

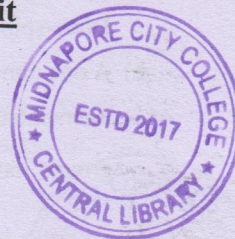
**PG (NEW) CBCS**  
**M.Sc. Semester-II Examination, 2019**  
**PHYSICS**  
**PAPER: PHS 201**

Full Marks: 40

Time: 2 Hours

**Use Separate Answer Scripts for each unit**

PHS 201.1:  
 QUANTUM MECHANICS-II  
 Marks-20



Answer any ONE question between 3 and 4.

1. Answer any two.

(Marks: 2×2=4)

a) For any vector  $A$ , show that

$$[\sigma, A \cdot \sigma] = 2iA \times \sigma$$

b) Find the normalized eigen function of  $\hat{S}_y$  with eigen value  $-1/2$  for electron.c) If  $V(x) = \frac{1}{2}m\omega^2 x^2 + bx$ Find the second order correction to the energy of  $n=1$  of Harmonic oscillator.

d) Find the velocity operator for electron in Dirac theory.

2. Answer any two.

(Marks: 4×2=8)

a) Find the C.G. coefficients for

$$J_1=1/2 \text{ and } J_2=1/2$$

b) For a Dirac particle moving in central potential, show that the orbital angular momentum is not a constant of motion.

c) A spin  $1/2$  particle of mass  $m$  with charge  $-e$  is in an external magnetic field  $B$ .

$$\text{Prove that } \frac{dS}{dt} = -\frac{e}{m}(S \times B)$$

d) A particle of mass  $m$  moves in one dimensional potential well defined by

$$V(x) = 0 \text{ for } -2a < x < -a$$

$$=\infty \text{ for } x > 2a \text{ and } x < -2a$$

$$=V_0 \text{ for } -a < x < a$$

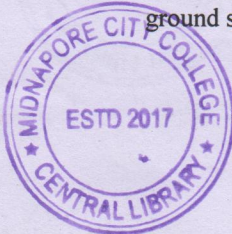
Calculate the energy of the ground state upto first order.

(Turn Over)



(2)

## 3. Answer any one.

(Marks:  $8 \times 1 = 8$ )a) Prove that  $p^2 = p^2$ b) Find the expression of the current density  $J_\mu$  for a spin zero particle in electro-magnetic field. (2+6)4. a) Show that  $\bar{\psi} \gamma_\mu \psi$  is a vector under Lorentz transformation (where  $\psi$  is the Dirac-spinor). (3)b) A one dimensional box of length  $a$  contains two particles each of mass  $m$ . The interaction between the particle is delocalised by  $V(x_1, x_2) = \lambda \delta(x_1 - x_2)$ . Find the ground state energy to first order in  $\lambda$ . [Given  $\int_0^a \sin^4 \frac{\pi x}{a} dx = \frac{3}{8} a$ ] (5)

PHS 201.2:

METHODS OF MATHEMATICAL PHYSICS – II

Marks-20

Answer question number 1, 2 and any ONE from rest.

## 1. Answer any two.

(Marks:  $2 \times 2 = 4$ )a) Show that  $x' = ax + b$  form a Lie group.b) Find the Fourier Transform of  $f(x) = 1$  for  $|x| < a$   
 $= 0$  for  $|x| > a$ 

c) State the orthogonality theorem for group.

d) Find the inverse Laplace transform of

$$f(s) = \frac{1}{s^2(s+1)^2}$$

## 2. Answer any two.

(Marks:  $4 \times 2 = 8$ )

a) Find the Fourier Transform of

$$f(x) = x^2 \text{ for } |x| < a$$

$$= 0 \text{ for } |x| > a$$

b) Show that the set of elements which are inverses of the elements of a class of a group also forms a class.

c)  $x' = (x - vt)$  $t' = (t - \frac{vx}{c^2})$  is the Lorentz transformation. Find the generator.d) Solve  $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial x \partial y} - 6 \frac{\partial^2 \psi}{\partial y^2} = y \cos x$ 

(Turn Over)



(3)

## 3. Answer any one.

(Marks:  $8 \times 1 = 8$ )

- a) If  $f(t) = 1$  for  $t > 0$   
 $= -1$  for  $t < 0$

Find the Fourier Transform of  $\frac{1}{2} [f(t + \frac{1}{2}) - f(t - \frac{1}{2})]$  (Marks: 3)

- b) A solution  $y(x)$  satisfies the following differential equation

$$\frac{d^2 y}{dx^2} - \omega^2 y = -\delta(x - a)$$

Where  $\omega$  is positive.

Find the Fourier Transformation of  $y(x)$

(Marks: 5)

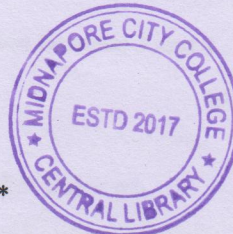
4. a) Show that  $SU(2)$  and  $SO(3)$  are homomorphic group.

(Marks: 5)

- b) If  $\hat{T}(\phi)f(x) = f(x + a\phi)$

Find the generator

(Marks: 3)



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