of many electron systems.

**Q.7 Answer the following.**

**16**

- a) Write a note on Slater's rules.
- b) Give the formulation of Valence-Bond method for the Hydrogen molecule.

Seat  
No.

**M.Sc. (Semester - II) (Old) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Electrodynamics (MSC09202)**

Day & Date: Saturday, 11-05-2024  
 Time: 11:00 AM To 02:00 PM

Max. Marks: 80

- Instructions:** 1) Q. No. 1 and 2 are compulsory.  
 2) Attempt any Three questions from Q.No.3 to Q.No.7.  
 3) Figures to the right indicates full marks.

**Q.1 A) Choose the correct alternatives from the options.****10**

- 1) If magnetic monopole existed, then which of the following Maxwell's equations will be modified \_\_\_\_\_.
  - a)  $\nabla \cdot \vec{E} = \rho/\epsilon_0$
  - b)  $\nabla \cdot \vec{B} = 0$
  - c)  $\nabla \times \vec{E} = -\partial \vec{B}/\partial t$
  - d)  $\nabla \times \vec{B} = \mu_0 J + \mu_0 \epsilon_0 \partial \vec{E}/\partial t$
- 2) The power radiated by an electric dipole is proportional to \_\_\_\_\_.
  - a)  $\omega$
  - b)  $\omega^2$
  - c)  $\omega^3$
  - d)  $\omega^4$
- 3) Poynting's vector S gives \_\_\_\_\_.
  - a) Energy transported per unit area per second
  - b) Energy stored per unit volume
  - c) Flux of fields
  - d) Electromagnetic Momentum contained per unit volume
- 4) The sum of coefficient of reflection and transmission in absorption free case is \_\_\_\_\_.
  - a) 1
  - b) 2
  - c) 0.66
  - d) 0
- 5) The vectors of the electromagnetic wave propagation can be expressed in \_\_\_\_\_.
  - a) dot product
  - b) cross product
  - c) unit vector
  - d) perpendicular vector
- 6) The Poynting's vector S of an electromagnetic wave is \_\_\_\_\_.
  - a)  $\vec{S} = \vec{E} \times \vec{H}$
  - b)  $\vec{S} = \vec{E} \times \vec{B}$
  - c)  $\vec{S} = \vec{E}/\vec{B}$
  - d)  $\vec{S} = \vec{E}/\vec{H}$
- 7) Faraday's laws are consequence of the conservation of \_\_\_\_\_.
  - a) charge
  - b) energy
  - c) magnetic field
  - d) both (b) and (c)
- 8) The expression for the continuity equation is \_\_\_\_\_.
  - a)  $\rho + J = 0$
  - b)  $d\rho/dt + \nabla \cdot J = 0$
  - c)  $d\rho/dt + J = 0$
  - d)  $\rho + \nabla J = 0$
- 9) SI unit of magnetic induction is \_\_\_\_\_.
  - a)  $NC^{-1}$
  - b) tesla
  - c) weber
  - d)  $NmA^{-1}$

- 10) The Maxwell's equation derived from Ampere's law is \_\_\_\_\_.
- |                          |                          |
|--------------------------|--------------------------|
| a) $\nabla \cdot I = H$  | b) $\nabla \cdot H = J$  |
| c) $\nabla \times B = J$ | d) $\nabla \times B = D$ |

**B) Write True /False.**

**06**

- 1) The complete theory of electromagnetic waves is contained in Maxwell's equations. (True/False)
- 2) In equipotential surface, potential is different everywhere. (True/False)
- 3) Total four Maxwell's equations in electrodynamics. (True/ False)
- 4) The direction of propagation of electromagnetic wave is  $(\vec{E} \times \vec{B})$ . (True/ False)
- 5) The equation of continuity is the consequence of conservation of charge. (True/ False)
- 6) Planck's law gives third Maxwell's equation. (True/ False)

**Q.2 Answer the following.**

**16**

- a) State and explain the Faraday's law.
- b) Explain the concepts: skin effect and skin depth.
- c) Derive the expression for the inhomogeneous wave equations.
- d) Derive the expression for Thomson cross-section.

