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 follow	ving questions.	20		
1.	If a coordinate corresponding to a rotation is cyclic, rotation of the system about given axis				
	remains invariant then the following quan	tity is conserved			
	(a) linear momentum, (b) angular moment	um, (c) kinetic energy, (d) potential energy			
2.	When a rigid body rotates about a given axis, the degrees of freedom it will have is				
	(a) 1 (b) 2 (c) 3	(d) 4			
•	How many degrees of freedom a rigid bod	ly possess			
3. (a	(a) 3 (b) 6 (c) 9 (d) infinite				
4	For the force free motion of a rigid body which one of following remains constant				
4.	throughout the motion?				
	(a) kinetic energy,	(b) angular momentum,			
	(c) magnitude of angular momentum,	(d) all of above.			

(a) X-axis (b) axis passing through a centre of a cube (c) Z-axis (d) diagonal axis of a cube [u, u] = (a) 1 (b) 0 (c) ih (d) - ih The Poisson bracket [u, v] is defined as (a) $\frac{\sum}{i} \frac{\partial u}{\partial p_i} \frac{\partial r}{\partial p_i} - \frac{\partial u}{\partial p_i} \frac{\partial r}{\partial q_i}$ (b) $\sum_{i} \frac{\partial u}{\partial q_i} \frac{\partial r}{\partial p_i} + \frac{\partial u}{\partial p_i} \frac{\partial r}{\partial q_i}$ (c) $\sum_{i} \frac{\partial q_i}{\partial u} \frac{\partial r}{\partial r} - \frac{\partial q_i}{\partial q} \frac{\partial p_i}{\partial u}$ (d) $\sum_{i} \frac{\partial q_i}{\partial u} \frac{\partial r}{\partial r} + \frac{\partial q_i}{\partial r} \frac{\partial p_i}{\partial u}$ Which transformation is a canonical transformation (a) P = 1/2 (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 If F, G and S are function of (q, p, t), then [FG, S] = Canonical transformations can often be conveniently found or verified by using (a) generating gap (b) generating function, (c) degenerating function, (d) separation tensor For Normal modes of vibration in small oscillation which is not true (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 For a system of two identical simple pendulum of mass m and length <i>l</i> connected by a massless spring of spring constant k, the frequency of small oscillation is (a) $\sqrt{\frac{\pi}{l} + \frac{2k}{m}}$ (b) $\sqrt{\frac{\pi}{l} - \frac{2k}{m}}$ (c) $\sqrt{\frac{\pi}{l} + \frac{k}{2m}}$ (d) $\sqrt{\frac{\pi}{l} - \frac{k}{2m}}$ Number of possible modes of vibration perpendicular to the axis is linear symmetric triatomic molecules are (a) two (b) three (c) four (d) five	What is the	e principal axis of	a cube of mass N	/I and length	'a'?
(c) Z-axis (d) diagonal axis of a cube [u, u] = (a) 1 (b) 0 (c) ih (d) - ih The Poisson bracket [u, v] is defined as (a) $\sum_{i} \frac{\partial u}{\partial q_{i}} \frac{\partial r}{\partial p_{i}} - \frac{\partial u}{\partial q_{i}} \frac{\partial r}{\partial q_{i}}$ (b) $\sum_{i} \frac{\partial u}{\partial q_{i}} \frac{\partial r}{\partial p_{i}} + \frac{\partial u}{\partial p_{i}} \frac{\partial r}{\partial q_{i}}$ (c) $\sum_{i} \frac{\partial d}{\partial u} \frac{\partial r}{\partial v} - \frac{\partial q_{i}}{\partial v} \frac{\partial r}{\partial u}$ (d) $\sum_{i} \frac{\partial q_{i}}{\partial u} \frac{\partial p_{i}}{\partial v} + \frac{\partial q_{i}}{\partial v} \frac{\partial p_{i}}{\partial u}$ Which transformation is a canonical transformation (a) $P = \frac{1}{2} (p^{2} + q^{2}), Q = \arctan(q/p)$, (b) $P = pq, Q = p/q$ (c) $P = p/q, Q = pq$ (d) $P = p/q, Q = q/p$ If F, G and S are function of (q, p, t), then [FG, S] = Canonical transformations can often be conveniently found or verified by using (a) generating gap (b) generating function, (c) degenerating function, (d) separation tensor For Normal modes of vibration in small oscillation which is not true (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 For a system of two identical simple pendulum of mass m and length <i>l</i> connected by a massless spring of spring constant k, the frequency of small oscillation is (a) $\sqrt{\frac{q}{t} + \frac{2k}{m}}$ (b) $\sqrt{\frac{q}{t} - \frac{2k}{m}}$ (c) $\sqrt{\frac{q}{t} + \frac{k}{2m}}$ (d) $\sqrt{\frac{q}{t} - \frac{k}{2m}}$ Number of possible modes of vibration perpendicular to the axis is linear symmetric triatomic molecules are (a) line (b) three (c) four (d) five To show (b) three (c) four (d) five	(a) X-axis	()	o) axis passing th	hrough a cen	tre of a cube
$\begin{bmatrix} u, u \end{bmatrix} = \\ (a) 1 \qquad (b) 0 \qquad (c) ih \qquad (d) - ih \\ The Poisson bracket [u, v] is defined as \\ (a) \frac{\sum \frac{\partial u}{\partial q_i} \frac{\partial v}{\partial p_i} - \frac{\partial u}{\partial q_i} \frac{\partial v}{\partial q_i} \qquad (b) \frac{\sum \frac{\partial u}{\partial q_i} \frac{\partial v}{\partial p_i} + \frac{\partial u}{\partial p_i} \frac{\partial v}{\partial q_i}}{(d) \sum \frac{i}{i} \frac{\partial u}{\partial v} + \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial v} + \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial v} + \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial v} + \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial v} + \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial v} + \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial v} + \frac{\partial q_i}{\partial v} \frac{\partial p_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial q_i}{\partial v} + \frac{\partial q_i}{\partial v} \frac{\partial q_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial q_i}{\partial v} + \frac{\partial q_i}{\partial v} \frac{\partial q_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial u}}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial u}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial u}}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial u}}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v}}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v}}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v}}}{(d) \sum \frac{i}{i} \frac{\partial q_i}{\partial v} - \frac{\partial q_i}{\partial v}}}$	(c) Z-axis	(đ	l) diagonal axis c	of a cube	
