**7-SYSTEMS OF PARTICLES & ROTATIONAL MOTION**

**1.Centre of Mass**

1. For a system of N particles, the position vector of centre mass is  2. The position vector of the centre mass of a two particle system is  3. The Cartesian co-ordinates of the centre of mass are given by  

4. For a continuous mass distribution  where *dm* is the mass of small element located at position  Also    5. The algebraic sum of the moments of masses of various particles of a system about its centre of mass is zero. 6. Velocity of CM of a two particle system is 

**2. Equations of Rotational Motion**

For a body in rotational motion under constant angular acceleration, the equations of motion can be written as 1.  2.  3. 

**3. Torque, Power of a Torque, Work done by a Torque and Angular Momentum**

1. Torque = Force x its perpendicular distance . from the axis of rotation or τ = *Fd* 2. Torque, τ =  or  3. Power of a torque = Torque x Angular velocity or P = τω 4. Work done by a torque = Torque x Angular displacement or  5. Angular momentum = Linear momentum x its perpendicular distance from the axis of rotation or L = *pd* 6. Angular momentum, L = *rp sin* or  7. For a particle of mass *m* moving with uniform sped *v* along a circle of radius *r*, *L* = *mvr* 8. Torque = Rate of change of angular momentum or 

**4. Moment of Inertia, Radius of Gyration and Rotational K.E**

1. Moment of inertia of a body about the given axis of rotation  2. Radius of gyration *K* is given by *I = MK2 or *

When all the particles are of same mass,  3. Theorem of parallel axes:  4. Theorem of perpendicular axes,  5. M.I of a circular ring about an axes through its centre and perpendicular to its plane, *I= MR2* 6. M.I of a thin ring about any diameter, 7. M.I of thin ring about any tangent in its plane,  8. M.I. of a circular disc about an axis through its centre and perpendicular to its plane,  9. M.I. of a circular disc about any diameter  10. M.I. of a circular disc about a tangent in its plane,  11. M.I. of a thin rod about an axis through its middle point ad perpendicular to rod,  12. M.I. of a thin rod about an axis through its one end and perpendicular to rod,  13. M.I. of a rectangular lamina of sides *l* and *b* about an axis through its centre and perpendicular to its plane  14. M.I. of a right circular solid cylinder about its symmetry axis.  15. M.I. of a right circular hollow cylinder about its axis  16. M.I. of a solid sphere about an axis through its centre,  17. M.I. of a solid sphere about any tangent,  18. M.I. of a hollow sphere about an axis through its centre,  19. M.I. of a hollow sphere about any tangent  20. Rotational K.E.  21. Total K.E. = Rotational K.E. + Translational K.E. 

**5. Relations between Torque, Angular momentum and Moment of Inertia**

1. Torque = M.I. x angular acceleration or 2. Work done by a torque, W =  3. Angular momentum = M.I. x angular velocity or *L = Iω*

**6. Law of Conservation of Angular Momentum**

In the absence of any external torque, *L = I ω =* a constant or  or 

**7. Motion of a Cylinder Rolling without Slipping on an Inclined Plane**

For a cylinder of mass M and radius R rolling without slipping down plane inclined at angle  with the horizontal,

1. Force of friction between the plane and cylinder  2. Linear acceleration,  3. Condition for rolling without slipping is 