R0238	Sub. Code
	521101

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2023

First Semester

Physics

CLASSICAL MECHANICS

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 1 = 10)$

Answer **all** the following objective questions by choosing the correct option.

1. The Number of degrees of freedom for a particle moving freely on the surface of a sphere is (CO1, K3)

   (a) one (b) two

   (c) three (d) four

2. The Lagrangian of the system is given as $L = \frac{1}{2}m\left(\dot{r}^2 + r^2\dot{\theta}^2\right) - V(r)$. The conserved quantity in the dynamics is (CO1, K4)

   (a) $m\dot{r}^2$ (b) $m\dot{r}^2\dot{\theta}^2$

   (c) $mr^2\dot{\theta}$ (d) $V(r)$

3. The transformation of generalized coordinates in the configuration space is known as (CO2, K2)

   (a) Canonical transformation

   (b) Point transformation

   (c) Legendre Transformation

   (d) Coordinate Transformation

4. The Poisson bracket $\{q^2, p^2\}_{q,p}$ value is (CO2, K5)

(a) 0 (b) 1

(c) $2qp$ (d) $4qp$

5. The dimension of moment of inertia is (CO3, K2)

(a) M (b) MT

(c) ML (d) ML^2

6. The number of independent coordinates required to specify a rigid body is (CO3, K1)

(a) three (b) six

(c) nine (d) infinite

7. The number of degrees of freedom for particle moving in a central force field is (CO4, K3)

(a) 1 (b) 2

(c) 3 (d) 4

8. At what velocity, the mass of the particle will be double of its rest mass? (CO4, K6)

(a) $\sqrt{3}c$ (b) $\sqrt{2}c$

(c) $\sqrt{3/2}c$ (d) ∞

9. Which of the following physical system is in stable equilibrium? (CO5, K2)

(a) An egg standing on end

(b) A book placed on a table

(c) A ball on the floor

(d) A pendulum is at rest

10. The kinetic and potential energy terms in normal coordinates are (CO5, K4)

(a) linear (b) quadratic

(c) cubic (d) constants

Part B (5 × 5 = 25)

Answer **all** the questions not more than 500 words each.

11. (a) Explain principle of virtual work done and D'Alembert's principle. (CO1, K1)

Or

(b) Obtain the equation of Lagrange equation of motion for Atwood's machine. (CO1, K1)

12. (a) Find under what conditions $Q = \alpha p / x$, $P = \beta x^2$ represent a canonical transformation? Here α and β are constants. (CO2, K5)

Or

(b) Solve the simple one dimensional harmonic oscillator problem using Hamilton-Jacobi method. (CO2, K4)

13. (a) Write a note on Momental ellipsoid. (CO3, K3)

Or

(b) Determine the Moment of Inertia of a mass of solid homogenous sphere with respect to any geometrical axis. (CO3, K3)

14. (a) Obtain the mass energy equivalence relation. (CO4, K4)

Or

(b) Discuss the method of classification of orbits using potential energy curves. (CO4, K3)

15. (a) Discuss stable, unstable and neutral equilibrium of one dimensional oscillator. (CO5, K4)

Or

(b) What are normal coordinates and how do they play vital role in small oscillations? (CO5, K5)

Part C (5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Derive Euler Lagrange equation of motion for holonomic systems. (CO1, K4)

Or

(b) Explain the elimination process by Routhian function using suitable example. (CO1, K4)

17. (a) Show that Poisson transformation is invariant under canonical transformation. (CO2, K5)

Or

(b) State and prove Liouville's theorem. (CO2, K3)

18. (a) Derive the transformation matrix for the rotation in three dimensional space using Eulerian angles. (CO3, K6)

Or

(b) State and prove parallel axis theorem and perpendicular axis theorem. (CO3, K3)

19. (a) Obtain the equations of motion for a particle moving in a inverse square law of force field. (CO4, K5)

Or

(b) Obtain the Lorentz transformation and deduce the expressions for length contraction and time dilation. (CO4, K4)

20. (a) Obtain the normal modes of vibrations of linear triatomic molecule. (CO5, K4)

Or

(b) Obtain the normal modes of vibrations of a diatomic molecule. (CO5, K4)

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R0239	Sub. Code
	521102

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2023

First Semester

Physics

MATHEMATICAL PHYSICS – I

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 1 = 10)$

Answer **all** the following objective questions by choosing the correct option.

1. If $\vec{a}$ is a constant vector and $\vec{r}$ is a position vector then which one of the following is vanishing? (CO1, K2)

   (a) $\vec{\nabla}(\vec{a} \,.\, \vec{r})$ (b) $\vec{\nabla} \times (\vec{a} \times \vec{r})$

   (c) $\vec{\nabla}.(\vec{a} \times \vec{r})$ (d) $\vec{\nabla}.\,(\vec{a} \,.\, \vec{r})\vec{a}$

2. Vector triple products $\vec{A} \times (\vec{B} \times \vec{C})$ and $(\vec{A} \times \vec{B}) \times \vec{C}$ are equal when and only when (CO1, K2)

