

**PARUL UNIVERSITY**  
**FACULTY OF APPLIED SCIENCE**  
**M.Sc., Winter 2018 - 19 Examination**

Semester: 1

Subject Code: 11204101

Subject Name: Quantum Mechanics-I &amp; Mathematical Physics-I

Date: 01/12/2018

Time: 10:30 am to 1:00 pm

Total Marks: 60

**Instructions:**

1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

- Q.1. A) Answer the following questions. (08)**
- (a) Elaborate non-degenerate perturbation theory in detail.
  - (b) Explain Stark effect.
- Q.1. B) Answer the following questions (Any two) (04)**
- (a) Do as directed. (04)
    1. Discuss the validity of time-independent perturbation theory.
    2. Give a validity condition for WKB approximation and define classical turning points.
  - (b) Explain calculation of ground state energy with the help of variational method. (04)
  - (c) Discuss the variational method for hydrogen atom. (04)
- Q.2. A) Answer the following questions. (04)**
- (a) Do as directed. (04)
    1. Elaborate two electron atoms with the relevant Schrödinger equation.
    2. Give the properties of transformation  $U(t, t_0)$ .
  - (b) Apply the WKB radial equation for the potential  $V(r) = V_0 \ln(r/a)$ , and show that the spacing between two levels, for  $l=0$ , is given by  $E_{n+1} - E_n = V_0 \ln\left(\frac{n+3/4}{n-1/4}\right)$  (04)
- Q.2. B) Answer the following questions (Any two) (03)**
- (a) Answer the following in short. (03)
    1. What is causality in context of quantum dynamics?
    2. The time-displacement operator  $U(t, t_0)$  is also known as \_\_\_\_\_
    3. What do you mean by the "dagger" of a matrix?
  - (b) Explain Bohr-Sommerfeld quantization. (03)
  - (c) Write a short note on sudden approximation. (03)
- Q.3. A) Answer the following questions. (08)**
- (a) Using convolution theorem, evaluate  $L^{-1}\left\{\frac{1}{s(s^2+4)}\right\}$
  - (b) Solve the differential equation by Laplace -  

$$y'' + 2y' + 5y = e^{-t} \sin t, \quad y(0) = 0, \quad y'(0) = 1$$
- Q.3. B) Answer the following questions (Any two) (04)**
- (a) Solve the following (04)
    1. Evaluate  $L\left\{\frac{t - \sin h 5t}{t}\right\}$
    2. Evaluate  $L\{t e^{-2t} \sin t\}$
  - (b) Prove that  $L^{-1}\left\{\log\left(\frac{s+1}{s}\right)\right\} = \frac{1-e^{-t}}{t}$  (04)
  - (c) Find 1)  $L\{(t)^2 u(t-2)\}$  2)  $L\{(t+2)^2 u(t+2)\}$  (04)
- Q.4. A) Answer the following questions. (04)**
- (a) Define the following (04)
    1. Group, sub-group and classes
    2. Reducible and irreducible representation
  - (b) Explain contra variant and covariant. (04)
- Q.4. B) Answer the following questions (Any two) (03)**
- (a) Answer the following in short. (03)
    1. Isomorphism.
    2. Symmetric tensor
    3. Homomorphism
  - (b) Explain conjugate and reciprocal tensors. (03)
  - (c) Explain Relative and absolute tensors. (03)