R8380	Sub. Code
	521201

M.Sc. DEGREE EXAMINATION, APRIL – 2023

Second Semester

Physics

QUANTUM MECHANICS –I

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

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

Answer **all** questions.

1. The commutator, $[x,p^2]$ = _____

   (a) Zero (b) $4i\hbar \times p$

   (c) $2i\hbar \times p$ (d) $2i\hbar(xp + px)$

2. The wave function for a particle must be normalizable because:

   (a) the particle's charges must be conserved

   (b) the particle's momentum must be conserved

   (c) the particle's must be somewhere in the region

   (d) the particle's angular momentum must be conserved

3. Consider liner harmonic oscillator. Which of the following state will exhibit minimum uncertainty?

   (a) ground state

   (b) first excited state

   (c) second excited state

   (d) third excited state

4. The ground state of the quantum system will have

   (a) No nodes (b) One nodes

   (c) Two nodes (d) More than two nodes

5. When inner product between two vectors vanishes, the state vectors are said to be

(a) Orthonormal (b) Orthogonal

(c) Normalized (d) Unit vectors

6. The dimension of the matrix representation of the position operator of the linear harmonic oscillator is

(a) 1 (b) 2

(c) 3 (d) ∞

7. The change in energy levels of an atom caused by a uniform external electric field is called

(a) Zeeman effect (b) Stark effect

(c) Coulombs effect (d) Gauss effect

8. The trial wavefunction chosen in the variational method must be

(a) Continuous and Single valued function

(b) Continuous and multi valued function

(c) Discontinuous and Single valued function

(d) Discontinuous and multi valued function

9. In time dependent perturbation theory, the Hilbert space of the system

(a) is modified and first and higher order modifications are calculated

(b) is modified and transition probabilities are calculated.

(c) is intact and first and higher order modifications are calculated

(d) is intact and transition probabilities are calculated.

10. The Fermi golden rule is applicable for the transitions when

(a) Initial state is a discrete state and the final state is also a discrete state.

(b) Initial state is a discrete state and the final state is continuous state

(c) Initial state is continuous state and the final state is also a discrete state

(d) Initial state is continuous state and the final state is also continuous state

Part B (5× 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Obtain the time independent Schrodinger equation from time dependent Schrodinger equation.

Or

(b) List the admissibility conditions on the wave function

12. (a) Discuss briefly about the quantum mechanical tunneling.

Or

(b) Derive the radial solutions to Rigid rotator.

13. (a) Compare the Schrodinger and Heisenberg pictures.

Or

(b) Define Hilbert space

14. (a) Obtain the first order corrections for energy and eigen functions in non degenerate time independent perturbation theory

Or

(b) Write a note on W.K. B approximation.

15. (a) Write a note on adiabatic approximation.

Or

(b) What are forbidden transitions? Explain

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

Answer any **five** questions.

16. State and prove Ehrenfest's theorem.

17. List the postulates of quantum mechanics and discuss each of them in detail.

18. Obtain the eigenvalues and eigenfunctions of a particle in a one dimensional infinite potential well.

19. Solve the Hydrogen atom problem and get the eigenfunctions and eigenvalues.

20. Using the ladder operator approach, obtain the solution for one dimensional linear harmonic oscillator.

21. Using time independent perturbation theory, obtain the expression for Stark effect in Hydrogen atom.

22. Obtain the ground state energy of helium atom using variational method.

23. Derive the Fermi golden rule.

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R8381	Sub. Code
	521202

M.Sc. DEGREE EXAMINATION, APRIL – 2023

Second Semester

Physics

MATHEMATICAL PHYSICS II

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

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

Answer **all** questions.

