

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

04

- 1) If $f(s)$ is a Laplace transform then $\lim_{s \rightarrow \infty} f(s) = 0$.
- 2) Fourier transform is a linear operator.
- 3) The associative law of multiplication is valid for the matrix product $A(BC) = (AB)C$.
- 4) A square matrix is called orthogonal if $A = A^{-1}$.

Q.2 Answer the following. (Any Six)

12

- a) Define singular point, explain in details its types with example.
- b) Find the pole of $f(z) = \frac{\sin(z-a)}{(z-a)^4}$
- c) If A is an orthogonal matrix, then show that $|A| = 1$.
- d) Determine the pole and residue at each pole of the function $f(z) = \cot Z$.
- e) Solve $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 9y = 0$
- f) Show that the transpose of an orthogonal matrix is also orthogonal.
- g) Find the inverse Laplace transform from $\tan^{-1} \frac{1}{s}$
- h) $y \log y dx + (x - \log y)dy = 0$

Q.3 Answer the following. (Any Three)

12

- a) If λ be an eigen value of matrix A (non-zero matrix) show that λ^{-1} is an eigen value of A^{-1} .
- b) Show that the eigen value of Hermitian matrix are real.
- c) Solve $ye^y dx = (y^3 + 2xe^y)dy$.
- d) State and prove the Parseval's Theorem.

Q.4 Answer the following. (Any Two)

12

- a) Evaluate $\int_0^\infty \frac{\cos 3\theta}{5+4\cos\theta} d\theta$
- b) Prove that $(AB)^n = A^n \cdot B^n$ if $A \cdot B = B \cdot A$.
- c) Solve the differential equation.
 $y \log y dx + (x - \log y)dy = 0$

Q.5 Answer the following. (Any Two)

12

- a) Verify that $A = \frac{1}{3} \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ -2 & 2 & -1 \end{bmatrix}$ is orthogonal.
- b) Evaluate the following integral using residue Theorem.
 $\int_c \frac{1+z}{z(z-2)} dz$ where c is circle $|z| = 1$
- c) Find the eigen value of a matrix $\begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$

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M.Sc. (Semester - I) (New) (NEP CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Solid State Physics (2321102)

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.

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M.Sc. (Semester - I) (New) (NEP CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Analog and Digital Electronics (2321106)

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.

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M.Sc. (Semester - I) (New) (NEP CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Research Methodology in Physics (2321105)

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?

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No.

M.Sc. (Semester - I) (Old) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Mathematical Physics (MSC03101)

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

Max. Marks: 80

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

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

- 1) Legendre polynomial is a set of _____ function.
 - a) orthogonal
 - b) odd
 - c) even
 - d) real
- 2) What are the eigen value of $\begin{pmatrix} 1 & -i \\ i & 1 \end{pmatrix}$?
 - a) Both are 0
 - b) 0 and 1
 - c) 0 and -1
 - d) 0 and 2
- 3) The eigen value of matrix $A = \begin{pmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{pmatrix}$ are _____.
 - a) $e^{\pm i\theta}$
 - b) $e^{\pm 2i\theta}$
 - c) $e^{\pm 3i\theta}$
 - d) $e^{\pm i\theta/2}$
- 4) If $|z^2 - 1| = |z|^2 + 1$ then z lies on _____.
 - a) The real axis
 - b) The imaginary axis
 - c) a circle
 - d) on ellipse
- 5) If $f(z) = e^{2z}$ then the imaginary part of $f(z)$ is _____.
 - a) $e^y \sin x$
 - b) $e^x \cos y$
 - c) $e^{2x} \cos 2y$
 - d) $e^{2x} \sin 2y$
- 6) If two eigen value of $\begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$ are 2,2 then the third eigen value is _____.
 - a) 2
 - b) 3
 - c) 7
 - d) 8
- 7) Let $u(x, y) = x + \frac{1}{2}(x^2 - y^2)$ be the real part of analytic function $f(z)$ of the complex variable, $z = x + iy$. The imaginary part of $f(z)$ is _____.
 - a) $y + xy$
 - b) xy
 - c) y
 - d) $y^2 - x^2$
- 8) If c is the contour defined by $|z| = \frac{1}{2}$ the value of the integral $\oint_c \frac{dz}{\sin^2 z}$ is _____.
 - a) ∞
 - b) $2\pi i$
 - c) 0
 - d) πi
- 9) Which of the following is on "even" function of t ?
 - a) $t^2 - 4t$
 - b) $t^3 + 6$
 - c) t^2
 - d) Not defined

10) A unitary matrix is defined by the expression _____.

