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**St Aloysius College (Autonomous)
Mangaluru**

Semester II – P.G. Examination – M.Sc. Physics

May - 2024

MATHEMATICAL PHYSICS II

ST. ALOYSIUS COLLEGE
P.G. Library
MANGALORE - 575 004

Time : 3 Hours

Max. Marks : 70

PART A

Answer all questions choosing ONE from each unit.

(4x15=60)

Unit I

- 1 a. Evaluate $\int_0^{\infty} \frac{dx}{1+x^6}$ by residue integration method. (9)
 b. Derive the Cauchy Riemann conditions. (6)

OR

2. a. What are residues? Explain with reference to the Laurent series. (6)
 b. Derive $\frac{1}{2\pi i} \oint_C \frac{f(z)}{z-z_0} dz = f(z_0)$. Also arrive at the expression for derivatives off(z_0). (9)

Unit II

3. a. Explain the method of Green's function to solve a differential equation. (6)
 b. For the group of symmetry transformations of a square, arrive at the elements and construct its multiplication table. (9)

OR

4. a. Show that the matrix $\begin{bmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$ forms a group under successive rotations. Does it belong to the category of SO (3) groups? (9)
 b. Give examples of groups under multiplication. Explain them. (6)

Unit III

5. a. The function $f(x) = \begin{cases} 1 & |x| < 1 \\ 0 & |x| > 1 \end{cases}$ is a symmetrical finite step function. (9)
 i) Find the Fourier Cosine transform of $f(x)$
 ii) Also find the inverse Cosine transform. (6)
 b. Find the Laplace transform of $f(t) = \frac{t}{2a} \sin at$ (6)

OR

6. a. Obtain the Fourier's transform of a Gaussian Function e^{-at^2} , with $a > 0$. (9)
 b. Define the Laplace transform of a function. Discuss its general properties. (6)

Unit IV

- 7 a. Explain the procedure of solving a set of linear equations using Gauss elimination method. (6)
 b. What is interpolation? Obtain the Newton's forward interpolation formula. (9)

OR

- 8 a. Evaluate $\int_0^{\pi} t \sin t dt$ using trapezoidal rule. (9)
 b. What is finite difference? Show how the forward difference of all orders can be formed. (6)

Contd..2

PART - B

Answer any TWO questions.

(2x5=10)

9. a. Determine the type of singularities for the following functions.

1. $F(z) = \frac{1}{z(z-2)^5} \frac{1}{(z-2)^3}$

2. $F(z) = e^{\frac{1}{z}}$.

- b. Explain direct product of groups. Define cosets.
c. State and Prove Fourier's convolution theorem.
d. Show that $(1 + \Delta)(1 - \nabla) = 1$.

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**St Aloysius College (Autonomous)
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Semester II – P.G. Examination – M.Sc. Physics

MAY - 2024

QUANTUM MECHANICS I

Time : 3 Hours

Max. Marks : 70

PART A

Answer all questions choosing ONE from each unit. (4x15=60)

Unit I

1. a. Setup the time dependent Scrodinger equation in one dimension. (6)
- b. Explain photoelectric effect and Compton effect and its observations. (9)
How did a new quantum theory lead to a correct explanation for the same? Write the correct equations for both effects.

OR

2. a. What is a wave packet? Explain with reference to de Broglie hypothesis. Also explain Heisenberg's uncertainty principle. (6)
- a. With the concept of probability density arrive at an expression for probability current density. (9)

Unit II

3. a. State the postulates of quantum mechanics. Also explain the importance of expectation values in the same. (9)
- b. Define Linear vector space. What is a basis? What is linear independence? (6)

OR

4. a. Show that observables having same set of eigen functions commute and also prove the converse of the same. (9)
- b. Find the eigen values of the matrix $A = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$. Also find the eigen vectors. (6)

Unit III

5. a. Solve the one dimensional barrier problem and arrive at the expression for transmission probability. (9)
- b. Arrive at te expression for expectation values of kinetic energy and potential energy for a linear harmonic oscillator. (6)

OR

6. a. What is Bohr's definition of Stationary states? Derive time independent Schrodinger equation and show that Schrodinger's theory reinforces Bohr's theory. (9)
- b. Show that for the infinite well the energy levels are not equally spaced whereas for the harmonic oscillator problem, the levels are equally spaced. (6)

Unit IV

7. a. Solve the eigen value equation for \hat{L}^2 and \hat{L}_z operators and hence define spherical harmonics. (9)
- b. Why is angular momentum an important problem in quantum mechanics? What is Bohr's postulate about angular momentum? (6)

OR

8. a) Solve the radial equation for spherical well problem and arrive at the solutions using Bessel's functions. (9)
- b) Arrive at the eigen values of \hat{L}^2 and \hat{L}_z operators. (6)

PART - B

Answer any TWO questions.

