GOVERNMENT POLYTECHNIC, BHUBANESWAR

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ENGINEERING MECHANICS

QUESTION BANK

PREPARED BY

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2 MARK QUESTIONS

CHAPTER-1

1. Define : (i) Force
   (ii) Scalar quantity
   (iii) Vector quantity
   (iv) Fundamental units & Derived Units
   (v) Resolution of force
   (vi) Composition of force
   (vii) Moment of force
   (viii) State the characteristics of a couple

2. Define : (i) Collinear force system
   (ii) Concurrent force system
   (iii) parallel force system
   (iv) Coplanar force system
   (v) Non-coplanar force system
   (vi) Non-concurrent force system

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3. Explain following :
   (i) Principle of superposition of force
   (ii) Principle Of transmissibility of force
   (iii) Varignon's principle
   (iv) Law of parallelogram of force
   (v) Law of triangle of force
   (vi) Law of polygon of force.

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4. Distinguish between Moment and Couple ?

CHAPTER-2

1. State Lami's Theorem ?
2. Explain Free body diagram ?
3. Distinguish between equilibrium force & equilibrant force ?
4. Explain different types of supports & beam with neat sketch ?
5. Explain different types of beam and different types of load on beam?

CHAPTER-3

1. Define the following terms:
   a. Friction
   b. Angle of friction
   c. Limiting friction

d. Dynamic friction

e. Coefficient of friction

f. Angle of repose

g. Static friction

2. Derived that the angle of repose is equal to the angle of friction ?

CHAPTER-4

1. Differentiate between centroid and centre of gravity ?
2. State the theorem of perpendicular axis ?
3. State the parallel axis theorem ?
4. Define the moment of inertia of a plane area ?

CHAPTER-5

1. Define the following :
   a) Mechanical advantage
   b) Velocity ratio
   c) Input
   d) Output
   e) Reversible machine
   f) Non-reversible machine
   g) Maximum MA
   h) Maximum efficiency
   i) Ideal machine

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2. Explain law of machine.
3. Explain : Self-locking machine .
4. What is a machine ? Explain the difference between a simple machine and a compound machine.
5. Derive the relation between mechanical advantage, velocity ratio and efficiency of a machine.
6. Define coefficient of restitution ?
7. Define momentum and impulse ?
8. State Newton's 1^{st}, ,2^{nd} and 3^{rd} law of motion ?

6/10 MARK QUESTIONS

CHAPTER-1

1. Two forces act at an angle of 120°. The bigger force is of 40 N and the resultant is perpendicular to the smaller one. Find the smaller force.

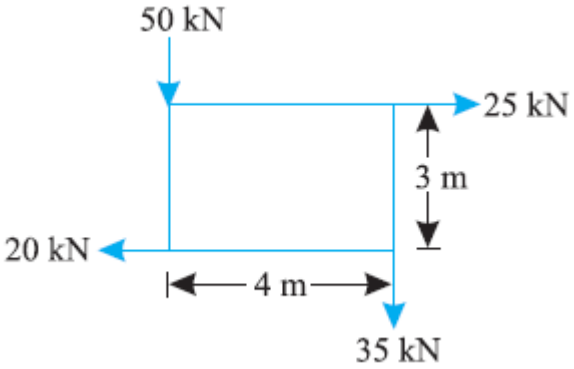
2. Find the magnitude of the two forces, such that if they act at right angles, their resultant is 10 N . But if they Act at 60°, their resultant is 13 N .

3. The following forces act at a point (i) 20N inclined at 300 towards North to East. (ii) 25N towards North (iii) 30N towards North west, and (iv) 35N inclined at 400 towards south of west. Find the magnitude and direction of the resultant force.

4. State and proof Parallelogram Law of Force.

5. A triangle ABC has its side AB = 40 mm along positive x-axis and side BC = 30 mm along positive y-axis. Three forces of 40 N, 50 N and 30 N act along the sides AB, BC and CA respectively. Determine magnitude of the resultant of such a system of forces.

6. A system of forces are acting at the corners of a rectangular block as shown in Fig. Determine the magnitude and direction of the resultant force.



7. Two equal forces of magnitude P are acting on a particle. (i) Find the angle between these two forces when their resultant is 1.5P. (ii) What can be maximum value of R and when it occurs?

8. Two forces equal to P and 2P respectively act on a particle. When the first force is increased by 120 Newton and the second force is doubled, the direction of resultant force remains the same in both cases. Determine the value of force P.

9. Find the magnitude and direction of the resultant of concurrent forces of 8N,10N,12N and 14N making angles of 300 ,600 ,1200 , and 1450 respectively with positive direction of X axis.