- $U = UT$: where superscript T means transpose
- $U = U^t$
- $U = U^*$
- $U' = U^+$

B) Fill in the blanks/ True or false.

06

- A square matrix is called orthogonal if $A = A^{-1}$ (T/F)
- Fourier transforms is a linear operator (T/F)
- If a function $f(z)$ is continuous & non zero at a point z_0 , then $f(z) \neq 0$, throughout some neighborhood of that point (T/F)
- The Fourier transform operator is unitary. (T/F)
- In a matrix using g elements then the possible ordered pair are $(3,3), (1,9), (9,1)$ (T/F)
- The first order ODE can never be linear separable and exact at the same time (T/F)

Q.2 Answer the following.

16

- Find the Laplace transform of $(1 + \sin 2t)$
- Derive an expression for 2^{nd} order homogeneous equation with constant coefficients.
- If A and B are two orthogonal matrices show that AB is also orthogonal matrix.
- Find the residue of $\frac{1}{(z^2+1)^3}$ at $z = i$

Q.3 Answer the following.

16

- Show that the eigen value of Hermitian matrix are real.
- Write matrix A gives below as the sum of symmetric and a skew symmetric
matrix $A = \begin{pmatrix} 1 & 2 & 4 \\ -2 & 5 & 3 \\ -1 & 6 & 3 \end{pmatrix}$

Q.4 Answer the following.

16

- Determine whether the following equation is exact and find its solution if it is exact

$$(4x^3 + 6xy + y^2) \frac{dx}{dy} = -(3x^2 + 2xy + 2)$$

- Explain the details of Parseval Theorem.

Q.5 Answer the following.

16

- If $A = \frac{1}{9} \begin{bmatrix} -8 & 1 & 4 \\ 4 & 4 & 7 \\ 1 & -8 & 4 \end{bmatrix}$ prove that $A^{-1} = A^1$, A^1 being the transpose of A .

- In square wave expand the Function
 $f(x) = 0; -\pi \leq x \leq 0$
 $f(x) = 4; -0 \leq x \leq \pi$ Fourier

Q.6 Answer the following.

16

- Find the residue of $\frac{1}{(z^2+1)^3}$ at $z = i$
- Solve $x \frac{dy}{dx} + y \log y = xy e^x$

Q.7 Answer the following.

- a) Find the eigen value of a matrix $\begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$
- b) Solve $\frac{dy}{dx} - \frac{\tan y}{1-x} = (1+x)e^x \sec y$.

- 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

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M.Sc. (Semester - I) (Old) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Analog and Digital Electronics (MSC03103)

Day & Date: Wednesday, 15-05-2024
 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.3 to Q.7.
 3) Figure to right indicate full marks.

Q.1 A) Choose correct alternative. (MCQ) 10

- 1) 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
- 2) Multiplexer 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
- 3) Op-amp is a _____ type of amplifier.
 - a) Current
 - b) Voltage
 - c) Power
 - d) Resistance
- 4) The op-amp comparator circuit uses _____.
 - a) Positive feedback
 - b) Negative feedback
 - c) Regenerative feedback
 - d) No feedback
- 5) Find the output of inverting amplifier?
 - a) $V_o = AV_{in}$
 - b) $V_o = -AV_{in}$
 - c) $V_o = -A(V_{in1} - V_{in2})$
 - d) None of the mentioned
- 6) What happen if any positive input signal is applied to open-loop configuration?
 - a) Output reaches saturation level
 - b) Output voltage swing's peak to peak
 - c) Output will be a sine waveform
 - d) Output will be a non-sinusoidal waveform
- 7) In 8085 Microprocessor, how many interrupts are maskable _____.
 - a) Two
 - b) Three
 - c) Four
 - d) Five
- 8) In how many different modes a universal shift register operates _____.
 - a) 2
 - b) 3
 - c) 4
 - d) 5

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M.Sc. (Semester - I) (Old) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Classical Mechanics (MSC03108)

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 θ 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 (θ) 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**

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

- 1) If Ψ_a and Ψ_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 (ψ)?
- 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.	
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M.Sc. (Semester - II) (New) (NEP CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Electrodynamics (2321202)

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.

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M.Sc. (Semester - II) (New) (NEP CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Classical Mechanics (2321206)

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 δ 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 (MATERIALS SCIENCE)
Quantum Mechanics (MSC03201)

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.	
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M.Sc. (Semester - II) (Old) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Electrodynamics (MSC03202)

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 indicate full marks.

