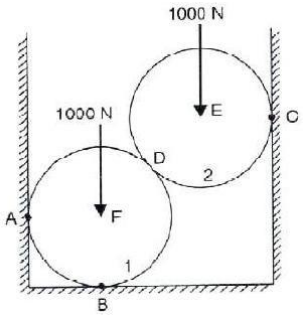
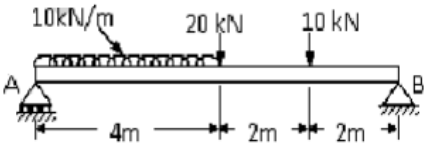
Unit-1: Introduction to Mechanics

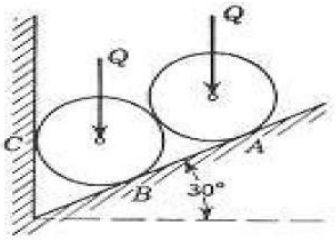
1. What is equilibrium? State the conditions for equilibrium of a rigid body in three dimensions.
2. State the converse of the law of triangle of forces.
3. State triangular law of forces. What is the use of this law?
4. State parallelogram law of forces.
5. Define free body diagram, transmissibility of a force and resultant of a force.
6. Define a Free Body Diagram. Give two examples with figures.
7. State and Prove Lami's theorem.
8. Write the equations of equilibrium for a system of Coplanar Concurrent Forces in terms of moments.
9. State and prove the Theorem of Varignon.
10. Explain the various systems of forces with suitable examples.
11. What are the laws to add two forces and several concurrent, coplanar forces? Explain in detail.
12. Distinguish clearly between resolution of forces and composition of forces.
13. Explain the following terms: i) Mass, ii) Continuum, iii) Rigid body, iv) Particle.
14. Two forces are acting on a body and the body is in equilibrium. What conditions should be fulfilled by these two forces?
15. If three concurrent forces are acting on a body which is in equilibrium, then prove that the resultant of the two forces should be equal and opposite of the third force.
16. Three forces of magnitude 150N, 300N and 500N are acting at the origin O (0, 0, 0) and are directed from the points A (3, 2, 4), B (3, -2, -4) and C (-1, -3, -4) respectively to the origin. Determine the magnitude of the resultant.
17. ABCD is a square, each side being 20 cm and E is the middle point of AB. Forces of 7, 8, 12, 5, 9 and 6 KN act on the lines of directions AB, EC, BC, BD, CA and DE respectively. Find the magnitude, direction and position of the resultant force.
18. The resultant of two concurrent forces is 1500 N and the angle between the forces is 90^0. The resultant makes an angle of 36^0 with one of the force. Find the magnitude of each force.
19. What do you understand by the term 'Couple'? Discuss the characteristics of a couple.
20. A force F = (10 i + 8 j – 5 k) N acts at point A (2, 5, 6) m. What is the moment of the force about the point B (3, 1, 4).
21. The forces P, Q, R and S act on a particle at O in the plane of the coordinate axis OX and OY making an angles p, q, r, s respectively with OX in the anti-clockwise direction. Determine the resultant and the angle it makes with OX when P = 3 KN, Q = 3 KN, R = 5 KN, S = 5 KN and p = 10°, q = 70°, r = 100°, s = 300° respectively.
22. Two spheres, each of weight 1000 N and radius 25 cm rest in a horizontal channel of width 90 cm as shown in the Figure. Find the reactions on the points of contact A, B and C.



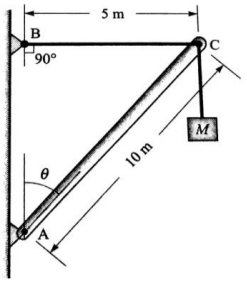
23. A beam AB is located supported and loaded as shown in the following figure. Find the reactions at the supports.



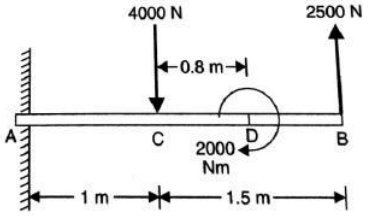
24. Two identical rollers, each of weight 100 N, are supported by an inclined plane and a vertical wall as shown in the following figure. Assuming smooth surfaces, find the reactions induced at the points of support A, B and C.



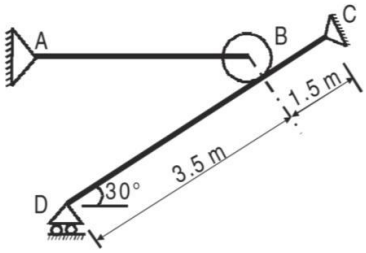
25. A 10 m boom supports a load of 600kg, as shown in the following figure. The cable BC is horizontal and 5m long. Determine the forces in the boom and the cable.



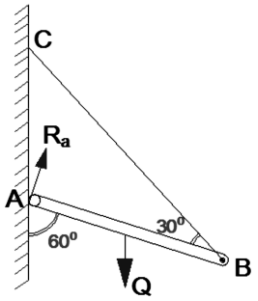
26. The following figure shows two vertical forces and a couple of moment 2000 N-m acting on a horizontal rod which is fixed at end A. Determine the resultant of the system.



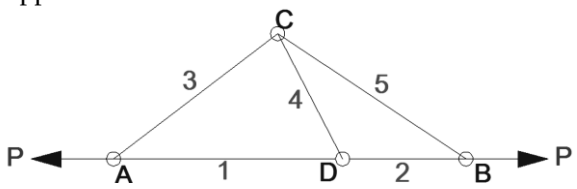
27. A 1000 N cylinder is supported by a horizontal rod AB and a smooth uniform rod CD which weighs 500 N as shown in the following figure. Assuming the pins at A, B, C and D, to be frictionless and weight of AB negligible, find the reactions at C and D.



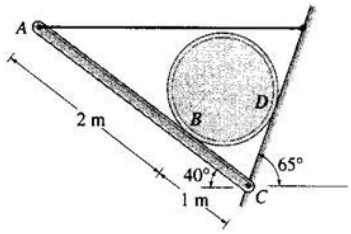
28. A prismatic bar AB of weight Q = 17.8 KN is hinged to a vertical wall at A and supported at B by a cable BC, as shown in the following figure. Determine the magnitude and direction of the reaction Ra at the hinge A and the tensile force *F* in the cable BC.