10. Four Forces of magnitude 10 N, 20 N, 30 N & 40 N are acting on a square of side ‘a’along four sides AB, BC, CD, DA respectively. Find resultant force & locate point of application with Point A of square.

11. List the systems of force & explain each one with drawing ?

12. Two like parallel forces of 50 N and 100 N act at the ends of a rod 360 mm long. Find the magnitude of the resultant force and the point where it acts.

13. Two unlike parallel forces of magnitude 400 N and 100 N are acting in such a way that their lines of action are 150 mm apart. Determine the magnitude of the resultant force and the point at which it acts.

14. Find magnitude and direction of the resultant of following forces are acting at a point. (i) 10 N along + Y axis (ii) 20 N at 210º with + X axis (iii) 30 N at 315º with + X axis.

15. Two unequal forces inclined to one another at an angle of 120º have resultant of 86.6 N, which makes an angle of 30° with one of the forces Find the magnitude of two forces.

16. Two forces are acting at an angle of 100°. One force is 60N and the resultant makes 60° with that. Calculate the other force?

17. Find the angle between the two equal forces acting on a body such that the square of their resultant is equal to the three times of their product.

18. If the two forces act along the same line the resultant is 12N. If they act at right angles, their resultant is (72) N Find the two forces ?

19. The resultant of two equal forces acting at a point with an angle 60º between them is 17.32 N. Find the magnitude of each force.

20. The resultant of the two forces is 232 N. The angle between the two forces in 45°. Find the forces if the F_2 is 1.5 times of F_1

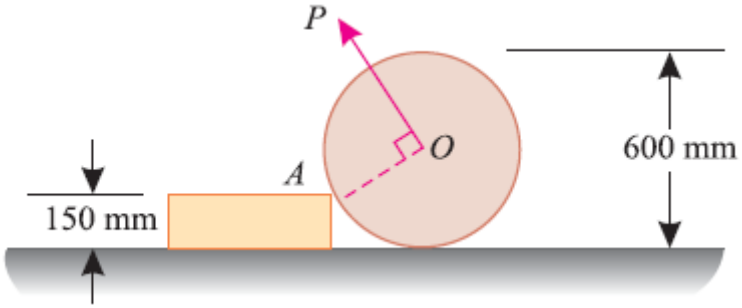
21. The forces 20 N, 30 N, 40 N, 50 N and 60 N are acting at one of the angular points of a regular hexagon, towards the other five angular points, taken in order. Find the magnitude and direction of the resultant force.

22. A horizontal line PQRS is 12 m long, where PQ = QR = RS = 4 m. Forces of 1000 N, 1500 N, 1000 N and 500 N act at P, Q, R and S respectively with downward direction. The lines of action of these forces make angles of 90°, 60°, 45° and 30° respectively with PS. Find the magnitude, direction and position of the resultant force.

23. Three forces of 2P, 3P and 4P act along the three sides of an equilateral triangle of side 100 mm taken in order. Find the magnitude and position of the resultant force.

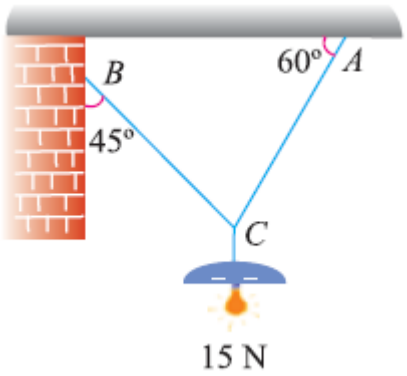
24. Four forces equal to P, 2P, 3P and 4P are respectively acting along the four sides of square ABCD taken in order. Find the magnitude, direction and position of the resultant force.

25. A uniform wheel of 600 mm diameter, weighing 5 kN rests against a rigid rectangular block of 150 mm height as shown in Fig. Find the least pull, through the centre of the wheel, required just to turn the wheel over the corner A of the block. Also find the reaction on the block. Take all the surfaces to be smooth.

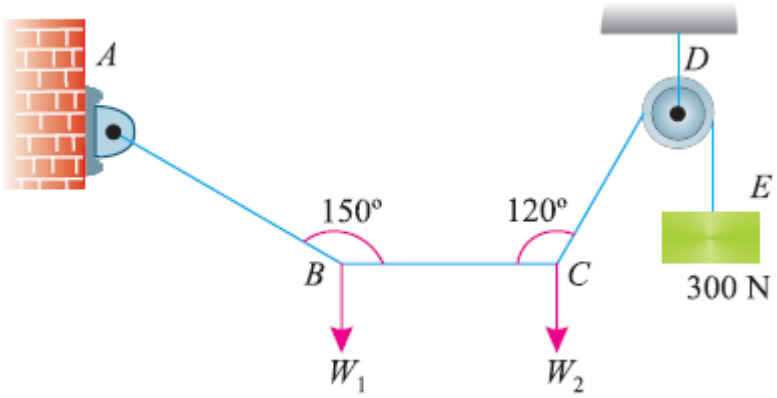


CHAPTER-2

1. An electric light fixture weighting 15 N hangs from a point C, by two strings AC and BC. The string AC is inclined at 60° to the horizontal and BC at 45° to the horizontal as shown in Using Lami's theorem, or otherwise, determine the forces in the strings AC and BC.



