07/05/2015

VCD   S.Y. B.Sc. PHYSICS-III IV- SEMESTER 2014-15   75 MARKS   2.30 HRS.

Note: i) All the questions are compulsory.

ii) Figures to the right indicate full marks.

iii) Use of non programmable calculator is allowed.

Q.1 Attempt the following:-

A) Attempt any 1:-   8M]
  a) Derive schrodinger's time independent equation.
  b) Derive schrodinger's time dependent equation.

B) Attempt any 1:-   7M]
  a) State the conditions of a 'well behaved' wave & show that
     $|\psi|^2 \neq |\psi 1|^2 + |\psi 2|^2$.
  b) If $\psi_1(x)$ and $\psi_2(x)$ are the solutions of STIE for different energy eigen values
     E_1 & E_2 then $\int_{-\infty}^{\infty} \psi_1^* \psi_2 \, dx = 0$.

C) Attempt any 1:-   5M]
  a) An eigen function of the operator d^2/dx^2 is $\psi = e^{2x}$ .find the corresponding eigen value.
  b) Find the expectation value of x for a wave function,
     $\psi(x) = \sqrt{2/l} \sin(\pi x/l)$, $0 < x < l$.

Q.2 Attempt the following:-

A) Attempt any 1:-   8M]
  a) What are Galilean transformation? Derive Galilean transformation equations for two inertial frames, state and prove Galilean invariance.
  b) Describe the experiment of Fizeau convection coefficient with the help of diagram.

B) Attempt any 1:-   7M]
  a) Explain stellar-aberration and Lorentz – fizerald contraction in short.
  b) Why the apparatus of Michelson – Morley experiment was rotated through 90°? Why did they repeat the experiment during day & night and during all season of the year?

C) Attempt any 1 :-   5M]
a) Show that the circle $x^2 + y^2 = a^2$ in a frame F appears to be an ellipse in frame F', which is moving with velocity v relative to F.
b) An event occurs at x=5m and t= 1×10^{-4} sec.in a reference frame F. calculate the co-ordinate of the event in a reference frame F' which is moving with velocity 2.7×10^8 m/s with respect to the frame F along a common XX' axis using Galilean transformation.

Q.3 Attempt the following:-

A) Attempt any 1 :-   8M]
a) Explain what is meant by one dimensional infinite rectangular potential well. Why is it also called a one dimensional box with rigid walls?
b) What is meant by zero potential? Discuss classically & quantum mechanically the motion of a particle for zero potential. Find the expectation value of momentum and comment on it.

B) Attempt any 1 :-   7M]
a) What is meant by finite square well potential? Set up STIE for a particle in one dimensional finite square well potential.
b) What is step potential? Discuss classical behavior of the motion of a particle when $E_0 > V_0$ & $E_0 < V_0$.

C) Attempt any 1 :-   5M]
a) Write down Schrodinger's equation for a particle in a infinite square well potential and show that its energy is quantized.
b) Show that expectation of momentum of a particle in a one dimensional box is zero. Comment on the statement.

Q.4 Attempt any 3: -   15M]

a) Normalize the following wave function. $\Psi_n = \sin(n\pi x/l)$; $0 < x < l$ n is an integer.
b) What is meant by normalization of wave function?.
c) A 2.0 meter long rod is moving along its length with velocity 0.8C. calculate its length as it appears to an observer on the earth.
d) Calculate the percentage contraction of a rod moving with velocity 0.6 times the velocity of light in a direction at 45° to its own length.
e) Derive the Schrodinger's equation for a free particle and find the expectation value of momentum.
f) An α – particle having energy 10 MeV approaches a potential barrier of height 50 MeV and width 10^{-15} m. determine the transmission coefficient ($m_\alpha = 6.68 \times 10^{-27}$ kg).