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## DEPARTMENT OF SCIENCES, II SEMESTER M.SC. (PHYSICS) END SEMESTER MAKE-UP EXAMINATIONS, JULY/AUGUST 2022

## QUANTUM MECHANICS - II [PHY 5253]

## (Choice Based Credit System (CBCS) - 2020)

Time: 3 Hours	MAX. MARKS: 50

Note: Answer all questions

- 1.
- a) Explain symmetrization principle. Construct the wave function for a system of two non-interacting identical particles by considering them to be
  i) distinguishable ii) Bosons iii) Fermions.
- b) Define density operators. Derive the properties satisfied by density operators for pure states.
- c) Apply the variational principle to estimate the ground state energy of the harmonic oscillator.

(Use the Gaussian trial wave function,  $\psi(x) = (2b/\pi)^{1/4} \exp(-bx^2)$ )

(4 + 3 + 3 = 10 Marks)

- 2.
- a) Derive expression for the first-order correction to the energy in nondegenerate perturbation theory.
- b) Solve the Schrodinger equation in the classical region for a general potential using WKB approximation.
- c) Explain selection rules in electromagnetic transitions.

(5 + 3 + 2 = 10 Marks)

- 3.
- a) Derive the expression for transition probability in the case of timedependent sinusoidal (harmonic) perturbation. Discuss your obtained result.
- b) Derive the Einstein's A and B coefficients. Obtain the relation between the Einstein's A coefficient and lifetime of an excited state.

(5 + 5 = 10 Marks)

4.

- a) Derive and explain the optical theorem in scattering theory.
- b) Discuss the Born approximation. Calculate the scattering amplitudes for scattering from Yukawa and Rutherford potentials.

(3 + 7 = 10 Marks)

## 5.

- a) Derive the Dirac equation. Discuss its importance.
- b) Write the explicit form of Dirac matrices and obtain the identities satisfied by these matrices.

(6 + 4 = 10 Marks)

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