Roll No. ....

MSCPHY-12 (M.Sc. PHYSICS)
First Year Examination-2015
PHY-501
Mathematical Physics and Classical Mechanics
(Introduction from Old Paper)

Time : 3 Hours **Maximum Marks :** 60

Note : This paper is of sixty (60) marks divided into three (03) sections A, B, and C. Attempt the questions contained in these sections according to the detailed instructions given therein.

Section - A

(Long Answer Type Questions)

Note : Section 'A' contains four (04) long-answer-type questions of fifteen (15) marks each. Learners are required to answer any two (02) questions only.

(2×15=30)

1. (a) Solve the equation using power series solution.

$$\left(1+x^2\right)\frac{d^2y}{dx^2}+x\frac{dy}{dx}-y=0$$

(b) Prove that

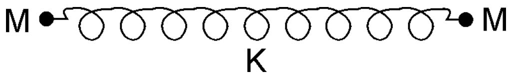
(i) $J_{1/2}(x)=\sqrt{\frac{2}{\pi x}}\ \text{Sin}\ x$

(ii) $J_{-1/2}(x) = \sqrt{\frac{2}{\pi x}} \text{ Cos } x$

(c) Find the expression for

$L[f^n(t)] =$

2. Express $f(x) = 4x^3 + 6x^2 + 7x + 2$ in terms of legendra polynomials.

(b) 

Find the modes of vibration for above two body problem using lagrange equation of motion.

(c) If F(s) is the complex fourier transform of f(x), then prove that

$$F\{f(x) \cos ax\} = \frac{1}{2}[F(s+a) + F(s-a)]$$

3. (a) Find the cononical equations of Hamilton.

(b) What are cyclic co-ordinates ? Write their importance for solving a problem.

(c) Explain contravariant, Covariant and mixed tensors.

4. (a) Show directly the transformation

$$Q = \log\left(\frac{1}{q}\sin p\right), P = q \cot p$$

is canonical.

(b) Using taylor sereis method obtain the solution of

$$\frac{dy}{dx} = 3x + y3 \text{ and } y = 1 \text{ when } x = 0$$

(c) Evaluate $\int_{-\infty}^{\infty} e^{-x^2/2} Hn(x)\, dx$

Section - B

(Short Answer Type Questions)

Note : Section 'B' contains eight (08) short-answer-type questions of five (05) marks each. Learners are required to answer any four (04) questions only. (4×5=20)

1. Solve the differential equation $2y^{11} + 5y^{1} + 2y = e^{-2t}$, $y(0) = 1$, $y^{1}(0) = 1$ using laplace transforms.
2. Explain alternate tensor and kronecker tensor.
3. Prove that $P_n(1) = 1$
4. Find the euqation of motion for a simple pendulam using lagrangian equation of motion.
5. If F(s) is the complex fourier transform of f(x) then prove that

   $$F\{(ax)\} = \frac{1}{a}F\left(\frac{s}{a}\right)$$

6. Derive equatio of motion in terms of poisson's breakets form.
7. Calculate $\int_0^1 \frac{dx}{1+x}$ using simpson's $\frac{1}{3}$ rule.
8. Describe the Hamiltonian and Hamilton's equation of motion for an ideal mass spring arrangement.

Section - C

(Objective Type Questions)

Note : Section 'C' contains ten (10) objective-type questions of one (01) mark each. All the questions of this section are compulsory. (10×1=10)

1. The Homogeneity of time leads to the law of conservation of :

   (a) Linear momentum (b) Angular momentum

   (c) Energy (d) Spin

2. It the Lagrangian does not depend on time explicitly :

(a) Hamiltonian is constant (b)Lagrangian is constant

(c) K. E. is constant (d) P.E. is constant

3. Value of Poisson bracket [X, X] is :

(a) 1 (b) 2

(c) 4 (d) 0

4. Any real index appears in the term of :

(a) Two times (b) One time

(c) Three times (d) All these

5. The relation between lagrangian and Hamiltonian is :

(a) $\frac{\partial H}{\partial t} = -\frac{\partial L}{\partial t}$ (b) $\frac{\partial H}{\partial t} = \frac{\partial L}{\partial t}$

(c) Both (a) and (b) (d) None of the two

6. Laplace transform of x^n is equal to the :

(a) $1/\delta^{n+1}$ (b) δ^{n+1}

(c) $n!/\delta^{n+1}$ (d) None of these

7. For a legndre polynomials $P_1(x)$ is equal to the :

(a) x^4 (b) x^3

(c) x^2 (d) x

8. Hermite polymials H1(x) is equal to the :

(a) x (b) 2x

(c) x2 (d) 3x

9. A rigid body moving freely in space has degree of freedom :

(a) 6 (b) 9

(c) 3 (d) 4

10. Generalized momentum associated with the cyclic coordinate is:

(a) Zero (b) Infinity

(c) Constant (d) None of these