**Q.3 Answer the following.**

- a) Write a detailed note on differential and integral forms of Maxwell's equations.
- b) Give detailed account on Maxwell's displacement current.

**10**

**06**

**Q.4 Answer the following.**

- a) Describe the reflection and refraction of electromagnetic waves at plane boundaries.
- b) Derive the expression for magnetic interaction between two current loops.

**10**

**06**

**Q.5 Answer the following.**

- a) What are the Gauge transformations? Derive the expressions for the wave equations in terms of electromagnetic potentials.
- b) Explain the Lorentz's and Coulomb's gauges with their gauge conditions.

**10**

**06**

**Q.6 Answer the following.**

- a) Derive the expression for the radiation from an oscillating electric dipole.
- b) Explain the concept radiation damping.

**10**

**06**

**Q.7 Answer the following.**

- a) Derive the Maxwell's equations for moving medium.
- b) State and prove the Poynting's theorem.

**10**

**06**

Seat No.	
----------	--

**M.Sc. (Semester - II) (Old) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Statistical Physics (MSC09206)**

Day & Date: Tuesday, 14-05-2024  
 Time: 11:00 AM To 02:00 PM

Max. Marks: 80

- Instructions:** 1) Question no. 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 alternatives.**

**10**

- 1) In Bose Einstein Condensation all the particle accumulates in \_\_\_\_\_.  
 a) excited state                      b) meta state  
 c) ground state                      d) all excited state
- 2) In Fermi Dirac statistics, particles are \_\_\_\_\_.  
 a) indistinguishable                      b) distinguishable  
 c) dimensionless                      d) weightless
- 3) The Boltzmann limit of Bosons and fermions is \_\_\_\_\_.  
 a)  $e^{\beta\mu} \ll 1$                       b)  $e^{\beta\mu} \gg 1$   
 c)  $e^{\beta\mu} = 0$                       d)  $e^{\beta\mu} = 1$
- 4) If  $r$  is the ratio of the probability that two particles are found in the same state to the probability that two particles belong to different states, then the ratio  $r_{MB} : r_{BD} : r_{FD}$  is \_\_\_\_\_.  
 a)  $1/2 : 1 : 0$                       b)  $1 : 0 : 2$   
 c)  $1 : 1 : 2$                       d)  $1 : 1/2 : 0$
- 5) In grand canonical ensemble, the system exchange \_\_\_\_\_.  
 a) only matter                      b) only energy  
 c) both matter and energy                      d) neither matter nor energy
- 6) In Maxwell Boltzmann statistics, particles are \_\_\_\_\_.  
 a) indistinguishable                      b) distinguishable  
 c) dimensionless                      d) weightless
- 7) Entropy in thermodynamics is measure of \_\_\_\_\_.  
 a) order of system                      b) pressure of system  
 c) volume of system                      d) disorder of system
- 8) Phase equilibrium curve terminates at \_\_\_\_\_.  
 a) Boiling point                      b) Sublimation point  
 c) Triple point                      d) Critical point
- 9) At a critical point,  $\frac{dp}{dv} =$   
 a) 1                      b) 0  
 c)  $\infty$                       d) -1
- 10) Ideal gas is one for which mutual interaction between the molecules is \_\_\_\_\_.  
 a) high                      b) negligible  
 c) zero                      d) repulsive

- B) State true or false.** **06**
- 1) Photons in black body radiation obeys Bose Einstein Statistics.
  - 2) The quantitative explanation of Brownian motion was given by Einstein.
  - 3) Second law of thermodynamics deals with phase transition.
  - 4) During first order transition of a matter from one phase to another, entropy remains constant.
  - 5) The point at which the vapor pressure curve abruptly terminates is called transition point.
  - 6) The transition from liquid He I to He II is called second order phase transition.

- Q.2 Answer the following.** **16**
- a) Explain microstates and macrostates.
  - b) Distinguish between Fermi Dirac Statistics and Bose Einstein Statistics.
  - c) Derive the conditions for phase equilibrium.
  - d) Explain Law of corresponding states.