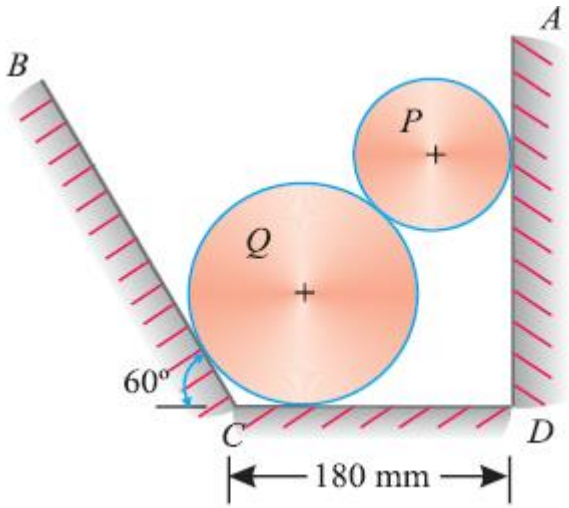
2. A light string ABCDE whose extremity A is fixed, has weights W1 and W2 attached to it at B and C. It passes round a small smooth peg at D carrying a weight of 300 N at the free end E as shown in Fig. If in the equilibrium position, BC is horizontal and AB and CD make 150° and 120° with BC, find (i) Tensions in the portion AB, BC and CD of the string and (ii) Magnitudes of W1 and W2.



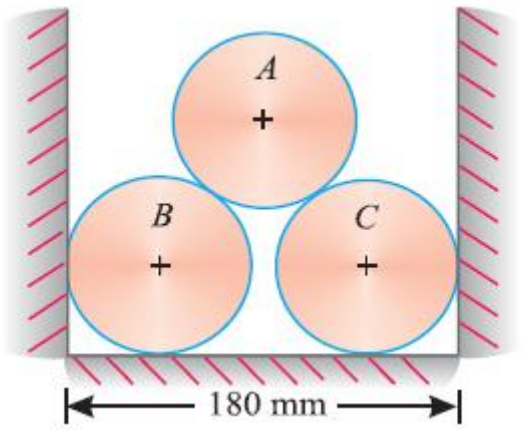
3. Two equal heavy spheres of 50 mm radius are in equilibrium within a smooth cup of 150 mm radius. Show that the reaction between the cup of one sphere is double than that between the two spheres.

4. A smooth circular cylinder of radius 1.5 meter is lying in a triangular groove, one side of which makes 15° angle and the other 40° angle with the horizontal. Find the reactions at the surfaces of contact, if there is no friction and the cylinder weights 100 N.

5. Two cylinders P and Q rest in a channel as shown in Fig. The cylinder P has diameter of 100 mm and weighs 200 N, whereas the cylinder Q has diameter of 180 mm and weighs 500 N. If the bottom width of the box is 180 mm, with one side vertical and the other inclined at 60°, determine the pressures at all the four points of contact.

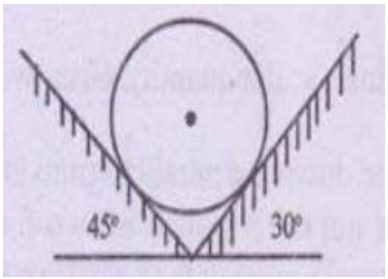


6. Three cylinders weighting 100 N each and of 80 mm diameter are placed in a channel of 180 mm width as shown in Fig. Determine the pressure exerted by (i) the cylinder A on B at the point of contact (ii) the cylinder B on the base and (iii) the cylinder B on the wall.

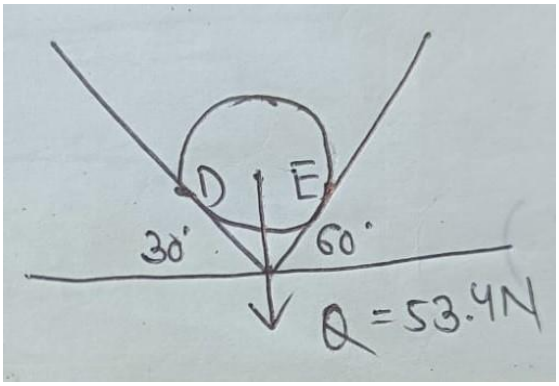


7. State and prove Lami's Theorem ?
8. A body of weight 70KN is suspended by two strings whose lengths are 6cm and 8cm from two points in the same horizontal level. The horizontal distance between the two points is 10cm. Determine the tensions of the strings.

