R1971

Sub. Code
521101

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2024

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 type questions by choosing the correct option.

1. An example of a rheonomous constraint is _____. (CO1, K1)

   (a) a bead rotating on a wire loop

   (b) a bead on a rotating wire loop

   (c) a simple pendulum

   (d) a torsional pendulum

2. The Lagrangian of a system is given by $L(\theta, \phi, \dot{\theta}, \dot{\phi},) = \frac{1}{2} ml^2 (\dot{\theta}^2 + \sin^2 \theta \dot{\phi}^2) - mgl \cos\theta$, where m, l and g are constants. Which of the following is conserved? (CO1, K4)

   (a) $\frac{\dot{\phi}}{\sin^2 \theta}$ (b) $\dot{\phi} \sin^2 \theta$

   (c) $\frac{\phi}{\sin^2 \theta}$ (d) $\phi \sin^2 \theta$

3. Which of the following requirements is applied in Hamilton-Jacobi theory? (CO2, K2)

(a) Both the new coordinates and new momenta are constant

(b) Only the new coordinates are constant

(c) Only the new momenta are constant

(d) The transformed Hamiltonian must be non-zero.

4. For a dynamical variable, $u = u(q, p, t)$ which of the following expressions is correct? (CO2, K3)

(a) $\frac{du}{dt} = \frac{\partial u}{\partial t} - [u, H]$ (b) $\frac{du}{dt} = \frac{\partial u}{\partial t} + [u, H]$

(c) $\frac{du}{dt} = \frac{\partial u}{\partial t} + [H, u]$ (d) $\frac{du}{dt} = -\frac{\partial u}{\partial t} + [u, H]$

5. A straight filament *AB* of mass *M* and length *l* lying along the *x*-axis with its center at the origin *O*. The moment of inertia along the three principal axes are ———————— (CO3, K3)

(a) $I_{xx} = 0, I_{yy} = I_{zz} = \frac{Ml^2}{6}$

(b) $I_{xx} = 0, I_{yy} = I_{zz} = \frac{Ml^2}{12}$

(c) $I_{xx} = \frac{Ml^2}{3}, I_{yy} = I_{zz} = \frac{Ml^2}{6}$

(d) $I_{xx} = \frac{Ml^2}{3}, I_{yy} = I_{zz} = \frac{Ml^2}{12}$

6. The real orthogonal matrix specifying the physical motion of a rigid body with one point fixed always has eigen value ————————. (CO3, K2)

(a) 0 (b) ± 1

(c) +1 (d) –1

7. The well-known Kepler's second law of planetary motion, i.e., conservation of areal velocity, is valid for ———————— (CO4, K3)

(a) inverse-square law of force only

(b) planetary motion only

(c) all central force motion

(d) both central and non-central forces

8. A relativistic particle moves with a constant velocity v with respect to the laboratory frame. In time τ, measured in the rest frame of the particle, the distance that it travels in the laboratory frame is ———————— $(\beta = v/c)$. (CO4, K5)

(a) $v\tau$ (b) $\dfrac{c\tau}{\sqrt{1-\beta^2}}$

(c) $v\tau\sqrt{1-\beta^2}$ (d) $\dfrac{v\tau}{\sqrt{1-\beta^2}}$

9. The potential of a diatomic molecules as a function of the distance r between the atoms is given by $V(r) = -ar^{-6} + br^{-12}$. The value of the potential at equilibrium separation between the atoms is ————————. (CO5, K5)

(a) $-\dfrac{4a^2}{b}$ (b) $-\dfrac{2a^2}{2b}$

(c) $-\dfrac{a^2}{2b}$ (d) $-\dfrac{a^2}{4b}$

10. Two balls of masses m and $2m$ are connected by a spring of spring constant k. The frequency of normal mode is _____ (CO5, K4)

(a) $\frac{3k}{2m}$ (b) $\frac{k}{m}$

(c) $\frac{2k}{3m}$ (d) $\frac{k}{3m}$

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

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

11. (a) Derive Euler-Lagrage's equation using D'Alembert's principle. (CO1, K2)

Or

(b) What is a cyclic or ignorable coordinates? Discuss their physical significance with an example. (CO1, K4)

12. (a) Show by applying Hamilton's variational principle that the shortest distance between two points in a plane is a straight line. (CO2, K2)

Or

(b) Derive the Hamilton-Jacobi equation for Hamilton's principal function. (CO2, K3)

13. (a) How do you construct the momental ellipsoid of a rigid body in the absence of any external torque? (CO3, K3)

Or

(b) Explain how a general rotation of a rigid body can be described in terms of Euler angles. (CO3, K2)

14. (a) The constant angular momentum in the central force problem is given by $l = mr^2 \frac{d\theta}{dt}$. Deduce the corresponding relation between $\frac{d}{dt}$ and $\frac{d}{d\theta}$. (CO4, K5)

Or

(b) Derive the relativistic addition of velocity formula for parallel velocities in the special theory of relativity. (CO4, K3)

15. (a) A particle of mass m, kept in a potential $V(x) = -\frac{1}{2}kx^2 + \frac{1}{4}\beta x^4$ with k and β positive constants undergoes small oscillations. Find its equilibrium points and compute the frequency of oscillation. (CO5, K5)

Or

(b) Deduce the eigenvalue equation for small oscillations. (CO5, K2)

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

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

16. (a) (i) State Newton's three laws of motion and explain their physical significance. (CO1, K1)

(ii) Derive the expression for the total energy of a system of particles.

