Seat No. : _____

# XW-121

**April-2013**

## M.Sc. (Sem.II)

## 407 PHYSICS

## (Quantum Mechanics II & Mathematical Physics II)

**Time : 3 Hours]** **[Max. Marks : 100**

**Instructions :** (1) Attempt **all** questions.
(2) Symbols used have usual meaning.

1. (a) What is meant by equation of State ? Discuss Schrodinger picture in detail, and derive Hamilton Jacobi's equation of motion. **7**

**OR**

What ae indistinguishable particles ? Define particle exchange operator and prove that it commutes with Hamiltonian operator. Discuss Pauli's exclusion principle.

(b) State assumptions made in Thomas-Fermi approximation theory. Derive Thomas-Fermi dimensionless equation. **7**

**OR**

Give fundamental difference between Hartree and Hartree-Fock approach. Derive Hartree-Fock equation of motion, and explain each term of it.

2. (a) Established a relation between Einstein coefficients for radiation. **7**

**OR**

Explain in detail, electric dipole interaction. Obtain corresponding matrix element and expression for transition probability.

(b) Define creation and annihilation operators for harmonic oscillator. How are they used to develop number operator ? Obtain energy eigen value of harmonic oscillator in terms of number operator. What are Fock states ? **7**

**OR**

Explain coherent states. Obtain an expression for coherent state $|\alpha >$. Find out expectation value of number operator for coherent state.

3. (a) Write statement of Cauchy-Riemann's first and second conditions ? Given proof of Cauchy integral theorem. **7**

**OR**

What is importance of the Cauchy-Riemann conditions ? Write statement and give proof of Cauchy's Integral Theorem for multiply connected Regions.

(b) Prove that u ($x$, y) and v ($x$, y) are harmonic functions. **7**

**OR**

Write statement of 'Residue theorem' and give proof of it.

4. (a) Transform the given second order differential equation into the integral form

$$Y''(x) + A(x)\, Y'(x) + B(x)\, Y(x) - g(x) = 0$$

$Y(a) = Y_0$ and $Y'(a) = Y'_0$ **7**

**OR**

Using Neumman series method obtain the solution of

$$\Phi(x) = 1 + x + \int_0^t (x - t)\, \Phi(t)\, dt$$

(b) Obtain the solution of Green's function. **7**

**OR**

Using separable Keinel method obtain the solution of

$$\Phi(x) = \lambda \int_{-1}^{+1} x - t\ \Phi(t)\, dt$$

5. Give answer of following short questions :

(1) Write unit of Einstein coefficient $A_{mn}$. **1**

(2) Eigen values for particle exchange operator are _____ and _____. **1**

(3) What is 'Exchange degeneracy' ? **1**

(4) Write basic essence/assumption of central field approximation.

(5) Creation and anhilation operators are _____ (Hermitian/non-Hermitian). Choose the correct one. **1**

(6) What is meant by first-quantization ? **1**

(7) Spin of a typical fermion can be _____. Choose the correct option from below.
a. (a) 0 (b) 1 (c) 5/2 **1**

(8) Prove that $f(z) = e^z$ and $f(Z) = Z^3$ are analytic functions. **2**

(9) Write Taylor's series of functions $e^z$ and $\frac{1}{(1 - z)}$. **1**

(10) What is a 'holomorphic function' ? **1**

(11) Find real and imaginary part of a function $f(Z) = Z^3$. **1**

(12) Write the general expression for the Volterra equation of second kind. **1**

(13) For discontinuation exist in the derivative of the Green's function is of the type _____. **1**

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