

B.Sc. PHYSICS
FIFTH SEMESTER (SPECIAL REPEAT)
CLASSICAL DYNAMICS

BSP-503A

(Use Separate Answer Scripts for Objective & Descriptive)

Duration : 3 hrs.

Full Marks : 70

[PART-A: Objective]

Time : 20 min.

Marks : 20

Choose the correct answer from the following:

1X20=20

- Which of the following is not a consequence of special relativity?
 - Moving objects look shorter in length (thinner) than stationary objects.
 - Time moves at a different rate for objects moving relative to each other.
 - Mass and energy are the same thing. If you increase an object's energy, you also increases its mass.
 - Nothing is certain; everything is relative.
- In the train thought experiment, two beams of light are fired from the center of a moving train car: one beam of light towards the front of the train and one towards the back. From the perspective of a person on the side of the tracks, watching the train, which beam of light reaches the edge of the train car first?
 - They arrive at the same time.
 - The beam going towards the front of the train car.
 - Neither, the light stays where it is.
 - The beam going towards the back of the train car.
- According to the Theory of Relativity, the speed of light in a vacuum is _____ for all observers?
 - Different
 - Dependent on the motion of the source of the light
 - The same
 - Dependent on the relative motion of the observer
- If c is a constant, then $[u, c] = \dots\dots$
 - 0
 - 1
 - 1
 - None
- Principle of virtual work is applied to a system of
 - Dynamic equilibrium
 - Static equilibrium
 - Both
 - None
- Generalised coordinates are
 - Depending on each other
 - Are independent of each other
 - Are necessarily spherical coordinates
 - None

7. If a function F does not depend on time explicitly, then its poisson bracket with the Hamiltonian H
- do not vanish
 - vanishes
 - F
 - undetermined
8. The number of degrees of freedom for the general motion of a rigid body is
- 2
 - 3
 - 5
 - 6
9. D' Alembert's principle is analogous to
- Newton's 1st law
 - Newton's 2nd law
 - Newton's 3rd law
 - Both b and c
10. The force of constraint in a motion of a body on an inclined plane under gravity
- Non-holonomic
 - holonomic
 - conservative
 - dissipative
11. Which of the following is correct?
- $[J_x, P_y] = -P_z$
 - $[J_x, P_y] = P_z$
 - $[J_x, P_z] = P_y$
 - $[J_x, P_y] = -P_x$
12. If we consider momentum and position coordinates together then it is called a
- Position space
 - Momentum space
 - Phase space
 - Minkowski space
13. In case of canonical transformations
- Hamilton's principle is satisfied in old as well as in new coordinates
 - The form of Hamilton's equations may or may not be preserved
 - The form of Hamilton's equations may or may not be preserved
 - Both a and b
14. The total of all the masses of small particles adds up to give the total body mass. This mass lies along with gravity gives a force vector which is being passed by _____
- Axis of rotation
 - Axis of rolling
 - Centre of Gravity
 - None of above
15. The all small masses that are being applied by all the infinite particles of the body act _____ to each other.
- Parallel
 - Perpendicular
 - Collinear
 - Divergent
16. If any external conservative force also is applied on the distributed loading then?
- The net force will act at the centroid of the structure only
 - The net load will not be formed as all the forces will be canceled

- c. The net force will act on the base of the loading horizontally
- d. The net force will not to be considered, there would be a net force of the distribution, rest will be the external forces

17. Law which states that square of period of any planet is proportional to cube of semimajor axis of its orbit is

- a. Kepler's Law of Periods
- b. Kepler's Law of Orbits
- c. Kepler's Law of Areas
- d. Newton's Second Law for a System of Particles

18. Which of following determines linear-angular relation?

- a. $s=r\theta$
- b. $s/r=\theta$
- c. $s=as$
- d. $s=\theta/r$

19. Which statement is correct

- a. central force is always attractive
- b. There is no radial symmetry is central force
- c. central force is irrotational
- d. None of above statement is correct

20. Which of the following statements about special relativity is FALSE?

- a. An assumption of special relativity is that the laws of physics are the same in all reference frames.
- b. An assumption of special relativity is that the speed of light is the same in all reference frames.
- c. Special relativity says that space and time are part of the same thing: spacetime.
- d. An assumption of special relativity is that the laws of the physics are the same in all 'constant velocity' reference frames.

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(PART-B : Descriptive)

Time : 2 hrs. 40 min.

Marks : 50

[Answer question no.1 & any four (4) from the rest]

1. a. Moving clocks run slow. Does this result have anything to do with the time it takes light to travel from the clock to your eye? Does time dilation depend on whether a clock is moving across your vision or directly away from you? 5+5

b. Does the special-relativistic time dilation depend on the acceleration of the moving clock? There is a twin brother A & B. A takes space voyage and B remain in the earth. According to time dilation, the clock with B runs faster than clock with A. If velocity of A is $0.8C$, then how much slow or fast the clock runs which is carried by A.

2. a. Why gravitational and coulomb's forces are called central force? Are central forces are conservative? Justify your answer. 5+5

b. how that the angular momentum is conserved under central force. From the expression of Lagrangian prove that Areal velocity is conserved under central force.

3. a. Reduce the two body problem to one body problem. 4+6
b. If two masses are attached by a spring with a spring constant k , and ratio of the two masses are 1:2 then evaluate the angular frequency. Also find the ratio with angular frequency if both masses are equal.

4. What do you understand by canonical transformation? Obtain the necessary condition for canonical transformation. Using the Legendre Transformation Method obtain the transformation equations for the second generating function $F_2(q_i, P_i, t)$. 1+3+6

5. a. Obtain the expression for the Hamiltonian function H and deduce its equations of motions. Show that the Hamiltonian H represents the total energy of the system E for any conservative system. 2+4+2+2

b. Derive the equation of motion for a particle moving under a central force, $F = \frac{-k}{r^2}$ where k is the force constant using Lagrangian dynamics.

6. a. Write down the basic differences between Lagrangian and Hamiltonian dynamics. 2+2+2+4
- b. State D' Alembert's Principle?
- b. Prove the anti-commutation property of the Poisson bracket ie $[u, v] = -[v, u]$
- c. Show $[uv, w] = u[v, w] + v[u, w]$
7. a. Show (i) $[J_x, P_x] = 0$ and (ii) $[J_z, J_x] = J_y$ 3+3+4
- b. Determine the values of m and n, so that the equations $Q = q^m \cos(np)$, $P = q^m \sin(np)$ present a canonical transformation.
8. a. Write down the differences between Galilian and Lorentz transformation. 2+2+2+4
- b. Calculate the rest energy of electron and proton in eV. Given $m_e = 9.11 \times 10^{-31}$ kg, and $m_p = 1.673 \times 10^{-27}$ kg.
- c. Derive the equation for Length contraction.
- d. A rocket is chasing enemy's space-ship. An observer on the earth observes the speed of rocket to be 2.5×10^8 m/sec and that of space-ship 2×10^8 m/sec. Calculate the velocity of enemy's ship as seen by rocket

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