(iii) Discuss the conservation law for the total energy of a system of particles.

Or

(b) (i) Derive Euler-Lagrange's equations from Hamilton's principle. (CO1, K4)

(ii) If L is a Lagrangian for a system satisfying Lagrange's equations, show by direct substitution that

$$L' = L + \frac{dF(x,t)}{dt}$$

also satisfies Lagrange's equations where F is arbitrary, but differentiable function of x and t.

17. (a) (i) Derive the Hamilton-Jacobi equation for Hamilton's principal function. (CO2, K3)

(ii) Solve the one-dimensional linear harmonic oscillator problem by applying the Hamilton-Jacobi technique.

Or

(b) (i) Describe the four basic canonical transformations with suitable examples. (CO2, K3)

(ii) Derive the direct conditions for a given transformation, $Q_i = P_i\,(q, p)$ and $P_i = P_I\,(q, p)$, is canonical.

18. (a) (i) Deduce the equation of motion for a heavy symmetric top in a uniform gravitational field with one point fixed in space. (CO3, K3)

(ii) Construct the Lagrangian of the above problem and identify the constants of motion.

Or

(b) (i) Starting from the relation for the kinetic energy of a rigid body, deduce the formula for the moment of inertia tensor. (CO3, K6)

(ii) Find the principal moments of inertia about the origin for a system of three equal masses are located at (a,0,0), (0, a, 2a) and (0,2a, a).

19. (a) (i) Derive the expression for the differential equation of the orbit in the Kepler problem.

(ii) Discuss the classification of orbits from the solution of the differential equation of the orbit in the Kepler problem. (CO4, K3)

Or

(b) (i) Derive the Lorentz transformation equations and prove that Lorentz transformation reduces to Galilean transformation when $v << c$

(ii) Explain how the Lorentz transformation affects the length of objects and the time between events. (CO4, K3)

20. (a) (i) What does equilibrium mean in small oscillations?

(ii) Discuss stable, unstable and neutral equilibrium of coupled oscillators in one dimension.

(iii) Construct the Lagrangian of a conservative system of n degrees of freedom whose potential energy is a function of position coordinate only.

Or

(b) Obtain the resonant frequencies and the normal modes of a linear triatomic molecule and discuss the nature of oscillations. (CO5, K4)

R1972

Sub. Code
521102

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2024

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 type questions by choosing the correct option.

1. If $A(t)$ be a vector function of the scalar variable t and be of constant length, then the vector $\frac{d\vec{A}(t)}{dt}$ is (CO1, K4)

   (a) parallel to $A(t)$ (b) perpendicular to $A(t)$

   (c) 0 (d) antiparallel to $A(t)$

2. If ϕ is a scalar function and $\vec{A}$ is any vector function, then which of the following quantity is non-vanishing? (CO1, K1)

   (a) $curl\ grad\ \phi$ (b) $div\ curl\ \vec{A}$

   (c) $div\ grad\ \phi$ (d) $div\ grad\left(\frac{1}{r}\right)$

3. if $AX = \lambda X, AY = \mu Y$ and $\lambda \neq \mu$, what is $(A - \lambda I)\mu$? (CO2, K3)

   (a) 0 (b) λY

   (c) μX (d) $(\mu - \lambda)Y$

4. If one of the basic eigen vectors of $\begin{pmatrix} 5 & 0 \\ 0 & 3 \end{pmatrix}$ is $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$, what is the another basic eigen vector? (CO2, K5)

(a) $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$ (b) $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$

(c) $\begin{pmatrix} 0 \\ -1 \end{pmatrix}$ (d) $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$