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

- 1) Electric field intensity (E) at any point in an electric field is equal to _____.
 a) (Potential gradient)² b) (Potential gradient)³
 c) Potential gradient d) none of these
- 2) In electromagnetic wave, the phase difference between electric and magnetic field vectors E and B is _____.
 a) π b) $\pi/2$
 c) $\pi/4$ d) 0
- 3) In the skin definition of skin depth, it is distance over which field amplitude reduces to _____.
 a) Nearly one fifth b) $1/e$
 c) One half d) One fourth
- 4) The _____ law is an equation that describes the magnetic field created by a current carrying wire and allows you to calculate its strength at various points.
 a) Ampere's b) Lorentz's
 c) Biot-Savart's d) Gauss
- 5) Which one of the fundamental equations was modified by Maxwell to form the basis of electromagnetic theory?
 a) Faraday law b) Ampere law
 c) Gauss law of electrostatic d) Gauss law of magnetostatic
- 6) The Poynting vector P is equal to _____.
 a) E.H b) $E \times H$
 c) E/H d) H/E
- 7) A sphere encloses an electric dipole with charges $\pm 3 \times 10^{-6}$ C. What is total electric flux across the sphere?
 a) zero b) $3 \times 10^{-6} Nm^2/C$
 c) $6 \times 10^{-6} Nm^2/C$ d) $-3 \times 10^{-6} Nm^2/C$
- 8) The effective length of an antenna is a measure of _____.
 a) Effectiveness of the antenna as a radiator
 b) length of the antenna neglecting fringe effects.
 c) range of the antenna.
 d) Power consumed by the antenna
- 9) Which of the following laws do not form a Maxwell equation?
 a) Planck's law b) Gauss's law
 c) Faraday's law d) Ampere's law

Seat
No.

M.Sc. (Semester - II) (Old) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Statistical Physics (MSC03206)

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 exited 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) ∞ 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 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**

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M.Sc. (Semester - III) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Semiconductor Physics (MSC03301)

Day & Date: Friday, 10-05-2024
 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 correct alternative.

10

- 1) Liquid-phase epitaxy (LPE) uses _____ to grow crystals on a substrate.
 - a) the solid
 - b) the solution
 - c) the gas
 - d) the vapors
- 2) Particles in an ionic crystal are held together by _____.
 - a) Nuclear forces
 - b) Electrons
 - c) Covalent bonds
 - d) Electrostatic forces
- 3) The shape of E-K diagram of the conduction band and valance band is _____.
 - a) Horizontal
 - b) Vertical
 - c) Parabolic
 - d) Elliptical
- 4) In Czochralski crystal growth process, the material is heated up to _____.
 - a) 950°C
 - b) 1420°C
 - c) 1000°C
 - d) 1200°C
- 5) The effective mass of an electron is _____.
 - a) mass of Free electron
 - b) mass of electron in periodic potential
 - c) both a & b
 - d) None of above
- 6) 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
- 7) A semiconductor has _____ temperature coefficient of resistance.
 - a) Negative
 - b) Positive
 - c) Zero
 - d) One
- 8) 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

Seat No.	
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M.Sc. (Semester - III) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Atomic, Molecular Physics (MSC03302)

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

- The doublets observed in alkali spectra are due to _____ Interaction.
 - Orbit orbit
 - Spin Spin
 - Spin Orbit
 - All of these
- For electronic excitation of molecules which is preferred _____.
 - Hartree Fock method
 - stern gerlect experiment
 - franck condon principle
 - Frank- Hertz experiment
- In case of vibration rotational spectrum, the lines to the lower frequency side of ω_0 are referred to as _____.
 - P branch
 - Q branch
 - R branch
 - bond origin
- If the motion is simple harmonic the force constant is given by _____.
 - $K = 4\pi^2\omega^2c^2$
 - $K = 4\pi^2\omega^2c^2\mu^2$
 - $K = 4\pi^2\omega^2c^2\mu$
 - $K = 4\pi^2\omega^2c\mu$
- Which of the following molecule will not show the microwave spectra?
 - CH_2Cl_2
 - SF_6
 - H_2O
 - CPH_3Cl
- The lowest vibrational energy is given by _____.
 - $\frac{1}{2}\omega$
 - ω
 - $\frac{1}{2}\omega^2$
 - ω^2
- When splitting of the energy levels due to strong magnetic field then the effect is known as _____ Effect.
 - Zeeman
 - Paschen back
 - Stark
 - Back-Goudsmit
- In LS coupling the interaction between _____ is assumed greater as compared to other.
 - Orbit orbit
 - Spin Spin
 - Spin Orbit
 - Both Spin Spin And Orbit orbit
- In computing the splitting of spectral lines in a weak magnetic field the lande g-factor arises because of _____.
 - Pauli Exclusion Principle
 - spin-orbit coupling
 - larmor precession
 - Relativistic correction