1. Let $Z = x + iy$. The function $f(Z) = |Z|^2$ is a
   (a) Single valued and analytic function
   (b) Single valued and non analytic function
   (c) Multi valued and analytic function
   (d) Multi valued and non analytic function

2. Let $f(z) = u(x,y) + iv(x,y)$ is an analytic function. If $v(x,y) = 2xy$, then $u(x,y)$ is
   (a) $2xy$ (b) $x^2 + y^2$
   (c) $x^2 - y^2$ (d) x^2

3. Which of the following function is a self adjoint one?
   (a) Bessel differential equation
   (b) Legendre differential equation
   (c) Laguerre differential equation
   (d) Hermite differential equation

4. The function of Gram-Schmidt Orthogonalization process is to convert a set of linearly independent non orthogonal functions into

(a) set of linearly independent orthogonal functions

(b) set of linearly dependent orthogonal functions

(c) set of linearly dependent non orthogonal functions

(d) set of linearly independent non orthogonal functions

5. The value of the gamma function, $\Gamma\left(\frac{1}{2}\right)$ is

(a) 0 (b) 1

(c) $\sqrt{\pi}$ (d) π

6. The value of the beta function, B(1, 1) is

(a) 0 (b) 1/2

(c) 1 (d) 2

7. The polynomial expression for $H_2(-x)$ is

(a) $4x^2 - 2$ (b) $4x^2 + 2$

(c) $-4x^2 - 2$ (d) $-4x^2 + 2$

8. The value of the Laguerre polynomial, $L_2(0)$ is

(a) 0 (b) 1

(c) 2 (d) ∞

9. Choose the incorrect statement

(a) A cyclic group is necessarily abelian

(b) Every subgroup of a cyclic group is also cyclic

(c) A cyclic group may have finite or infinite number of elements in it.

(d) All the abelian groups are cyclic.

10. The set of elements which are conjugate to one another is called as

(a) Group (b) Subgroup

(c) Representation (d) Class

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

Answer **all** questions, choosing either (a) or (b).

11. (a) State and prove Cauchy fundamental theorem.

Or

(b) Find the location of poles for the following function, $f(Z) = \frac{Z}{1+e^z}$

12. (a) Using method of separation of variables, solve the two dimensional heat equation in Cartesian coordinates.

Or

(b) Using method of separation of variables, solve the two dimensional wave equation in Cartesian coordinates.

13. (a) Derive any one of the recurrence relation for Legendre polynomials.

Or

(b) Derive the recurrence relation $\overline{|(Z+1)} = Z\overline{|(Z)}$ where $\overline{|(Z)}$ is Gamma function.

14. (a) Derive any one of the recurrence relations for Laguerre polynomials.

Or

(b) Write the Rodrigue's formula for Hermite polynomials and deduce the second order Hermite polynomials, $H_2(x)$.

15. (a) Define group and sub groups. Give any one example for each.

Or

(b) Explain the reducible and irreducible representations of groups.

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

Answer any **five** questions.

16. Derive the Cauchy Riemann conditions for analyticity and show that the function $f(Z) = Z^2$ is an analytic function.

17. Evaluate the integral

$$\oint_{|Z|=2} \frac{e^x}{Z^2+1} dZ$$

18. Solve the three dimensional Laplace equation in Cartesian Coordinates using method of separation of variables.

19. Derive the orthogonality relation for Bessel polynomials.

20. Evaluate $\int_0^\infty \exp(-x^4) dx$.

21. Obtain the orthogonality relation for Hermite polynomials

22. State and prove Great orthogonality theorem.

23. Build the character table for C_{2v} point group.

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R8382	Sub. Code
	521203

M.Sc. DEGREE EXAMINATION, APRIL – 2023

Second Semester

Physics

ELECTROMAGNETIC THEORY

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

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

Answer **all** the questions.

1. The electric field due to dipole is given by $E(r) = -\vec{\nabla}\varphi(r)$, then $\vec{\nabla}\left(\frac{1}{r^3}\right)$ is equal to

   (a) $-\frac{r}{r^5}$ (b) $-\frac{3r}{r^5}$

   (c) $\frac{3r}{r^5}$ (d) $\frac{r}{r^5}$

2. The Lorentz force represents as ———— and it is ———— to the velocity and magnetic induction.

   (a) $f = nqv(J \times B)$, perpendicular

   (b) $f = nq(Idl \times B)$, parallel

   (c) $f = q(v \times B)$, perpendicular

   (d) $f = nq(J \times B)$, parallel

3. The displacement current in a good conductor is ———————— compared to the conduction current at any frequency is ————————.