5. What is the value of $\delta_{ik} \in_{ikm}$? (CO3, K5)

(a) covariant vector (b) 1

(c) 0 (d) 3

6. What is the rank of inner product of tensors A_r^{pq} and B_t^s? (CO3, K2)

(a) a tensor of mixed symmetry

(b) an antisymmetric tensor

(c) a symmetric tensor

(d) 0

7. Mean of a Poisson's distribution is 5. What is the standard deviation? (CO4, K3)

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

(c) 3 (d) 4

8. The first four moments of a distribution about the value 5 are 2, 20, 40 and 50. What is the mean? (CO4, K3)

(a) $\frac{112}{4}$ (b) 23

(c) 7 (d) 8

9. If $L\{F(t)\} = f(s)$, then $L\{t^n F(t)\}$ is equal to (CO5, K5)

(a) $\frac{d^n}{ds^n} f(s)$ (b) $(-1)^n \frac{d^n}{ds^n} f(s)$

(c) $(-1)^n \frac{d}{ds} f(s)$ (d) none of these

10. $L^{-1}\left\{\frac{1}{s^2}\right\} = ?$ (CO5, K3)

(a) t^2 (b) $\frac{1}{t}$

(c) t (d) e^t

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

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

11. (a) In a gravitational field of mass m, the potential is given by $-m/r$, where r is the distance from the mass, given by $r^2 = x^2 + y^2 + z^2$. Obtain the components of force vector by differentiation. Find the curl of the force and show that it is zero. (CO1, K4)

Or

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

(i) cylindrical coordinates and

(ii) spherical coordinates

12. (a) Evaluate A^{50} for the matrix $A = \begin{pmatrix} \frac{4}{3} & \frac{\sqrt{2}}{3} \\ \frac{\sqrt{2}}{3} & \frac{5}{3} \end{pmatrix}$. (CO2, K5)

Or

(b) Express $\Delta = \begin{vmatrix} 2bc & c^2 & b^2 \\ c^2 & 2cb - b^2 & a^2 \\ b^2 & a^2 & 2ab - c^2 \end{vmatrix}$ as a perfect square of a determinant and find its value. If the determinant $\Delta = 0$ then $a^3 + b^3 + c^3 = 3abc$. (CO2, K3)

13. (a) Prove that the direct product of two tensors results in a new tensor of rank equal to the sum of ranks of these tensors. (CO3, K2)

Or

(b) Show that for a rectangular system of coordinates the raising and lowering of a suffix leaves the components unaltered in three-dimensional space. (CO3, K3)

14. (a) Outline the characteristics of normal distribution. (CO4, K1)

Or

(b) Show that: (CO4, K3)

(i) $\text{var}(x) = E^2(x) - [E(x)]^2$

(ii) $E^2(x) \geq [E(x)]^2$

(iii) $\text{var}(x + a) = \text{var}(x)$

15. (a) Prove that Fourier transform of a convolution integral is given by the product of transforms of the convolution functions. (CO5, K4)

Or

(b) State any five properties of Laplace transform. (CO5, K1)

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

Answer **all** questions not more than 1,000 words each.

16. (a) Verify Stoke's theorem for the vector $\vec{A} = (2x - y)\,\hat{i} - yz^2\hat{j} - y^2z\hat{k}$ over the upper half surface of the sphere $x^2 + y^2 + z^2 = 1$. (CO1, K3)

Or

(b) Show that $r^n\bar{r}$ is an irrotational vector for any value of n, but is solenoidal only if $n = -3$ (r is the position vector of a point) (CO1, K4)

17. (a) Find the characteristic roots and characteristic vectors of the matrix. (CO2, K5)

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 0 & 2 & 3 \\ 0 & 0 & 2 \end{pmatrix}$$

Or

(b) Prove that : (CO2, K4)

(i) the determinant of a square matrix is the product of its eigen values

(ii) the trace of a square matrix is the sum of its eigen values.

18. (a) The components of a first rank tensor in rectangular Cartesian coordinate system are given as $xy, 2y - z^2, xz$. Write its covariant components in spherical coordinates. (CO3, K2)

Or

(b) Find the Christoffel's symbols corresponding to (CO3, K5)

(i) $s^2 = a^2 d\theta^2 + a^2 \sin^2 \theta \, d\phi^2$

(ii) $ds^2 = dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta \, d\phi^2$

19. (a) Define Poisson's distribution. Calculate the mean and standard deviation of Poisson's distribution. (CO4, K5)

Or

(b) Obtain a probability density function for the normal distribution and thus find out values of the mean and standard deviation. (CO4, K4)

20. (a) Laplace transform of the displacement function y (t) for a forced, frictionless spring-mass is found to be (CO5, K5)

$$y(s) = \frac{\omega_0 F_0 / M}{\left(s^2 + \omega_0^2\right)\left(s^2 + \omega^2\right)}$$

for a particular set of initial conditions. Find y (t).