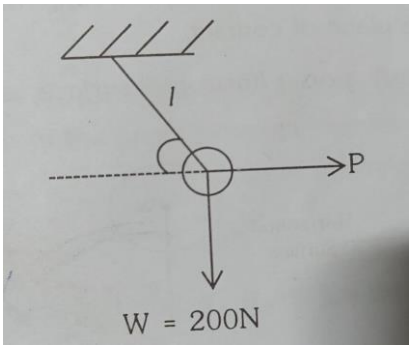
9. A heavy spherical ball of weight 12 kN rests on a V-trench as shown in Figure. Find the reactions assuming the contact surfaces to be smooth.



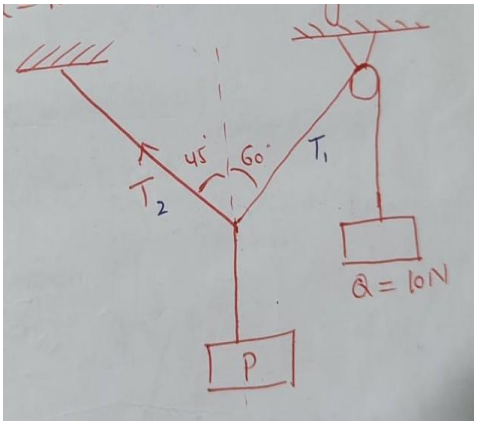
10. A ball of weight Q=53.4 N rest ia a right angle through as shown in the fig. Determine the force exerted on the sides of through at D and E if all surfaces are perfectly smooth.



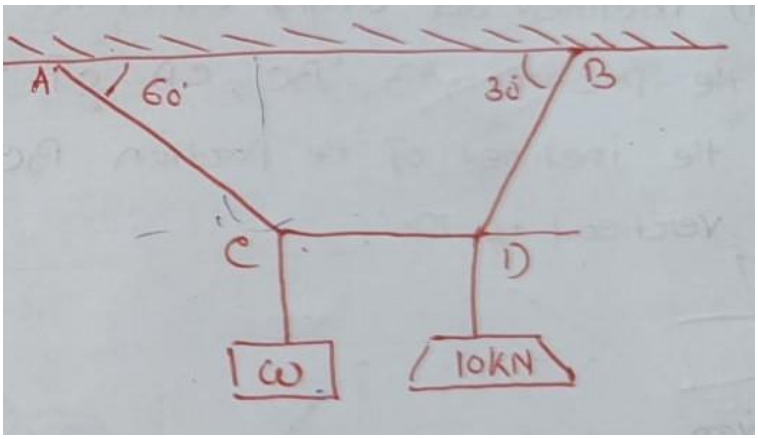
11. A weight of 200 N is tried to the end of a string of length as shown in the figure. Findthe magnitude of a force (P) to pull the weight at an angle of 30°. Also find the tension in the string.



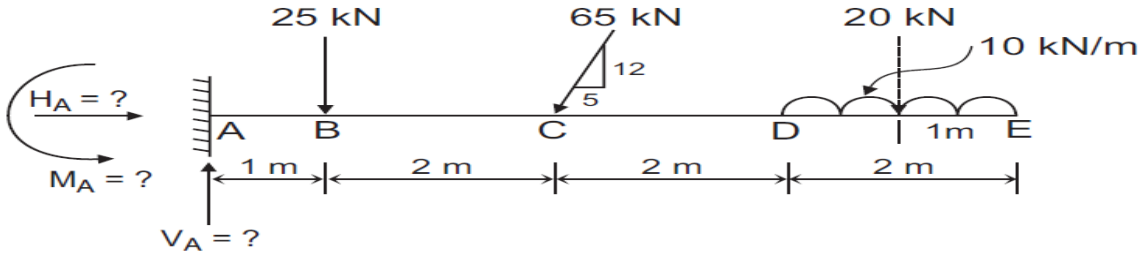
12. If a weight 80N is suspended by two fine strings, one of which is horizontal and the other is inclined at an angle of 30° to the horizontal, then what is the tension in the inclined string.
13. A string of length 24 cm is attached to a point on a smooth verical wall to a point on the surface of a sphere of radious 12 cm. the sphere whose weight is 100 KN hangs in equilibrium against the wall. Find the tension is the string and reaction of the wall.
14. The system shown in the figure is in equilibriun If Q=10 N Find the magnitute of weight P.