29. Determine the axial force induced in each bar of the system shown in the following figure due to the action of the applied forces *P*.

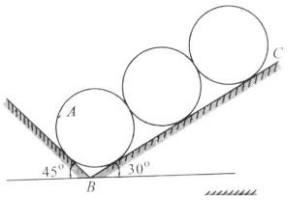


30. A bracket is constructed by attaching member ABC to wall CD with a frictionless hinge at C and a horizontal cable at A, as shown in the following Figure. A smooth cylinder of weight 1.2 KN is placed in the bracket as shown. Determine the force acting on the cylinder at contact points B and D and the tension in the cable and reactions at support C.

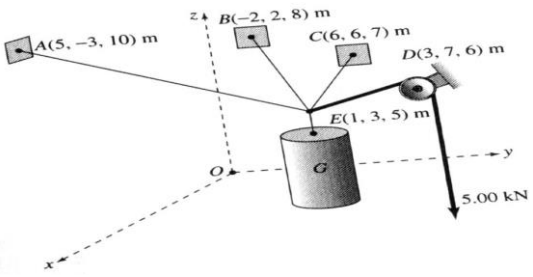


31. A machine component of length 2.5 meters and height 1 meter is carried upstairs by two men, who hold it by the front and back edges of its lower face. If the machine component is inclined at 30^0 to the horizontal and weighs 100 N, find how much of the weight each man supports?

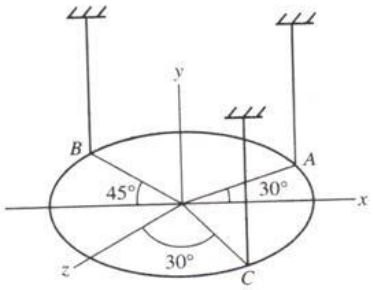
32. The following Figure shows several identical smooth rollers of weight W each stacked on an inclined plane. Determine a) the maximum number of rollers which will lie in a single row as shown and b) all forces acting on roller A maximum number of rollers stacked in one row.



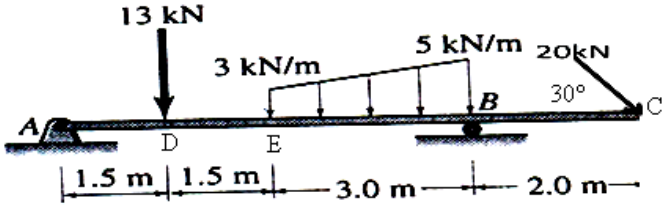
33. The system shown in the following figure consists of four cables EA, EB, EC and ED joined together at E. Cable ED passes over a small frictionless pulley at D and is used to apply the 5 KN force needed to place the container G in position shown. If the tension in cable EA is 4.5 KN, determine the mass 'm' of the container G.



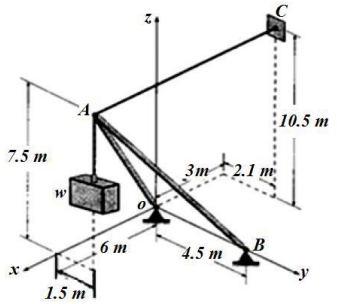
34. Refer to following figure. If the maximum allowable strength for each cable is 10.5 KN, determine the permissible weight of the homogeneous circular plate of diameter 4m.



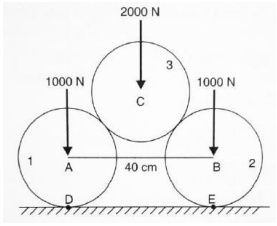
35. Find the reactions at supports A and B for the force system acting on the beam as shown in the following figure.



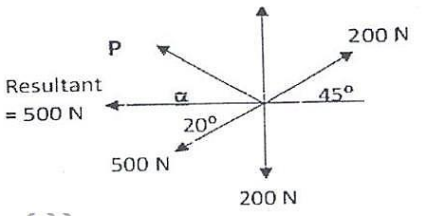
36. A crate of weight W = 1.5 KN is supported as shown in the following figure, by members AO and AB and cable AC. Determine the force in the cable AC and in members AO and AB.



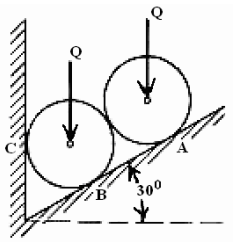
37. Two smooth circular cylinders, each of weight W = 1000 N and radius 15 cm, are connected at their centers by a string AB of length = 40 cm and rest upon a horizontal plane, supporting above them a third cylinder of weight = 2000 N and radius 15 cm as shown in the following figure. Find the force S in the string AB and the pressure produced on the floor at the points of contact D and E.



38. The four coplanar forces are acting at a point as shown in the figure below. One force is unknown (P). The resultant is 500 N and acting along X axis. Determine the unknown force (P) and its inclination (α) with X axis.

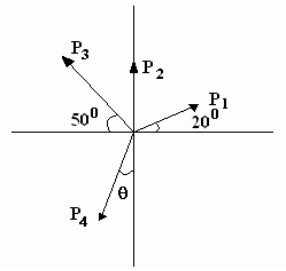


39. Two identical rollers, each of weight 100 N, are supported by an inclined plane and a vertical wall as shown in the following figure. Assuming smooth surfaces, find the reactions induced at the points of support A, B and C.

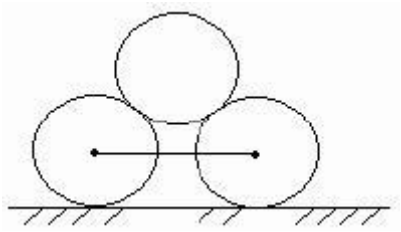


40. Five strings are tied at a point and are pulled in all directions, equally spaced, from one another. If the magnitude of the pulls on three consecutive strings is 70 N, 40 N and 55 N respectively, find graphically the magnitude of the pulls on two other strings, if the system is in equilibrium.