- 10) laser cooling of atoms is produced due to _____.
 a) Absorption of photons by atoms
 b) scattering of photons by atoms
 c) Transfer of momentum from photon to atoms
 d) transfer of energy from photons to atoms

B) Fill in the blank from given parenthesis.**06**

- 1) Selection rule for the harmonic oscillator undergoing vibrational changes are ____ ($\Delta v = +1/\Delta v = +1, +2, +3 \dots$)
- 2) _____ is the source for the microwave spectrometer (Klystron/Ncrnst filament).
- 3) In case of _____ effect the interaction energy between the electron and the field F is greater than the interaction energy between the electron spin and orbit (strong field stark /weak field stark).
- 4) For organic molecules the skeletal vibrations usually fall in the range $14000-700\text{cm}^{-1}$.
- 5) Spin orbit interaction are magnetic in nature.
- 6) The hyperfine structure is observed due to the different isotope of the same chemical element.

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

- a) Explain paschen back effect
- b) Explain X ray spectra and there types.
- c) What are spectral lines, and write transition rule.
- d) Explain Pauli's exclusion principle and write down the possible combination for two equivalent P electrons.

Q.3 Answer the following.

- a) Give brief outline of components in infra-red spectrometer. **12**
- b) Consider a gas of hydrogen atom in the atmosphere of the sun where the temperature is 5000K if a sample from this atmosphere contains 6.023×10^{23} of hydrogen atom in the ground state the number of hydrogen atoms in the first exited state is approximately 8×10^{12} where n is an integer the value of n is...? (Boltzmann constant = 8.617×10^{-5} eV/K) **04**

Q.4 Answer the following.

- a) Obtain the expression for diatomic molecule as a non-rigid rotator. **12**
- b) State and explain the intensity rule for Zeeman Effect. **04**

Q.5 Answer the following.

- a) Explain in detail unharmonic oscillation of a diatomic molecule with the help of energy profile diagram. **12**
- b) Discuss the classification of molecules in terms of principle moment of inertia. **04**

Q.6 Answer the following.

- a) Discuss Microwave spectroscopy. **12**
- b) What is morse function? Discuss the nature of morse curve. **04**

Q.7 Answer the following.

- a) Discuss vector model for LS coupling in a weak magnetic field with the help of vector model diagram. **08**
- b) What are the characteristic of symmetric and asymmetric tops types of molecules? **08**

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M.Sc. (Semester - III) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Materials Processing (MSC03307)

Day & Date: Wednesday, 15-05-2024
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 the correct alternative.

10

- 1) What is the primary difference between crystalline and amorphous solids?
 - a) Crystalline solids have a regular atomic arrangement, while amorphous solids lack long-range order.
 - b) Crystalline solids have higher density compared to amorphous solids.
 - c) Crystalline solids are transparent, while amorphous solids are opaque.
 - d) Crystalline solids are always metallic, while amorphous solids are non-metallic
- 2) Which model is commonly used to understand the properties of nanocrystals?
 - a) Three-dimensional lattice model
 - b) Hard sphere two-dimensional
 - c) Bohr's atomic model
 - d) Molecular dynamics model
- 3) Which type of pump operates by trapping gas molecules on a surface and then desorbing them by heating?
 - a) Rotary pump
 - b) Diffusion pump
 - c) Turbomolecular pump
 - d) Ion pump
- 4) What is the primary purpose of the Joule heating process in materials preparation?
 - a) To cool down the material rapidly
 - b) To induce chemical reactions
 - c) To melt the material for deposition
 - d) To provide energy for vaporization or sublimation
- 5) The sol-gel process is commonly used for the synthesis of:
 - a) Metallic nanoparticles
 - b) Ceramic materials
 - c) Polymer composites
 - d) Carbon nanotube

