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PGIS-O-1008 B-18

M.Sc. I Semester (CBCS) Degree Examination

PHYSICS

(Mathematical Physics - I)

Paper - SCT 1.1 (Old)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

Answer all the Questions of 15 marks and any two questions of 10 marks each.

1. a) Classify the partial differentiation equation and explain its characteristics. **(6+9)**

   b) Solve the Laplace equation in Cartesian co-ordinates using the method of separation of variables.

OR

2. a) Discuss the solution of the Laguerre's polynomial by power series method. **(10+5)**

   b) Discuss any one property of Bessel function.

3. a) Explain different operators and their representation in detail. **(10+5)**

   b) Give an application of diagonalization of a real symmetric matrix.

OR

4. a) Find the determinant of the following matrix, $A = \begin{bmatrix} 3 & 2-i & -3i \\ 2+i & 0 & 1-i \\ 3i & 1+i & 0 \end{bmatrix}$ **(6+9)**

   b) Prove that the determinant of any Hermitian matrix is real.

5. a) What is tensor? Give physical examples. List out the conventions and notations used to represent tensors. **(6+9)**

   b) Show that symmetry is an intrinsic property of a tensor and is independent of the coordinate system.

OR

6. a) Discuss covariant, contravariant and invariant tensors with suitable examples. (10+5)

b) Explain the inner and outer products of tensors.

7. a) What is a finite group? Give an example. (5+10)

b) Describe in detail the representation and application of SU(2) and SU(3) groups.

OR

8. a) Verify whether $A = \{1, i, -1, -i\}$ form a group. (8+7)

b) What are unitary groups? Discuss the representation of unitary groups.

9. Discuss the properties of Legendre polynomials. (10)

10. Write a note on Hilbert space of n-dimension. (10)

11. Explain pseudo tensors with examples. (10)

12. What are Lie groups? Discuss. (10)

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PGIS-N-1007 B-18

M.Sc. I Semester (CBCS) Degree Examination

PHYSICS

Mathematical Physics - I

Paper - SCT 1.1 (New)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

Answer all the questions of 15 marks and any two questions of 10 marks each.

1. a) Describe the general solution of the First Non-homogenous differential equations with constant coefficients. **(9+6)**

   b) Solve the equation $(y' + x) = (y/x)$.

OR

2. a) Obtain the Laguerre's equation using power series method. **(10+5)**

   b) Prove $(n+1)L_{n+1}(x) = (2n+1-x)L_n(x) - nL_{n-1}(x)$

3. a) Explain function space and Dual space. **(6+9)**

   b) Define Linear operator, Unitary operator and Orthogonal operator. Give examples.

OR

4. a) Explain Hermitian and Unitary matrices. **(8+7)**

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

5. a) Explain symmetric and anti symmetric tensors. **(5+5+5)**

   b) State and explain Quotient law for tensors.

   c) What is covariant differentiation? Illustrate.

OR

6. a) Explain the addition and subtraction of tensors with examples. (8+7)

b) Explain Christoffel symbols of first and second kind.

7. a) Explain the basic concepts of a group and sub group. (8+7)

b) Verify whether $A = \{1, i, -1, -i\}$ form a group.

OR

8. a) Explain Reducible and irreducible representations. (8+7)

b) Construct a 3D rotational group.

9. Write a note on the behaviour of Bessel functions, $J_n(x)$. (10)

10. Describe the matrix representation of linear operators. (10)

11. Discuss the procedure of contraction of a tensor with suitable examples. (10)

12. Explain homomorphism and isomorphism with examples. (10)

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PGIS-O-1006 B-18

M.Sc. I Semester (CBCS) Degree Examination

PHYSICS

Introductory Quantum Mechanics

Paper - HCT 1.3

(Old)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

Answer all the questions of 15 marks and any two questions of 10 marks each.

1. a) Discuss experimental background for wave particle duality. **(8+7)**

b) State and explain Heisenberg's uncertainity principle. Discuss any one application of it.

OR

2. a) State and prove Ehrenfest's theorem. **(8+7)**

b) Show that the Ehrenfest's theorem is the quantum equivalent of the equation of motion of a classical particle.

3. a) Give the physical meaning of degenerate and non-degenerate energy levels. **(6+9)**

b) Obtain Eigen values and Eigen functions for a particle in a square well potential.

OR

4. What are spherically symmetric potentials? Separate the Schrodinger equation into radial and angular parts for a spherically symmetric potential case. **(15)**

5. Using time independent perturbation theory, obtain first and second order corrections for the degenerate system. **(15)**

OR

6. a) Write a note on matrix representation of an operator. **(5+10)**

b) Obtain matrix method solution of linear harmonic oscillator.