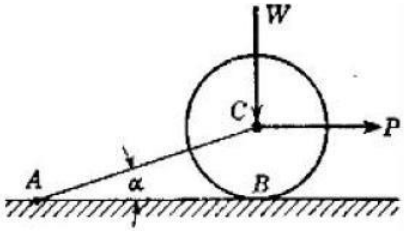
41. Knowing that the particle A shown in the following figure is in equilibrium under the action of forces P_1 = 350 N, P_2, P_3 = 225N and P_4 = 375N. Find the magnitudes of P_2 and direction θ of P_4.



42. Two smooth cylinders of 3 m diameter and weighs 100 N are separated by a chord of 4m long. They support another smooth cylinder of diameter 3 m and weighs 200 N as shown in the following figure. Find the tension in the chord.



43. A right circular roller of weight W rests on a smooth horizontal plane and is held in position by an inclined bar AC as shown in the figure. Find the tension S in the bar AC and the vertical reaction R_b at B if there is also a horizontal force P acting at C.

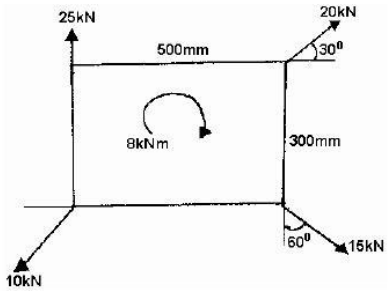


44. A system of forces consists of:
    I. Force P1 = 3i + 5j – 6k acting through point (2, 1, -3)
    II. Force P2 = 5i – 4j + 3k acting through point (1, 4, 2) and a moment M = 20i – 35j + 60k.

The forces are in Newton (N) units, distances in 'm' units and the moment in 'N-m' units. Calculate:

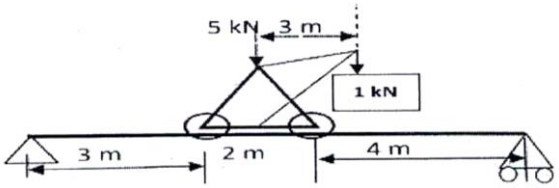
A. The component of the resultant forces and its magnitude
B. The total moment of the system about the origin 'O'.
C. The moment of the system about the line through 'O' drawn in the 1st octant which makes angles of 650 and 750 with X and Y axes respectively.

45. Determine the magnitude, direction and position of the resultant of the system of forces as shown in figure.



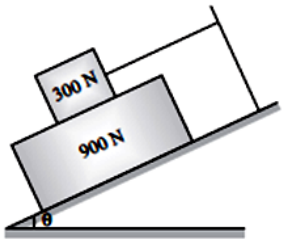
Unit-2: Friction, Centroid

1. Why static coefficient of friction is always greater than kinetic coefficient of friction?
2. State the Laws of friction.
3. Explain the types of friction with examples.
4. Explain (i) coefficient of friction; (ii) cone of friction.
5. Define angle of friction and angle of repose.
6. The force required to pull a body of weight 100 N on a rough horizontal plane is 30 N. Determine the coefficient friction if the force applied is at an angle of 15^0 with the horizontal.
7. Prove that the angle of friction is equal to the angle of the inclined plane, when a solid body of weight W placed on the inclined plane, is about to slide down.
8. A block weighing 100 N is resting on a rough plane inclined 20^0 to the horizontal. It is acted upon by a force of 50N directed upward at angle of 14^0 above the plane. Determine the friction. If the block is about to move up the plane, determine the co-efficient of friction.
9. A ladder 5m long and of 250 N weight is placed against a vertical wall in a position where its inclination to the vertical is 300. A man weighing 800 N climbs the ladder. At what position will he induce slipping? The co-efficient of friction for both the contact surfaces of the ladder viz. with the wall and the floor is 0.2.
10. A ladder 6 m long and weighs 300 N is resting against a wall at an angle of 60^0 to the ground. A man weighing 750 N climbs the ladder. At what position along the ladder from the bottom does he induce slipping? The coefficient of friction for both the wall and the ground with the ladder is 0.2.
11. A ladder 5 m long rests on a horizontal ground and leans against a smooth vertical wall at an angle of 70^0 with the horizontal. The weight of the ladder is 300 N. The ladder is on the verge of sliding when a man weighing 750 N stands on a rung 1.5 m along the ladder. Calculate the coefficient of friction between the ladder and the floor.
12. A ladder 12 m length and weighs 500 N is resting against a smooth wall. Find the coefficient of friction between floor and ladder if ladder starts slipping when the angle between ladder and floor is $\leq 50°$. Find the reactions at support for the following beam.



13. A mine cage weighs 12 KN and can carry a maximum load of 20 KN. The average frictional resistance of the side guides is 500 N. What constant cable tension is required to give a loaded cage an upward velocity of 3 m/s from rest in a distance of 3 m?

14. What should be the value of θ in following figure which will make the motion of 900 N blocks down the plane to impend? The coefficient of friction for all contact surfaces is 0.3.

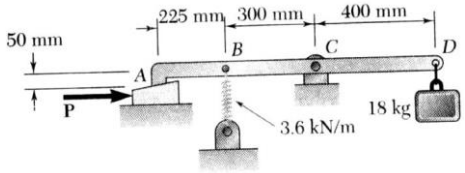


15. What is a wedge? State its uses and the method of solving the problems on wedge friction.

16. What is a Wedge? Deduce an expression for its efficiency.

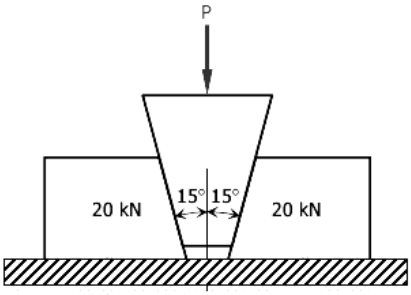
17. What is a wedge? Explain how a wedge is used to raise heavy loads.

18. A 18 Kg mass is hung from a lever which rests against a 100 wedge at A and is supported by a frictionless hinge at C. Knowing that the coefficient of static friction is 0.25 at both surfaces of the wedge and that for the position shown in the following figure the spring is stretched 100 mm, determine a) the magnitude of the force P for which motion of the wedge is impending, b) the components of the corresponding reaction at C.

