CLASS: M.Sc. PHYSICS **15A / 324**

St. JOSEPH'S COLLEGE (AUTONOMOUS) TIRUCHIRAPPALLI – 620 002

SEMESTER EXAMINATIONS – APRIL 2015

TIME: 2 Hrs. 20 min. **MAXIMUM MARKS: 70**

SEM	SET	PAPER CODE	TITLE OF THE PAPER
II	2014	14PPH2105	QUANTUM MECHANICS

SECTION – B

Answer all the questions: **5 x 5= 25**

31. a. Show that:
    (i) The eigen values of a Hermitian operator are real.
    (ii) The eigen functions of a Hermitian operator belonging to different eigen values are orthogonal.

OR

b. Explain Schrodinger Picture. Obtain the time derivative of the expectation value of an observable in it.

32. a. How is the spin eigen functions expressed? Give the eigen value of S^2 and S_z.

OR

b. Show that $[L^2, L_x] = 0$ with complete steps.

33. a. What do you understand by a classical turning point? Discuss briefly the validity conditions of WKB approximation.

OR

b. Explain the variational principle. The result of the variation method always gives in upper limit for the ground state energy of the system. Why?

34. a. If the asymptotic form of a scattering solution to the Schrodinger equation with short range potential is of the form $\psi \sim e^{lkz} + f(\theta)\, e^{lkr/r}$ where the first term gives the incident wave and the second one the outgoing scattered wave, show that the differential scattering cross section is $\sigma(\theta) = |f(\theta)|^2$.

OR

b. Show that the function given by $\psi s = \int G(\bar{r}, \bar{r}^1) \int (r^1) dr^{-1}$ with $G(\bar{r}, \bar{r}^1) = e^{ik} |\bar{r}, \bar{r}^1| / |\bar{r}, \bar{r}^1|$ is a solution of the equation $(\nabla^2 + k^2)\psi_s = -4\pi\int(r)$. Hence show that the problem of scattering by a potential $V(\bar{r})$ may be formulated in terms of the integral equation $\psi(\bar{r}) = e^{l\bar{k}.\bar{r}} - \left[\frac{2m}{4\pi h^2}\right] \int G(\bar{r}, \bar{r}^1)\, V(\bar{r}^1)\, \psi(\bar{r}^1)\, d\bar{r}^1$.

35. a. With the necessary sketch, explain the ingenious attempt of Dirac to explain the negative energy states through hole theory.

OR

b. Show that $(\alpha.A) + (\alpha.B) = (A.B) + i\sigma'.(A \times B)$.

SECTION – C

Answer any THREE questions: **3 x 15 = 45**

36. If a and a^+ are the ladder operators and H is a Hamilton for a linear harmonic oscillator, show that $H = \left[a^+ a + \frac{1}{2}\right] hw$. What are the eigen value of a^+ and a?

37. (i) What are Clebsch-Goldan Coefficients? Explain their significance. List down the rules for framing CG coefficient matrices.

(ii) Obtain the Clebsch-Gorbon Coefficients of combining two angular momenta of half each.

38. Explain briefly the principle of time-dependent perturbation theory.

    A perturbation H'(t) is on in a system for a time t. state and explain the expression for calculating the probability that a transition has occurred to state k from n during this time. Explain the importance of Fermi-Golden Rule.

39. Apply the method of Partial Wave analysis to obtain the scattering amplitude for scattering of nuclei.

40. Deduce Dirac's relativistic Hamiltonian for a free particle. Obtain its the energy eigen values and eigen vectors. Give physical interpretation to the solutions obtained.

****