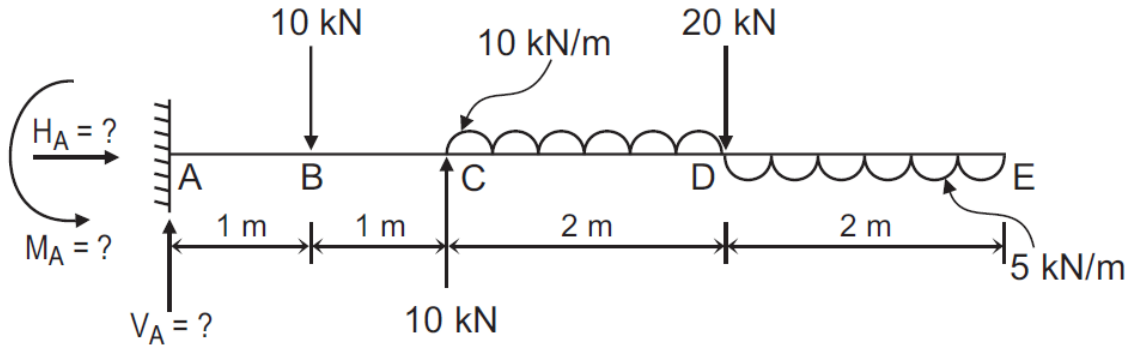
15. A cored Supported at A & B Carries a load of 10 KN at 'D' and a load of W at ' C' as shown in the Fiqure Find the value of W so that CD remains horizontal.



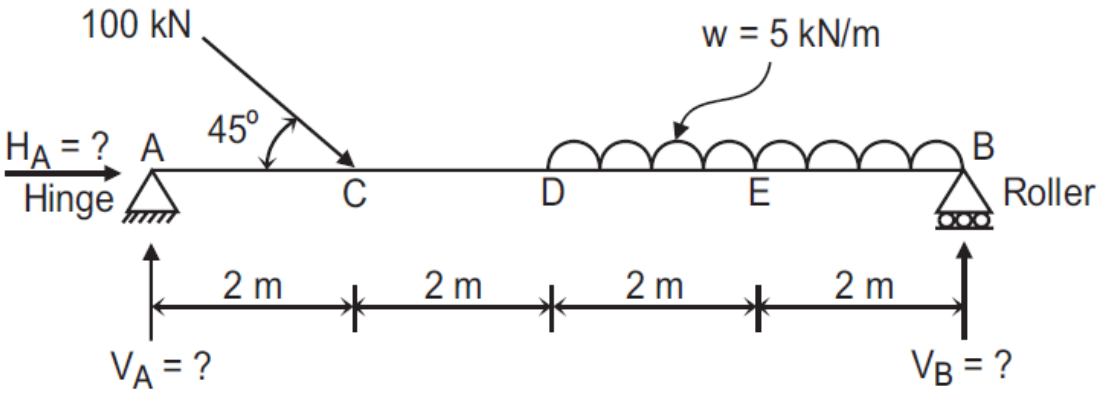
16. A cantilever beam of 4m length having fixed support on left hand is carrying point loads of 10 kN, 5 kN, 20 kN and 15 kN at an interval of 1m from free end respectively find the support reaction for the beam.
17. Determine the support reaction of a cantilever beam as shown in fig.



18. Determine the support reaction of cantilever beam as shown in fig.



19. Find the reaction for the beam shown below.



20. A simply supported beam of span 10m carries three points loads of 40 kN, 30 kN and 20 kN from left hinge support at the distance 2 m, 5 m and 8 m respectively in downward direction. The right-hand support is roller. Find support reaction for the beam.

CHAPTER-3 [FRICTION]

1. A body of weight 500N is pulled up an inclined plane, by a force of 350N. The inclination of the plane is 300 to the horizontal and the force is applied parallel to the plane. Determine the co-efficient of friction.

2. A uniform ladder of length 3.25 m and weighing 250 N is placed against a smooth vertical wall with its lower end 1.25 m from the wall. The coefficient of friction between the ladder and floor is 0.3. What is the frictional force acting on the ladder at the point of contact between the ladder and the floor?

3. A ladder 7m long rest against a on horizontal ground & lean smooth vertical wall at an angle 60 with the horizontal. The weight of ladder 5OO N. The ladder is at a man weight is 300 N stand 2.5m bottom of the ladder. find the coefficient of friction b/w the ladder and floor.

4. A body of weight 60 N is place on rough horizontal plane surface. Application of push force of 18 N acting at 20° to horizontal requires just move the body. Find the coefficient of friction.

