MSC-2
QM-II

Set-1

QUANTUM MECHANICS-II

Full Marks : 70

Time : 3 hours

Q. No. 1 is compulsory and answer any **five** from the rest

The figures in the right-hand margin indicate marks

1. Answer the following : 2 × 10

(*a*) Distinguish between normal Zeeman effect and anomalous Zeeman effect.

(*b*) Explain why in case of electric-dipole transition the initial and final states have '*l*' differing by 1.

(*c*) What do you mean spontaneous and stimulated emission ?

(*d*) Discuss the validity of WKB approximation.

(*e*) What is turning point ?

(*f*) Explain the optical theorem.

(*g*) Under what condition the Born approximation is valid ?

(*h*) Write the asymptotic form of the wave function in the case of scattering by a fixed potential.

(*i*) Show that Schrödinger equation is the non-relativistic approximation to the Klein-Gordon equation.

(*j*) Why is field quantization needed ?

2. Develop time independent perturbation theory for a non-degenerate system and obtain expressions for 1st order corrections to energy eigenvalues and eigenvectors. 10

3. Discuss the time dependent perturbation theory and derive an expression for the transition probability for a group of states per unit time. 10

4. What is WKB approximation ? Solve the problem of linear harmonic oscillator by WKB method and compare the results with those obtained by classical method. 2 + 8

5. Derive the connection formulae for WKB approximation. Use them to derive the Bohr -Sommerfeld quantization rule. 8 + 2

6. (*a*) What do you mean by the term differential cross-section and total cross-section ? 5

   (*b*) Derive formula for the expansion of plane wave in spherical harmonics for $l = 0$ to 2 and $m = -l$ to $+l$. 5

7. Calculate the scattering cross-section for screened coulomb potential using Born approximation. Discuss the validity of the result. 8 + 2

8. What are the motivations for formulating Dirac equation ? Derive the Dirac equation. 2 + 8