CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY

II Semester of M Sc Physic Examination May 2018

PS 718 Classical Mechanics-II

Date: 07-05-2018 Day: Monday Time: 1.30PM To 02:00 PM Maximum Marks: 20

MCQ

Important Instructions:

- Tick the correct answer and it should be written in question paper itself.
- Use of non-programmable calculator is allowed.

Q - I Choose the correct answer for the following questions. **20**

1. If a coordinate corresponding to a rotation is cyclic, rotation of the system about given axis remains invariant then the following quantity is conserved **1**

(a) linear momentum, (b) angular momentum, (c) kinetic energy, (d) potential energy

2. When a rigid body rotates about a given axis, the degrees of freedom it will have is **1**

(a) 1 (b) 2 (c) 3 (d) 4

3. How many degrees of freedom a rigid body possess **1**

(a) 3 (b) 6 (c) 9 (d) infinite

4. For the force free motion of a rigid body which one of following remains constant throughout the motion? **1**

(a) kinetic energy, (b) angular momentum,

(c) magnitude of angular momentum, (d) all of above.

5. What is the principal axis of a cube of mass M and length 'a'? **1**

(a) X-axis (b) axis passing through a centre of a cube

(c) Z-axis (d) diagonal axis of a cube

6. [u, u] = **1**

(a) 1 (b) 0 (c) iħ (d) - iħ

7. The Poisson bracket [u, v] is defined as **1**

(a) $\sum_i \frac{\partial u}{\partial q_i}\frac{\partial v}{\partial p_i} - \frac{\partial u}{\partial p_i}\frac{\partial v}{\partial q_i}$ (b) $\sum_i \frac{\partial u}{\partial q_i}\frac{\partial v}{\partial p_i} + \frac{\partial u}{\partial p_i}\frac{\partial v}{\partial q_i}$

(c) $\sum_i \frac{\partial q_i}{\partial u}\frac{\partial p_i}{\partial v} - \frac{\partial q_i}{\partial v}\frac{\partial p_i}{\partial u}$ (d) $\sum_i \frac{\partial q_i}{\partial u}\frac{\partial p_i}{\partial v} + \frac{\partial q_i}{\partial v}\frac{\partial p_i}{\partial u}$

8. Which transformation is a canonical transformation **1**

(a) P = ½ ($p^2 + q^2$), Q = arctan (q/p), (b) P = pq, Q = p/q

(c) P = p/q, Q = pq (d) P = p/q, Q = q/p

9. If F, G and S are function of (q, p, t), then [FG, S] = ----------------------- **1**

10. Canonical transformations can often be conveniently found or verified by using **1**

(a) generating gap (b) generating function,

(c) degenerating function, (d) separation tensor

11. For Normal modes of vibration in small oscillation which is not true **1**

(a) they are resonance frequency/ies

(b) Assigns new generalized coordinates to each frequency.

(c) differentiate frequency corresponding to symmetric/asymmetric stretching and bending

(d) shows longitudinal and translational mode of vibration

12. For a system of two identical simple pendulum of mass m and length *l* connected by a massless spring of spring constant k, the frequency of small oscillation is **1**

(a) $\sqrt{\frac{g}{l}+\frac{2k}{m}}$ (b) $\sqrt{\frac{g}{l}-\frac{2k}{m}}$ (c) $\sqrt{\frac{g}{l}+\frac{k}{2m}}$ (d) $\sqrt{\frac{g}{l}-\frac{k}{2m}}$

13. Number of possible modes of vibration perpendicular to the axis is linear symmetric triatomic molecules are **1**

(a) two (b) three (c) four (d) five

14. For vibration of triatomic molecule frequency of small oscillation is **1**

(a) $\sqrt{\frac{k}{m}\left(1+\frac{2m}{M}\right)}$ (b) $\sqrt{\frac{k}{m}\left(1+\frac{M}{2m}\right)}$ (c) $\sqrt{\frac{k}{m}\left(1-\frac{2m}{M}\right)}$ (d) $\sqrt{\frac{k}{m}\left(1-\frac{M}{2m}\right)}$

15. According to special theory of relativity which one is not an absolute quantity? **1**

(a) time (b) mass (c) height (d) both a and b

16. Length contraction happens only **1**

(a) perpendicular to direction of motion (b) along direction of motion

(c) parallel to direction of motion (d) both a and b

17. A rod of proper length *l*0 oriented parallel to the *x*-axis moves with speed 2*c*/3 along the *x*-axis in the S-frame, where *c* is the speed of the light in free space. The observer is also moving along the *x*-axis with speed *c*/2 with respect to the S-frame. The length of the rod as measured by the observer is **1**

(a) $0.35l_0$ (b) $0.48l_0$ (c) $0.87l_0$ (d) $0.97l_0$

18. For a nonlinear system, the dynamical variables describing the properties of the variables such as position, velocity, acceleration, etc. appear in the equations are in a linear form. True or False **1**

19. For a non-linear system which of the following statement/s is/are true **1**

(a time evolution equations are linear

(b) if $f_1(x,t)$ and $f_2(x,t)$ are linearly independent solutions of the time evolution equation for the system, then a linear combination of $c_1 f_1(x,t) + c_2 f_2(x,t)$, where c_1 and c_2 are constants, is also a solution.

