PD-368
(523) M.Sc. PHYSICS (THIRD SEMESTER)
Examination Dec. 2020
Compulsory/Optional
Group-
Paper-I
Name/Title of Paper- QUANTUM MECHANICS-II
Time: 3:00 Hrs.]

[Maximum Marks: 80
[Minimum Pass Marks: --

नोटः दोनो खण्डों से निर्देशानुसार उत्तर दीजिए। प्रश्नों के अंक उनके दाहिनी ओर अंकित है।
Note: Answer from Both the Section as Directed. The Figures in the right-hand margin indicate marks.

Section A 1X10

1 **A.** State True or False

i. Variation method is one way of finding approximations to the lowest energy eigen state and some excited states
ii. By applying Harmonic perturbation we induce transition between stationary states of quantum system
iii. Time dependent perturbation theory is also known as theory of non-variation of constant.
iv. Dirac operator $'\alpha'$ and $'\beta'$ are 6X6 Matrices.
v. According to Fermi Golden rule the transition Probability per unit time is proportional to the density of final states.

b. Fill in the Blank

i. The transmission coefficient for penetration of a particle through a potential barrier is give by the expression_____ .
ii. According to selection rule for simple Harmonic oscillator when the transition is to take place between states m and n, value of m=_____.
iii. _____type of wave functions describe Bosons.
iv. Scattering is deviation of a particle from the original direction of motion caused by its interaction with _____.
v. Sufficient condition for the validity of Born approximation for small values of 'r' is _____.

2 Answer the following questions:- 2X5

a. Discuss in short about normal Helium atom.
b. State and prove Fermi Golden rule for the rate of transition.
c. Briefly explain "Scattering cross section.
d. What are Symmetric and anti-symmetric wave functions?
e. Obtain selection rules for simple Harmonic Oscillator.

Section B

Answer all questions.

Unit I

Evaluate the energy values of 15

a. Normal state of Hydrogen
b. Normal state of Helium atom. Using variation method.

Or

Is the WKB method application to potential Well problem? Calculate the transmission probability of a particle through a potential well with the help of WKB method.

Unit II

Discuss the time dependent perturbation theory and derive an expression for the transition probability to a group of states per unit time. 15

Or

Deduce an expression for the Einstein transition probability by Perturbation Theory.

Unit III

Discuss Born Approximation in scattering calculations and apply it to obtain Rutherford formula. 15

Or

Deduce an expression for the scattering cross section of particles by a spherically symmetric potential. Explain the significance of phase shift term that appears in the formula.

Unit IV

Derive Klein-Gorden Equation Discuss The Short comings associated with the interaction of this equations and how they were overcome? 15

Or

a. Use Dirac equations to show that electron is endowed with Spin ½.
b. Explain the significance of two sets of energy negative and positive for a free particle and hence mention the discovery of position.