19. (a) Obtain eigen values for J^2 and J_z.

Or

(b) Obtain matrices for L_x, L_y, L_z in terms of Pauli's spin matrices.

20. (a) Develop Dirac's equation (relativistic) for a free particle and obtain plane wave solution.

Or

(b) Discuss negative energy states.

SECTION D — ($2 \times 10 = 20$ marks)

21. (a) Give the complete theory of WKB approximation for a particle placed in a slowly varying potential.

Or

(b) Calculate the transition probability coefficient a_n for adiabatic approximation.

22. (a) Obtain Clebsh–Gordan coefficients for $j_1 = \frac{1}{2}; j_2 = \frac{1}{2}; m_1 = \frac{1}{2}$ and $m_2 = \frac{1}{2}$.

Or

(b) Show that the energy ΔE calculated by Dirac for Hydrogen atom is less than that done by Schrodinger and the ΔE calculated using Dirac's concept is given by $\frac{r^2 m_0 C^2 (n-1)}{n^3 zn}$ where $r = \frac{Ze^2}{\hbar}$.