Or

(b) Find finite Fourier sine transform of t^2 in the range $0 \le t \le \pi$. (CO5, K4)

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R1973

Sub. Code
521103

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2024

First Semester

Physics

ELECTRONICS

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

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

1. In intrinsic semiconductor, the Fermi energy lies ————————. (CO1, K1)

   (a) Close to VB (b) Close to CB

   (c) Half of band gap (d) All of them

2. In laser diode, the laser current increases exponentially with temperature. (CO1, K3)

   (a) True (b) False

   (c) Partially True (d) Partially False

3. h-parameter of a transistor is sensitive to ———————— (CO2, K2)

   (a) Its mode

   (b) Operating point

   (c) Transistor connection

   (d) All of them

4. In push-pull amplifier, the two active transistors are ————. (CO2, K4)

(a) in-phase (b) out of phase

(c) both (a) and (b) (d) none of them

5. Unit of slew rate of an op-amp is ———— (CO3, K1)

(a) A (b) V

(c) A/ μs (d) V/ μs

6. Which of the following filter is used for smoothening the image? (CO3, K4)

(a) Low pass (b) High pass

(c) Case dependent (d) None of them

7. d-flip flop refers to ———— flip flop. (CO4, K3)

(a) Delay (b) Data

(c) Both (a) and (b) (d) None of them

8. Ring counter imitates the behavior of ————. (CO4, K4)

(a) Flip flop (b) Shift register

(c) Memories (d) All of them

9. "In DAC, RZR is preferred than weighted resistor method". (CO5, K3)

(a) True (b) False

(c) Case dependent (d) None of them

10. Voltage to time conversion employs ————. (CO5, K6)

(a) DAC (b) ADC

(c) Both (a) and (b) (d) None of them

Part B (5 × 5 = 25)

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

11. (a) Classify extrinsic semiconductors. (CO1, K2)

Or

(b) Summarize the characteristics of Gunn diode. (CO1, K4)

12. (a) Elaborate the need for biasing in transistors. (CO2, K2)

Or

(b) Describe the basic working principle of JFET. (CO2, K3)

13. (a) Brief out the working of feedback amplifier. (CO3, K3)

Or

(b) How does a sine wave generator work? (CO3, K4)

14. (a) Explain the working of JK flip flop. (CO4, K2)

Or

(b) Compare ROM, PROM and EPROM. (CO4, K3)

15. (a) Enlighten sampling theorem. (CO5, K1)

Or

(b) Outline the functioning of comparators. (CO5, K2)

Part C (5 × 8 = 40)

Answer **all** the questions not more than 1,000 words each.

16. (a) Elaborate the PN junction diode. (CO1, K3)

Or

(b) Give a detailed note on characteristics and applications of Schottky diode. (CO1, K2)

17. (a) Figure and describe the action of PNP and NPN transistors. (CO2, K3)

Or

(b) How does a UJT work? List out the advantages of UJT. (CO2, K4)

18. (a) Sketch and explain the working of op-amp as an inverting amplifier, differentiator and integrator. (CO3, K5)

Or

(b) Draw and explain the block diagram of Schmitt trigger and band pass filters. (CO3, K3)

19. (a) Describe the working of RS flip flop and clocked RS flip flop. (CO4, K4)

Or

(b) Explain the working of different type of shift registers. (CO4, K5)

20. (a) Elucidate Digital-Analog-Converter using weighted resistor method. (CO5, K6)

Or

(b) Label the Analog-Digital-Converter process by successive approximation method. (CO5, K2)

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R1974

Sub. Code
521501

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2024

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 type questions by choosing the correct option.

1. The type of error, the source of which cannot be revealed by the repetition of experiments is termed as _____ error. (CO1, K1)

   (a) random (b) systematic

   (c) truncation (d) relative

2. In _____ method the number of significant digits roughly doubles in each iteration. (CO1, K2)

   (a) Newton (b) false position

   (c) secant (d) Horner

3. The order of interpolation is n if the number of points used is (CO2, K1)

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

   (c) $n + 2$ (d) $n - 1$

4. If $f(0) = 1$ and $f(0.7) = 2.01$ then $f(0.61)$ is (CO2, K2)

(a) 1.8435 (b) 1.88

(c) 1.8845 (d) 1.84

5. The value of $\int_0^1 (1 + x)\,dx$ by the ordinary trapezoidal rule is (CO3, K2)

(a) 0.5 (b) 1.5

(c) 2.5 (d) 2

6. If the error in a numerical integration of a first-order differential equation is of the order of h^N then the order of the method is (CO3, K3)

(a) $N + 1$ (b) N

(c) $N - 1$ (d) $N + 2$

7. The order of the augmented matrix of a system of n linear in homogeneous equations is (CO3, K2)

(a) $(n) \times (n)$ (b) $(n) \times (n + 1)$

(c) $(n + 1) \times (n + 1)$ (d) $(n + 1) \times (n)$

8. In the Gauss elimination method, the process used to reduce the propagation of error is known as (CO4, K4)

(a) ill condition (b) pivoting

(c) partial pivoting (d) diagonalization

9. The important requirement of C programming is (CO4, K3)

(a) input variables (b) output variables

(c) arrays (d) function

10. How many number of pointer (*) does C have against a pointer variable declaration? (CO5, K3)

(a) 7 (b) 254

(c) 255 (d) no limits

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

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

11. (a) Distinguish between absolute error and relative error with an example. (CO1, K2)