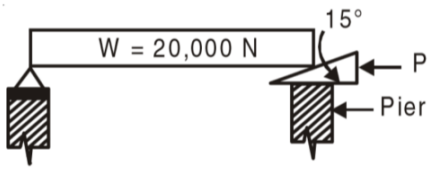


19. A force of 500 N is acting on a block of mass 50 Kg resting on a horizontal surface. Determine its velocity after the block has travelled a distance of 10m. Coefficient of kinetic friction is 0.5.

20. As shown in the following figure, two blocks each weighing 20 KN and resting on a horizontal surface, are to be pushed apart by a 300 wedge. The angle of friction is 150 for all contact surfaces. What value of P is required to start movement of the blocks?



21. The level of precast beam weighing 20,000 N is to be adjusted by driving a wedge as shown in the following figure. If coefficient of friction between the wedge and pier is 0.35 and that between beam and the wedge is 0.25, determine the minimum force P required on the wedge to make adjustment of the beam. Angle of the wedge is 15^0.

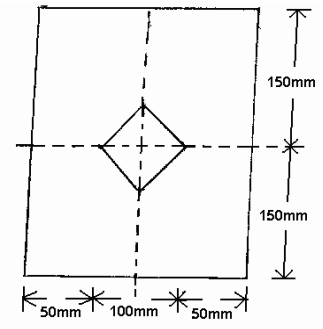


22. A square threaded screw jack has a pitch of 1 cm and a mean diameter of 7.5 cm. The mean diameter of the bearing surface between the cap and the screw is 9 cm. The coefficient of friction between all surfaces is 0.10. What force is required at the end of a lever 90 cm long to raise a load of 40 KN?

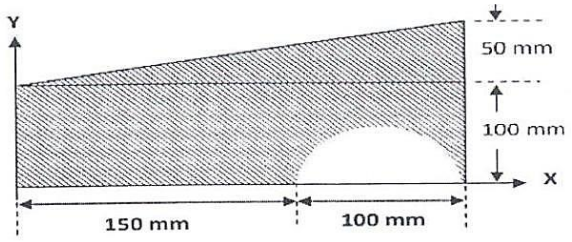
23. A square thread screw of a hand press has a mean diameter of 40 mm and pitch 5 mm. The diameter of the wheel turning the screw is 1.2 m. If a horizontal effort of 200 N is applied to the wheel, find the force exerted by the press on a cotton bale being compressed. Coefficient of friction is 0.1. Is the press self-locking?
24. Explain the principles of operation of a screw-jack with a neat sketch.
25. What is a self-locking screw jack?
26. A screw jack has square threads of mean diameter 6 cm, of helix angle 100 and coefficient of friction 0.25. Determine the force that must be applied to the end of 50 cm lever to i) rise ii) lower a weight of 2500 N.
27. A Screw Jack has square threads of mean diameter of 10 cm and a pitch of 1.25 cm. Determine the force that must be applied to the end of 50 cm lever to raise a weight 50 KN and the efficiency of the jack.
28. In a screw-jack, where the helix angle of thread is $\boldsymbol{\alpha}$ and the angle of friction is $\boldsymbol{\varphi}$, *W* is the load to be moved up / down, and ***P*** is the effort applied horizontally to a lever at a distance **L** from the axis of the screw, discuss the effects of moving the load (a) up and (b) down, if (i) $\boldsymbol{\varphi} < \boldsymbol{\alpha}$, and (ii) $\boldsymbol{\varphi} > \boldsymbol{\alpha}$ in each case.
29. Outside diameter of a square threaded spindle of a screw Jack is 40 mm. The screw pitch is 10 mm. If the coefficient of friction between the screw and the nut is 0.15, neglecting friction between the nut and collar, determine

a) Force required to be applied at the screw to raise a load of 2000 N
b) The efficiency of screw jack.
c) Force required to be applied at pitch radius to lower the same load of 2000 N and
d) Efficiency while lowering the load.
e) What should be the pitch for the maximum efficiency of the screw? and
f) What should be the value of the maximum efficiency?

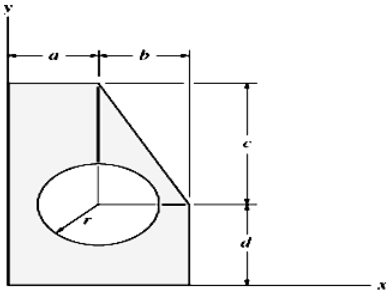
30. Find the centroidal coordinates of rectangular area of width w and depth d.
31. Differentiate between centroid and center of gravity.
32. Locate the centroid of the plane area shown in the following figure.



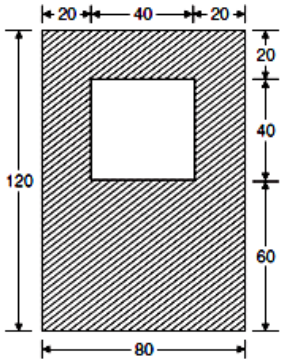
33. Compare the location of the centroids of an arc of a circle and a sector of a circle subtending the same angle at the centre of the circle.
34. Determine the moment of inertia of an area of semi-circle of radius 2.5 cm about the centroidal x and y axes.
35. Determine the centroid of the shaded area of above lamina.



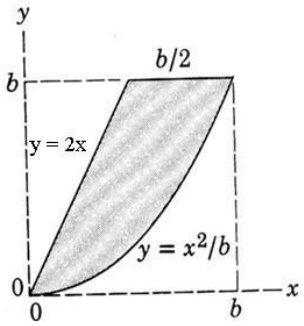
36. Find the centroidal coordinates of the area of the plane as shown in the following figure. Given a = 30 cm, b = 30 cm, c = 60 cm, d = 40 cm, and r = 20 cm.



