

6. (a) Two points are moving with uniform velocities  $u$  and  $v$  along perpendicular lines  $OX$  and  $OY$ , the motion being towards  $O$ . If initially their distances from  $O$  are  $a$  and  $b$  respectively, show that the angular velocity of the line joining them is the greatest when the time  $t$  equals to

$$\frac{au + bv}{u^2 + v^2} \quad (9)$$

- (b) A motor car weighing 20 quintals and travelling at 15 m/s is brought to rest in 25 meters by the application of its brakes. Find the work done by the force of resistance (assumed uniform) offered by the brakes. (6)
7. (a) State principle of work and energy. Use this to solve the problem : A bullet fired with a velocity of 1600 m/s passes through three planks in succession. If it loses a velocity of 400 m/s in penetrating each plank, find the ratio of their thickness to which the resistance is supposed to be proportional. (9)
- (b) Derive the mathematical expression of differential equation of central orbit. (6)

May-2026

**B.Sc. Mathematics - 6th SEMESTER**

**Dynamics (BMH24-603/ MTU-306-V)**

Time : 3 Hours]

[Max. Marks : 75

*Instructions :*

1. It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.
2. Answer any four questions from Part-B in detail.
3. Different sub-parts of a question are to be attempted adjacent to each other.

**PART-A**

1. (a) The distance  $x$  meters travelled by a particle moving along a straight line in  $t$  seconds is given by the formula  $x = 2t^3 - 9t^2 + 12t + 6$ . Find velocity when the acceleration is zero. (1.5)
- (b) Prove that in rectilinear motion with uniform acceleration, the average velocity during an interval of time is the mean of the initial and final velocities. (1.5)
- (c) Define relative velocity. (1.5)
- (d) Define periodic motion. (1.5)
- (e) A body of mass 100 Kg is carried by a lift moving with an upward acceleration of  $1.2 \text{ m/s}^2$ . Find the magnitude of the push experienced by the body. (1.5)

- (f) Write the mathematical expression for acceleration along the radius vector of a particle moving along a plane curve. (1.5)
- (g) Define angular momentum. How it is related to real velocity? (1.5)
- (h) Define centripetal force. Also, write its mathematical expression. (1.5)
- (i) Define units of power in FPS and MKS systems. (1.5)
- (j) State Kepler's laws of planetary motion. (1.5)

### PART-B

2. (a) A body falls freely from the top of a tower and during the last second of its flight it falls  $\frac{16}{25}$  th of the whole distance. What is the height of the tower? (9)
- (b) A 150 Kg block is lowered from a window using a rope with a breaking strength of 120 Kg. What is the maximum time for which the block can remain on the rope, if the distance to be covered is 20 m? (6)
3. (a) A bus is beginning to move with an acceleration of  $\frac{1}{3} \text{ m/s}^2$ . A man who is  $\frac{40}{3}$  m behind the bus starts running at 3 m/s to catch the bus. After what time will the man be able to catch the bus? Explain the double answer. Find the time if the man were  $\frac{27}{2}$  m behind and show that the man would never catch the bus if he were more than  $\frac{27}{2}$  m behind. (9)

- (b) If the period of a S.H.M. is 10 seconds and the particle starts from a distance 5 m from the center of the path, find the maximum velocity, the time that has elapsed before it has described 2 m and the velocity it has acquired. (6)
4. (a) A particle of mass 0.2 Kg lies on a smooth table at a distance 9.8 m from the edge of the table. It is connected to a mass of 0.4 Kg by a light string which passes over a smooth pulley fixed at the edge of the table. The 0.4 Kg mass is hanging freely. If the system starts from rest, how long will it take the 0.2 Kg mass to reach the edge of the table? And what will be its velocity there? (9)
- (b) A mass  $m_1$  hanging vertically is connected to another mass  $m_2$  placed on a smooth inclined plane of inclination  $\alpha$  by means of a light inelastic string passing over a smooth pulley at the top of the plane. The system is released from rest, find the expression of tension in the string. (6)
5. (a) A shot is fired from a gun on the top of a cliff 90 m high with a velocity of 80 m/s at an elevation of  $30^\circ$ . Find the horizontal distance from the vertical line through gun and point, when the shot strikes the ground. (9)
- (b) Show that for a given velocity of projection, the maximum range down a plane of inclination  $\alpha$  is greater than up the plane and are in the ratio  
 $(1 + \sin \alpha) : (1 - \sin \alpha)$ . (6)