- 6) Electrodeposition methods such as DC and pulsed electrodeposition are commonly used for:
 - a) Sol-gel synthesis
 - b) Synthesizing metal nanoparticles
 - c) Chemical precipitation reactions
 - d) Depositing thin films
- 7) High-energy ball milling is primarily used for:
 - a) Fabricating thin films
 - b) Synthesizing nanocrystals
 - c) Producing metallic alloys
 - d) Conducting chemical vapor
- 8) Mechanochemical reactions involve chemical transformations induced by:
 - a) High temperatures
 - b) High pressures
 - c) Mechanical forces
 - d) Ultraviolet radiation
- 9) Which process leads to the amorphization of materials by mechanical means?
 - a) Milling at low speeds
 - b) Milling with small balls
 - c) Mechanical milling
 - d) Ball milling at room temperature
- 10) Grain growth in materials occurs due to:
 - a) Cooling of the material
 - b) The presence of impurities
 - c) Nucleation and growth of new grains
 - d) Reduction in temperature

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

- 1) Crystalline solids have a regular atomic arrangement, while amorphous solids lack long-range order.
- 2) The hard sphere two-dimensional model is commonly used to understand the properties of nanocrystals.
- 3) The ratio of grain volume to grain boundary volume is not significant in materials sciences.
- 4) Top-down approaches in materials synthesis involve fabricating materials from smaller to larger scale.
- 5) Temperature has no effect on materials preparation processes.
- 6) Grain growth occurs due to the nucleation and growth of new grains.

Q.2 Answer the following. (4*4)**16**

- a) Explain the concepts of grain boundary segregation and pinning.
- b) Discuss the key milling parameters in high-energy ball milling.
- c) Compare and contrast normal and reverse chemical precipitation reactions.
- d) Describe grain boundary segregation and pinning mechanisms.

- Q.3 Answer the following.**
- a) Classify materials based on dimensional classifications. Provide examples for each classification and discuss their application. **10**
 - b) Classify materials based on dimensional classifications. Provide examples for each classification. **06**
- Q.4 Answer the following.**
- a) Define and differentiate between crystalline and amorphous solids. Provide examples of each type and explain their structural characteristics. **10**
 - b) Discuss the process of aggregation in materials preparation. **06**
- Q.5 Answer the following.**
- a) Compare and contrast the top-down and bottom-up approaches in the synthesis of materials. Provide examples of each approach. **10**
 - b) Discuss the processes of mechanical alloying and mechanical milling. How do these processes lead to amorphization and crystallization in materials? **06**
- Q.6 Answer the following.**
- a) Elaborate on the sol-gel process. What are the key steps involved, and what types of materials can be synthesized using this method? **10**
 - b) Describe the role of surfactants in chemical methods of materials synthesis. **06**
- Q.7 Answer the following.**
- a) Explore the various chemical methods for materials synthesis, including hydrothermal, solvothermal, sonochemical, and microbial routes. Provide examples for each method. **10**
 - b) Define high-energy ball milling and discuss its chronological evolution. How has this method advanced over time? **06**

Seat No.	
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M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Materials Characterization (MSC03308)

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) Choose the correct alternative. 10

- 1) Error of measurement is the difference between _____.
 a) True value and measured value
 b) Precision and True value
 c) Measured value and Precision
 d) None of the above
- 2) On which factor does the average kinetic energy of gas molecules depend?
 a) Nature of the gas
 b) Temperature
 c) Volume
 d) Mass
- 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) Which of the following parameters can't be found with Hall Effect?
 a) Polarity
 b) Conductivity
 c) Carrier concentration
 d) Area of the device
- 5) Beer Lambert's law gives the relation between which of the following?
 a) Reflected radiation and concentration
 b) Scattered radiation and concentration
 c) Energy absorption and concentration
 d) Energy absorption and reflected radiation
- 6) The driving force for sintering is reduction in _____.
 a) Internal energy
 b) Surface tension
 c) Surface energy
 d) Entropy
- 7) A bulb contains one mole of hydrogen mixed with one mole of oxygen at temperature T. The ratio of rms values of velocity of hydrogen molecules to that of oxygen molecules is _____.
 a) 1: 16
 b) 1: 4
 c) 4: 1
 d) 16: 1
- 8) In single X-ray diffraction measurement, the crystal is mounted on _____.
 a) X-ray source
 b) Goniometer
 c) Diffraction plate
 d) Fluorescent plate

- 9) In Hall Effect, the output voltage produced across the crystal is due to _____.
a) Drop across the crystal due to the current passed through it
b) Induced voltage by the applied magnetic field
c) Movement of charge carriers towards one end
d) All of the above
- 10) Which of the following is not a limitation of Beer Lambert's law, which gives the relation between absorption, thickness and concentration?
a) Concentration must be lower
b) Radiation must have higher bandwidth
c) Radiation source must be monochromatic
d) Does not consider factors other than thickness and concentration that affect absorbance

B) Write True/ False. 06

- 1) Zero error is an indication of instrumental error.
- 2) Ceramics have high modulus of elasticity.
- 3) An ideal gas is that which can be liquefied.
- 4) According to Beer Lambert's law, absorbance depends on colour of the solution.
- 5) The Hall Effect coefficient is 6.25 when the number of electrons in a semiconductor is 10^{20} .
- 6) Bragg's law is not a sufficient condition for diffraction by crystalline solids.