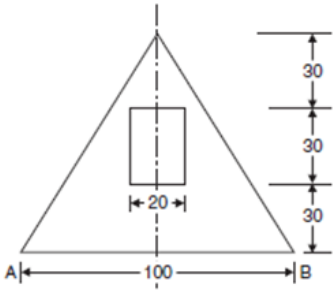
37. From a circular area of diameter 2d, a smaller circle of diameter d is removed. The centre of the smaller circle is at a distance of d/2 from that of the larger circle. Find the centroid of the remaining area.
38. What should be the length to radius ratio, i.e. *l*/*r* of a solid cylinder such that the moments of inertia about its longitudinal and transverse axes are equal?
39. For the shaded area as shown in the following figure, determine the Moment of Inertia of an area of plane figure about their centroidal axes. All units are in centimeters.



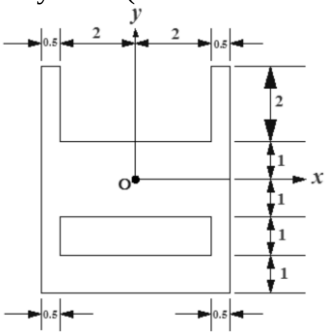
40. Determine the centroid of a hemisphere of radius ***R***.
41. Explain the terms moment of inertia and radius of gyration of a plane figure.
42. Determine the centroidal coordinates of shade area with respect to x and y axes as shown in the following figure.



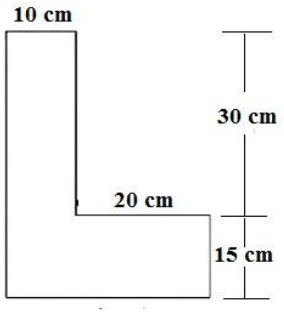
43. Determine the moment of inertia an area of a triangle with a rectangular cut as shown in the following figure, about the base *A-B* and the centroidal axis parallel to *AB*. (All dimensions are in Centimeters).



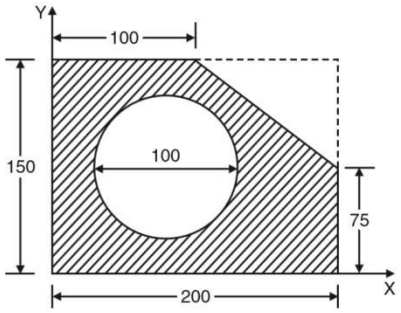
44. Determine the moments of inertia and the radius of gyration of the area, shown in the following figure, with respect to the x and y axes. (All dimensions are in mm).



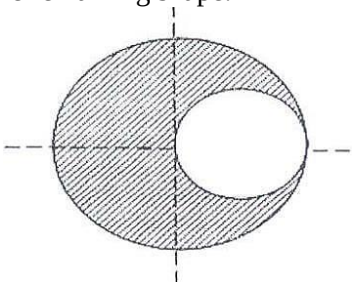
45. Find the centroid of the plane lamina shown in the following figure.



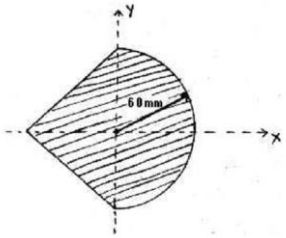
46. Determine the coordinates X_c and Y_c of the centre of a 100 mm diameter circular hole cut in a thin plate so that this point will be the centroid of the remaining shaded area shown in the following figure. All dimensions are in mm.



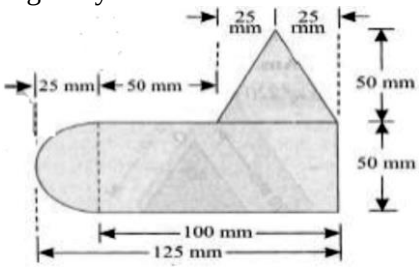
47. A circle is cut from a circle of diameter 450 mm as shown in the figure below. Calculate the polar moment of inertia of the remaining shape.



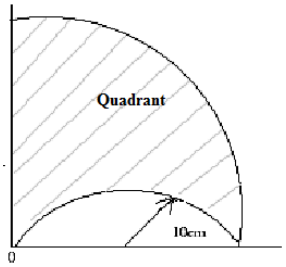
48. Locate the centroid of a shaded area as shown in the following figure:



49. Uniform lamina shown in the following figure consists of rectangle, a semi-circle and a triangle. Find the center of gravity.

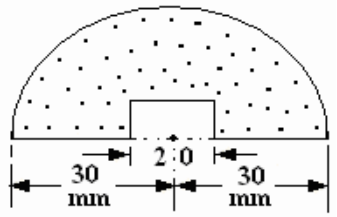


50. Locate the centroid of the shaded area as shown in the Figure 4(a).

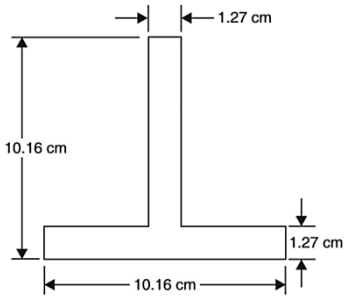


Unit-3: Centre of Gravity, Area Moment of inertia

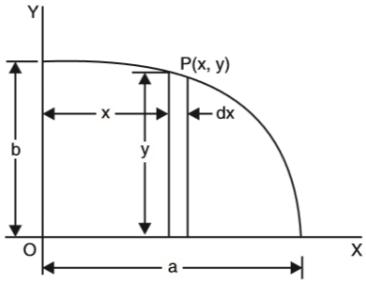
1. What is the importance of center of gravity?
2. State parallel axis theorem as applied to mass moment of inertia.
3. State and prove parallel axis theorem.
4. State perpendicular axis theorem.
5. State and prove Pappu's theorems of area and volume.
6. Differentiate between area moment of inertia and mass moment of inertia.
7. Determine the moment of inertia of a hollow sphere of radii R1 and R2, and determine the radius of gyration of a solid sphere.
8. Find the moment of inertia about the horizontal centroidal axis of shaded portion as shown in the following figure:



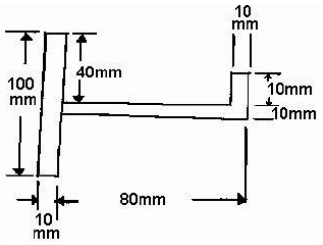
9. State and prove theorem of Pappu's.
10. State and prove the equation for polar moment of inertia.
11. What is Radius of gyration? Explain.
12. Determine the moment of inertia of a T-section shown in the figure about an axis passing through the centre of the section and perpendicular to the stem or vertical leg.