- Q.3 Answer the following.**
- a) Explain the second order phase transition with an example of  $\text{BaTiO}_3$ . **08**
  - b) Define energy fluctuation. Derive energy fluctuation in Canonical ensemble. **08**

- Q.4 Answer the following.**
- a) State and prove Liouville's theorem. **08**
  - b) Derive the expression for Bose Einstein distribution law. **08**

- Q.5 Answer the following.**
- a) Derive Ehrenfest's equation for second order phase transition. **08**
  - b) Using Vander Waal's equation of reduced state, calculate the values of critical constants. **08**

- Q.6 Answer the following.**
- a) Derive Clausius- Clapeyron equation for first order phase transition. **08**
  - b) Discuss the condition of ideal Bose gas. **08**

- Q.7 Answer the following.**
- a) Define and explain types of ensemble. State their importance in statistical mechanics. **08**
  - b) Derive Sackur-Tetrode equation for entropy of a gas. **08**



Seat No.	
-------------	--

Set **P**

**M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Semiconductor Physics (MSC09301)**

Day & Date: Friday, 10-05-2024  
 Time: 11:00 AM To 02:00 PM

Max. Marks: 80

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

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

- 1) Epitaxial growth is best suited for growing \_\_\_\_\_.  
 a) Polycrystalline silicon  
 b) very thin single crystal layer on a substrate  
 c) single crystals several inches in size  
 d) single crystal of several mm in size
- 2) In a semiconductor, the energy gap between the valence band and conduction band is about \_\_\_\_\_.  
 a) 5 eV  
 b) 10 eV  
 c) 15 eV  
 d) 1 eV
- 3) A semiconductor has \_\_\_\_\_ temperature coefficient of resistance.  
 a) Negative  
 b) Positive  
 c) Zero  
 d) One
- 4) Electron-hole pairs are produced by \_\_\_\_\_.  
 a) Recombination  
 b) Thermal energy  
 c) Ionization  
 d) Doping
- 5) At the absolute zero temperature (-273° C), an intrinsic semiconductor has \_\_\_\_\_.  
 a) A few free electrons  
 b) Many Holes  
 c) Many free electrons  
 d) No holes or free electrons
- 6) The drift velocity of the conductor \_\_\_\_\_.  
 a) Increase with an increase in temperature  
 b) Decrease with decrease in temperature  
 c) Increase with decrease in the temperature  
 d) Decrease with the increase in temperature
- 7) Ohm's law is not obeyed by \_\_\_\_\_.  
 a) conductor  
 b) semiconductor  
 c) insulator  
 d) dielectrics
- 8) In Schottky barrier, barrier height depends on \_\_\_\_\_.  
 a) Amount of doping material  
 b) Type of doping material  
 c) Temperature  
 d) None of the above

- 9) In electroluminescence, the EHPs are generated by \_\_\_\_\_.  
a) Light absorption                      b) Electron bombardment  
c) Applying electric field                d) none of above
- 10) The probability that an electron in a metal occupies the fermi level, at any temperature ( $> 0K$ ) is \_\_\_\_\_.  
a) 0    b) 1  
c) 0.5    d) 1.0

**B) Fill in the blanks OR write True /False.****06**

- 1) The current density (J) of semiconductor is \_\_\_\_\_.
- 2) In MBE evaporation of material that produces flux of atoms is \_\_\_\_\_ dependent.
- 3) A vacant partially filled band is called \_\_\_\_\_.
- 4) The random motion of holes and free electrons due to thermal agitation is called diffusion. (True/False)
- 5) The particle flux is inversely proportional to particle velocity. (True/False)
- 6) The strength of a semiconductor crystal comes from Electron-pair bonds. (True/False)

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

- a) Diffusion and recombination
- b) Optical absorption in semiconductors
- c) Chemical vapor deposition
- d) Nucleation & crystal growth

**Q.3 a)** Define Luminescence? Explain different types of Luminescence with example. **10**

**b)** Elucidate Direct and Indirect semiconductors. **06**

**Q.4 a)** Describe growth of multiple crystals from Molecular Beam Epitaxy. **10**

**b)** Explain Vapor phase epitaxy. **06**

**Q.5 a)** Deduce an expression of electron and hole concentration at equilibrium. **10**

**b)** Write a note on Indirect recombination (trapping). **06**

**Q.6 a)** Describe crystal growth by Czochralski method. **10**

**b)** Elucidate gel method with suitable example. **06**

**Q.7 a)** Give an account of Metal-Semiconductor Interface with band diagrams. **10**

**b)** Draw equilibrium energy band diagram for a metal to an p-type semiconductor where

- 1)  $\Phi_M < \Phi_S$
- 2)  $\Phi_M > \Phi_S$

Seat  
No.

