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## 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.

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

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

(b) Prove that
(i) $\mathrm{J}_{1 / 2}(\mathrm{x})=\sqrt{\frac{2}{\pi \mathrm{x}}} \operatorname{Sin} \mathrm{x}$

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

(c) Find the expression for

$$
\mathrm{L}\left[\mathrm{f}^{\mathrm{n}}(\mathrm{t})\right]=
$$

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

$$
M \bullet \boxed{0} 00000000 \cdot \mathrm{M}
$$

Find the modes of vibration for above two body problem using lagrange equation of motion.
(c) If $\mathrm{F}(\mathrm{s})$ is the complex fourier transform of $\mathrm{f}(\mathrm{x})$, then prove that

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

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

$$
\frac{d y}{d x}=3 x+y 3 \text { and } y=1 \text { when } x=0
$$

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

## 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.
$(4 \times 5=20)$

1. Solve the differential equation $2 y^{11}+5 y^{1}+2 y=e^{-2 t}, y(0)=1$, $y^{1}(0)=1$ 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 $\mathrm{F}(\mathrm{s})$ is the complex fourier transform of $\mathrm{f}(\mathrm{x})$ then prove that $\mathrm{F}\{(\mathrm{ax})\}=\frac{1}{\mathrm{a}} \mathrm{F}\left(\frac{\mathrm{s}}{\mathrm{a}}\right)$
6. Derive equatio of motion in terms of poisson's breakets form.
7. Calculate $\int_{0}^{1} \frac{\mathrm{dx}}{1+\mathrm{x}}$ using simpson's $1 / 3$ 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.
$(10 \times 1=10)$

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 $[\mathrm{X}, \mathrm{X}]$ 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) $\frac{\partial \mathrm{H}}{\partial \mathrm{t}}=-\frac{\partial \mathrm{L}}{\partial \mathrm{t}}$
(b) $\frac{\partial \mathrm{H}}{\partial \mathrm{t}}=\frac{\partial \mathrm{L}}{\partial \mathrm{t}}$
(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) $\delta^{n+1}$
(c) $\mathrm{n}!/ \delta^{\mathrm{n}+1}$
(d) None of these
7. For a legndre polynomials $\mathrm{P}_{1}(\mathrm{x})$ is equal to the :
(a) $x^{4}$
(b) $\mathrm{x}^{3}$
(c) $x^{2}$
(d) $x$
8. Hermite polymials $\mathrm{H} 1(\mathrm{x})$ is equal to the :
(a) $x$
(b) $2 x$
(c) x 2
(d) $3 x$
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