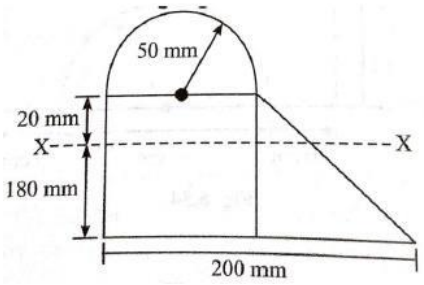
13. An isosceles triangle section ABC has a base of 100 mm and 60 mm height. Determine the moment of inertia of triangle about the centroid and about base.
14. What is transfer theorem? Explain.
15. Derive the Moment of Inertia of a quarter circle of radius 'r' about the base and the centroidal axes.
16. Find the position of the centre of gravity of the plane lamina in the form of a quarter of an ellipse, shown in the following figure.



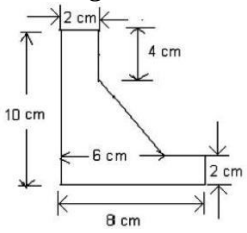
17. Compute the moment of inertia of the plane area shown in figure about its horizontal centroidal axis.



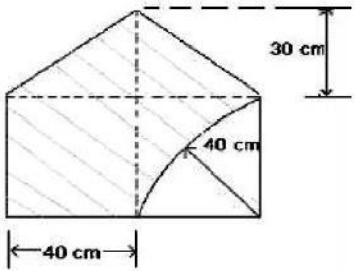
18. Find the moment of inertia of the following figure about the given XX axes.



19. Find the centroid of the area shown in figure.

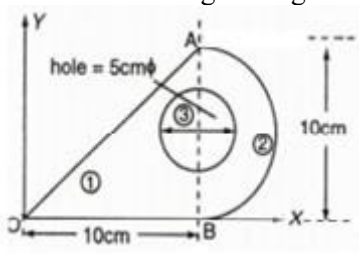


20. Find the moment of inertia of shaded area shown in the following figure, below about centroidal axes.

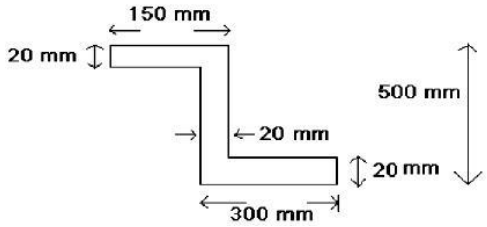


Unit-4: Mass Moment of Inertia, Kinetics of Rigid bodies

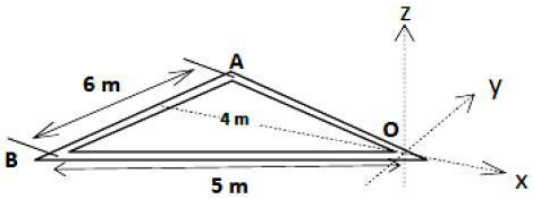
1. Find out the mass moment of inertia of a right circular cone of base radius R and mass M about the axis of the cone.
2. Find the mass moment of inertia of a solid cylinder of radius r, height h and mass m about centroidal x and y axes
3. Find the moment of inertia of the area in the given figure about the axis 'AB'



4. Find the centroid of the Z section shown in the following figure.



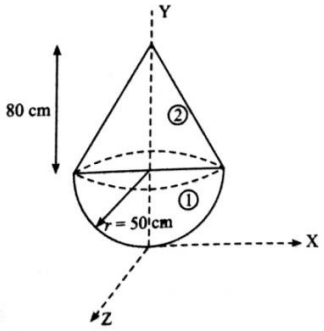
5. State work-energy theorem for a system of particles.
6. Write the equations of translation.
7. Deduce an equation for moment of inertia of right circular solid cone about its generating axes of base radius 'R' and altitude 'h'.
8. A uniform steel rod is bent into the shape of an isosceles triangle (OA = OB). Determine the mass moment of inertia about an axis through O perpendicular to the plane of the figure. The total mass of the rod is 12 Kg.



9. State D'Alembert principle giving equations.
10. Define "Work", "Power", and "Energy".
11. Define mass moment of inertia and explain the transfer formula for mass moment of inertia.
12. What are the parameters that define rectilinear motion? State the relationship between these parameters.
13. Determine the work done by an electric motor in winding up a uniform cable which hangs from a hoisting drum if its free length is 20 m and weighs 800 N. The drum is rotated by the motor.
14. Define motion. Write different types of motion.
15. Define the term radius of gyration. Write the units.
16. What is fixed axis rotation? Explain.
17. Explain work-energy method for a plane motion.
18. A body weighing 70 KN rests in equilibrium on a rough plane whose slope is 30^0. The plane is raised to a slope of 45^0. What is the force applied to the body parallel to the plane that will support the body on the plane?

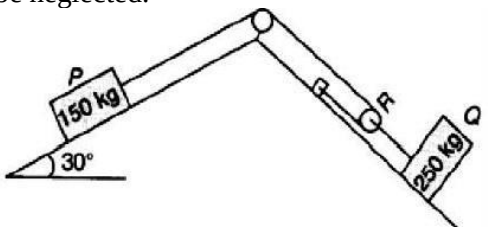
19. The weight of a body on earth is 980N. If the acceleration due to gravity on earth is 9.80 m/s^2, what will be the weight of the body on
    a. The moon, where gravitational acceleration is 1.6m/s2 and
    b. The sun, where gravitational acceleration is 270 m/s2.