(a) completely negligible, lower than optical frequency

(b) very small, lower than resonating frequency

(c) very small, higher than resonating frequency

(d) having admissible net charge, lower than an optical frequency

4. When an EMW propagates in a conducting medium, the magnetic energy density is

(a) much lower than electric energy density and both are undamped

(b) much lower than electric energy density

(c) much greater than electric energy density and magnetic energy density damped off exponentially

(d) much greater than electric energy density and both are damped off exponentially

5. The degree of polarization is defined as

(a) $P(\theta_i) = \dfrac{R_\perp - R_{||}}{R_\perp + R_{||}}$

(b) $P(\theta_i) = \dfrac{R_\perp + R_{||}}{R_\perp - R_{||}}$

(c) $P(\theta_i) = \left(\dfrac{R_\perp + R_{||}}{R_\perp - R_{||}} \right)^2$

(d) $P(\theta_i) = \left(\dfrac{R_\perp - R_{||}}{R_\perp + R_{||}} \right)^2$

6. When an EMW propagates through two media, its

(a) frequency differs depends on the media

(b) wavelength remains unchanged

(c) frequency remains unchanged

(d) frequency and wavelength remains unchanged

7. The refractive index of the medium varies with frequency, then the medium is said to be

(a) dispersion medium

(b) anomalous medium

(c) denser medium

(d) rarer medium

8. The assumption of Lorentz's for dispersion of gas molecule damping is

(a) proportional to the number of librated electrons in the gas medium

(b) due to the collision between the gas molecules

(c) depend on the driving force on them

(d) proportional to the velocity of electron

9. Instability can be understood interms of

(a) pressure at the boundary

(b) magnetic pressure and stresses

(c) self-magnetic field

(d) the presence of field

10. Magneto-hydrodynamics is the study of interaction between

(a) instability of conducting fluid and the electric and magnetic field

(b) the motion of conducting fluid

(c) the motion of conducting fluid and the electric and magnetic field

(d) electric and magnetic field

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

Answer **all** questions, choosing either (a) or (b).

11. (a) State and prove Gauss divergent law. Obtain expression of expression of field due to spherically symmetric charge distribution at an external point.

Or

(b) Define Ampere's circuital law. Prove that $curlB = \mu_o J$.

12. (a) What is skin depth? Mention the significance of the results obtained by electromagnetic wave propagating in a conducting medium.

Or

(b) Obtain the wave equation interms of electromagnetic potential.

13. (a) What is discontinuity? Explain the boundary conditions at the surface of the discontinuity.

Or

(b) What is kinematic properties? Explain the phenomenon of total internal reflection.

14. (a) Explain the phenomenon of coherence and incoherence of scattered light.

Or

(b) What is local field? Deduce the expression of Clasusius – Mossotti relation for non-polar isotropic dielectrics.

15. (a) What is confinement of plasma? Hence describe Pinch effect.

Or

(b) Describe the conditions for plasma existence.

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

Answer any **five** questions.

16. (a) Calculate the force on a point charge moving in a magnetic field.

(b) Derive the expression of magnetic vector potential.

17. Deduce the expression of a plane electromagnetic wave propagating in an isotropic medium. Mention its significance.

18. State and derive Poynting theorem. Explain its significances.

19. What is degree of polarization? State and explain Brewster's law.

20. Explain the experimental demonstration of anomalous dispersion in gases.

21. State and explain Biot-savart law. List the comparisons of electrostatics and magnetostatics.

22. (a) Briefly explain the concept and magneto – hydrodynamics equation.

(b) Based on the force, deduce the expression of magnetic pressure.