**M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Atomic and Molecular Physics (MSC09302)**

Day & Date: Monday, 13-05-2024  
 Time: 11:00 AM To 02:00 PM

Max. Marks: 80

- Instructions:** 1) Question no. 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) Multiple choice questions.****10**

- 1) Which model describes the structure of atoms as consisting of a dense, positively charged nucleus surrounded by electrons in orbit?
  - a) Rutherford model
  - b) Bohr model
  - c) Vector atom model
  - d) Larmar precession model
- 2) The Landé g-factor is a dimensionless quantity that determines the magnetic moment of an atomic or subatomic particle. What does it describe?
  - a) Spin-orbit interaction
  - b) Hyperfine structure
  - c) Relativistic correction
  - d) Magnetic interaction
- 3) Which of the following is responsible for the splitting of spectral lines into multiple components due to the interaction between the magnetic moment of the electron and the external magnetic field?
  - a) Zeeman effect
  - b) Stark effect
  - c) Fine structure
  - d) Lamb shift
- 4) Which phenomenon describes the splitting of spectral lines in the presence of an external magnetic field?
  - a) Stark effect
  - b) Zeeman effect
  - c) Paschen-Back effect
  - d) Fine structure spectra
- 5) What is the term used to describe the splitting of X-ray spectral lines?
  - a) Stark effect
  - b) Zeeman effect
  - c) X-ray fine structure
  - d) Hyperfine structure spectra
- 6) Which type of bonding involves the sharing of electron pairs between atoms?
  - a) Covalent bonding
  - b) Ionic bonding
  - c) Van der Waals bonding
  - d) Metallic bonding
- 7) What is the qualitative treatment of the  $H_2^+$  molecule?
  - a) It is a nonpolar molecule with a single bond.
  - b) It is a polar molecule with a single bond.
  - c) It is a nonpolar molecule with a double bond.
  - d) It is a polar molecule with a double bond.
- 8) Which branch of spectroscopy studies the rotation of molecules and is based on the Born-Oppenheimer approximation?
  - a) Vibrational spectroscopy
  - b) Electronic spectroscopy
  - c) Rotational spectroscopy
  - d) Nuclear magnetic resonance spectroscopy

- 9) What is the molecular polarizability?
- Ability of a molecule to undergo nuclear magnetic resonance
  - Measure of the molecule's ability to be polarized by an external electric field
  - Ability of a molecule to emit Raman spectra
  - Measure of the molecule's ability to absorb infrared radiation
- 10) Which spectroscopic technique is based on the interaction of electromagnetic radiation with molecular rotations?
- Infrared spectroscopy
  - Raman spectroscopy
  - Microwave spectroscopy
  - Electronic spectroscopy

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

- Atomic and molecular polarizability refers to the ability of an atom or molecule to be polarized by an external electric field.
- Group theoretical selection rules for infrared and Raman transitions are based on the symmetry properties of the molecular vibrations.
- Covalent bonding involves the transfer of electrons from one atom to another.
- Ionic molecules have a balanced distribution of electrons between atoms, resulting in a nonpolar nature.
- The wave function of an electron in a hydrogen atom depends only on the radial distance from the nucleus.
- The orbital angular momentum of an electron in an atom can have any value from 0 to  $\hbar$ .

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

- Explain the significance of the fine structure in atomic spectra arises, and what are the factors contributing to it?
- Explain the Zeeman effect in atomic spectra.
- Explain the concept of van der Waals bonding and provide an example of a molecule where van der Waals forces are significant.
- Define atomic and molecular polarizability.

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

- Explain how group theory is used to determine the allowed vibrational transitions in both infrared and Raman spectroscopy.
- Discuss the principles of infrared spectroscopy and Explain how infrared radiation interacts with molecular vibrations to produce absorption spectra.