20. Write Impulse-Momentum equation
21. State the law of conservation of momentum.
22. State and prove parallel axis theorem.
23. Write the impulse-momentum equation and mention its application.
24. Write the differential equation of motion of rectilinear motion, and explain it.
25. What do you mean by instantaneous centre of rotation?
26. Determine the centre of gravity of the following figure:



27. A pulley weighs 500 N and has a radius of 0.75 m. A block weighing 400 N is supported by an inextensible wire wound round the pulley. Determine the velocity of the block 2 seconds after it is released from rest. Assume the motion is under constant acceleration.
28. A car enters a curved portion of the road of radius 200 m traveling at a constant speed of 20 m/s. Determine the components of velocity and acceleration of the car in the x and y direction 10 seconds after it has entered the curved portion of the road.
29. Two blocks shown in Figure below are originally at rest. Determine:
    (i) The acceleration of each block.
    (ii) Tension in cables.

    Assume the effect of friction in the pulleys, between the blocks and inclines as negligible. Mass of the pulley can also be neglected.



30. Define work energy principle. Also derive the equation for work energy.
31. A man of weight 70 Kg standing at the end of a small boat of weight 35 Kg fires a bullet of mass 25 gm to hit a wooden block of weight 2.25 gm resting on the shore. If the bullet embedded block starts moving 5 m/s, determine the velocity of the boat.
32. A 2000 Kg Automobile is driven down a 5^0 incline at a speed of 90 kmph. When the brakes are applied causing a constant total braking force of 7.5 KN. Determine the distance traveled by Automobile as it comes to stop. Use work-energy method.
33. A flywheel of an engine has a mass of 605 tonnes and radius of gyration 1.8 meters. If the maximum and minimum speeds of the flywheel are 120 rpm and 118 rpm respectively, find the fluctuation of energy.
34. Find the work done in drawing a body weighing 1000 N through a distance 10 m along a horizontal surface by a horizontal force of 400 N.

35. Explain briefly about the Kinematics of Rotational Motion around a Fixed Axis.
36. State the Principle of Conservation of Momentum.

37. Find the mass moment of inertia of a solid sphere of radius r and mass m about any axis. An elevator gross weight 15 KN is moving in the upward direction, such that the displacement is given by $x = t^3 - 4t^2 + 6t + 7$m. Determine the tension in the cable supporting the elevator at t = 2 seconds.

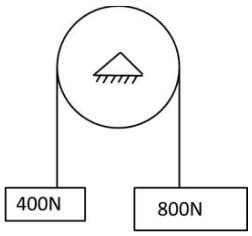
38. A car starts from rest on a curved road of 250 m radius and accelerates at a constant tangential acceleration of 0.6 m/sec^2. Determine the distance and time for which that car travel before the magnitude of total acceleration attained it becomes 0.75 m/sec^2.

39. A body of mass 10 Kg is suspended by a string of length 1 m. It is struck by a bullet travelling horizontally with a velocity of 450 m/sec. The bullet weights 30 gms and gets embedded into the body after striking it. Determine the maximum angle through which the body swings.

40. The initial angular velocity of a rotating body is 2 rad/s and initial angular acceleration is zero. The rotation of the body is according to the relation $\alpha = 3t^2 - 3$. Find: a) Angular velocity and b) Angular displacement when t = 5 seconds. Consider the angular displacement in radians and time in seconds.

41. Show that the moment of inertia of a thin circular ring of mass "M" and mean radius with respect to its geometric axis is MR^2.

42. The pulley shown in the following figure weighs 600 N and has a radius of 0.8 m. A rope passing over this pulley supports 800 N load at one end and 400 N at another end. Determine the tension in the string and the angular acceleration of the pulley if the blocks are allowed to move.

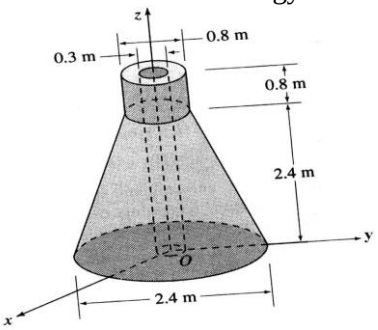


43. A train starts from rest and moves along a curved track of radius 800 m with uniform acceleration until it attains a velocity of 72 kmph at the end of 3 minute. Determine the tangential, normal and total acceleration in m/s^2 of the train at the end of second minute.

44. Determine the moment of inertia of the composite mass shown in the following figure with respect to the Y-axis. What is the radius of gyration with respect this axis? The material has a mass density $\rho = 500$ Kg/m^3.

45. A police officer in a patrol car parked in a 100 kmph zone observes a passing automobile travelling at a slow, constant speed. Believing that the driver of the automobile might be intoxicated, the officer starts his car, accelerates uniformly to 140 kmph in 8 sec, and maintaining a constant velocity of 140 km/hr, overtakes the motorist 42 sec after the automobile passed him. Knowing that 18 sec elapsed before the officer began pursuing the motorist, Determine
    a. The distance the officer travelled before overtaking the motorist
    b. The motorist's speed.

46. A train weighing 400000 KN is running up an inclined plane 1 in 100 at uniform speed of 54 kmph. If the total resistance to motion is 0.5% of its weight, find the power exerted by the steam engine. If the steam is cut-off while the train is ascending the gradient, how far the train will go up the plane, before coming to rest, assuming the frictional resistance to remain constant during the travel.
47. A bullet of mass 100 gm is fired in to a freely suspended target of mass 10 Kg. Due to impact, the bullet gets embedded in the target and the target with bullet moves with a velocity of 7 m/sec. Calculate the velocity of bullet and loss of kinetic energy.