(a) 1 (b) 0 (c) if (d) - if The Poisson bracket [u, v] is defined as (a) $\sum_{i} \frac{\partial u}{\partial q_{i}} \frac{\partial v}{\partial r_{i}} - \frac{\partial u}{\partial p_{i}} \frac{\partial v}{\partial q_{i}}$ (b) $\sum_{i} \frac{\partial u}{\partial q_{i}} \frac{\partial r}{\partial p_{i}} + \frac{\partial u}{\partial p_{i}} \frac{\partial v}{\partial q_{i}}$ (c) $\sum_{i} \frac{\partial q_{i}}{\partial u} \frac{\partial r}{\partial v} - \frac{\partial q_{i}}{\partial v} \frac{\partial r}{\partial u}$ (d) $\sum_{i} \frac{\partial q_{i}}{\partial u} \frac{\partial r}{\partial v} + \frac{\partial q_{i}}{\partial v} \frac{\partial r}{\partial u}$ Which transformation is a canonical transformation (a) $P = \frac{1}{2} (p^{2} + q^{2}), Q = \arctan(q/p)$, (b) $P = pq, Q = p/q$ (c) $P = p/q, Q = pq$ (d) $P = p/q, Q = q/p$ If F, G and S are function of (q, p, t), then [FG, S] = Canonical transformations can often be conveniently found or verified by using (a) generating gap (b) generating function, (c) degenerating function, (d) separation tensor For Normal modes of vibration in small oscillation which is not true (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 For a system of two identical simple pendulum of mass m and length <i>l</i> connected by a massless spring of spring constant k, the frequency of small oscillation is (a) $\sqrt{\frac{u}{l} + \frac{2k}{m}}$ (b) $\sqrt{\frac{u}{l} - \frac{2k}{m}}$ (c) $\sqrt{\frac{u}{l} + \frac{k}{2m}}$ (d) $\sqrt{\frac{u}{l} - \frac{k}{2m}}$ Number of possible modes of vibration perpendicular to the axis is linear symmetric triatomic molecules are (a) two (b) three (c) four (d) five	[u, u] =				
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$\sum_{i} \frac{\partial q_{i}}{\partial u} \frac{\partial p_{i}}{\partial v} - \frac{\partial q_{i}}{\partial u} \frac{\partial p_{i}}{\partial u} \qquad (d) \sum_{i} \frac{\partial q_{i}}{\partial u} \frac{\partial p_{i}}{\partial v} + \frac{\partial q_{i}}{\partial v} \frac{\partial p_{i}}{\partial u}$ Which transformation is a canonical transformation $(a) P = \frac{1}{2} (p^{2} + q^{2}), Q = \arctan(q/p), \qquad (b) P = pq, Q = p/q$ $(c) P = p/q, Q = pq \qquad (d) P = p/q, Q = q/p$ If F, G and S are function of (q, p, t), then [FG, S] = Canonical transformations can often be conveniently found or verified by using $(a) \text{ generating gap} \qquad (b) \text{ generating function}, \qquad (c) \text{ dgenerating function,} \qquad (d) \text{ separation tensor}$ For Normal modes of vibration in small oscillation which is not true $(a) \text{ they are resonance frequency/ies}$ $(b) \text{ Assigns new generalized coordinates to each frequency.}$ $(c) \text{ differentiate frequency corresponding to symmetric/asymmetric stretching and bending}$ $(d) \sqrt{\frac{g}{l} + \frac{2k}{m}} \qquad (b) \sqrt{\frac{g}{l} - \frac{2k}{m}} \qquad (c) \sqrt{\frac{g}{l} + \frac{k}{2m}} \qquad (d) \sqrt{\frac{g}{l} - \frac{k}{2m}}$ Number of possible modes of vibration perpendicular to the axis is linear symmetric triatomic molecules are $(a) \text{ two } (b) \text{ three } (c) \text{ four } (d) \text{ five}$	(a) $i {}^{O}q_i$	$\mathcal{O}_{i} \mathcal{O}_{i} \mathcal{O}_{i} \mathcal{O}_{i}$	(b) $i \circ q_i \circ p_i$		
(c) <i>i</i> cut ev ev ev ev (d) <i>i</i> cut ev ev ev ev (d) <i>i</i> cut ev ev ev ev Which transformation is a canonical transformation (a) $P = \frac{1}{2}(p^2 + q^2)$, $Q = \arctan(q/p)$, (b) $P = pq$, $Q = p/q$ (c) $P = p/q$, $Q = pq$ (d) $P = p/q$, $Q = q/p$ If F, G and S are function of (q, p, t), then [FG, S] = Canonical transformations can often be conveniently found or verified by using (a) generating gap (b) generating function, (c) degenerating function, (d) separation tensor For Normal modes of vibration in small oscillation which is not true (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 For a system of two identical simple pendulum of mass m and length <i>l</i> connected by a massless spring of spring constant k, the frequency of small oscillation is (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) $\sqrt{\frac{g}{l} - \frac{k}{2m}}$ Number of possible modes of vibration perpendicular to the axis is linear symmetric triatomic molecules are (a) two (b) three (c) four (d) five	$\Sigma \frac{\partial q_i}{\partial q_i}$	$\frac{\partial p_i}{\partial q_i} - \frac{\partial q_i}{\partial q_i} \frac{\partial p_i}{\partial q_i}$	$\Sigma \frac{\partial q_i}{\partial q_i} \frac{\partial p}{\partial q_i}$	$\frac{\partial \mathbf{q}_i}{\partial \mathbf{q}_i} + \frac{\partial \mathbf{q}_i}{\partial \mathbf{q}_i} \frac{\partial \mathbf{p}_i}{\partial \mathbf{q}_i}$	
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(a) two (b) three (c) tour (d) five	triatomic	molecules are			
	(a) two	(b) three	(c) tour	(d) five	