Q.2 Answer the following. 16

- a) What are standard distribution functions?
- b) State fundamental concept of vacuum.
- c) Write a note nanocrystalline and amorphous solids.
- d) Explain Beer-Lambert Law.

Q.3 Answer the following. 08

- a) Explain the Laue method for single crystal structural analysis. 08
- b) Describe in detail about the factors affecting the intensity in powder XRD. 08

Q.4 Answer the following. 08

- a) Write in detail about four probe method of conductivity measurement. 08
- b) Elaborate the UV-Vis absorption spectroscopy with neat labelled diagrams. 08

Q.5 Answer the following. 08

- a) Explain in detail about Root pumps. 08
- b) Write in detail about methods of sample preparation. 08

Q.6 Answer the following. 08

- a) How are cubic structures analyzed? Explain. 08
- b) Elaborate Vibrational spectroscopy for determining the molecular bonds. 08

Q.7 Answer the following. 08

- a) Explain about the generation and detection of X-rays. 08
- b) Explain Photoluminescence spectroscopy as the technique of measurement of band gap in solids.

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M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Semiconductor Devices (MSC03401)

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

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M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Nuclear and Particle Physics (MSC03402)

Day & Date: Saturday, 11-05-2024
 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) The electric quadrupole moment Q is zero for _____ Nuclei.
 - a) Spherical
 - b) Oblate
 - c) Prolate
 - d) All of these
- 2) The shell model explain _____.
 - a) Even Number of nuclei
 - b) magic number
 - c) Odd number
 - d) All of these
- 3) The symmetry term in the semi empirical mass formula is due to _____.
 - a) Non equality of proton number Z and Neutron number N
 - b) Non spherical shape of nuclei
 - c) Charge independence of nuclear force
 - d) Non zero value of quadrpole moment of nuclei
- 4) A nucleus of medium mass with excess of neutrons may decay with the emission of _____.
 - a) Electron
 - b) Proton
 - c) Positron
 - d) Neutron
- 5) In beta decay _____ are emitted.
 - a) Gamma ray
 - b) Electron
 - c) Proton
 - d) Neutron
- 6) The radius R of the nucleus is given by _____.
 - a) $R=r_0A^{-1/3}$
 - b) $R=r_0A^{1/3}$
 - c) $R=r_0A^{-3}$
 - d) $R=r_0A^3$
- 7) Which one of the following is not a member of the lepton family?
 - a) Electron
 - b) Muon
 - c) Proton
 - d) Neutrino
- 8) The conservation laws of energy of momentum
 - a) Are valid for all the situations at all level
 - b) Are always obeyed at the microscopic level but always violated at the atomic level
 - c) May be violated at the atomic level if the violation does not last too long
 - d) Are no longer valid at any level
- 9) Quantum chromodynamics explains the _____ among the quarks.
 - a) Chemical reaction
 - b) chain reaction
 - c) nuclear fission
 - d) strong interaction

- 10) The nuclear force between the nucleons are _____.
- a) central force
 - b) non central forces
 - c) columbic forces
 - d) cohesive forces

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

- 1) The binding energy of the deuteron is _____.
- 2) If Q value of nuclear reaction is negative the reaction is _____.
- 3) The velocity of charged particle in cyclotron is _____.
- 4) Electron capture is one of the modes of Gamma decay process. (True/False)
- 5) Baryons contain one quark and one anti quark. (True/False)
- 6) Quark experiences all four fundamental forces of nature. (True/False)

Q.2 Answer in brief. 16

- a) Write a note on binding energy and nuclear stability.
- b) Discuss types of nuclear reactions.
- c) Discuss advantages of particle accelerators.
- d) Discuss significance of collective shell model.

Q.3 Answer the following.

- a) Explain the properties of deuteron also discuss the bound state of deuteron assuming a square well potential. 10
- b) Write a note on radioactive dating and define alpha, beta and gamma decay. 06

Q.4 Answer the following.