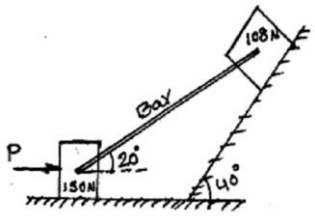


48. The position of a particle which moves along a straight line is defined by $x = t^3 - 6t^2 - 15t + 40$. x is in meters, t is in seconds. Determine the distance travelled by the particle from t = 4 sec and t = 6 sec.
49. A particle starts from rest and moves along a straight line with constant acceleration $\boldsymbol{a}$. If it acquires a velocity $\boldsymbol{v}$ = 3 m/s after having travelled a distance of $\boldsymbol{s}$ = 7.5 m, find the magnitude of the acceleration.
50. Write the equations of plane motion of a rigid body. What are the different types of rigid body motion? Explain.
51. The driver of an automobile moving with a constant speed V_0 = 64 kmph along a straight level road steps on the accelerator so as to increase the power by 20 percent. How far will the car travel before attaining a speed of 80 kmph? Assume that the resistance to motion remains constant and equal to 5% of the weight of the car.
52. A 20 Kg block starting from rest slides up a 300 inclined plane under the action of a 175 N force directed along the inclined plane. The coefficient of kinetic friction between the block and the plane is 0.2. Determine the (i) speed of the block after it slides 4.5 m and (ii) the distance travelled by the block when its speed becomes 4.5 m/s.
53. A cross belt drive is to transmit 7.5 KW at 1000 rpm of the smaller pulley. The diameter of the smallest pulley is 250 mm and velocity ratio is 2. The centre distance between the pulleys is 1250mm. A flat belt of thickness 6 mm and of coefficient friction 0.3 is used over the pulleys. Determine the necessary width of the belt if the maximum allowable stress in the belt is 1.75N/mm2 and density of the belt is 1000 Kg/m3.
54. A body weighing 20N is projected up a 200 inclined plane with a velocity of 12 m/s, coefficient of friction is 0.15. Find:
    a. The maximum distance S that the body will move up the inclined plane.
    b. Velocity of the body when it returns to its original position.
55. A 6 kg block slides on a rough surface and come to rest. The deceleration is constant, initial velocity = 0.8 m/s. Distance travelled before coming to rest = 2.5m.
    a. Determine the value of friction coefficient.
    b. An additional 2.5 kg block is fixed to the top of the 6 kg block.

    Assuming same initial velocity, find the distance travelled by the system before coming to rest.

56. A car travelling at a speed of v = 60 kmph is braked and comes to rest in 8sec after the brakes are applied. Find the minimum coefficient of friction between the wheels and the road.

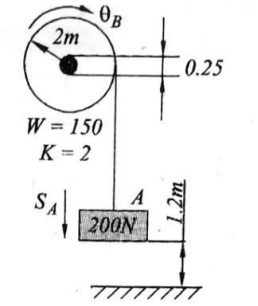
57. A 108 N block is held on a 40^0 incline by a bar attached to a 150 N block on a horizontal plane shown in Figure. The bar which is fastened by smooth pins at each end is inclined 20^0 to the horizontal. The coefficient of friction between each block and its plane is 0.325. For what horizontal force P, applied to 150 N block will motion to the right be impending?



58. Define Impulse and Momentum, and derive their expressions from the differential equation of rectilinear motion of a particle.

59. A shaft running at 200 rpm is to drive a parallel shaft at 300 rpm. The pulley on the driving shaft is 60 cm diameter. Calculate the diameter of the pulley on the driven shaft by taking belt thickness into account, which is 5 mm thick.

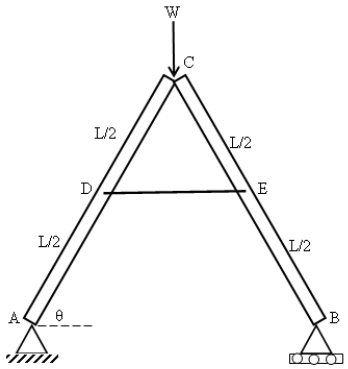
60. A solid circular cylinder and a sphere are started from rest from the top of an inclined plane at the same time, and both roll without sliding down the plane. When the sphere reaches the bottom of the incline, if the cylinder is 3.6 m behind it, what is the total length of the inclined plane?
61. A train weighing 10,000 KN is being pulled up a 2 % grade. The train resistance is constant at constant rate from 6 mps to 12 mps in a distance of 300 m. Determine the pull exerted by the locomotive.
62. A pulley of radius 2 m, weighing 150 N is mounted over an axle of diameter 0.25 m. The friction between pulley and axle is constant at 50 N. It supports of a block A of weight 200 N and start from rest from the position shown in the following figure. How many turns the pulley make before it stops, if block A dropped from a height of 1.2 m.



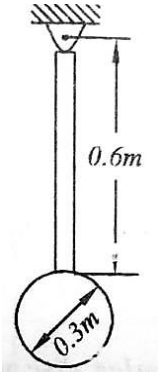
63. What is curvilinear motion, give an example?
64. What is fixed axis rotation?
65. A belt 100 mm wide and 8mm thick is transmitting power at a belt speed of 1600 m/minute. The angle of lap of the smaller pulley is 165^0 and coefficient of friction is 0.3. The maximum permissible stress in the belt is 2 N/mm^2 and the mass of the belt is 0.9 Kg/m. Find the power transmitted and the initial tension in the belt. Also find the maximum power that can be transmitted and the corresponding belt speed.

Unit-5: Mechanical Vibration, Virtual Work

1. Mention the forces which are generally omitted while applying the principle of virtual work.
2. A body moving with simple harmonic motion has amplitude of 1 m and a period of oscillation of 2 seconds. What will be its velocity and acceleration 0.4 seconds after passing an extreme position?
3. Distinguish between Simple and Compound Pendulums.
4. A 5 Kg mass drops 2 m upon a spring whose modulus is 10 N/mm. What will be the speed of the block when the spring is deformed 100mm?
5. Derive an expression for tension in the cable in terms of θ and W. Use method of virtual work.



6. A 2 HP motor of weight 18.5 Kg is mounted symmetrically on four identical springs each of stiffness 200 gm/mm. Determine the frequency and the time period of vibration of the motor.
7. A mass of 10 Kg is attached to a hanging spring of spring constant 750 gm/mm. Derive the expressions for displacement and maximum velocity when a) the mass starts vibrating by displacing it 0.10 m below its equilibrium position and b) the mass vibrates with initial velocity of 3.5 m/s.
8. The compound pendulum in the following figure consist of a slender rod 0.6 m long weighing 30 N to which is attached a solid circular disc of 0.3 m diameter that weighs 40 N. Compute the period of small oscillations.



9. A weight of 50 N suspended from a spring vibrating vertically with amplitude of 7.5 cm and a frequency of 1 oscillation/sec. Find: (i) the stiffness of the spring (ii) the maximum tension induced in the spring (iii) the maximum velocity of the weight.