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

- Describe the differences between covalent, ionic, and van der Waals bonding.
- Explain the concept of hybridization in molecules with its types of hybrid orbitals formed.

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

- Describe the vibrational levels in diatomic and polyatomic molecules, focusing on the Morse oscillator model for vibrational levels.
- Explain the Zeeman effect in detail and how spectral lines split in the presence of an external magnetic field.

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

- a) Discuss the significance of X-ray spectra in atomic physics. Explain how X-ray spectral lines are produced and how they are used to study atomic structure and composition.
- b) Describe the Stark effect and its role in atomic spectroscopy.

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

- a) Describe Born - Oppenheimer approximation in detail.
- b) Give the schematic representation of interaction energies between 4p4d electrons in JJ coupling.

Seat No.	
----------	--

**M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Functional Nanomaterials (MSC09306)**

Day & Date: Wednesday, 15-05-2024  
 Time: 11:00 AM To 02:00 PM

Max. Marks: 80

- 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) Select the correct alternative. 10**

- 1) The method stabilizes nanosized water droplets in an organic solvent is \_\_\_\_\_.  
 a) Aqueous synthesis                      b) Chemical synthesis  
 c) Sputtering synthesis                  d) Spin coating synthesis
- 2) The plasma torch method is similar to the \_\_\_\_\_.  
 a) Laser ablation  
 b) Chemical vapour decomposition  
 c) Arc discharge  
 d) Electrolysis
- 3) Polymer has outstanding property of being \_\_\_\_\_.  
 a) heavy weight                              b) corrosive  
 c) light weight                                d) brittle
- 4) The stabilizing element in  $\beta$ -phase of Ti alloys is \_\_\_\_\_.  
 a) Al    b) Mo  
 c) O    d) N
- 5) The curing process of thermoset is completely \_\_\_\_\_.  
 a) reversible                                  b) irreversible  
 c) adiabatic                                    d) isothermal
- 6) The might nanofibers add to existing textiles \_\_\_\_\_.  
 a) For decoration or design  
 b) To enhance certain qualities of the fabric  
 c) To make the textile radioactive  
 d) Nanofibers cannot be added to other textiles
- 7) When size of nanoparticle is \_\_\_\_\_ the quantum confinement effects occur.  
 a) greater than exciton Bohr radius.  
 b) smaller than exciton Bohr radius.  
 c) equal to exciton Bohr radius.  
 d) all of above
- 8) The formula of crystal growth rate is \_\_\_\_\_.  
 a)  $\frac{dr}{dt} = \frac{D(C_h - C_i)}{rd_m}$                       b)  $\frac{dr}{dt} = \frac{D(C_h - C_i)}{r}$   
 c)  $\frac{dr}{dt} = \frac{D(C_h - C_i)}{d_m}$                       d)  $\frac{dr}{dt} = \frac{r(C_h - C_i)}{D}$

- 9) Which of the following act as a catalyst in the preparation of Buna-S?  
a) Benzoyl peroxide                      b) Hydrogen peroxide  
c) Cumene hydroperoxide                d) Acrylonitrile
- 10) The alignment of single nanotube (SWNT) in the nanofibers was confirmed by \_\_\_\_\_ spectroscopy and TEM.  
a) IR    b) Raman  
c) UV-Visible                                 d) NMR

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

- 1) Carbon atom can form four covalent bonds.
- 2) Quantum dots have two dimensions.
- 3) The motion of electron confined in two directions in the nanowires.
- 4) The electrospinning process can be adjusted to control fiber diameter by varying electric field strength and polymer solution concentration.
- 5) The range of identical Temperature for synthesis of MOF is 500° C to 600° C.
- 6) In second generation, method of TiO<sub>2</sub> Polar organic electrolyte is used.

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

- a) Write down the advantages and disadvantages of metal oxide frameworks.
- b) What are the applications of TiO<sub>2</sub> nanotube array?
- c) Discuss the applications of quantum dots in biomedicine.
- d) Write note on ball milling synthesis method of Boron Nitride nanotubes.

