See- 2018-19

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MCC/19/M.Sc./Sem.-II/PHS/1

# 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**

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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

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

   b) Find the normalized eigen function of $\widehat{S_y}$ with eigen value -1/2 for electron.

   c) If V(x)=$\frac{1}{2}m\omega^2 + bx$

   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 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 ½ particle of mass m with charge –e is in an external magnetic field ***B***.

   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 for -2a<-x<-a

   =∞ for x>2a and x<-2a

   =$V_0$ for –a<x<a

   Calculate the energy of the ground state upto first order.

(Turn Over)

3. **Answer any one.** (Marks: 8×1=8)

   a) Prove that $\not{p}^2=p^2$

   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 $\bar{\psi}r_\mu\psi$ 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)

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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: 2×2=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: 4×2=8)

   a) Find the Fourier Transform of
   $f(x)=x^2$ for |x|<a
   =0 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 $\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial x\partial y}-6\frac{\partial^2\psi}{\partial y^2}=y\cos x$

3. **Answer any one.** (Marks: 8×1=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

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

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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