(b) Describe in brief W.K.B. method for a one dimensional potential V(x) for finding energy eigen values and eigen functions. Under what conditions does W.K.B. method work?

9. (a) Obtain the equation of motion of operators in Heisenberg picture. Obtain condition for dynamical variable to be a constant of motion in quantum mechanics.

Or

(b) How can you diagonalise a matrix by unitary transformation? Show that under unitary transformation a Hermitian operator remains Hermitian and the trace of the operator remains unchanged

10. (a) Obtain C.G. coefficients when two angular momenta $j_1 = \frac{1}{2}$ and $j_2 = \frac{1}{2}$ are coupled.

Or

(b) What is Pauli's theory? Show that asymmetric wave function for 2-electrons would vanish if both occupy the same position with identical spin.

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(For the candidates admitted from 2012 – 2013 onwards)

M.Sc. DEGREE EXAMINATION, NOVEMBER 2017.

First Semester

Physics

QUANTUM MECHANICS — I

Time : Three hours Maximum : 75 marks

PART A — (5 × 5 = 25 marks)

Answer ALL questions.

1. (a) Give an account of orthonormal wave functions. Write a short note on expansion theorem in connection with linear vector space.

Or

(b) Calculate the radius of Bohr's first orbit with the help of Heisenberg uncertainty relation.

2. (a) Calculate the transmission coefficient of electrons of energy E through one dimensional rectangular potential barrier.

Or

(b) Set-up Schrodinger equation for a rigid rotator and find out the energy eigen values.

3. (a) What is Stark effect? Give the theory of first order stark effect for the ground state of hydrogen atom.

Or

(b) Explain in detail how Sommerfeld extended the Bohr Theory and explain the postulates.

4. (a) Describe Dirac's BRA and KET notations. Mention some of its properties.

Or

(b) State the principles of matrix mechanics and apply them to the case of a linear operator.

5. (a) What are C.G. coefficients? Mention their properties and selection rules?

Or

(b) If σ_x, σ_y and σ_z are Pauli spin matrices and A and B are any constant vectors, show that $(\vec{\sigma}.A)\,(\vec{\sigma}.B) = A.B + i\sigma.(A \times B)$.

PART B — (5 × 10 = 50 marks)

Answer ALL questions.

6. (a) Show that the probability density ρ and the probability current density J satisfy the continuity equation $\frac{d\rho}{dt} + \nabla.J = 0$. What is its physical significance in Quantum Mechanics?

Or

(b) What are symmetric and anti-symmetric wave functions? Show how do they lead to Pauli's Exclusion principle.

7. (a) Give the formulation of time independent Schrodinger wave function. Discuss the interpretation of position probability density and normalization of wave function.

Or

(b) Write down the radial wave function for hydrogen atom and solve it to obtain expression for ground state.

8. (a) Use the first order perturbation theory to find out the energy levels of ground state of helium atom. How are the results modified in variation technique?

Or