   (a) $\vec{A} \parallel \vec{B}$ (b) $\vec{C} \parallel \vec{B}$

   (c) $\vec{C} \parallel \vec{A}$ (d) $\vec{C} \perp \vec{A}$

3. Rank of matrix $\begin{pmatrix} 2 & 1 & 3 \\ 3 & 1 & 5 \end{pmatrix}$ is (CO2, K3)

   (a) 1 (b) 2

   (c) 3 (d) –1

4. What is the maximum number of independent elements in an antisymmetric matrix of order 2×2? (CO2, K3)

(a) 1 (b) 2

(c) 3 (d) 4

5. If A^{μ} and B_{γ} are components of contravariant and covariant vectors, what is the nature of the quantity $A^{\mu} B_{\gamma}$? (CO3, K4)

(a) zero

(b) an invariant

(c) a covariant

(d) a mixed tensor of rank two

6. How many independent components can an antisymmetric tensor of rank two have in n-dimensional space? (CO3, K2)

(a) n^2 (b) $n(n+1)$

(c) $\frac{n(n+1)}{2}$ (d) $2n$

7. Mean of a Poisson's distribution is 5. What is the standard deviation? (CO4, K5)

(a) $\frac{5}{2}$ (b) $\sqrt{5}$

(c) 3 (d) 4

8. In a normal distribution, the ratio of mean deviation from mean and its standard deviation is nearly (CO4, K5)

(a) 1 (b) 1/2

(c) 1/3 (d) 1/5

9. Special form of integral transform with kernel $k(s,m)=e^{-isn}$ is (CO5, K2)

(a) Laplace transform

(b) Fourier transform

(c) Fourier cosine transform

(d) Fourier sine transform

10. Laplace transform is a special case of integral transform when the kernal is (CO5, K1)

(a) e^{-ist} (b) e^{-st}

(c) sin st (d) cos st

Part B ($5 \times 5 = 25$)

Answer **all** the questions not more than 500 words each.

11. (a) Evaluate $\int_c \vec{F}.d\vec{V}$ when $\vec{F}=xy\hat{i}+yz\hat{j}+zx\hat{k}$, when C is the curve $\vec{r}=t\hat{i}+t^2\hat{j}+t^3\hat{k}$, t varying from –1 to 1. (CO1, K3)

Or

(b) Express the vector $\vec{V}=2x\hat{t}-z\hat{j}+y\hat{k}$ in cylindrical coordinates. (CO1, K3)

12. (a) Diagonalize the matrix $\begin{pmatrix} 4/3 & \sqrt{2}/3 \\ \sqrt{2}/3 & 5/3 \end{pmatrix}$ by determining the appropriate diagonalizing matrix. (CO2, K5)

Or

(b) If $A=\begin{pmatrix} 1 & 2 \\ -2 & 1 \end{pmatrix}$, find scalars a and b such that $I+\alpha A+bA^2=0$, where I is the unit matrix and 0 is the null matrix both of order two. (CO2, K5)

13. (a) Demonstrate the following identities (i) $\delta_{ij} = 3$, (ii) $\delta_{ij}\varepsilon_{ikm} = 0$, (iii) $\varepsilon_{iks}\varepsilon_{mps} = \delta_{im}\delta_{kp} - \delta_{ip}\delta_{km} = 0$.

(CO3, K3)

Or

(b) Express (i) the vector product $\vec{A} \times \vec{B}$ and (ii) $\vec{\nabla}.\left(\vec{\nabla} \times \vec{A}\right)$ in tensor notation. Hence show that $\vec{\nabla}.\left(\vec{\nabla} \times \vec{A}\right) = 0$. (CO3, K4)

14. (a) The following data are the number of seeds of germinating out of 10 on damp filter for 80 sets of seeds. Fit a binomial distribution to these data.

(CO4, K5)

x:	0	1	2	3	4	5	6	7	8	9	10
f:	6	20	23	12	8	6	0	0	0	0	0

Or

(b) In an experiment two dice are thrown together. Find the probability that the sum of the face values of the dice equals or exceeds 10. (CO4, K4)

15. (a) Verify the definition of Fourier transform and its inverse for the function $f(x) = e^{-x^2/2}$, $-\infty < x < \infty$.

(CO5, K3)

Or

(b) Show that $L\left(t^n\right) = \frac{n!}{s^{n+1}}$, $n \geq 0$. (CO5, K3)

Part C (5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Using Gauss divergence theorem evaluate $\iint_s \vec{F}.\hat{n}\,ds$, where $\vec{F} = 2x^2y\hat{t} - y^2\hat{j} + 4xz^2\hat{k}$ and S is a closed surface in the first octant bounded by $y^2 + z^2 = 9$ and $x = 2$. (CO1, K3)

Or

(b) Consider $\vec{F} = 3\hat{i} - \hat{j} - 2\hat{k}$ and V to be the three-dimensional space enclosed by the place $x = 0$, $y = 0$, $z = 0$ and $2x + 2y + z = 4$. Evaluate $\iiint_V \vec{F}\ dx\ dy\ dz$. (CO1, K5)

17. (a) Find A^{-3} using Cayley-Hamilton theorem for the non-singular matrix A, where $A = \begin{pmatrix} 2 & 4 \\ 1 & 1 \end{pmatrix}$. Verify that A^{-3} is the inverse of A^3. (CO2, K6)