7. a) Define scattering cross section and scattering amplitude. (6+9)

b) Obtain Briet-Wigner formula by the method of partial wave analysis.

OR

8. Solve the problem of scattering by square well potential and explain the results. (15)

9. Discuss inadequacies of classical physics. (10)

10. Sketch out eigen functions for hydrogen atom and explain. (10)

11. Distinguish between Schrodinger and Heisenberg pictures of quantum mechanics. (10)

12. State and explain Optical theorem and its applicability. (10)

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PGIS-N-1005 B-18

M.Sc. I Semester (CBCS) Degree Examination

PHYSICS

(Introductory Quantum Mechanics)

Paper - HCT 1.3

(New)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

Answer all the questions of 15 marks and any two questions of 10 marks each.

1. a) Discuss the results of the Stern-Gerlach experiment. **(5+10)**

   b) Obtain one dimensional Schrodinger equation for free particle and give the operator forms of energy and momentum.

OR

2. What is Hermitian operator? Prove that eigen values of Hermitian operator are real and eigen functions belonging to the distinct eigen values are orthogonal. **(15)**

3. Solve the problem of a particle in a spherical symmetric potential and obtain eigen values and eigen functions. **(15)**

OR

4. Obtain eigen values and eigen functions of the Hydrogen atom and discuss. **(15)**

5. Discuss the basic formalism of time independent perturbation theory and obtain expressions for energy and wave functions at first order for a non-degenerate system. **(15)**

OR

6. a) Obtain first order correction to ground state energy in the case of a simple harmonic oscillator if the perturbation is $H' = bX^2$ where b is a constant. **(10+5)**

   b) Construct the matrix representation of the linear operator.

7. Define differential and total cross-sections. Obtain an expression for scattering amplitude by the method of partial wave analysis. **(15)**

OR

8. a) Using Born approximation method, discuss the theory of scattering by square well potential. **(10+5)**

   b) State and explain optical theorem.

9. Write a note on basic postulates of Quantum Mechanics. **(10)**

10. Discuss about degeneracy of an eigen state and give its physical meaning. **(10)**

11. Solve the harmonic oscillator problem using matrix method. **(10)**

12. Differential scattering cross section for a certain process is $\frac{d\sigma}{d\Omega} = a + b\cos^2\theta$ (where a & b are constants and θ ranges from 0 to π), obtain total scattering cross section. **(10)**

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PGIS-O-1004 B-18

M.Sc. I Semester (CBCS) Degree Examination

PHYSICS

(Electrodynamics)

Paper - HCT 1.2

(Old)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

Answer all the questions of 15 marks and two questions of 10 marks each.

1. a) Define electrostatic potential. Obtain the expression for the potential in terms of charge density. **(9+6)**

b) Derive the expression for the field and potential of a dipole.

OR

2. a) Derive expression for the electrostatic energy of a localized charge distribution. **(9+6)**

b) Obtain the expression for the energy of interaction between two dipoles.

3. a) State Ampere's law in the integral form. Obtain the expression for the magnetic field inside a thin long solenoid carrying current. **(9+6)**

b) Deduce the expression for magnetic scalar potential.

OR

4. a) Obtain the expression for the force and torque of a localized current distribution. **(9+6)**

b) Explain the concept of electrostatic energy in a dielectric.

5. a) What is gauge transformation? Explain the Lorentz and Coulomb gauge transformation. **(10+5)**

b) Write a note on displacement current.

OR

6. Set up the Maxwell's field equations with relevant physical explanation. **(15)**

7. From Maxwell's equations derive Poynting's theorem and hence obtain expressions for the energy and momentum of electromagnetic field. **(15)**

OR

8. Explain the principle of invariance. Write briefly on Lorentz transformation coordinates. **(15)**

9. Discuss the boundary conditions of electrostatics and magnetostatics. **(10)**

OR

10. Obtain an expression for magnetic vector potential. **(10)**

11. What is skin depth? Explain. **(10)**

OR

12. Discuss Reflection and refraction of EM waves. **(10)**

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PGIS-N-1003 B-18

M.Sc. I Semester (CBCS) Degree Examination

PHYSICS

(Electrodynamics)

Paper - HCT 1.2

(New)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

Answer all the questions of 15 marks and any two questions of 10 marks each.

1. a) Derive Poisson and Laplace equation satisfied by the electrostatic potential. **(5+10)**

   b) Derive multipole expansion of electrostatic potential of an artbitrary localized charge distribution.

OR

2. a) Obtain an expression for the electrostatic energy in dielectric medium. **(7+8)**

   b) Derive expressions for electrostatic field and potential due to electric dipole.

3. a) State and explain Biot-Savart's law. **(3+12)**

   b) Obtain an expression for the magnetic field due to infinitely long solenoid carrying a steady current.

