Write the following information in the first page of Answer Script before starting answer

Exam ID Number_____

Course_____   Semester_____

Paper Code _____Paper Title _____

Type of Exam: _____ (Regular/Back/Improvement)

Important Instruction for students:

1. Student should write objective and descriptive answer on plain white paper.
2. Give page number in each page starting from 1st page.
3. After completion of examination, Scan all pages, convert into a single PDF, rename the file with Class Roll No. **(2019MBA15)** and upload to the Google classroom as attachment.
4. Exam timing from 10am – 1pm (for morning shift).
5. Question Paper will be uploaded before 10 mins from the schedule time.
6. Additional 20 mins time will be given for scanning and uploading the single PDF file.
7. Student will be marked as ABSENT if failed to upload the PDF answer script due to any reason.

B.Sc. PHYSICS
FIRST SEMESTER
MECHANICS
BSP-102

**Duration : 3 hrs.**   **Full Marks : 70**

(PART-A : Objective)

Time : 20 min.   **Marks : 20**

*Choose the correct answer from the following:*   *1X20=20*

1. Angular displacement θ of a flywheel varies with time as $\theta = at + bt^2 + ct^3$ then angular acceleration is given by
   a. $a + 2bt - 3ct^2$ b. $2b - 6t$
   c. $a + 2b - 6t$ d. $2b + 6ct$

2. Three rods each of length L and mass M are placed along X, Y and Z-axes in such a way that one end of each of the rod is at the origin as shown in figure. The moment of inertia of this system about Z axis is:

   a. $\frac{2ML^2}{3}$ b. $\frac{4ML^2}{3}$

   c. $\frac{5ML^2}{3}$ d. $\frac{ML^2}{3}$
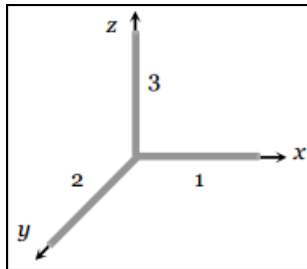
3. A sphere rolls down on an inclined plane of inclination θ. What is the acceleration as the sphere reaches bottom:
   a. $\frac{5}{7}g\sin\theta$ b. $\frac{3}{5}g\sin\theta$
   c. $\frac{2}{7}g\sin\theta$ d. $\frac{2}{5}g\sin\theta$

4. A ring of radius $0.5\ m$ and mass $10\ kg$ is rotating about its diameter with an angular velocity of $20\ rad/s$. Its kinetic energy is:
   a. $10\ J$ b. $100\ J$
   c. $500\ J$ d. $250\ J$

5. A force of $(2\hat{i} - 4\hat{j} + 2\hat{k})\ N$ acts at a point $(3\hat{i} + 2\hat{j} - 4\hat{k})\ metre$ from the origin. The magnitude of the torque is:
   a. $Zero$ b. $24.4\ Nm$
   c. $0.244\ Nm$ d. $2.444\ Nm$

6. *A* and *B* are two wires. The radius of *A* is twice that of *B*. They are stretched by the same load. Then the stress on *B* is:
    a. Equal to that on *A*
    b. Four times that on *A*
    c. Two times that on *A*
    d. Half that on *A*

7. Minimum and maximum values of Poisson's ratio for a metal lies between:
    a. -∞ to +∞
    b. 0 to 1
    c. -∞ to 1
    d. 0 to 0.5

8. The most probable value of the density of the earth is found to be:
    a. 4.5 g/cm³
    b. 3.5 g/cm³
    c. 5.5 g/cm³
    d. 6.5 g/cm³

9. By which curve will the variation of gravitational potential of a hollow sphere (spherical shell) of radius *R* with distance be depicted:

    a.

    b.

    c.