- a) Derive an explain bethe- Weizsacker formula. 10
- b) What is the significance of binding energy per nucleon, If mass of proton, Neutron and uranium nucleons what will be the binding energy per nucleon ($m_p=1.0078$ amu, $m_n=1.0087$ amu ${}_{92}\text{U}^{238} = 238.0508$ amu) 06

Q.5 Answer the following.

- a) Derive and explain breit-wigner dispersion formula. 10
- b) Write a note on nuclear fission and fusion. 06

Q.6 Answer the following.

- a) What are the fundamental forces. Give the broad classification of elementary particles and there interaction in nature. 10
- b) The uncertainty relation to estimate the K.E of the nucleon, the nuclear radius is about 8×10^{-3} cm and mass of the nucleus is about $940\text{MeV}/c^2$. 06

Q.7 Answer the following.

- a) Give the account of meson octet and find out charge, Isospin, I_3 , Baryon number, strangeness and hypercharge with the schematic diagram. 10
- b) Discuss construction and working of cyclotron with schematic diagram. 06

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M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2024
PHYSICS (MATERIALS SCIENCE)
Physics of Nano Materials (MSC03403)

Day & Date: Tuesday, 14-05-2024
 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) Multiple choice questions.

10

- 1) The nanoscale involves the range from approximately _____
 a) 1nm to 1000 nm b) 1nm to 100 nm
 c) 1nm to 10 nm d) 1nm to 0.001 nm
- 2) Top-down and bottom-up approaches differ in degrees of
 a) Speed b) Quality
 c) Quality, speed and cost d) cost
- 3) Graphene is a _____nanomaterial with single atomic layer of carbon structure.
 a) 3D b) 2D
 c) 1D d) 0D
- 4) Beer-Lamberts law is applied to the analysis of a mixture by _____ without the need for extensive pre-processing of the sample.
 a) Thermometry b) Spectrophotometry
 c) Calorimetry d) Diffractometry
- 5) In _____ semiconductor repels the negative ions and attracts the positive ions.
 a) Schottky effect b) Frenkel effect
 c) Hopping d) Polar
- 6) Molecular beam epitaxy (MBE) is an elegant material growth technique that is most simply described as a very refined form of
 a) pulse vapor deposition b) chemical vapor deposition
 c) physical laser deposition d) Sputtering
- 7) A scanning probe microscopy (SPM) is used for studying _____ scale level.
 a) surfaces at the nano b) molecules at the nano
 c) atoms at the nano d) defects at the micro
- 8) The BET is commonly used to generate a specific surface area result expressed in units of
 a) mass per area of sample (g/m^2)
 b) area per mass of sample (m^2/g)
 c) Density per mass of sample
 d) area per density of sample

- 9) X-Ray Diffraction (XRD) allows one to ascertain the molecular structure of a _____ through the sample.
 - a) crystalline material by absorbing x-rays
 - b) crystalline material by diffracting x rays
 - c) single crystal material by diffracting x-rays
 - d) non-crystalline material by diffracting x-rays
- 10) Nanotubes are formed by folding or rolling _____
 - a) nanocarbon into a cylindrical shape structure.
 - b) two-dimensional graphite into a circular shape structure.
 - c) nanodiamond into a cylindrical shape structure.
 - d) two-dimensional graphite into a cylindrical shape structure.

B) State True or False.

06

- 1) Sputtering is a physical process in which atoms in a solid-state are released and pass into the gas phase by bombardment with energetic ions, mainly noble gas ions.
- 2) Surface plasmon resonance is the manifestation of a resonance effect due to the interaction of conduction electrons of metal nanoparticles with incident photons.
- 3) Nanotechnology could also enable objects to harvest energy from their environment.
- 4) The Principle of UV-Visible Spectroscopy is based on the absorption of visible light by chemical compounds, which results in the production of distinct spectra.
- 5) The electroplating process is also known as electrodeposition.
- 6) Nanoparticles of silver are used to deliver antimicrobial properties in hand washes, bandages, and socks.

Q.2 Answer the following.

16

- a) Explain in brief the top-down approach of synthesis of nanomaterials.
- b) Define the Density of States at Low - dimensional Structures.
- c) Explain the phenomenon of photoluminescence.
- d) Illustrate the technique of electrodeposition.

Q.3 Answer the following.

- a) Explain the various conduction mechanism in bulk materials. **08**
- b) Mention the basic principle of SPM and highlight the details of STM. **08**

Q.4 Answer the following.