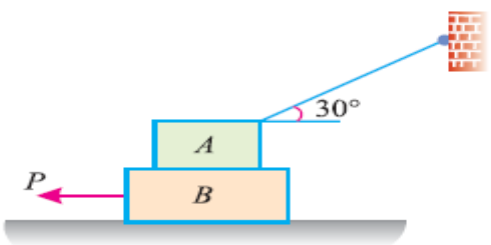
5. A pull force of 60N acting at 25° to horizontal plane, is requires just to move the body placed on rough horizontal plane surface. For the same body a push force of 75N acting at 25° to horizontal plane is requires just move the body. Find the weight of the body & coefficient of friction between the body and the rough horizontal plane surface.

6. A body of weight of 50N is pulled along a rough horizontal plane by a force of 18N acting on angle of 140 with horizontal. Find the coefficient of friction

7. A ladder 5 meters long rests on a horizontal ground and leans against a smooth vertical wall at an angle 70° with the horizontal. The weight of the ladder is 900 N and acts at its middle. The ladder is at the point of sliding, when a man weighing 750N stands on a rung 1.5 metre from the bottom of the ladder. Calculate the coefficient of friction between the ladder and the floor.

8. A uniform ladder of 4 m length rests against a vertical wall with which it makes an angle of 45°. The coefficient of friction between the ladder and the wall is 0.4 and that between ladder and the floor is 0.5. If a man, whose weight is one-half of that of the ladder ascends it, how high will it be when the ladder slips?

9. Two blocks A and B of weights 1 kN and 2 kN respectively are in equilibrium position as shown in If the coefficient of friction between the two blocks as well as the block B and the floor is 0.3, find the force (P) required to move the block B.



10. A block of weight 50N is move along a rough horizontal plane surface by a pull of 18N acting at an angle of 14° with horizontal. Find the coefficient of friction.

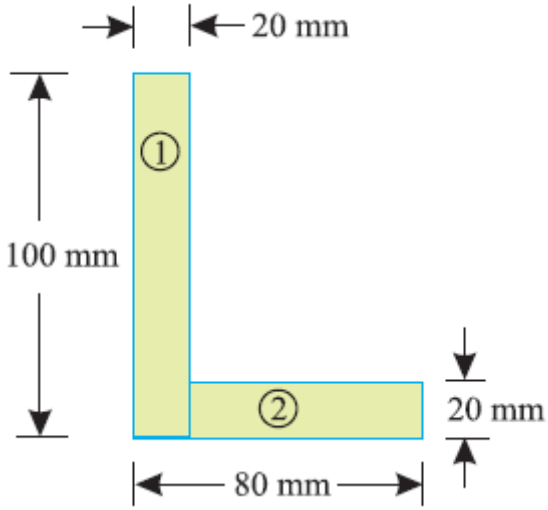
11. A body of weight 450N is Palled up an inclined plane by a force if 300N. The inclination of the plane is 30 degree to the horizontel and the force is a applied Parallel to the Plane Determine the co-efficient of Friction.

CHAPTER-4 [Centre of Gravity & MI]

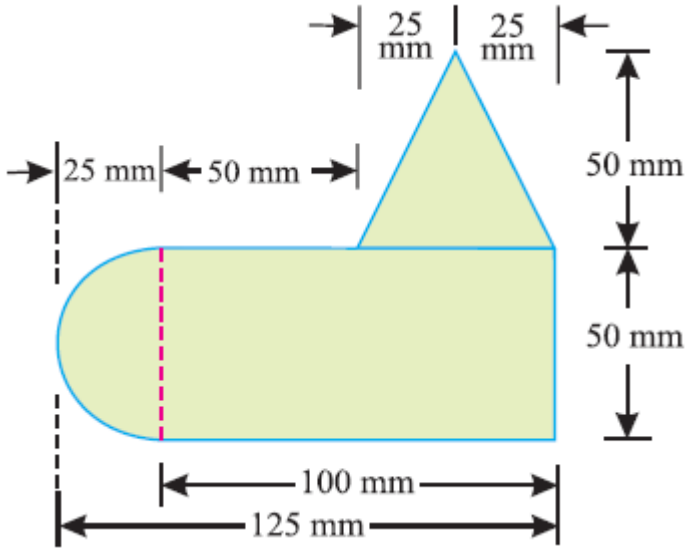
1. Find the centre of gravity of a 100 mm × 150 mm × 30 mm T-section.

2. An I-section has the following dimensions in mm units :
   Bottom flange = 300 × 100
   Top flange = 150 × 50
   Web = 300 × 50
   Determine mathematically the position of centre of gravity of the section.