(2x5=10)

9. a) What are expectation values? Explain how it plays an important role in measurement of physical quantities?
- b) Show that the eigen functions of commuting observables are simultaneous.
- c) For the wave function of the infinite well, $\psi_n(x) = A \sin\left(\frac{n\pi}{a} x\right)$, find the normalization constant A .
- d) Compare classical and quantum mechanical scattering.

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Semester II – P.G. Examination – M.Sc. Physics
May - 2024

CONDENSED MATTER PHYSICS I

Time : 3 Hours

Max. Marks : 70

PART A

1 Answer all questions choosing **ONE** from each unit. (4x15=60)

Unit I

- 1 a. Show that the primitive vectors of the reciprocal lattice of bcc direct lattice are those of fcc lattice (6)
- b. Explain the concept of the geometric structure factor and its significance in X-ray diffraction analysis. (9)

OR

2. a. Define symmetry operations in crystallography. How do symmetry operations contribute to the identification of crystal systems? Provide examples to illustrate different crystal systems. (9)

- b. Draw a typical x-ray spectrum and explain the terms (6)
- I) Short wavelength limit II) Characteristic x-rays
 III) Bremsstrahlung IV) X-ray filters

Unit II

3. a. Explore the bonding characteristics in crystals. Provide specific examples of crystals where each type of bonding is prevalent, and discuss the implications on their properties. (9)
- b. Set up differential elastic wave equations for the case of a cubic crystal (6)

OR

4. a. Explore the concept of phonon momentum and its role in inelastic scattering of photons by phonons. (9)
- b. Differentiate between primary and secondary bonds. Provide examples of each type (6)

Unit III

5. a. Explain I) concept of holes II) constant energy surface (6)
- b. Describe Kronig-penny model of electrons moving in a periodic potential. Explain how does it lead to the formation of forbidden energy gaps. (9)

OR

6. a. What is Hall Effect? Deduce the expression for Hall coefficient in metals and mention its significance. (6)
- b. Deduce the expression for Hall coefficient in metal and mention its significance (9)

Unit IV

7. a. With relevant theory, explain the variation of Fermi energy with impurity density and temperature for an extrinsic semiconductor. (6)
- b. Distinguish between electronic, ionic and orientational polarizability. (9)
Derive an expression for ionic polarizability.

OR

8. a. Explain the phenomenon of polarization in dielectrics solids. Obtain Clausius- Mossotti relation. (9)
- b. Define orientational polarizability and obtain an expression for the same. (6)

PART - B**Answer any TWO questions.****(2x5=10)**

9. a. What are miller indices? How do you find miller indices of a given plane?
- b. Thermal conductivity of an artificial sapphire crystal 3mm in diameter is maximum at 30K. Estimate roughly the maximum value of the thermal conductivity. Given: for sapphire velocity of sound = 10^4 m/sec. and heat capacity per unit volume = 2700 J/m³/K
- c. Show that Brillouin zone boundaries are Bragg reflection planes.
- d. Derive LST equation for ionic crystal.

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Semester II- P.G. Examination – M.Sc. Physics

May, 2024 -

RESEARCH METHODOLOGY AND ETHICS

Time: 3 hrs.

Max Marks: 70

PART - A

Answer all questions choosing ONE from each unit.

(3x18=54)

UNIT- I

1. a) What are the characteristics of research? Explain briefly the need and importance of research. (8)
- b) Discuss the various postulates for Maintaining Ethical Standards in Higher Education. (5)
- c) Differentiate Morals, Ethics and Laws. (5)

OR

2. a) Discuss in detail the problems that lead to unethical behaviors of research (8)
- b) What is reduntant publication? Explain the various types. (5)
- c) Explain the process of identifying the right journals for publication of your manuscript using various criteria/tools of selection. (5)

UNIT- II

3. a) What is a literature review? What is its purpose? Explain the methodology of doing it. (8)
- b) How do you identify the research gaps? Discuss briefly. (5)
- c) Explain the various bibliographic styles used in research report. (5)

OR

4. a) Why is research report important? What are the steps involved in writing a research report? (8)
- b) Explain the process of error analysis. (5)
- c) Write a note on data acquisition and data sampling. (5)

UNIT- III

- 5.a) What is patent and copyright? Explain the steps involved in patenting. (8)
- b) Discuss briefly the IPR issues in physical and biological sciences. (5)
- c) What do you mean by indexed journal? What is the difference between h-index and g index? (5)

OR

- 6. a) What is the purpose of the IPR? Explain the different types of Intellectual properties. (8)
- b) What are the features of scholarly research article? How do you identify them? (5)
- c) Write a note on impact factor of a journal. (5)

PART - B

Answer any FOUR questions.

(4x4=16)

- 7. a) Write a note on plagiarism of a research article.
- b) What are the Potential Consequences of Ignoring Ethical Principles and Regulations?
- c) Explain the importance industrial design and geographical indicators.
- d) Discuss briefly the process of filing and registering for IPR.
- e) Write a note on SNIP and SJR.
- f) Explain the importance of trademarks with suitable examples.