- a) State the principle of Photo-luminescence, Fluorescence, Phosphorescence, Cathodoluminescence, and Electroluminescence phenomenon. **10**
- b) Give a general concept and important characteristics of AFM. **06**

Q.5 Answer the following.

- a) Describe the quantum confinement effect. **08**
- b) Explain the Poole - Frenkel Effect. **08**

Q.6 Answer the following.

- a) Describe the phenomena of core-shell in nanomaterials. **10**
- b) Discuss the era of nanostructures of carbon fullerenes. **06**

Q.7 Answer the following.

- a) Explain the Drude model quantum theory and its interpretation. **08**
- b) State and explain in brief different chemical growth routes. **08**

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**M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April - 2024
PHYSICS (MATERIALS SCIENCE)**

Advanced Techniques of Materials Characterization (MSC03406)

Day & Date: Thursday, 16-05-2024

Max. Marks: 80

Time: 03:00 PM To 06:00 PM

- Instructions:** 1) attempt five question.
2) Q. Nos. 1 and. 2 are compulsory.
3) Attempt any three questions from Q. No. 3 to Q. No. 7

Q.1 A) Multiple Choice questions. 10

- 1) In SEM, once an electron beam hits a sample, the sample ejects _____.
 - a) Electrons and x-rays
 - b) Positrons and Gamma rays
 - c) Anti-electrons and ultraviolet rays
 - d) Neutrinos and Radio waves
- 2) _____ technique is suitable for function group detection.
 - a) FTIR
 - b) UV -VIS Spectroscopy
 - c) XRD
 - d) NMR
- 3) An elastic collision of photon with a molecule results into _____.
 - a) Compton scattering
 - b) Raman scattering
 - c) Both: Raman and Compton scattering
 - d) Rayleigh scattering
- 4) On the electromagnetic spectrum, the visible light is found between _____.
 - a) X-rays and Gamma rays
 - b) Infrared and Ultraviolet
 - c) X-rays and Ultraviolet
 - d) Radio and Micro waves
- 5) In Electron microscope, light source is replaced by a beam of very fast moving _____.
 - a) Electron
 - b) Neutron
 - c) Proton
 - d) Photon
- 6) The magnitude of nuclear magneton is _____.
 - a) $5.05 \times 10^{-27} J/T$
 - b) $9.27 \times 10^{-24} J/T$
 - c) $5.05 \times 10^{-27} eV/T$
 - d) $9.27 \times 10^{-24} eV/T$
- 7) The energy of the back scattered electrons in SEM is _____ that of secondary electrons.
 - a) Equal to
 - b) Less than
 - c) Greater than
 - d) None of these
- 8) In the formula, $\mu = \alpha E$ what represents the symbol " α "?
 - a) Polarization
 - b) Magnitude of polarization
 - c) Polarisability
 - d) None of above
- 9) The size of the Ellipsoid in the Raman spectroscopy represents _____ of polarization.
 - a) Intensity
 - b) Magnitude
 - c) Power
 - d) Direction

- 10) Solids with more than one atom in the smallest unit cell exhibit _____.
- Acoustic phonons
 - Optical phonons
 - Both acoustic phonons and optical phonons
 - None of the above

B) Fill in the blanks/State true false 06

- _____ transitions take place in UV -Vis Spectroscopy.
- _____ is the unit of molar absorption coefficient.
- The polarization in the Raman spectroscopy is represented by _____.
- _____ technique is used for determination of surface area of material.
- Elastic scattering is take place in Raman scattering. (True/False)
- Metal can transmit X rays. (True/False)

Q.2 Answer the following 16

- Acoustic and Optical phonon modes.
- Auger Transitions.
- Magic Angle Spinning (MAS).
- IR and Raman active substances

Q.3 Answer the following

- Describe the process of image formation and working of Scanning Tunneling Microscopy (STM) with schematic diagram. 10
- Explain technique used for surface area measurement. 06

Q.4 Answer the following

- Describe principle, and working of Atomic force microscopy (AFM) with schematic diagram. 10
- Explain applications of NMR spectroscopy. 06

Q.5 Answer the following

- Describe principal and working of X-ray photoelectron spectroscopy with schematic diagram. 10
- Elucidate difference between SEM and TEM. 06

Q.6 Answer the following

- Describe principal and working of TEM with schematic diagram. 10
- Give an account of Electrostatic and Magnetic focusing in electron microscope. 06

Q.7 Answer the following

- Describe principal and working of Raman Spectroscopy with schematic diagram. 10
- Explain the necessity of high-resolution NMR spectrometer for solid samples. 06