Or

(b) Determine the eigenvalues and eigenvectors of the matrix $A = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$ and verify the orthogonality of its eigenvectors. (CO2, K4)

18. (a) Show that in a Cartesian coordinate system, the contravariant and covariant components of a vector are identical. (CO3, K4)

Or

(b) Show that the matrix $\begin{pmatrix} -xy & -y^2 \\ x^2 & xy \end{pmatrix}$ represents a tensor whereas the matrix $\begin{pmatrix} -xy & -y^2 \\ -x^2 & -xy \end{pmatrix}$ is not a tensor. (CO3, K5)

19. (a) Define Poisson's distribution. Calculate the mean and standard deviation of Poisson's distribution. (CO4, K1)

Or

(b) Define normal distribution. Obtain the probability density function for it and thus find out values of the mean and standard deviation. (CO4, K1)

20. (a) Find the Fourier series for the periodic function $f(x)$ defined by $f(x)=\begin{cases} -\pi & if\ -\pi<x<0 \\ x & if\ 0<x<\pi \end{cases}$. Hence prove that $\frac{\pi^2}{8}=\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\ldots$ (CO5, K5)

Or

(b) Obtain the Laplace transform of half wave rectifier function defined by $f(t)=\begin{cases} \sin \omega t & 0<t<\frac{\pi}{\omega}, \\ 0 & \frac{\pi}{\omega}<t<\frac{2\pi}{\omega}, \end{cases}$ with period $T=\frac{2\pi}{\omega}$. (CO5, K4)

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R0240	Sub. Code
	521103

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2023

First Semester

Physics

ELECTRONICS

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 1 = 10)$

Answer **all** the following objective questions by choosing the correct option.

1. N type and P type semiconductor can be obtained by adding the impurities of _____ respectively. (CO1, K1)

   (a) arsenic and indium

   (b) boron, indium

   (c) indium, antimony

   (d) antimony, bismuth

2. Depletion region in junction diode or zener diode behaves as (CO1, K1)

   (a) conductor

   (b) insulator

   (c) cut off region

   (d) perfect semiconductor

3. Silicon type transistors are more often used than germanium type because it (CO2, K3)

(a) has small cut off current I_{cbo} and high operating temperature

(b) has small variation due to majority career

(c) does not have temperature dependent

(d) is due to fast moving of majority carriers at optimum temperature

4. A TRIAC is a three terminal with four layer ———— device. (CO2, K3)

(a) unidirectional

(b) bidirectional Thyrister

(c) two transistors internally coupled

(d) transistor

5. An ideal operational amplifier has input impedance of ———— and it means that the ———— (CO3, K2)

(a) zero, input current is zero

(b) infinite, input current is few milli ampere

(c) zero, output current is zero

(d) infinite, input current is zero

6. A differential amplifier has differential mode gain of 100 and a common mode gain of 0.01, the CMRR in db is (CO3, K4)

(a) 40 db (b) 0.01 db

(c) 80 db (d) 50 db

7. A JK flip flop with $J = 1$ and $K = 1$ has a 10 kHz clock input. The Q output is (CO4, K4)

(a) considerably 1

(b) a 5kHz triangular wave

(c) a 5 kHz square wave

(d) a 15 kHz rectangular wave

8. EPROM uses _____ and has high density. (CO4, K2)

(a) to retain memory when power supply cut off

(b) one transistor memory cell

(c) non-volatile memory

(d) all the above

9. The resolution of an 8 bit ADC, whose full scale input 8 volt is (CO5, K4)

(a) $\frac{1}{32}$ (b) $\frac{1}{16}$

(c) 8 (d) $\frac{1}{8}$

10. In voltage to frequency conversion circuit, the frequency of the output pulses from the comparator is _____ to the input analog voltage. (CO5, K1)

(a) inversely proportional

(b) directly proportional

(c) infinite

(d) equal

Part B (5 × 5 = 25)

Answer **all** the questions not more than 500 words each

11. (a) (i) What are the two different mechanisms of breakdown in PN junction? Explain them.

(ii) With the IV characteristics curve, describe the working of PN junction diode. (CO1, K1)

Or

(b) Explain the principle and working of photo diode with the characteristic diagram. (CO1, K2)

12. (a) (i) How does emitter resistance help to stabilize Q point of an amplifier?

(ii) Draw the circuit and explain the working of potential divider biasing. (CO2, K5)

Or

(b) Discuss the construction and working of class B push pull amplifier circuit. Find its power and efficiency. (CO2, K2)

13. (a) Explain the operation of an integrated circuit using operational amplifier. Find its output. (CO3, K5)

Or

(b) (i) What is sample-hold circuit?

(ii) Draw the simple form of sample-hold circuit and discuss its working. (CO3, K2)

14. (a) Differentiate static RAM and dynamic RAM. Briefly explain about PROM. (CO4, K3)

Or

(b) Describe the working of ring counter with necessary circuit. Obtain its truth table and timing diagram of ring counter. (CO4, K2)

15. (a) Explain the working of time division multiplexing with its circuit. (CO5, K5)

Or

(b) Discuss the R-2R ladder network with the four input voltage circuit. (CO5, K4)

Part C $(5 \times 8 = 40)$

Answer **all** questions not more than 1000 words each.