Or

(b) For the secant method obtain an expression for the error e_{n+1}. (CO1, K1)

12. (a) Obtain the second-order Newton polynomial interpolation formula. (CO2, K2)

Or

(b) Construct the forward central-difference interpolation formula. (CO2, K2)

13. (a) Derive the composite trapezoidal rule for the evaluation of a definite integral. (CO3, K2)

Or

(b) The Hermite equation is $x'' - 2tx' + 2x = 0$. Find the solution at $t = 0.1$ and 0.2 by the Euler method with $x(0) = 0$ and $x'(0) = 2$. (CO3, K3)

14. (a) Describe the processes of pivoting and partial pivoting. (CO4, K2)

Or

(b) Obtain an expression for the total number of arithmetic operations involved in the Gauss elimination scheme. (CO4, K5)

15. (a) Explain pointer variable with an example. (CO5, K2)

Or

(b) Explain the use of arrays with an example program. (CO5, K2)

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

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

16. (a) The following table gives the measured output voltage (y) of an electronic circuit as a function of the applied input voltage (x). Find the least-squares straight-line fit far the given data. (CO1, K5)

x in V	0.1	0.2	0.3	0.4	0.5
y in V	0.15	0.2	0.25	0.3	0.35

Or

(b) The lowest molecular orbital energy of a hydride molecule is the negative root of the equation $0.75E^2 + 0.35\ E - 0.023 = 0$. Find the energy with five decimal accuracy using the Newton method with $E_0 = -0.5$. (CO1, K5)

17. (a) For the data $(x, f) = (0,1), (0.5, 1.648), (0.7, 2.013)$, $(1, 2.718)$ compute f (0.61) by forming a divided difference table. (CO2, K3)

Or

(b) Given $(x, f) = (3,168), (7,120), (9,72)$ applying the Lagrange interpolation method determine *f(6)*. (CO2, K3)

18. (a) Evaluate the integral $\int_1^3 (1 + \exp(x))\,dx$ by the Simpson's 1/3 rule with step size 0.5. (CO3, K5)

Or

(b) The equation of motion of the damped linear harmonic oscillator driven by a periodic force is $x' = -x + \sin(t), x(0) = 1$. Find $x(0.1)$ by the 4th-order Runge-Kutta method. (CO3, K5)

19. (a) Solve the following system by the Gauss elimination method.
$X + Y + Z = 2, 2X + Y + 2Z = 2,$
$3X - Y + 2Z = -1$. (CO4, K3)

Or

(b) Find the solution of $5X + Y = 3, X - 7Y = 15$ after two iterations with the initial guess $(X, Y) = (0, 0)$ by the Jacobi method. (CO4, K3)

20. (a) Explain various control statements in C with sample programs. (CO5, K3)

Or

(b) Write a complete C program to find both the roots of a quadratic equation. (CO5, K5)

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R1975

Sub. Code
521301

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2024

Third Semester

Physics

ADVANCED MOLECULAR SPECTROSCOPY

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **ALL** the following objective type questions by choosing the correct option

1. Which of the following factors affects the rotational spectrum of a molecule? (CO1, K2)

   (a) Electronic configuration

   (b) Molecular weight

   (c) Bond length

   (d) Molecular shape

2. What type of molecule is best studied using rotational spectroscopy? (CO1, K2)

   (a) Linear molecules

   (b) Spherical molecules

   (c) Symmetric top molecules

   (d) Asymmetric top molecules

3. There is no IR absorption for nitrogen molecule because (CO2, K2)

(a) Its polarizability is zero

(b) Its has no vibrational level

(c) Its has no rotational level

(d) Its dipole moment is zero

4. Which of the following statements about selection rule in vibrational spectroscopy is true? (CO2, K4)

(a) Only $\Delta v = 0$ transitions are allowed

(b) Both $\Delta v = \pm 1$ transition are allowed

(c) Only $\Delta v = +1$ transitions are allowed

(d) Only $\Delta v = -1$ transitions are allowed

5. Which type Raman scattering involves a decrease in energy of the scattered photon (CO3, K4)

(a) Stokes scattering

(b) Anti-stokes scattering

(c) Rayleigh scattering

(d) Inelastic scattering

6. Raman effect may be considered as the optical analogue of (CO3, K4)

(a) Photo electric effect

(b) Zeeman effect

(c) Compton effect

(d) Stark effect

7. The effect chemical shift is explained by (CO4, K2)

(a) Microware spectrum

(b) NQR spectrum

(c) ESR spectrum

(d) NMR spectrum

8. Hyperfine splitting of atom levels is due to (CO4, K2)

(a) Spin orbit interaction

(b) Electron spin-electron interaction

(c) Relativistic correction

(d) Electron spin-nuclear spin interaction

9. Mossbauer spectroscopy relies on the interaction of (CO5, K6)

(a) Electromagnetic radiation with the electrons

(b) X-rays with nuclei

(c) Gamma rays with nuclei

(d) Infrared radiation with molecular vibrations

10. The recoilless emission and absorption of gamma rays in Mossbauer spectroscopy is achieved through the (CO5, K6)

(a) Compton effect (b) Doppler effect

(c) Zeeman effect (d) Stark effect

Part B (5 × 5 = 25)