23. Obtain the Fresnel's equation, when E-vector is parallel to the plane of incidence.

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R8383	Sub. Code
	521505

M.Sc. DEGREE EXAMINATION, APRIL – 2023

Second Semester

Physics

Elective : MATERIALS AND CHARACTERIZATION

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the questions.

1. If the shape of the nucleus is cylindrical, the free energy change associated with the nucleus is

   (a) $\Delta G = 2\pi r h\sigma_l + \pi r^2\sigma_e + 2\pi r^2 h\Delta\sigma_v$

   (b) $\Delta G = 2\pi r h\sigma_l + \pi r^2\sigma_e + \pi r^2 h\Delta G_v$

   (c) $\Delta G = \pi r h\sigma_l + 2\pi r^2\sigma_e + \pi r^2 h\Delta G_v$

   (d) $\Delta G = 2\pi r h\sigma_l + \pi r^2 h\Delta G_v$

2. The flux growth method is particularly suitable for crystals to be

   (a) free from thermal strain

   (b) free from external reaction

   (c) free from liquid phase

   (d) free from the formation of poly crystals

3. Buckyballs are extremely stable and it can be withstand.

(a) its cylindrical structure and size

(b) at high temperature and low pressure

(c) its volume

(d) at high temperature and high pressure

4. $BaTiO_3$ nanomaterial has ———— and is widely used in the manufacturing of ————.

(a) magnetic nanopowder, cathode materials

(b) high dielectric constant, multilayer ceramic capacitors

(c) ferro magnetic property, electromagnets

(d) quantum dot structure, drug delivery system

5. Electron beam machine is carried out in

(a) high pressure vessel

(b) thermally insulated area

(c) vacuum

(d) a restricted atmosphere

6. In the earlier, silicon and germanium are grown by

(a) chemical vapour deposition

(b) physical vapour deposition

(c) electron beam evaporation

(d) all the above

7. The cell performance can also be improved by optimizing the

(a) thickness of the electrolytes

(b) compositions of materials used

(c) size, shape and pores in the electrolytes

(d) all the above

8. Carbon based composite plates exhibits

(a) good electrical properties

(b) good chemical stability and high corrosion resistance

(c) poor mechanical performance

(d) good electrical and poor chemical performance

9. Acoustic emission test is generally used for detecting and locating imperfection in

(a) mechanically loaded structure

(b) ceramic coated heavy materials

(c) plastic based materials

(d) hard and light materials

10. Radio graphic test is also known as

(a) radio wave test

(b) ultrasonic test

(c) x ray or gamma ray test

(d) magnetic particle test

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Obtain the expression for super saturation. Also explain how to control it.

Or

(b) With the schematic diagram, describe the growth mechanism of a crystal by slow cooling method.

12. (a) Explain the need of nano. Discuss the principle behind nanotechnology.

Or

(b) With an example, describe how to obtain magnetic nanoparticles.

13. (a) Explain the preparation of transparent conducting oxide by spray pyrolysis method.

Or

(b) Explain the principle and working of modified chemical vapour deposition technique.

14. (a) Discuss how structural factors are responsible for higher ionic conductivity.

Or

(b) Examine the mechanism behind lithium ion transport in lithium batteries.

15. (a) Describe the principle and applications of acoustic emission technique.

Or

(b) Describe the principle and working of pulse-echo method.

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

Answer any **five** questions.

16. Illustrate the preparation of a crystal by Czochralski method with neat diagram.

17. Describe solvent evaporation and temperature gradient method to grow a crystal.

18. List the different types of carbon nanotubes. Mention its electrical and mechanical properties.

19. With an example, illustrate the preparation and scientific importance of polymer electrolytes in lithium battery applications.

20. Explain the principle, construction and working of physical vapour deposition technique. Mention its advantages and limitations.

21. Discuss the preparation and importance of ZnO and MoS_2 nanoparticles.

22. (a) Discuss the concepts and feasibility of ion conducting polymer nanocomposites.

(b) Briefly explain the free volume theory.

23. What is the principle of liquid penetrant testing technique? Explain the working of any one type. List its applications.

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