**Q.3 Answer the following.**

- a) What are the key processing parameters of Electrospinning process of Nanofiber and explain any four key parameters in detail.
- b) Explain the basic material used for Polymer Nanocomposites.

**08****08****Q.4 Answer the following.**

- a) Describe Layer-by-Layer (LBL) assembly with semiconductor Nanoparticles and Nanowires.
- b) Define Metal Oxide Frameworks. Write down its advantages and disadvantages.

**08****08****Q.5 Answer the following.**

- a) Write in detail Electrospinning Process for Nanofibers.
- b) Explain the synthesis method of semiconductor Nanocrystal in organic solvent.

**08****08****Q.6 Answer the following.**

- a) What is polymerization? Explain Emulsion polymerization.
- b) Explain in detail Arc discharge and Arc melting synthesis method of Boron Nitride Nanotube.

**08****08****Q.7 Answer the following.**

- a) Discuss the fabrication process of TiO<sub>2</sub> nanotube arrays by electrochemical anodization with First synthesis generation.
- b) What are properties of polymer Nanocomposites

**08****08**

Seat No.	
-------------	--

Set **P**

**M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Semiconductor Devices(MSC09401)**

Day & Date: Thursday, 09-05-2024  
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- 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) Choose correct alternatives.****10**

- 1) TRIACs is used where the transfer of large \_\_\_\_\_ is involved.
  - a) power
  - b) voltage transfer
  - c) electron transfer
  - d) charge transfer
- 2) In a CCD operation the thermal relaxation time is \_\_\_\_\_ than the charge storage time.
  - a) longer
  - b) much longer
  - c) shorter
  - d) much shorter
- 3) Light emission is not possible in Si due to its \_\_\_\_\_.
  - a) direct band gap
  - b) high mobility
  - c) indirect band gap
  - d) doping
- 4) GaAs is better for MESFET than silicon due to \_\_\_\_\_.
  - a) low mobility
  - b) low power levels
  - c) temperature stability
  - d) high capacitance
- 5) The lasing threshold current density for \_\_\_\_\_ junction LASER is lowest.
  - a) homo
  - b) hetero
  - c) graded
  - d) double hetero
- 6) The switching ON behavior of SCR is based on \_\_\_\_\_.
  - a) regenerative
  - b) breakdown
  - c) blocking
  - d) etching
- 7) A CCD involves \_\_\_\_\_ actions.
  - a) charge storage and transfer
  - b) only charge transfer
  - c) only storage
  - d) charge storage and loss
- 8) Two valley model of TEDs based on GaAs is proposed by \_\_\_\_\_.
  - a) BCS
  - b) BBS
  - c) RWH
  - d) NWH
- 9) The condition  $h\nu < E_g$  causes \_\_\_\_\_ of light in semiconductor.
  - a) absorption
  - b) transmission
  - c) reflection
  - d) modulation





Seat No.	
----------	--

Set **P**

**M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANOPHYSICS)**  
**Nuclear and Particle Physics (MSC09402)**

Day & Date: Saturday, 11-05-2024  
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- Instructions:** 1) Question 1 and 2 are compulsory.  
 2) Attempt any three questions from Q. Nos. 3 to Q. Nos. 7.  
 3) Figure to right indicate full marks.

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

- According to collective model, the first three energy levels of  $^{228}\text{Th}$  90 are shown in following figure, then find expected spin parity and energy of the next level are given by \_\_\_\_\_.
  - $6^+$ , 393keV
  - $6^-$ , 393keV
  - $5^+$ , 930keV
  - $8^+$ , 330keV
- Which of the following is fermion?
  - Alpha particle
  - H- atom
  - $^7\text{Be}_4$  nucleus
  - deuteron
- Which of the following is not belonging to lepton family?
  - pions
  - neutron
  - proton
  - All of these
- Which of the following is the disadvantages of semiconductor detector?
  - Low accuracy
  - high avalanche breakdown voltage
  - low sensitivity
  - it should be maintained at low temperature
- Energy equivalent of 1 a. m. = \_\_\_\_\_.
  - 931eV
  - 931meV
  - 931MeV
  - 931keV
- In the distribution of cosmic ray, the latitude effect is maximum at \_\_\_\_\_.
  - Equator of Earth
  - pole of earth
  - $45^\circ$  latitude
  - $-15^\circ$  latitude
- Parity violates in \_\_\_\_\_.
  - beta decays
  - alpha decays
  - gamma decays
  - photon decay
- Identify the nucleus if its radius is given to be 3.46fm \_\_\_\_\_.
  - $^7\text{Li}$
  - $^{24}\text{Mg}$
  - $^{64}\text{Cu}$
  - $^{27}\text{Al}$
- GM counter cannot detect the \_\_\_\_\_.
  - protons
  - alpha particles
  - beta particles
  - neutrons