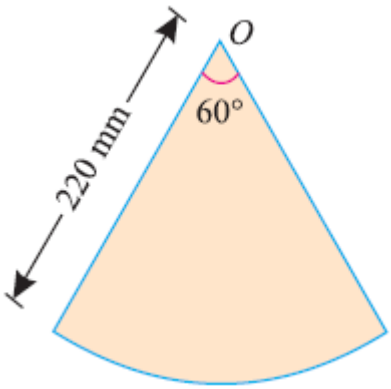
3. Find the centroid of L- Section



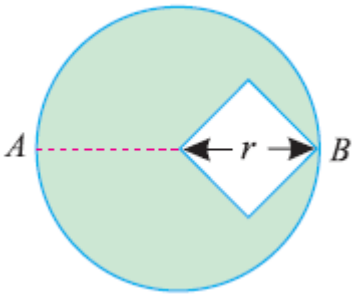
4. A uniform lamina shown in Fig consists of a rectangle, a circle and a triangle. Determine the centre of gravity of the lamina. All dimensions are in mm.



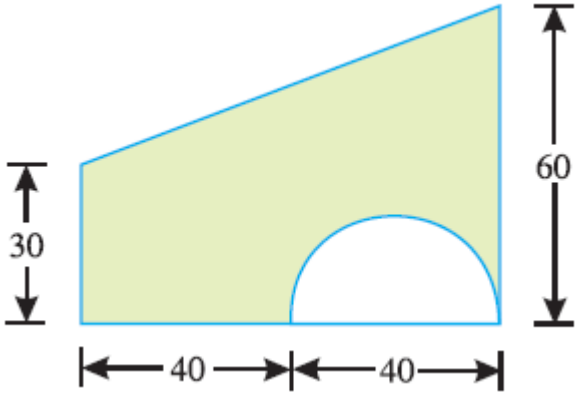
5. A plane lamina of 220 mm radius is shown in figure given below .Find the centre of gravity of lamina from the point O.



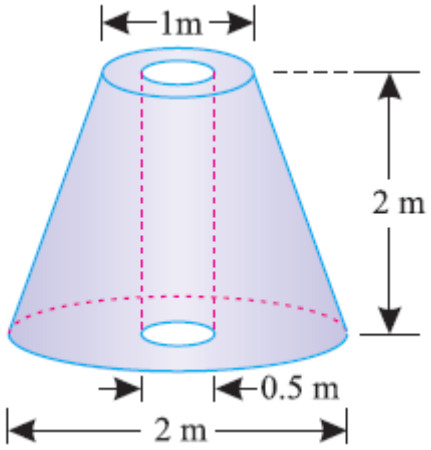
6. A square hole is punched out of circular lamina, the digonal of the square being the radius of the circle as shown in Fig.. Find the centre of gravity of the remainder, if r is the radius of the circle.



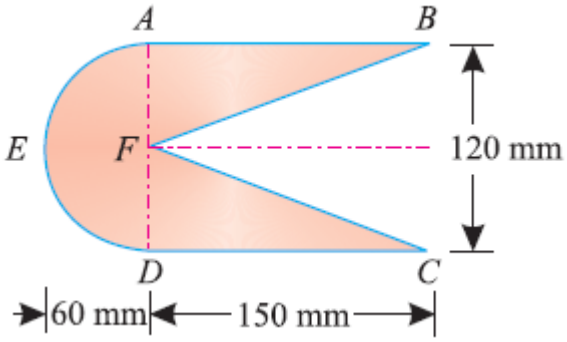
7. A semicircular area is removed from a trapezium as shown in Fig.(dimensions in mm) Determine the centroid of the remaining area (shown hatched).



8. A frustum of a solid right circular cone has an axial hole of 50 cm diameter as shown in Fig . Determine the centre of gravity of the body.

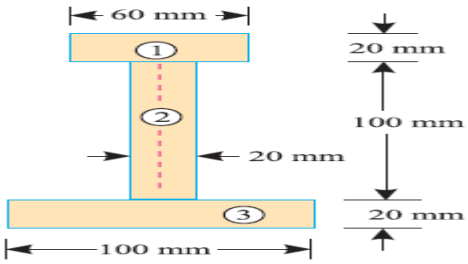


9. A solid consists of a right circular cylinder and a hemisphere with a cone cut out from the cylinder as shown in Fig. Find the centre of gravity of the body.

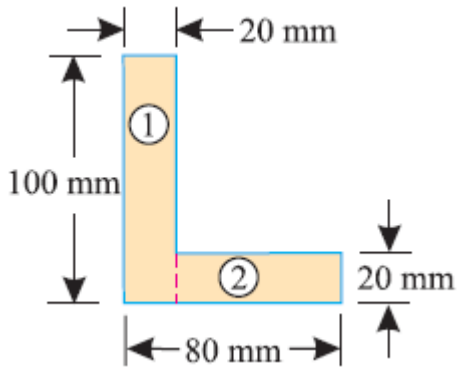


10. Find the moment of inertia of a T-section with flange as 150 mm × 50 mm and web as 150 mm × 50 mm about X-X and Y-Y axes through the centre of gravity of the section.