(c) a small change in parameter can lead to dramatic and sudden changes of the co-ordinates and other parameters in both qualitative and quantitative behavior of the system.

(d) method of quadrature is applicable where the non linearity is higher than second order.

20. The phase trajectories of simple harmonic oscillator is **1**

(a) set of concentric ellipses

(b) set of concentric curves centered at the origin

(c) spirals into the equilibrium points

(d) librational and rotational motions inside the separatrics

CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY

II Semester of M Sc Physic Examination May 2018

PS 718 Classical Mechanics-II

Date: 07-05-2018 Day: Monday Time: 2.00PM To 04:30 PM Maximum Marks: 50

Instructions:

1. **Section I and II must be attempted in TWO ANSWER SHEET.**
2. Make suitable assumptions and draw neat figures wherever required.
3. Use of non-programmable calculator is allowed.
4. Show necessary calculations.

SECTION – I

Q – II Answer the following questions as directed **20**

1. Calculate the moment of inertia of a ring of mass M and radius R along the axis passing through center, perpendicular to plane. Draw appropriate diagram. 2

2. Calculate the inertia tensor for a solid cube of mass M and side length ‘a’, with the coordinate axes parallel to the edges of the cube and the origin at a corner. 2

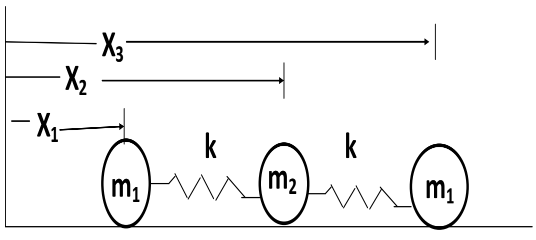
3. The coordinates and momenta, x_i, p_i (i = 1, 2, 3) of a particle satisfy the canonical Poisson bracket relations $[x_i , p_j] = \delta_{ij}$. If $C_1 = x_2 p_3 + x_3 p_2$ and $C_2 = x_1 p_2 - x_2 p_1$ are constants of motion, and *if* $C_3 = [C_1, C_2] = x_1 p_3 + x_3 p_1$, then find $[C_2 , C_3]$. 2

4. Let (p, q) and (P, Q) be two pairs of canonical variables. The transformation $Q = q^{\alpha} \cos(\beta p)$, $P = q^{\alpha} \sin(\beta p)$ is canonical for $\alpha = 1/2$, $\beta = 2$. 2

5. Explain the physical significance of Hamilton’s principal function. 2

6. Write the potential energy and kinetic energy of a simple pendulum of bob mass m with a mass M at the moving support. From this, identify the components of potential energy and kinetic energy for constructing the secular determinant. 2

7. Write the kinetic energy and potential energy of a system as shown in figure. 2



8. Deduce relativistic form of Newton’s second law of motion. 2

9. How fast must an unstable particle move to travel 20 m before it decays? The mean lifetime of the particle at rest = $2.6 * 10^{-8}$ s. 2

10. Draw the phase curves for the simple harmonic oscillator with proper value of semi-major axis and semi-minor axis derived using first integral equation. 2

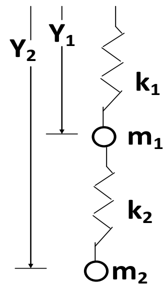
SECTION – II

Q-III Answer the following questions as directed **30**

1. Show that a principal axes of a cube of mass M and edge length 'a' is its diagonal axes. 5

2. For a harmonic oscillator deduce the phase angle of the oscillation using H-J method. 5

3. Consider the system shown in Fig. Find its frequency for small oscillations. 5



4. The average lifetime of μ-mesons at rest is $2.3 * 10^{-6}$ s. A laboratory measurement on μ-meson gives an average lifetime of $6.9 * 10^{-6}$ s. (i) What is the speed of the mesons in the laboratory? (ii) What is the effective mass of a μ-meson when moving at this speed, if its rest mass is $207m_e$? (iii) What is its kinetic energy? 5

5. Using the Poisson bracket, show that the following transformation is canonical. 5

$$Q = \arctan \frac{\alpha q}{p}$$
$$P = \frac{\alpha q^2}{2}\left(1 + \frac{p^2}{\alpha^2 q^2}\right)$$

6. A train with proper length L moves at speed 5c/13 with respect to the ground. A ball is thrown from the back of the train to the front. The speed of the ball with respect to the train is c/3. As viewed by someone on the ground, how much time does the ball spend in the air and how far does it travel? 5