

PARUL UNIVERSITY
FACULTY OF APPLIED SCIENCE
M.Sc., Winter 2019-20 Examination

Semester: 1

Subject Code: 11204101

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

Date: 29/11/2019

Time: 10:30am to 01:00pm

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) Essay type/ Brief note (4x2) (Each of 04 marks) (08)

- (a) Explain briefly the basic concepts of time-independent perturbation theory.
- (b) Why the hydrogen atom in the ground state does not show a first order stark effect? Explain.

Q.1. B) Answer the following questions (Any two)**(a) Short note/ Brief note (2x2)/ Schematically label the figures (2x2) (Each of 02 marks) (04)**

1. Define Stark effect and degenerate energy levels.
2. Write down the expression for the second order correction to the energy and wavefunction for the time independent perturbation theory.

(b) Discuss the perturbation theory for degenerate energy levels. (04)**(c) Explain the principle of variation method and show that this method gives an upper bound to ground state energy. (04)****Q.2. A) Answer the following questions.****(a) Short note/ Brief note (2x2)/ Fill in the blanks. (Each of 02 marks) (04)**

1. Explain WKB approximation in short.
2. Give application of Schrodinger equation.

(b) Calculate the expectation value of $|H-W|^2$ in the state $| \rangle$. (04)**Q.2. B) Answer the following questions (Any two)****(a) Short note/ Multiple choice questions. (Each of 01 marks) (03)**

1. As per variation method, expectation value $\langle H \rangle$ of Hamiltonian operator H of the system is always greater than and/or equal to _____.
2. WKB approximation is valid for _____ varying potential.
3. Write down the expression for the ground state energy W_{\min} of a one dimensional harmonic oscillator.

(b) Write a short note on propagator. (03)**(c) Write a short note on transition approximation. (03)**

Q.3. A) Essay type/ Brief note (4x2) (Each of 04 marks) (08)

(a) Derive the general formula for the solution of differential equation using Laplace's transformation.

(b) Derive the solution of the below differential equation of Simple harmonic oscillator under the resistive load using Laplace's transformation

$$m \frac{d^2x}{dt^2} + b \frac{dx}{dt} + kx = 0$$

Where $x(0) = x_0$ and $x'(0) = 0$.

Q.3. B) Answer the following questions (Any two)

(a) Short note/ Brief note (2x2)/ Schematically label the figures (2x2) (Each of 02 marks) (04)

1. Find out the Laplace of $L(t^k e^{-at})$

2. Find out the Laplace of $L(t \cdot \cos at)$

(b) Obtain the formula of Inverse Laplace's transform. (04)

(c) At any instant for LCR circuit, the sum of the potential difference around the loop must be zero. (04)
Find out the equation of current flowing through the circuit using Laplace's transformation.

Q.4. A) Answer the following questions.

(a) Short note/ Brief note (2x2)/ Fill in the blanks. (Each of 02 marks) (04)

1. Define group and class.

2. What is sub-group? Discuss its properties.

(b) Discuss different types of group in detail. (04)

Q.4. B) Answer the following questions (Any two)

(a) Short note/ Multiple choice questions. (Each of 01 marks) (03)

1. Define character.

2. Define representation.

3. Define rank of tensor.

(b) Write a short note on Fundamental tensor. (03)

(c) Explain relative and absolute tensor. (03)