    d.
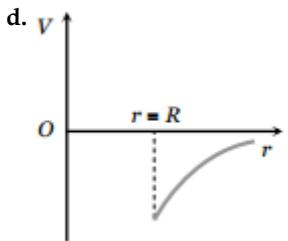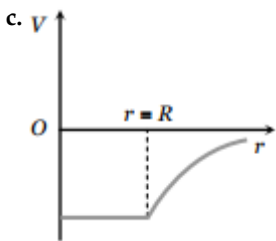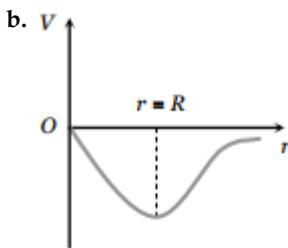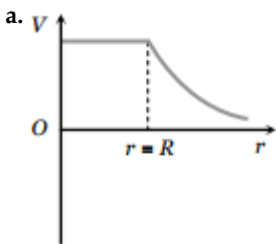
10. If the distance between two masses is doubled, the gravitational attraction between them:
    a. Is doubled
    b. Becomes four times
    c. Is reduced to half
    d. Is reduced to a quarter

11. In an elastic collision, there is/are conservation(s) of:
    a. Momentum
    b. Energy
    c. None
    d. Both a and b

12. Which of the following is not a conservative force?
    a. Elastic spring force
    b. Friction force
    c. Electric force
    d. Gravitational force

13. Conservative force is equal to:
    a. Positive gradient of potential energy
    b. Negative gradient of inverse of potential energy
    c. Negative gradient of potential energy
    d. Positive gradient of inverse of potential energy

14. Impulse of a force is equal to:
    a. Change of momentum
    b. Change of kinetic energy
    c. Change of force
    d. Change of potential energy

15. The motion of a rocket is based on:
   a. Angular momentum
   b. Linear momentum
   c. Mass
   d. Kinetic energy

16. Which one of the following is invariant under Galilean transformation?
   a. Velocity
   b. Momentum
   c. Length
   d. Potential energy

17. Rocket Engines lift rocket from the earth surface because the hot gas with high velocity:
   a. Push against the air
   b. Push against the earth
   c. Heat up the air which lifts the rocket
   d. React against the rocket and push it up

18. The SI unit of spring constant is:
   a. m/N
   b. N/m
   c. Nm
   d. It has no unit

19. The number of coordinates required to describe a collision in laboratory frame is:
   a. 3
   b. 4
   c. 5
   d. 6

20. Which one of the following is the work done by a conservative force along a closed path?
   a. Negative
   b. Positive
   c. Zero
   d. Cannot be determined

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(PART-B : Descriptive)

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

1. Derive the expression for gravitational potential and Field inside the solid sphere. What is the nature of potential and field at the centre of the solid sphere?   8+2=10

2. **a.** What are inertial and non-inertial frames of reference?   4+6=10
   b. Obtain Galilean transformation equations for inertial frames of references (include figures).

3. **a.** Write a short note on inertial and gravitational mass.   5+5=10
   b. Two bodies of mass M_1 and M_2 are placed distance d apart. Show that at the position where gravitational field due to them is zero, the potential is given by
   $$V = -\frac{G}{d}\left(M_1 + M_2 + \sqrt{M_1 M_2}\right)$$
   Where G= gravitational constant

4. **a.** Define center of mass. Obtain the expression for velocity of the center of mass of a system of particles.   2+3+5=10
   b. State the principle of conservation of linear momentum and support it with an example.

5. **a.** Show that the acceleration of a body of circular symmetry rolling down the inclined plane is given by   5+2+3=10
   $$a = \frac{R^2}{K^2 + R^2} g \sin\theta$$
   Where R=radius of the body, K= radius of gyration, g = acceleration due to gravity and θ = angle of inclination of rolling plane to the horizontal.
   b. What would be the value of 'a' for a cylindrical body?
   c. A solid cylinder (i) rolls, (ii) slides from rest down an inclined plane. Neglect friction and compare the velocities in both cases when the cylinder reaches the bottom of the incline.

6. **a.** What are Coriolis and centrifugal forces?   4+6=10
   b. Discuss some applications of Coriolis forces.

7. **a.** State and the principle of conservation of angular momentum.   1+6+3=10
   b. Using the concept of conservation of angular momentum and energy, explain the scattering of a positive particle by a massive nucleus.
   c. Derive the expression for Moment of Inertia of a rectangular lamina about an axis passing through its centre and parallel to one side.

8. **a.** What is a collision? Show that for a perfectly inelastic collision, there is a decrease of energy after collision.   1+4+1+4=10
   b. Is linear restoring force conservative in nature? Obtain an expression for potential energy for a body subjected to a linear restoring force.

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