11. An I-section is made up of three rectangles as shown in Fig. Find the moment of inertia of the section about the horizontal axis passing through the centre of gravity of the section.



12. Find the moment of inertia about the centroidal X-X and Y-Y axes of the angle section shown in Fig.



13. State and prove the theorem of perpendicular axis applied to moment of inertia.

14. Prove the parallel axis theorem.

15. Prove that the moment of inertia of a rectangular section having width 'b' and depth 'd' about x-x axis is $bd^3/12$.

16. Prove that the moment of inertia of a rectangular section having width 'b' and depth 'd' about y-y axis .

CHAPTER-5 [SIMPLE LIFTING MACHINE]

1. Define M.A, V.R. and efficiency of a simple lifting machine and derive the relationship between them.

2. In a lifting machine, an effort of 15N can lift a load of 300N and an effort of 20N can lift a load of 500N. Find the law of machine. Also find the effort required to lift a load of 880N.

3. In a lifting machine, whose velocity ratio is 50, an effort of 100 N is required to lift a load of 4 kN. Is the machine reversible ? If so, what effort should be applied, so that the machine is at the point of reversing ?

4. In a certain machine, an effort of 100 N is just able to lift a load of 840 N, Calculate efficiency and friction both on effort and load side, if the velocity ratio of the machine is 10.

5. What load can be lifted by an effort of 120 N, if the velocity ratio is 18 and efficiency of the machine at this load is 60% ? Determine the law of the machine, if it is observed that an effort of 200 N is required to lift a load of 2600 N and find the effort required to run the machine at a load of 3.5 kN.

6. In a lifting machine, an effort of 40 N raised a load of 1 kN. If efficiency of the machine is 0.5, what is its velocity ratio ? If on this machine, an effort of 74 N raised a load of 2 kN, what is now the efficiency ? What will be the effort required to raise a load of 5 kN ?

7. The law of a machine is given by the relation : $P = 0.04\ W + 7.5$ where (P) is the effort required to lift a load (W), both expressed in newtons. What is the mechanical advantage and efficiency of the machine, when the load is 2 kN and velocity ratio is 40 ? What is the maximum efficiency of the machine ? If (F) is the effort lost in friction, find the relation between F and W. Also find the value of F, when W is 2 kN.

8. simple wheel and axle has wheel and axle of diameters of 300 mm and 30 mm respectively. What is the efficiency of the machine, if it can lift a load of 900 N by an effort of 100 N.

9. A drum weighing 60 N and holding 420N of water is to be raised from a well by means of wheel and axle. The axle is 100 mm diameter and the wheel is 500 mm diameter. If a force of 120 N has to be applied to the wheel, find (i) mechanical advantage, (ii) velocity ratio and (iii) efficiency of the machine.

10. The larger and smaller diameters of a differential wheel and axle are 80 mm and 70 mm respectively. The effort is applied to the wheel of diameter 250 mm. What is the velocity ratio? Find efficiency and frictional effort lost, when a load of 1050 N is lifted by an effort of 25 N.

11. With a differential wheel and axle, an effort of 6 N raised a load of 60 N. If the efficiency at this load is 80%, find the velocity ratio of the machine. If the diameter of the effort wheel is 300 mm, determine the difference betwen the diameters of the axles. If the sum of the diameters of the axles is 280 mm, determine the diameter of each axle.

12. A worm and worm wheel with 40 teeth on the worm wheel has effort wheelof 300 mm diameter and load drum of 100 mm diameter. Find the efficiency of the machine, if it can lift a load of 1800 N with an effort of 24 N.

13. In a double threaded worm and worm wheel, the number of teeth on the worm wheel is 60. The diameter of the effort wheel is 250 mm and that of the load drum is 100 mm. Calculate the velocity ratio. If the efficiency of the machine is 50%, determine the effort required to lift a load of 300 N.

14. In a single purchase crab winch, the number of teeth on pinion is 25 and that on the spur wheel 100. Radii of the drum and handle are 50 mm and 300 mm respectively. Find the efficiency of the machine and the effect of friction, if an effort of 20 N can lift a load of 300 N.

15. In a double purchase crab winch, teeth of pinions are 20 and 25 and that of spur wheels are 50 and 60. Length of the handle is 0.5 metre and radius of the load drum is 0.25 metre. If efficiency of the machine is 60%, find the effort required to lift a load of 720 N.

16. A screw jack has a thread of 10 mm pitch. What effort applied at the end of a handle 400 mm long will be required to lift a load of 2 kN, if the efficiency at this load is 45%.