16. (a) Describe the construction and working of Schottky diode. Mention its applications. (CO1, K1)

Or

(b) What is zener diode? Explain the working of zener diode with the VI characteristics curve. (CO1, K3)

17. (a) Explain the construction, working and applications of SCR. (CO2, K4)

Or

(b) (i) In a fixed biasing circuit $R_B = 1M, R_c = 5K, V_{cc} = 6V$ and $\beta = 100$. determine the Q point.

(ii) Describe how a transistor working as an amplifier? (CO2, K5)

18. (a) Sketch the circuit and explain the working of triangular wave generator using operation amplifier. (CO3, K6)

Or

(b) (i) Describe the construction and working of first order low-pass Butterworth filter. Explain its frequency response.

(ii) Design a low-pass filter having a cut off frequency of 2 kHz with a pass band gain of 2.5. (CO3, K4)

19. (a) Draw the schematic circuits of RS flip flop and explain its outputs. (CO4, K4)

Or

(b) What is register? Explain the working of serial in serial out shift register circuit. (CO4, K5)

20. (a) Explain the construction and working of voltage to frequency conversion circuit. (CO5, K5)

Or

(b) Describe the analog to digital conversion circuit (ADC) by successive approximation method. (CO5, K2)

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R0241	Sub. Code
	521501

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2023

First Semester

Physics

Elective — NUMERICAL ANALYSIS AND C-PROGRAMMING

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 1 = 10)$

Answer **all** the following objective questions by choosing the correct options.

1. Find the root of $x^4 - x - 10 = 0$ approximately upto 4 iterations using Bisection Method. Let $a = 1.5$ and $b = 2$. (CO1, K3)

   (a) 1.68 (b) 1.86

   (c) 1.59 (d) 1.66

2. In the least squares method, what are the "errors" that are minimized? (CO1, K1)

   (a) Absolute errors

   (b) Relative errors

   (c) Sum of squared errors

   (d) Mean errors

3. Find the divided differences table for the following data (CO2, K3)

x	4	7	12
	9	34	120

(a) 1.15 (b) 1.77

(c) 1.31 (d) 1.48

4. For a set of n + 1 data points, what is the minimum degree of a polynomial required to uniquely interpolate the data when n data points are specified? (CO2, K2)

(a) 1 + n (b) n

(c) n or less (d) 1 + n or loss

5. Find $\int_1^3 (x^2 + 2x)dx\,dy$ by using Trapezoidal rule with two sub intervals (CO3, K3)

(a) 14 (b) 15

(c) 16 (d) 17

6. What is the primary goal of the Runge-Kutta method? (CO3, K1)

(a) Approximation

(b) Integration

(c) Differentiation

(d) Extrapolation

7. Which term describes the process of gradually refining an estimate using successive approximations? (CO4, K2)

(a) Iteration

(b) Differentiation

(c) Extrapolation

(d) Integration

8. In the Gauss-Jordan method, what type of matrix is often transformed into its row-echelon form? (CO4, K1)

(a) Square

(b) Symmetric

(c) Rectangular

(d) Diagonal

9. Which data type in C is used to represent a single character? (CO5, K2)

(a) String (b) Char

(c) Byte (d) Character

10. What is the primary function of the main() function in a C program? (CO5, K1)

(a) Input (b) Output

(c) Execution (d) Declaration

Part B $(5 \times 5 = 25)$

Answer **all** the questions not more than 500 words each.

11. (a) Explain Newton's method : Error analysis.(CO1, K4)

Or

(b) Briefly discuss about Bisection method. (CO1, K4)

12. (a) Explain Quadratic and Linear interpolation. (CO2, K4)

Or

(b) Using Lagrange interpolation find y(3) from the following data: (CO2, K3)

x:	0	1	4	7	11
y:	0	1	76	154	525

13. (a) Given $y' = 2x + y/x - y$, with $y = 2$ for $x = 2$. Find y approximately for x = 0.3 by Euler's method in four steps taking $h = 0.1$. (CO3, K3)

Or

(b) Using the Taylor series method, approximate the value of $y(0.4)$ and $y(0.5)$ correct to four decimal places for the differential equation $y' = 2xy + e^x$, given the initial condition $y(0) = 3$. (CO3, K3)

14. (a) Solve the following system of linear equations using the Gauss-Jacobi method with two iterations: $4x - y + 2z = 8$, $2x + 6y - z = 3$, $x - 2y + 5z = 6$. (CO4, K3)

Or

(b) List the iteration methods and explain them briefly. (CO4, K4)

15. (a) What are pointers? Explain briefly. (CO5, K4)

Or

(b) Write a short note on Control Statements. (CO5, K4)

Part C ($5 \times 8 = 40$)

Answer **all** the questions not more than 1000 words each.

