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PGIS - N 1001 B - 15

M.Sc. Ist Semester (CBCS) Degree Examination

Physics

(Classical Mechanics)

Paper : HCT 1.1

(New)

Time : 3 Hours Maximum Marks : 80

Instructions to Candidates:

Answer all questions.

1. a) State and explain conservation of linear, angular momentum and energy of a single particle system.

   b) Explain the motion under a time dependant force, $F = F_0 \sin \omega t$. **(10+5)**

(OR)

2. a) What is a central force field? Derive the equation of motion in a central force field.

   b) Explain bounded and unbounded motions with suitable examples. **(9+6)**

3. a) Describe the generalized coordinates with a suitable example.

   b) Derive the Lagrange's equation of motion from D'Alembert's principle for a conservative holonomic system. **(5+10)**

(OR)

4. a) What are constraints? Explain the different types of constraints with examples.

   b) Write down the importance of Lagrangian formulation. **(9+6)**

5. a) Derive Hamilton's equations of motion. Show that Hamiltonian is conserved if the Lagrangian does not involve time explicitly.

   b) Obtain the canonical equations in terms of Poisson Bracket notation. **(10+5)**

(OR)

6. a) Describe canonical transformation for new set of coordinates P_k and Q_k.

   b) What are the conditions for the transformation to be canonical?

   c) Prove that $[L_x, L_y] = L_z$ **(6+5+4)**

7. a) Describe the four vectors, four momentum and four forces in relativistic mechanics.

b) Derive the equation of continuity for the motion of a fluid. **(8+7)**

(OR)

8. a) Describe the basic concepts in continuum mechanics.

b) Express Lorentz force in covariant form. **(7+8)**

9. State and explain Kepler's laws of planetary motion. **(10)**

OR

10. Use the Lagrangian method to obtain the equation of motion for a spherical pendulum. **(10)**

11. Define Poisson Brackets and explain their properties. **(10)**

OR

12. Derive the Navier - Stoke's equation for the motion of fluids. **(10)**

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PGIS-N 1003 B-15
M.Sc Ist Semester (CBCS) Degree Examination
Physics
(Electro Dynamics)
Paper - HCT-1.2
(New)

Time : 3 Hours Maximum Marks : 80

Instructions to Candidates:

Answer all questions.

1. a) Deduce the expression for the potential of a localized charge distribution.

b) Discuss the physical significance of various multipoles. **(8+7)**

OR

2. a) Obtain the expression for the electric field due to a quadrupole.

b) When does Poisson equation reduce to Laplace equation? **(10+5)**

3. a) Deduce the expression for the field due to a circular current element.

b) Obtain the expression for the energy in a magnetic field. **(8+7)**

OR

4. a) Derive the expression for the field due to a magnetized object.

b) Discuss the effect of magnetic field on atomic orbitals. **(8+7)**

5. a) What is displacement current? Explain its significance.

b) Starting from Faraday's law arrive at the Maxwell's equation. **(8+7)**

OR

6. a) What is Poynting's vector? Obtain an expression for Poynting's vector.

   b) Derive the expression for momentum flux density. **(8+7)**

7. a) Obtain the expression for reflection and transmission coefficients of electromagnetic wave incident normally on a dielectric interface.

   b) Deduce an expression for the electric field due to a point charge under relativistic motion. **(8+7)**

OR

8. a) Obtain an expression for the reflection coefficient for a wave incident normally on a conducting surface.

   b) Explain the covariant formulation of the laws of electrodynamics. **(8+7)**

9. Explain the effect of external field on an electric dipole. **(10)**

OR

10. Obtain the expression for the field due to a current carrying conductor. **(10)**

11. Starting from the differential form, obtain Maxwell's equations in integral form. **(10)**

OR

12. Arrive at the Lienard-Wiechert potentials and fields for a moving point charge. **(10)**

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PGIS - N 1005 B-15
M.Sc. Ist Semester Degree Examination
Physics
(Introductury Quantum Mechanics)
Paper : HCT 1.3
(New)

Time : 3 Hours Maximum Marks : 80

Instructions to Candidates:

Answer ALL questions.

1. a) Show that the quantum mechanical expectation values obey classical equations of motion.

   b) Find the position expectation value of the wave function $\psi(x) = \exp\{-(x-2)^2\}$ **(10+5)**

(OR)

2. a) Develop a three dimensional wave equation for a particle subjected to a force.

   b) Explain continuity condition. **(10+5)**

3. a) What is spherically symmetric potential? Write schrodinger equation for a spherically symmetric potential in polar coordinates and separate it for each variable.

   b) Give the physical interpretation of eigen values and eigen functions. **(10+5)**

(OR)

4. Set up the Schrodinger equation for Hydrogen atom and arrive at the radial equation. **(15)**

5. a) Prove that eigen values of a Hermitian operator are real.

   b) Prove that observables having a common set of eigen functions commute. **(7+8)**

(OR)

6. Prove that commuting observables possess a common set of eigen functions. Also prove the converse. **(15)**

7. Describe the time independent perturbation theory for perturbed harmonic oscillator and obtain the energy eigen values. **(15)**

(OR)

8. a) Explain the stationary perturbation theory for solving the Schrodinger equation for a non-degenerate system.

b) State and explain optical theorem. (10+5)

9. State and prove Ehrenfest's theorem. (10)

(OR)

10. Show that the energy eigen functions of a particle in an infinite square well form an orthonormal set. (10)

11. Using ladder operator method, deduce eigen value spectrum of J^2 and J_z. (10)

(OR)

12. What is Born approximation? Derive the expression for the scattering amplitude in this approximation and discuss its validity. (10)

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PGIS - N 1007 B - 15
M.Sc. Ist Semester (CBCS) Degree Examination
Physics
(Mathematical Physics)
Paper :SCT 1.1
(New)

Time : 3 Hours Maximum Marks : 80

Instructions to Candidates:

Answer all questions.