OR

4. a) Obtain the expression for the magnetic dipole-moment of a current loop. **(7+8)**

   b) Find the vector potential and hence magnetic flux density at a point inside an infinite wire carrying current.

5. a) What are Lorentz and Coulomb gauges? Explain. **(5+10)**

   b) Obtain Maxwell's equations in terms of vector and scalar potentials.

OR

6. a) State and explain Faradays law of induction. (5+10)

b) Obtain expressions for the electromagnetic energy and momentum density.

7. a) Discuss the propagation of electromagnetic waves in a conducting medium. (7+8)

b) Derive expressions for reflection and transmission coefficients of electromagnetic waves.

OR

8. a) What are Lienard-Wiehart potentials? Explain. (5+10)

b) Obtain expressions for the electromagnetic potentials of a point charge moving with uniform velocity along a straight line.

9. What are the boundary conditions in electrostatics? Explain. (10)

10. Explain any two applications of Amperes law. (10)

11. Write a note on Lorentz gauge transformations. (10)

12. What are covariant formulation of the laws of electrodynamics? Explain. (10)

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PGIS-O-1002 B-18

M.Sc. I Semester (CBCS) Degree Examination

PHYSICS

(Classical Mechanics)

Paper - HCT 1.1

(Old)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

Answer all the questions of 15 marks and any two questions of 10 marks each.

1. a) State and explain Newton's second and third laws of motion. **(7+8)**
   b) Derive the conservation laws for energy and momentum of single particle.

OR

2. a) State and explain Kepler's laws of planetary motion. **(6+9)**
   b) Discuss Rutherford's scattering problem.

3. a) What are holonomic and nonholonomic constraints? Explain with examples. **(6+9)**
   b) Derive the Lagrange's equations of motion using D'Alembert's principle.

OR

4. a) State and explain Hamilton's variational principle? **(6+9)**
   b) Obtain Lagrange's equation of motion from variational principle for nonholonomic systems.

5. a) Using Legendre transformations, obtain Hamilton's equations of motion. **(10+5)**
   b) Discuss any one application of the variational principle.

OR

6. a) What are canonical transformations? State the necessary and sufficient condition for a transformation to be canonical. **(7+8)**
   b) What are Poisson brackets? Write down canonical equations of motion in terms of Poisson brackets.

7. State and explain basic concepts of continuum mechanics. Obtain Navier Stoke's equations. **(15)**

OR

8. a) Explain the basic concepts in continuum mechanics and obtain the equations of continuity and motion. **(10+5)**

   b) Discuss any one application of continuum mechanics.

9. Write a note on two-body central force field motion. **(10)**

10. Describe the generalized coordinates. **(10)**

11. Obtain Hamilton-Jacobi equations. **(10)**

12. Set up Lorentz co-variant form of equation of motion and explain. **(10)**

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PGIS-N-1001 B-18

M.Sc. I Semester (CBCS) Degree Examination

PHYSICS

(Classical Mechanics)

Paper - HCT 1.1

(New)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

Answer all the questions of 15 marks and any two questions of 10 marks each.

1. a) Describe the mechanics of a single particle and prove the conservation of linear momentum, angular momentum and energy of a single particle.

   b) State and explain the Newton's third law of motion. **(12+3)**

OR

2. a) What are bounded and unbounded motions? Explain.

   b) Describe in detail the Rutherford scattering of alpha particles. **(5+10)**

3. a) What are constraints? Explain them with examples.

   b) Construct the Lagrangian of an Atwood's machine and hence obtain the Lagrange's equation of motion. **(8+7)**

OR

4. a) What are generalized coordinates? Explain.

   b) State and explain D'Alembert's principle? Deduce Lagrange's equations of motion from D'Alembert's principle for a holonomic system. **(5+10)**

5. a) Derive the Hamilton's equations of motion and prove that Hamiltonian is a constant of motion.

   b) Write a note on Hamiltonian formulation. **(10+5)**

OR

6. a) Define Poisson brackets? Write down equations of motion in Poisson bracket notations.
   b) Obtain the Hamilton's equations for a simple pendulum and hence obtain its time period. **(8+7)**

7. a) List out basic concepts of continuum mechanics? Explain.
   b) Explain the Four vector and four momentum formulations in relativistic mechanics. **(7+8)**

OR

8. a) Describe the Lorentz transformation and obtain its transformation equations.
   b) Derive the equation of continuity for motion of the fluid. **(6+9)**

9. Explain the Kepler's laws of planetary motion. **(10)**

10. Write a note on properties of the Poisson brackets. **(10)**

11. Solve the harmonic oscillator problem using the Hamilton-Jacobi method. **(10)**

12. Write a note on four dimensional formulations of relativistic mechanics. **(10)**