16. (a) Explain in detail about Non-linear systems and Horner's method. (CO1, K4)

Or

(b) What is Scent method? Discuss its significance for error analysis. (CO1, K4)

17. (a) Give an account for Lagrange interpolation. (CO2, K5)

Or

(b) Using Newton's divided difference formula determine f(1) and f(7) from the data: (CO2, K5)

x:	2	6	8	12	15
f(x):	57	131	28	800	1324

18. (a) Evaluate $\int_0^4 dx / 2x + 1$ by using (i) Trapezoidal rule (ii) Simpson's 1/3 rule and (iii) Simpson's 3/8 rule given that. (CO3, K5)

Or

(b) Obtain the value of y at $x = 0.1$. If y satisfies $y' = x^2 + y + x$, $y(0) = 1$ taking $h = 0.1$ using Runge-Kutta method of second and third order. (CO3, K5)

19. (a) Solve the following system of linear equations using the Gaussian elimination method: (CO4, K5)

(i) $3x + 2y - z = 10$

(ii) $2x - y + 3z = -5$

(iii) $x + 4y - 2z = 15$

Or

(b) (i) $3x + 2y - z = 10$ (CO4, K5)

(ii) $2x - y + 3z = -5$

(iii) $x + 4y - 2z = 15$

Perform the Gaussian elimination method to find the values of x, y, and z.

20. (a) Discuss in detail about Operators and Expressions. (CO5, K6)

Or

(b) Explain the importance of arrays and strings with examples. (CO5, K6)

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R0242	Sub. Code
	521301

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2023

Third Semester

Physics

ADVANCED MOLECULAR SPECTROSCOPY

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 1 = 10)$

Answer **all** the following objective questions by choosing the correct option.

1. CH_3Cl belongs to the category of (CO1, K1)

   (a) Linear molecule

   (b) Symmetric Top molecule

   (c) Asymmetric Top molecule

   (d) Spherical Top molecule

2. The unit for dipole moment is (CO1, K1)

   (a) Debye (b) Gauss

   (c) Debye/cm (d) Henry

3. Zero point energy for the lowest vibrational level will be (CO2, K1)

   (a) $\frac{1}{2}\bar{v}_0$ (b) $\bar{v}_0$

   (c) $\frac{3}{2}\bar{v}_0$ (d) 1

4. The range of middle IR region in the electromagnetic spectrum is given by (CO2, K1)

(a) $50 - 12500\, cm^{-1}$ (b) $12500 - 4000\, cm^{-1}$

(c) $4000 - 400\, cm^{-1}$ (d) $400 - 50\, cm^{-1}$

5. Change in polarization is mandatory to observe, (CO3, K2)

(a) Rotational spectra (b) Vibrational spectra

(c) Electronic spectra (d) Raman spectra

6. Hyper Raman Scattering is a ———————— (CO3, K2)

(a) 3 photon process (b) 3 electron process

(c) 3 phonon process (d) 2 photon process

7. The nuclear spin of $_2He^4$ is ———————— (CO4, K2)

(a) 0 (b) Half integer

(c) Integer (d) None of the above

8. When a nucleus of magnetic moment μ is placed in a magnetic field B_0, the interaction energy is ———————— (CO4, K1)

(a) $E = -\mu B_0 \cos\theta$ (b) $E = -\mu B_0 \sin\theta$

(c) $E = -\mu B_0 \tan\theta$ (d) $E = -\mu B_0 \cot\theta$

9. The resonant absorption of gamma rays was observed by Mossbauer only in the year ———————— (CO5, K1)

(a) 1958 (b) 1968

(c) 1950 (d) 1970

10. ^{57}Co is a source of (CO5, K1)

(a) Gamma ray (b) Beta ray

(c) Alpha ray (d) X-ray

Part B ($5 \times 5 = 25$)

Answer **all** the questions not more than 500 words each.

11. (a) Outline the effect of isotopic substitution on the rotational spectra of molecules with necessary diagram. (CO1, K3)

Or

(b) The first line in the rotation spectrum of carbon monoxide has a frequency of 3.8626 cm^{-1}. Calculate the rotational constant and hence the C-O bond length in carbon monoxide. (CO1, K3)

12. (a) (i) The frequency of OH stretching vibration in CH_3OH is 3300 cm^{-1}. Estimate the frequency of OD stretching vibration in CH_3OD. (CO2, K3)

(ii) One of the fundamental vibration modes of H_2O occurs at 3652 cm^{-1}. What would be the frequency of the corresponding mode in D_2O?

Or

(b) Obtain the expression for vibrational energy of a vibrating diatomic molecule and plot the energy levels correspond to fundamental, overtones and hot bands. (CO2, K3)

13. (a) Explain resonance Raman scattering with necessary energy level diagrams. (CO3, K4)

Or

(b) If the bond length of H2 is 0.07417 nm, what would be the positions of the first three rotational Raman lines in the spectrum? Where $^{1}H = 1.673 \times 10^{-26}\ kg$. (CO3, K3)

14. (a) Discuss in detail the chemical shifts with suitable examples. (CO4, K4)

Or

(b) Explain the principle of NMR with suitable diagram. (CO4, K4)

15. (a) Describe in detail the recoilless emission and absorption of gamma rays with necessary diagrams. (CO5, K4)

Or

(b) Write a short notes on chemical isomer shift with suitable diagram for the NQR spectrometry. (CO5, K4)

Part C (5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Obtain the expression for rotational energy of rigid diatomic molecule. How rigid rotator is different from non-rigid rotator? (CO1, K4)

Or

(b) What is Stark Effect? Discuss in detail the importance of stark effect studies in microwave spectroscopy? (CO1, K4)

17. (a) State and explain Franck-Condon principle with necessary diagrams. (CO2, K5)

