http://www.bputonline.com

Registration no:

Total Number of Pages: 02

M.Sc
MPYC103

1st Semester Back Examination 2017-18
QUANTUM MECHANICS-I
Branch: M.Sc.(AP)
Time: 3 Hours
Max marks: 70
Q Code:B943
Answer Question No.1 which is compulsory and any FIVE from the rest.
The figures in the right hand margin indicate marks.

Q1 **Answer the following questions:** **(2 x 10)**

a) Show $(\boldsymbol{\sigma}\cdot \mathbf{A})(\boldsymbol{\sigma}\cdot\mathbf{B})=\mathbf{A}\cdot \mathbf{B}+ i\boldsymbol{\sigma}\cdot(\mathbf{A}\times\mathbf{B})$ where σ , A and B are vectors.

b) Write the expression for orbital and spin magnetic moments of elecron.

c) Show that Hermitian operators have real eigenvalues.

d) Define linear vector space and write its properties.

e) In a measurement, the enegy was found to be $E=0.2E_1 +0.3\,E_2 +0.5\,E_3$. What is the probability that the system is found in state 3?

f) **If L i**s the orbital angular momentum vector,show that **LxL=i ħL.** .

g) Define rotation operator? Show that it commutes with Hamiltonian H.

h) Write the solution of radial equation for l=0 and draw the waves inside and outside the potential well.

i) What are partial waves? Write expression for the free particle wave function in terms of partial waves,

j) If a state function is expanded in terms of orhonormal states, write the completeness and orthonormal relations.

Q2 **a)** Obtain uncertainty product of two operators A and B. **(8)**

(b) If a and $a^\dagger$ are annihilation and creation operators on the Harmonic oscillator basis, find $< n|a|m >$ and $< m|a^\dagger|n>$. **(2)**

Q3 Derive the relation $H = \hbar\omega\,(a^\dagger a +1/2)$ for the Harmonic oscillator in one dimension and show that $<n|\,H|n >= E_n = \hbar\omega(\,n + ½)$, where a and $a^\dagger$ are the annihilation and creation operators respectively. **(10)**

Q4 **(a)** What are outgoing and incoming waves for the free particle? Show that the radial flux is conserved in presence of potential in the absence of source. **(7)**

http://www.bputonline.com

http://www.bputonline.com

(b) Define the density operator $\hat{\rho}$. Show that Trace($\hat{\rho}$) = 1. Obtain the expectation value of the operator O i.e. < O >. **(3)**

Q5 a) What is spin? Obtain magnetic moment of a charged particle in terms of angular momentum as well as spin angular momentum. Construct Pauli Hamiltonian from the spin and orbital angular momentum interaction, hence write Schrodinger wave equation from it.[i] **(8)**

b) What are Pauli spin matrices? Obtain these matrices for the spin in 2×2 representation of angular momentum. **(2)**

Q6 a) What are Clebsch-Gordon Coefficients(C.G. Coefficients)? Obtain the Recurrence relation between the C.G. Coefficients. **(7)**

(b) Obtain the C G Coefficients due to addition of $j_1 = 1/2$ and $j_2 = 1/2$. **(3)**

Q7 (a) Discuss Heisenberg, Schrodinger and Dirac pictures in quantum mechanics and derive equation of motion of operators in Heisenberg picture. **(8)**

(b) Show that the Hamiltonian H is a constant of motion. **(2)**

Q8 a) (a) Obtain the normalised radial solution from the radial equation of H-atom and write the general solution ψ_{nlm} (r, θ, φ). Plot the radial probability density distribution for n = 1, 2 and 3 for l=0 **(8)**

(b) Write down Radial solutions R_{10} for H-atom and calculate < r > in the ground state. **(2)**

http://www.bputonline.com