(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) $\sqrt{\frac{k}{m}\left(1-\frac{M}{2m}\right)}$

	According to speci	al theory of relativity wh	nich one is not an abso	lute quantity?	1	
15.	(a) time	(b) mass (c)	height (d) both a an	d b		
16.	Length contraction happens only				1	
	(a) perpendicular to direction of motion (b) along direction of motion					
	(c) parallel to dire	ction of motion	(d) both a and b			
17.	A rod of proper lea	ngth 10 oriented parallel	to the <i>x</i> -axis moves	with speed $2c/3$ along the	1	
	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 $c/2$ wi	th respect to the S-fra	me. The length of the rod		
	as measured by the observer is					
	(a) 0.35 <i>l</i> ₀	(b) $0.48l_0$	(c) $0.87l_0$	(d) 0.97 <i>l</i> ₀		
18.	For a nonlinear sys	stem, the dynamical varia	ables describing the pro-	operties of the variables	1	
	such as position, v	elocity, acceleration, etc.	appear in the equation	ns are in a linear form.		
	True or False					
19.	For a non-linear system which of the following statement/s is/are true				1	
	(a time evolution e	quations 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 coordinates 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
- (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

1

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

- Calculate the moment of inertia of a ring of mass M and radius R along the axis passing through 2 center, perpendicular to plane. Draw appropriate diagram.
- 2. Calculate the inertia tensor for a solid cube of mass M and side length 'a', with the coordinate 2 axes parallel to the edges of the cube and the origin at a corner.
- 3. The coordinates and momenta, x_i , p_i (i = 1, 2, 3) of a particle satisfy the canonical Poisson 2 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 $[C_2, C_3]$.
- 4. Let (p, q) and (P, Q) be two pairs of canonical variables. The transformation $Q = q^{\alpha} \cos(\beta p)$, 2 $P = q^{\alpha} \sin(\beta p)$ is canonical for $\alpha = 1/2$, $\beta = 2$.
- 5. Explain the physical significance of Hamilton's principal function.
- 6. Write the potential energy and kinetic energy of a simple pendulum of bob mass m with a mass 2 M at the moving support. From this, identify the components of potential energy and kinetic energy for constructing the secular determinant.
- Write the kinetic energy and potential energy of a system as shown in figure.



8.

Deduce relativistic form of Newton's second law of motion.

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.

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.

20

2

2

2

	<u>SECTION – II</u>						
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					

The average lifetime of μ -mesons at rest is 2.3 * 10⁻⁶ s. A laboratory measurement on μ -meson 4. 5 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. Using the Poisson bracket, show that the following transformation is canonical.

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

A train with proper length L moves at speed 5c/13 with respect to the ground. A ball is thrown 6. 5 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?

δm,

5