Or

(b) Discuss in detail the IR spectrophotometer instrumentation with necessary schematic diagram. (CO2, K5)

18. (a) State Mutual exclusion principle. Show that IR and Raman spectroscopy measurements are complement to one another in the case of structure determination. (CO3, K6)

Or

(b) What is Raman scattering? Explain the Raman scattering phenomenon with the help of quantum theory. (CO3, K5)

19. (a) Obtain the Bloch equations. (CO4, K5)

Or

(b) Outline briefly the applications of Fourier Transform NMR spectroscopy. (CO4, K4)

20. (a) Discuss in detail the quadrupole interactions in a system having $I = ½$ in the ground state and $I = 3/2$ in the excited state. (CO5, K6)

Or

(b) Explain how the molecular structure and electronic structure can be determined using Mossbauer spectrum. (CO5, K5)

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R0243	Sub. Code 521302

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2023

Third Semester

Physics

QUANTUM MECHANICS – II

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 1 = 10)$

Answer **all** the following objective questions by choosing the correct option.

1. The product of J_+ and J_- is (CO1, K2)

   (a) $J_x^2 + J_y^2 - 2\hbar J_z$ (b) $J_x^2 + J_y^2 + 2\hbar J_z$

   (c) $J_x^2 + J_y^2 + \hbar J_z$ (d) $J_x^2 + J_y^2 - \hbar J_z$

2. The expectation value of $< J_z^2 >$ is (CO1, K2)

   (a) $m\hbar$ (b) $-m\hbar$

   (c) $m^2\hbar^2$ (d) $-m^2\hbar^2$

3. Hartree-Fock equation is not acceptable, when the particles are (CO2, K1)

   (a) single and indistinguishable

   (b) single and distinguishable

   (c) many and indistinguishable

   (d) many and distinguishable

4. Relation between spin angular momentum operator $\hat{S}$ and the Pauli spin matrices $\hat{\sigma}$ is (CO2, K2)

(a) $\hat{S} = \frac{1}{2}\hbar\hat{\sigma}$ (b) $\hat{S} = \hbar\hat{\sigma}$

(c) $\hat{S} = -\frac{1}{2}\hbar\hat{\sigma}$ (d) $\hat{S} = -\hbar\hat{\sigma}$

5. The probability density in relativistic case is (CO3, K1)

(a) $P(r,t) = \frac{i\hbar}{2mc^2}(\psi * \frac{\partial\psi}{\partial t} - \psi\frac{\partial\psi^*}{\partial t})$

(b) $P(r,t) = \frac{-i\hbar}{2mc^2}(\psi\frac{\partial\psi^*}{\partial t} - \psi^*\nabla\psi)$

(c) $P(r,t) = \frac{-i\hbar}{2mc^2}(\psi^*\frac{\partial\psi}{\partial t} - \psi^*\frac{\partial\psi^*}{\partial t})$

(d) $P(r,t) = \frac{i\hbar}{2mc^2}(\psi\frac{\partial\psi^*}{\partial t} - \psi^*\frac{\partial\psi^*}{\partial t})$

6. Relativistic expression for the energy is (CO3, K1)

(a) $E = (P^2c^2 + m^2c^4)^{1/2}$

(b) $E = (P^2c^2 - m^2c^4)^{1/2}$

(c) $E = (P^2c^2 + m^2c^4)^2$

(d) $E = (P^2c^2 - m^2c^4)^2$

7. The Hamiltonian density can be written as (CO4, K1)

(a) $\mathcal{H} = \pi(r,t)\dot{\psi}(r,t) - \mathcal{L}$

(b) $\mathcal{H} = \pi(r,t)\dot{\psi}(r,t) + \mathcal{L}$

(c) $\mathcal{H} = \dot{\pi}(r,t)\dot{\psi}(r,t) - \mathcal{L}$

(d) $\mathcal{H} = \pi(r,t)\psi(r,t) - \mathcal{L}$

R0243

8. The dimension of force in natural unit is (CO4, K2)

(a) $[M]^0$ (b) $[M]^1$

(c) $[M]^2$ (d) $[M]^{-1}$

9. The Fermi Golden rule is (CO5, K1)

(a) $W = \frac{2\pi}{\hbar}|H'_{if}|^2 \rho(E_f)$ (b) $W = \frac{2\pi}{\hbar}|H'_{fi}|^2 \rho(E_f)$

(c) $W = \frac{2\pi}{\hbar}|H'_{fi}|\rho(E_f)$ (d) $W = \frac{2\pi}{\hbar}|H'_{if}|\rho(E_f)$

10. Choose the correct statement regarding scattering is (CO5, K1)

(a) inelastic if there is not exchange of energy

(b) elastic if there is exchange of energy

(c) inelastic if there is no exchange of energy and momentum

(d) elastic if there is no exchange of energy

Part B ($5 \times 5 = 25$)

Answer **all** the questions not more than 500 words each.