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

11. (a) Explain the effect of isotopic substitution on rotational constant B. (CO1, K2)

Or

(b) Classify the molecules based on their moment of inertia. (CO1, K2)

12. (a) Discuss about the breakdown of Born-Oppenheimer approximation on P and R branches of IR spectrum of diatomic molecule (CO2, K2)

Or

(b) Explain the effect of anharmonicity on the vibrational spectra of diatomic molecule using Morse curve. (CO2, K2)

13. (a) Write down the advantages of Raman technique over IR for vibrational studies (CO3, K4)

Or

(b) Deduce and sketch the pure rotational Raman spectrum of a diatomic molecule (linear molecule). (CO3, K4)

14. (a) Explain the principle of NMR and obtain the resonance condition. (CO4, K2)

Or

(b) Explain in detail about the spin-spin coupling. (CO4, K6)

15. (a) Discuss the role nuclear-electron interaction in determining the electronic structure of atoms and molecule. (CO5, K6)

Or

(b) Explain in detail about the nuclear interaction in Mossbauer spectrometry. (CO5, K6)

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

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

16. (a) Obtain the expression for moment of inertia and rotational energy level for a rigid diatomic molecule. (CO1, K2)

Or

(b) Explain in detail about the technique and instrumentation of microwave (CO1, K2)

17. (a) Deduce and sketch the vibrational energy levels for a diatomic molecule undergoing simple harmonic motion (CO2, K2)

Or

(b) Discuss about the breakdown of Born-Oppenheimer approximation on P and R branches of IR spectrum of diatomic molecule. (CO2, K4)

18. (a) Write down the differences between IR and Raman spectroscopy in detail. (CO3, K4)

Or

(b) Explain the Classical theory of Raman effect in detail. (CO3, K4)

19. (a) Explain the construction and working of continuous wave NMR spectroscopy (CO4, K2)

Or

(b) Explain in detail about the Fourier Transform NMR spectrophotometer. (CO4, K2)

20. (a) Explain in detail about the Hyperfine structure of Electron Spin Resonance (ESR) absorption (CO5, K6)

Or

(b) Discuss the fundamentals of Mossbauer spectroscopy and its application in studying the hyperfine interactions of nuclei in materials. (CO6, K6)

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R1976

Sub. Code
521302

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2024

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 dimension of the matrix for the angular momentum $j = 1$ is (CO1, K1)

   (a) 2×2 (b) 3×3

   (c) 4×4 (d) 5×5

2. Which of the operator will commute with J_Z? (CO1, K3)

   (a) J_x (b) J_y

   (c) J_+ (d) J^2

3. The eigenvalues of the particle exchange operator are (CO2, K4)

   (a) $+1, -1$ (b) $+i, -i$

   (c) $0, +1$ (d) $+i, +1$

4. Which of the following particle's overall wave function will be antisymmetric? (CO2, K3)

   (a) Photon (b) Electron

   (c) Phonon (d) Boson

5. The number of Dirac matrices are (CO3, K2)

(a) 2 (b) 3

(c) 4 (d) 5

6. The Dirac matrices are (CO3, K1)

(a) Traceless matrices

(b) Matrices having unit trace

(c) Matrices having trace equal to -1

(d) Matrices having trace equal to 4

7. The eigenvalues of the Fermionic number operator are (CO4, K4)

(a) 0, 0 (b) 0, + 1

(c) +1, –1 (d) +1, +2

8. In the process of quantization, the Poisson brackets in the classical case are replaced by (CO4, K2)

(a) Lagrange brackets

(b) Canonical brackets

(c) Anticommutation relation

(d) Commutation relation

9. In the scattering theory, the incoming wave is taken as (CO5, K1)

(a) Spherical wave

(b) Cyclindrical wave

(c) Plane wave

(d) Modulated spherical wave

10. The optical theorem connects the (CO5, K3)

(a) Scattering amplitude to the total cross section

(b) Differential cross section to total cross section

(c) Incoming wave amplitude to scattering amplitude

(d) Incoming wave amplitude to incoming intensity

Part B (5 × 5 = 25)

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

11. (a) Derive the commutations relation among J_z, J_+ and J. (CO1, K3)

Or

(b) List the properties of Pauli spin matrices. (CO1, K4)