- 10) Nuclear force is \_\_\_\_\_.
- Spin dependent
  - charge dependent
  - both charge and spin independent
  - spin dependent but charge independent

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

- Gamma decays are the transitions between two isomers.
- The decays processes always dominant by weak interactions.
- Strangeness number and third component of isospin of proton is 1, 0 respectively.
- Baryon number of  $e^+$  and  $e^-$  are 0, 0 respectively.
- Unit of quadrupole moment Barn ( $1\text{barn} = 10^{-24}\text{cm}^2$ )
- Energy spectrum of Alpha particles is discrete.

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

- Give brief account of semiconductor detector.
- Explain the basic properties (mass, size, shape, spin, binding energy etc.) of the nucleus.
- What are the types of interactions in nature. Explain strong and weak nuclear interactions.
- Explain the Nuclear fission and Fusion reactions with the examples.

**Q.3 Answer the following.**

- What are nuclear forces? Write the properties of nuclear forces and explain Meson theory of nuclear forces. 08
- Explain the theory of Alpha, Beta, Gamma decays with their properties. 08

**Q.4 Answer the following.**

- Derive the expression for the atomic number of stable isobar using the liquid drop model. Hence solve the following problem find the stable isobar nuclide  $A = 125$  (given  $a_c = 0.7\text{MeV}$  and  $a_{\text{sym}} = 22.5\text{MeV}$ ). 08
- Derive the expression for the Q value in alpha decays. Solve following problem 08  
Consider the spontaneous emission of alpha decay from  ${}_{92}\text{U}^{232}$ . Find the kinetic energy of alpha particle, if the energy Q is released.

**Q.5 Answer the following.**

- What are the cosmic rays. Explain the primary and secondary cosmic rays. 08
- Explain the nuclear Fermi Gas model. Discss its advantages and disadvantages. 08

**Q.6 Answer the following.**

- Derive the semi empirical mass formula. Discuss the advantages and disadvantages of liquid drop model. 08
- Classify the elementary particles. Write short notes of conservation laws in elementary particles. 08

**Q.7 Answer the following.**

- Discuss the CPT conservations in Nuclear reactions. 06
- Write short notes on any two particle accelerators. 10

Seat No.	
----------	--

**M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Characterization of Nano Materials (MSC09403)**

Day & Date: Tuesday, 14-05-2024  
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- 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) Select correct alternative from following. 10**

- 1) What type of technique is FTIR spectroscopy?
  - a) A dispersive technique
  - b) An emission technique
  - c) An absorbance technique
  - d) A UV-Vis technique
- 2) The most commonly used laser for Raman spectroscopy is \_\_\_\_\_.
  - a) ND: YAG
  - b) Ruby laser
  - c) He-Ne laser
  - d) Semiconductor Laser
- 3) X-ray diffractometers are not used to identify the physical properties of which of the following?
  - a) Metals
  - b) Liquids
  - c) Polymeric materials
  - d) Solids
- 4) TGA techniques is used to find \_\_\_\_\_.
  - a) changes in weight
  - b) changes in length
  - c) changes in height
  - d) none of A, B, C
- 5) The resolving power of TEM is derived from \_\_\_\_\_.
  - a) electrons
  - b) specimens
  - c) power
  - d) ocular system
- 6) Which of the following is not related to Kerr effects?
  - a) Self-phase modulation
  - b) Cross-phase modulation
  - c) Four-wave mixing
  - d) Stimulated Raman Scattering
- 7) Vibrational transition of molecule is related to \_\_\_\_\_.
  - a) FTIR
  - b) UV -vis Spectroscopy
  - c) XRD
  - d) NMR
- 8) STM was first developed by \_\_\_\_\_ in 1981.
  - a) Ruska
  - b) Thomson
  - c) Knoll
  - d) Binning
- 9)  $1 \times 10^{-9}$  meter is equal to \_\_\_\_\_.
  - a) one nano meter
  - b) one micro meter
  - c) one mile meter
  - d) one centimeter
- 10) XPS stands for \_\_\_\_\_.
  - a) x-ray polarized spectroscopy
  - b) x-ray photoelectron scattering
  - c) x-ray photoelectron spectroscopy
  - d) x-ray photo electron scanner