11. (a) Discuss the addition of two angular momenta using the triangular rule. (CO1, K1)

Or

(b) Write notes on spin vectors for spin ½ systems. (CO1, K1)

12. (a) How did Hartree obtain the central field in his theory of many electron atom? (CO2, K4)

Or

(b) Show that α and β are eigen functions of S_x^2 and not of S_x. (CO2, K4)

13. (a) How Klein-Gordon equation leads to positive and negative probability density? Explain. (CO3, K4)

Or

(b) List the properties of the Dirac matrices. (CO3, K2)

14. (a) Give the classical field equation and explain the physical quantities involved in it. (CO4, K3)

Or

(b) Obtain the relation between Hamiltonian density and conjugate field $\pi(r,t)$. (CO4, K3)

15. (a) Derive the total scattering cross section from differential scattering cross section. (CO5, K2)

Or

(b) Give the validity of Born approximation. (CO5, K3)

Part C (5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Calculate the C-G coefficient for a system having $j_1 = j_2 = \frac{1}{2}$. (CO1, K4)

Or

(b) Express the angular momentum components L_x, L_y and L_z in spherical polar coordinates. (CO1, K4)

17. (a) Explain the particle exchange operator and prove that the eigen values of the same is ∓ 1 (CO2, K4)

Or

(b) Discuss Thomas-Fermi model of an atom with necessary equations. (CO2, K3)

18. (a) Show that for a Dirac particle moving in a central potential the orbital angular momentum is not a constant of motion. (CO3, K4)

Or

(b) Obtain Dirac relativistic equation for a free particle. (CO3, K4)

19. (a) Define the number operator for a system of Fermions and show that its eigen values are zero and one. (CO4, K4)

Or

(b) Discuss the quantisation of electromagnetic field and obtain the equation for the total energy of the field. (CO4, K4)

20. (a) Derive the equation of optical theorem and explain why it is called so? (CO5, K4)

Or

(b) Obtain the relation between the scattering cross section in a Laboratory and Centre of Mass coordinate system. (CO5, K3)

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R0244	Sub. Code
	521303

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2023

Third Semester

Physics

CONDENSED MATTER PHYSICS – I

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 1 = 10)$

Answer **all** the following objective questions by choosing the correct options.

1. The effective number of lattice points in a primitive cell are (CO1, K2)

   (a) 1 (b) 2

   (c) 4 (d) 8

2. The minimum number of ions in the unit cell of an ionic crystal with FCC space lattice is (CO1, K1)

   (a) 16 (b) 12

   (c) 8 (d) 2

3. The frequency of K_α-line of a source of atomic number Z is proportional to (CO2, K2)

   (a) Z^2 (b) $(Z-1)^2$

   (c) $1/Z$ (d) Z

4. Hydrogen atom does not emit X-ray because (CO2, K1)

   (a) Its energy levels are close to each other

   (b) Its energy levels are too far apart

   (c) It is too small in size

   (d) It has a single electron

5. Point defects in crystals cannot be produced by (CO3, K1)

(a) elastic deformation

(b) quenching from high temperatures

(c) plastic deformation

(d) irradiation with X-rays

6. Which of the following is the surface defect? (CO3, K2)

(a) vacancy (b) screw dislocation

(c) edge dislocation (d) twin boundaries

7. The SI unit of atomic specific heat is (CO4, K1)

(a) Cal/g °C (b) J/kg atom K

(c) erg/g atom K (d) Cal/g atom °C

8. The zero-point energy of a solid on the Debye model is (CO4, K1)

(a) $\frac{3}{5}R\theta_D$ (b) $\frac{1}{2}R\theta_D$

(c) $\frac{9}{8}R\theta_D$ (d) $\frac{3}{4}R\theta_D$

9. The drift velocity of electron in a metal is of the order of (CO5, K2)

(a) 10^5 m/s (b) 0.1 mm/s

(c) 10 m/s (d) zero

10. In Kronig-Penney model, if there exists no potential barrier (CO5, K1)

(a) there is a periodic dependence of E on k

(b) e is not a continuous function of k

(c) there are no forbidden energy regions

(d) all values of energy E are not allowed

Part B (5 × 5 = 25)

Answer **all** the questions not more than 500 words each.

11. (a) What are the symmetry operations possible in a cubic system? (CO1, K3)

Or

(b) Describe the structure of diamond with a suitable diagram. (CO1, K3)

12. (a) Show that the reciprocal lattice of *bcc* is *fcc*. (CO2, K4)

Or

(b) Describe the Laue method of X-ray diffraction. (CO2, K3)

13. (a) Derive an expression for the number of Frenkel defects at a given temperature. (CO3, K4)

Or

(b) Explain grain boundary and tilt boundary with suitable sketches. (CO3, K3)

14. (a) Explain particle displacement in two branches in case of a linear diatomic lattice. (CO4, K4)

Or

(b) Write the salient feature of classical theory of specific heat and what are its merits and demerits. (CO4, K4)

15. (a) Summarize the salient feature of quantum free electron theory of metals. (CO5, K3)

Or

(b) State and prove Wiedemann-Franz law. (CO5, K4)

Part C (5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Describe the 14 types of Bravais lattice in three dimensions with suitable diagrams. (CO1, K4)

Or

(b) Explain the hexagonal close packed structure and calculate the atomic packing factor. (CO1, K4)

17. (a) Derive Moseley's law on the basis of Bohr's theory and discuss its importance. (CO2, K5)

Or

(b) Explain the Rotating crystal method with neat diagram. (CO2, K4)