12. (a) Write a note on exchange degeneracy. (CO2, K4)

Or

(b) Describe the classification of elements in the periodic table. (CO2, K2)

13. (a) Derive the continuity equation for the Relativistic Schrodinger equation. (CO3, K3)

Or

(b) Write a note on the negative energy states. (CO3, K5)

14. (a) Obtain the Lagrangian equations for the classical fields. (CO4, K2)

Or

(b) Give a brief account of quantization of relativistic Klein Gordan field. (CO4, K4)

15. (a) What is Born approximation? Give the validity regimes of Born approximation. (CO5, K4)

Or

(b) Explain briefly about the scattering by square well potential. (CO5, K2)

Part C (5 × 8 = 40)

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

16. (a) Obtain the common eigen basis for J^2 and J_z. (CO1, K5)

Or

(b) Construct the CG coefficients for the addition of two spin ½ systems. (CO1, K6)

17. (a) Write the salient features of the Thomas Fermi model of atom. (CO2, K4)

Or

(b) Explain in detail about Hartree method and Hartree-Fock method. (CO2, K5)

18. (a) Solve the relativistic Schrodinger equation for the Hydrogen atom. (CO3, K4)

Or

(b) Obtain the plane wave solutions for the Dirac Hamiltonian. (CO3, K5)

19. (a) Describe the process of quantization of non relativistic fields. (CO4, K4)

Or

(b) Quantize the electromagnetic field and obtain photon as its quanta. (CO4, K6)

20. (a) Obtain the expression for scattering amplitude in partial wave analysis. (CO5, K6)

Or

(b) Explain the scattering by screened Coulomb potential. (CO5, K5)

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R1977

Sub. Code
521303

M.Sc., DEGREE EXAMINATION, NOVEMBER – 2024

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 option

1. The number of lattice points in the primitive cell is (CO1, K2)

   (a) One (b) Two

   (c) Three (d) Four

2. The number of distinct lattice types in two dimension is (CO1, K4)

   (a) Two (b) Three

   (c) Four (d) Five

3. The physical dimension of the reciprocal lattice vectors is (CO2, K3)

   (a) [length] (b) 1/[length]

   (c) $[\text{length}]^2$ (d) Dimensionless

4. Metallic sodium has a bcc structure. The which of the following line will appear in the diffraction? (CO2, K4)

   (a) (100) (b) (111)

   (c) (200) (d) (300)

5. When the temperature of the crystal decreases, the equilibrium concentration of vacancies will (CO3, K1)

(a) Increase (b) Decrease

(c) Become zero (d) Be unaltered

6. The translational symmetry is perfect in (CO3, K2)

(a) Alloys (b) Ideal crystal

(c) Glass materials (d) Amorphous materials

7. If there are 2 atoms in the primitive cell, then there will be (CO4, K5)

(a) 3 acoustic branches and 9 optical branches

(b) 3 acoustic branches and 6 optical branches

(c) 3 acoustic branches and 3 optical branches

(d) 3 acoustic branches and 0 optical branches

8. High temperature limit of the specific heat capacity, C_v is (CO4, K1)

(a) $3 Nk_B$ (b) $2 Nk_B$

(c) Nk_B (d) ∞

9. In the free electron model, the plot of energy versus wave vector is (CO5, K2)

(a) Linear

(b) Parabolic

(c) Positive exponential

(d) Negative exponential

10. The relationship between carrier concentration and magnitude of Hall coefficient is (CO5, K3)

(a) Linear (b) Quadratic

(c) Cubic (d) Inverse

Part B (5 × 5 = 25)

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

11. (a) What are point groups? Give examples. Give the differences between space groups and point groups. (CO1, K3)

Or

(b) Explain the hexagonal closed pack structure. (CO1, K3)

12. (a) Write a short note on generation of X rays for crystal structure analysis. (CO2, K2)

Or

(b) List the salient features of the Laue method (CO2, K3)

13. (a) Explain in detail the stacking fault. (CO3, K3)

Or

(b) Explain the mechanism of color centers. (CO3, K2)

14. (a) State Dulong-Petit's law. What are discrepancies in the Dulong-Petit's law? (CO4, K1)

Or

(b) Brief explain the Einstein model for specific heat capacity. (CO4, K2)

15. (a) Differentiate the metals, semiconductors and insulators in the basis of electronic band structure. (CO5, K3)

Or

(b) State Bloch theorem. Explain the role of Bloch theorem in obtaining the electronic band structure of crystals. (CO5, K4)

Part C (5 × 8 = 40)

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

16. (a) List the 14 different Bravais lattices in three dimensional configurations using the unit cell parameters. (CO1, K4)

Or

(b) Elucidate the structural features of NaCl and Diamond. (CO1, K4)

17. (a) Construct the reciprocal lattice structure of FCC lattice. (CO2, K5)