1. a) Describe the general solution of the first order linear differential equation.

   b) Solve the equation $y' + x = y/x$ **(8+7)**

(OR)

2. a) Obtain the Legendre's differential equation using power series method.

   b) Give the classification of partial differential equations. **(10+5)**

3. a) Define Cauchy's sequence. Explain Hilbert's space of n-dimension.

   b) Find the inverse of the matrix $A = \begin{bmatrix} 1 & 3 \\ 2 & 1 \end{bmatrix}$ **(8+7)**

(OR)

4. a) Describe the matrix representation of linear operators.

   b) Write a note on Hermitian and unitary matrices. **(8+7)**

5. a) Define a tensor. State and explain quotient rule of tensors.

   b) Write a note on curvilinear coordinates. **(10+5)**

(OR)

6. a) Define Christoffel symbols of first kind. Explain contraction and outer product operations with an example for both.

   b) Explain raising and lowering of indices in tensors. **(9+6)**

7. a) Explain the basic concept of a group. State the properties that a set of elements need to be satisfied in order to form a group.

b) If a group H of order h is a sub group of a group G of order g, show that g is an integral multiple of G. (9+6)

8. a) Define homomorphism and isomorphism of groups. If $\Phi(g) = g'$ is a homomorphism of G to G' and e, e' are identity elements in G and G', show that

$\Phi(e) = e' \, and \, \Phi(g^{-1}) = (g')^{-1}$

b) Prove that $A = \begin{bmatrix} 0 & -i \\ -i & 0 \end{bmatrix}$ (9+6)

9. Solve $y'' + y' - 2y = 0$ (10)

(OR)

10. Explain diagonalization and spectral theory in vector spaces. (10)

11. Discuss the Einstein summation convention. Give two examples of physical quantities which are tensors. (10)

(OR)

12. Give an account of applications of group theory in Physics. (10)

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PGIS - O 1002 B-15
M.Sc. Ist Semester (Non CBCS) Degree Examination
Physics
(Classical Mechanics)
Paper : 1.1
(Old)

Time : 3 Hours Maximum Marks : 80

Instructions to Candidates:

Answer any **SIX** questions of **12** marks and **two** questions of 4 marks each.

1. Discuss the conservation laws of linear momentum, angular momentum and energy. Obtain the equation of motion in each case. **(12)**

2. Discuss the Kepler's laws of planetary motion. **(12)**

3. Explain different types of constraints obtain Lagrange's equations from D'Alembert's principle **(12)**

4. What are generalized co-ordinates? Obtain Lagrange's equations of motion from variational principle. **(12)**

5. What are Poisson brackets? Obtain the equations of motion in Poisson bracket notation. **(12)**

6. Outline the Hamilton -Jacobi theory for solving Hamilton's equations of motion **(12)**

7. Discuss the four vector formulations for velocity, momentum and acceleration. **(12)**

8. Give an account of basic concepts of continuity equations and explain their applications**(12)**

9. Write a note on scattering in central force field. **(4)**

10. What is symmetry and cyclic co-ordinates? Explain. **(4)**

11. Obtain Hamilton Jacobi equation for the Hamilton's characteristic function. **(4)**

12. Discuss the basic concepts of continuum mechanics. **(4)**

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PGIS-O 1004 B - 15

M.Sc. Ist Semester (Non CBCS) Degree Examination

Physics

(Quantum Mechanics-I)

Paper : 1.2

(Old)

Time : 3 Hours Maximum Marks : 80

Instructions to Candidates:

Answer any **six** questions of **12** marks and **two** questions of **4** marks each

1. a) Explain the principle of superposition and wave-particle duality.

   b) Obtain a mathematical expression for the group velocity of a wave pocket. **(6+6)**

2. State and prove the Ehrenfest's theorem. Discuss the physical interpretation of eigen value and eigen function. **(12)**

3. Discuss the problem of particle in one dimensional box and solve the Schrodinger wave equation for eigen values and eigen functions of that particle. **(12)**

4. What are spherically symmetric potentials? Separate the Schrodinger equation into radial and angular parts for a spherically symmetric potential. **(12)**

5. a) Define Hilbert space and observables.

   b) Define Hermitian operator and show that the momentum operator is Hermitian. **(6+6)**

6. Solve the linear harmonic oscillator using matrix method for its eigen values and eigen functions. Discuss significance of zero point energy. **(12)**

7. Discuss the basic principle of variation method and show that the ground state of Helium can be calculated using variation principle. **(12)**

8. A particle is elastically scattering while moving in spherically symmetric potential.

   Discuss the phase shift analysis for this case and obtain an expression for the scattering amplitude in terms of phase shift. **(12)**

9. Normalize the wave function $\phi(x) = e^{-|x|} \sin \alpha x$ (4)

10. Show that wave function for a particle in an one dimensional box is orthogonal (4)

11. Using Heisenberg uncertainty principle, show that electron cannot exist inside the nucleus. (4)

12. Explain the features of Born approximation. (4)