18. (a) Write a detailed note on line imperfections.(CO3, K4)

Or

(b) Give a brief account of (i) Quasi crystals and (ii) Super fluidity. (CO3, K5)

19. (a) Describe the vibrations of a one-dimensional monoatomic linear lattice. (CO4, K6)

Or

(b) Compare the assumptions and results of Einstein's and Debye's theories. Discuss the agreement with experimental observation. (CO4, K6)

20. (a) Discuss the metal, insulator and semiconductor on the basis of band theory of solids. (CO5, K5)

Or

(b) Discuss Kronig-Penney model for the motion of an election in a periodic potential. (CO5, K6)

R0245	Sub. Code
	521509

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2023

Third Semester

Physics

Elective – MICROPROCESSOR AND INSTRUMENTATION

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A $(10 \times 1 = 10)$

Answer **all** the following objective questions by choosing the correct option.

1. ———— numbers of flip-flops indicate the status arising for the execution of arithmetic or logical instruction. (CO1, K2)

   (a) Four (b) Five

   (c) Eight (d) Five or Eight

2. Operations carried out in the machine cycle is (CO1, K1)

   (a) opcode fetch (b) read operation

   (c) IO/$\overline{M}$ (d) interrupt request

3. Rotate accumulator left instruction refers the mnemonics as (CO2, K2)

   (a) RLC (b) RAL

   (c) RAR (d) RLA

4. RET instruction is used at the (CO2, K3)

(a) interrupt process

(b) beginning of the subroutine

(c) one step operation

(d) end of the subroutine

5. Microcontroller of 8051 has ———— banks of working registers and these banks occupy the first ———— bytes of on-chip data RAM. (CO3, K1)

(a) 16, 32 (b) 4, 32

(c) 8, 8 (d) 8, 64

6. $\overline{PSEN}$ is a program store enable and it is a read strobe to (CO3, K3)

(a) stack pointer

(b) program counter

(c) external program memory

(d) internal memory device

7. Programmable peripheral interface (Intel 8255) has three 8 bit ports and further the port C is divided into (CO4, K1)

(a) two of 4-bit ports

(b) two 8 bit ports

(c) three ports

(d) eight ports

8. The programmable communication interface chip is fabricated using (CO4, K6)

(a) semiconductor technology

(b) CMOS technology

(c) P-channel silicon technology

(d) N-channel silicon gate technology

9. The output of the transducer is not directly connected to indicator, because (CO5, K4)

(a) zero level output is produced

(b) there is a chance for short circuit

(c) low level output is produced

(d) all the above

10. Piezoelectric transducer is used to measure (CO5, K2)

(a) pressure and acceleration

(b) the material properties

(c) crystal characteristics

(d) electrical properties of crystal

Part B ($5 \times 5 = 25$)

Answer **all** the questions not more than 500 words each.

11. (a) What are the different types of flags in Intel 8085? Eloborate each of them. (CO1, K6)

Or

(b) Described the upcode fetch machine cycle and the memory read machine cycle of 8085. (CO1, K2)

12. (a) (i) What is one pass and two pass assembler? Explain with example.

(ii) Mention the advantages and disadvantages of assembly language. (CO2, K6)

Or

(b) Draw the schematic diagram of 8085 interrupts and describe its function. (CO2, K2)

13. (a) Show the details of 8051 interrupts and explain the enabling of 8051 interrupts. (CO3, K1)

Or

(b) Sketch and explain the block diagram of Intel 8051 microcontroller. (CO3, K2)

14. (a) Sketch the schematic diagram for memory and I/O interfacing and explain the function of memory interfacing using 74LS138. (CO4, K5)

Or

(b) Describe the architecture of programmable peripheral interface (Intel 8255 A). (CO4, K2)

15. (a) Explain the construction and working of resistive strain gauge transducer. Mention its applications. (CO5, K5)

Or

(b) Sketch the circuit and discuss the working of instrumentation amplifier. (CO5, K2)

Part C (5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Describe the different types of addressing modes for register and immediate data of 8086 with examples. (CO1, K2)

Or

(b) (i) List and explain the data transfer groups of intel 8085 (any five).

(ii) Explain the pin description for minimum mode and the maximum mode of Intel 8086. (CO1, K3)

17. (a) List and explain logical instructions of Intel 8085. (CO2, K1)

Or

(b) (i) What are pseudo instructions? Explain any five of them.

(ii) Briefly explain stack operations in 8085. (CO2, K6)

18. (a) Describe the different types of registers in 8051 microcontroller. (CO3, K4)

Or

(b) Write an assemble language program of (i) multibyte addition and (ii) multibyte subtraction using microcontroller instructions. (CO3, K4)

19. (a) (i) Mention the classifications of data transfer scheme and explain them.

(ii) Described the function of synchronous and asynchronous data transfer. (CO4, K4)

Or

(b) (i) Draw the relevant diagram of microprocessor based scheme for temperature measurement and control system.

(ii) Write an ALP for temperature monitoring system. (CO4, K6)

20. (a) What is thermo resistive transducer? Explain its construction, working and advantages of thermo resistive transducer. (CO5, K1)

Or

(b) Sketch the schematic diagram of interfacing of A/D converter using 8051 and describe its working. (CO5, K5)

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