Or

(b) Explain the rotating crystal method with suitable sketches. (CO2, K4)

18. (a) Describe in detail the Frenkel and Schottky defects. (CO3, K4)

Or

(b) Elaborate edge dislocation and screw dislocation. (CO3, K3)

19. (a) Show that Debye model of specific heat capacity correctly predicts the behavior of specific heat capacity at low temperatures. (CO4, K5)

Or

(b) Obtain the phonon dispersion relation for diatomic lattice. (CO4, K5)

20. (a) Show that the forbidden gap arises in the Kronig-Penney model. (CO5, K4)

Or

(b) Derive the expression for density of states for free electron theory in three dimensions. (CO5, K3)

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R1978

Sub. Code
521509

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2024

Third Semester

Physics

Elective — MICROPROCESSOR AND INSTRUMENTATION

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

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

1. What is the maximum amount of memory that can be addressed by the 8085 microprocessors? (CO1, K2)

   (a) 64 KB (b) 128 KB

   (c) 256 KB (d) 512 KB

2. What is the data bus width of the 8086 microprocessors? (CO1, K2)

   (a) 8 bits (b) 16 bits

   (c) 32 bits (d) 64 bits

3. What is the clock frequency of the 8085 microprocessors? (CO2, K2)

   (a) 1 MHz (b) 2 MHz

   (c) 3 MHz (d) 4 MHz

4. Which instruction is used to multiply two unsigned 8-bit numbers in the 8086 microprocessors? (CO2, K4)

   (a) MUL (b) IMUL

   (c) AAM (d) AAD

5. What is the size on the on-chip RAM in the 8051 microcontrollers? (CO3, K4)

(a) 128 bytes (b) 256 bytes

(c) 512 bytes (d) 1 kilobyte

6. Which of the following is NOT a feature commonly found in 8-bit microcontrollers? (CO3, K4)

(a) Analog to Digital Converter

(b) Timers/Counters

(c) Universal synchronous receiver-transmitter (UART)

(d) Floating-point unit (FPU)

7. Which mode of operation is used for handshake-based data transfer in 8255 PPI? (CO4, K2)

(a) Mode 0 (b) Mode 1

(c) Mode 2 (d) Mode 3

8. What is the primary function of the PCI 8251? (CO4, K2)

(a) Digital to Analog conversion

(b) Analog to Digital conversion

(c) Serial communication

(d) Parallel communication

9. Which of the following is an example of an active transducer? (CO5, K6)

(a) Thermocouple

(b) Strain gauge

(c) Piezoelectric sensor

(d) LVDT (Linear Variable Differential Transformer)

10. In Piezoelectric transducer, what type of energy conversion occurs? (CO5, K6)

(a) Electrical to mechanical

(b) Mechanical to electrical

(c) Light to electrical

(d) Heat energy to electrical

Part B (5 × 5 = 25)

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

11. (a) Briefly explain the maximum mode configuration of 8086 microprocessors. (CO1, K2)

Or

(b) Write down the features of 8086 microprocessors. (CO1, K2)

12. (a) Define interrupt and their two classes. Write in detail about the interrupt service routine. (CO2, K2)

Or

(b) Write an assembly language program to toggle the bits of port P1. (CO2, K2)

13. (a) Illustrate the oscillator circuit and execution timing of 8051. (CO3, K4)

Or

(b) Compare microprocessor and microcontroller. (CO3, K4)

14. (a) Explain about Programmable DMA controllers and its functions. (CO4, K2)

Or

(b) Explain the functions of a Programmable Communication Interface in detail. (CO4, K6)

15. (a) Explain the LVDT transducer with a neat diagram. (CO5, K6)

Or

(b) Explain the principle and working of a photovoltaic cell. (CO5, K6)

Part C (5 × 8 = 40)

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

16. (a) Illustrate neat block diagram of 8085 microprocessor and explain its internal architecture. (CO1, K2)

Or

(b) List the registers present in 8086 microprocessor and discuss its functionality. (CO1, K2)

17. (a) Draw the pin diagram of 8085 microprocessor and explain the functionality of each pin. (CO2, K2)

Or

(b) Explain the Branch, Stack and I/O instructions of 8085 microprocessor with an example. (CO2, K4)

18. (a) Describe the functions of various pins of 8051 microcontroller with pin diagram. (CO3, K4)

Or

(b) Explain the memory organization in 8051 microcontrollers. (CO3, K4)

19. (a) Explain the functions of 8255 Programmable Peripheral Interface with a neat diagram. (CO4, K2)

Or

(b) Discuss how microprocessors are interfaced with I/O and memory in detail. (CO4, K2)

20. (a) With neat sketch explain the function of A/D converter with 8051. (CO5, K6)

Or

(b) Explain in detail about the classification of transducers. (CO5, K6)

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