- B) Answer True/False.** **06**
- 1) Infrared, and Raman spectra are complementary to each other.
  - 2) The resolution of SEM is greater than TEM.
  - 3) In Diffractometers, the intensities of the diffraction peaks of a given compound in a mixture are proportional to the fraction of the material in the mixture.
  - 4) 'There is plenty of room at the bottom' this quote by Richard Feynman.
  - 5) Bulk material has high surface to volume ratio.
  - 6) Young's modulus is the mechanical property of the material.

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

- a) What is the principal of AFM?
- b) Describe in brief some applications of STM.
- c) Explain the limitations of XRD.
- d) What is the Kerr effect?

**Q.3 Answer the following.**

- a) What are secondary and backscattered electrons? Explain SEM in detail with neat diagram. **10**
- b) Explain principal and working of EDAX. **06**

**Q.4 Answer the following.**

- a) Draw the block diagram of AFM and describe each part of microscope. **10**
- b) Write a note on Instrumentation of XPS. **06**

**Q.5 Answer the following.**

- a) Describe basic instrumentation setup for UV-VIS spectro photometer. **10**
- b) What is the Nuclear Magnetic Resonance Spectroscopy. **06**

**Q.6 Answer the following.**

- a) Describes the instrumentation and working of FTIR spectrometer. **10**
- b) Explain Nano-lithographic techniques. **06**

**Q.7 Answer the following.**

- a) Discuss the working principle of Raman Spectroscopy. What are Stoke's and antistoke's lines. **10**
- b) Write a note on Photoluminescence and optical band gap. **06**

Seat No.	
----------	--

**M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2024**  
**PHYSICS (NANO PHYSICS)**  
**Nano Material Fabrication Techniques (MSC09408)**

Day & Date: Thursday, 16-05-2024  
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- Instructions:** 1) Question no. 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) Select correct alternative from following.** **10**

- 1) Which of the following is the detection limit of Auger Electron Spectroscopy?
  - a) 0.1% monolayer
  - b) 0.5% monolayer
  - c) 1% monolayer
  - d) 2% monolayer
- 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) Which of the following is used in electron microscope?
  - a) Electron beams
  - b) Magnetic fields
  - c) Light waves
  - d) Electron beams and magnetic fields
- 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\_\_\_\_\_.
- Auto focusing microscope
  - Antenna focusing microscope
  - Atomic force microscope
  - None of the mentioned

**B) Answer True/ False.**

**06**

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

**Q.2 Answer the following.**

**16**

- Explain Magnification in SEM.
- What are the applications of Raman Spectroscopy?
- Write a short note on Optical microscope
- What is Bragg's condition of diffraction?

**Q.3 Answer the following.**

- What is cross polarization? Explain CP-MAS experiment in detail.
- Write a note on Rayleigh Criteria.

**10**

**06**

**Q.4 Answer the following**

- What are different types of an optical spectrometer? Explain any one in detail with neat diagram.
- Write a short note on optical microscopy and its limitations.

**10**

**06**

**Q.5 Answer the following.**

- What is the principle of TEM? Explain the construction and working of TEM with neat diagram.
- What are the properties of X-ray?

**10**

**06**

**Q.6 Answer the following.**

- Explain in details of image formation in Scanning Tunneling Microscopy (STM).
- Discuss the nuclear spin interaction in solids.

**10**

**06**

**Q.7 Answer the following.**

- Explain different Electron Energy Analysers in XPS.
- What is resonance condition in ESR and NMR?

**10**

**06**