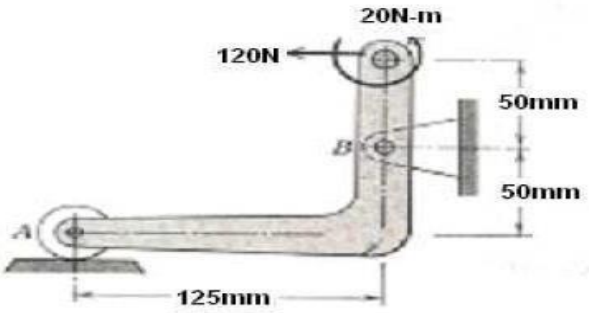
SOLID MECHANICS &HYDRULIC MACHINES

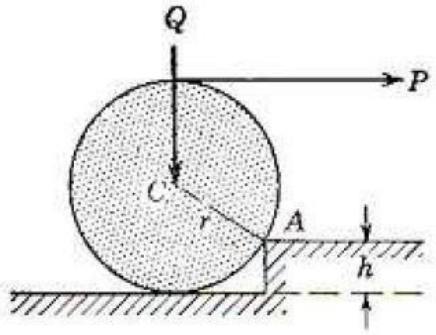
UNIT-1

1. Calculate the magnitude of the force supported by the pin at B for the bell crank loaded and supported as shown in Figure.

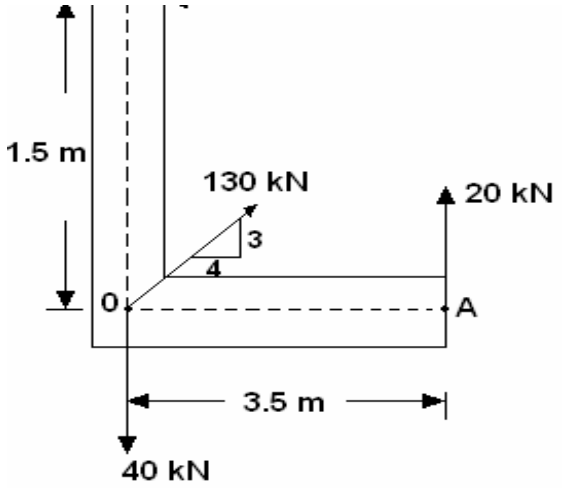


2. A roller of radius r = 0.3 m and weight Q = 2000 N is to be pulled over a curb of height h = 0.15m.by a horizontal force P applied to the end of a string wound around the circumference of the roller. Find the magnitude of P required to start the roller over the curb. [3 Marks]

{As shown in the Figure }



3. State and Prove Lami's Theorem
4. Distinguish between co-planar and non-co planar forces. Classify the various types of forces.
5. Forces are applied to an angle bracket as shown in figure 2. Determine the magnitude and direction of the resultant

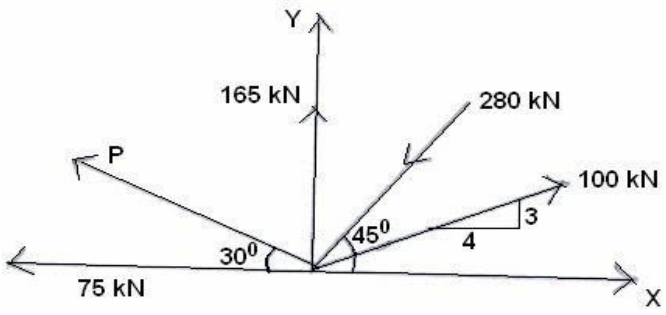


6. A.) State and prove Varignon's Theorem

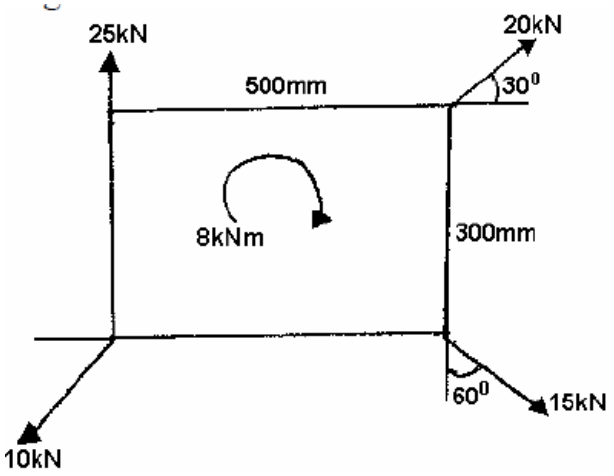
B.) State and prove parallelogram law of forces.

7. Calculate the magnitude of "P" and the resultant of the force system shown in figure. The algebraic sum of

horizontal components of all these forces is -325 kN.

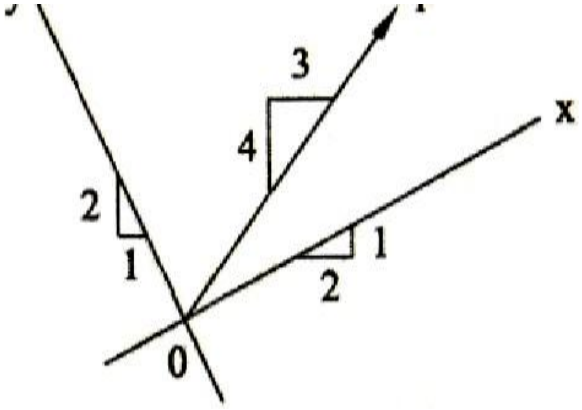


8. Determine the magnitude, direction and position of the resultant of the system offorces as shown in figure.

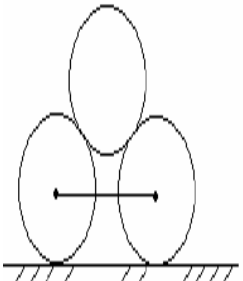


9. What do you mean by coplanar concurrent force system? Explain with suitable example.

10. If the X component is as shown in figure of P is 893 N, determine P and its Y component.

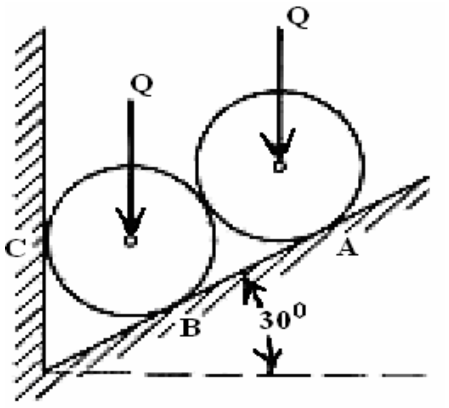


11.Two smooth cylinders of 3 m diameter and 100 N weight are separated by a chord of 4m long. Theysupport another smooth cylinder of diameter 3m and 200N weight as shown in figure. Find the tension in the chord.



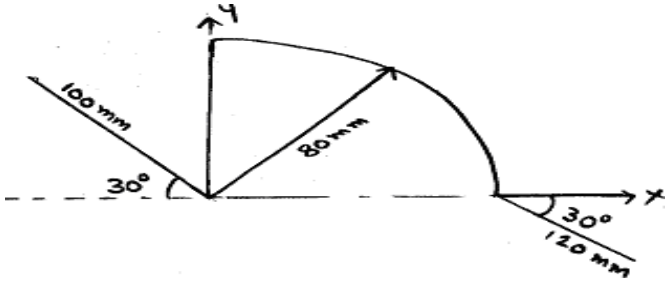
12. Define free body diagram, Transmissibility of a force and resultant of a force.

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

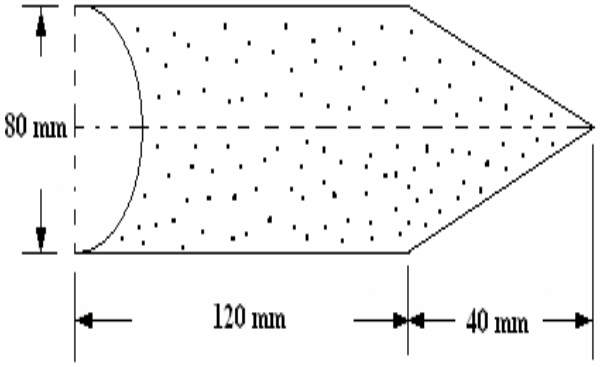


UNIT-2

1. Locate the centroid of the wire bent as shown in figure

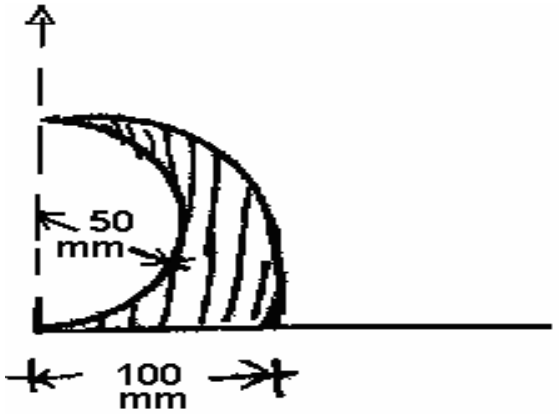


2. Find the Centroid for the shaded area about y – axis. As shown in the fig.



3. State and prove Pappus theorem

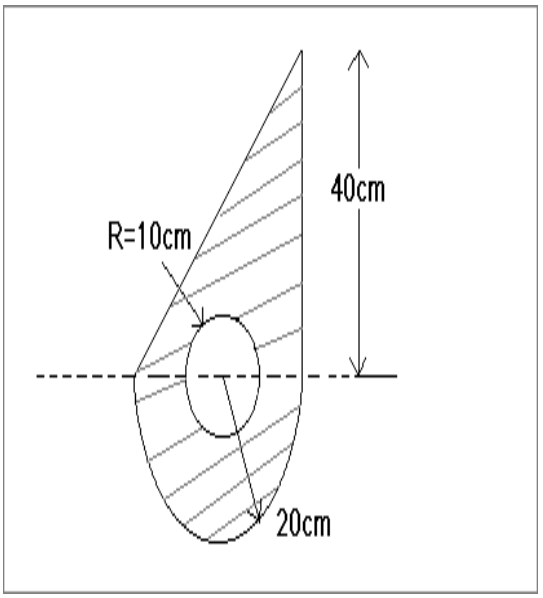
4. Locate the centroid of the shaded area shown in figure



5. Find the centroid of Quarter circle having the radius R

6. From first principles deduce an expression to determine the Moment of Inertia of a triangle ofbase ‘b’ and height ‘h’

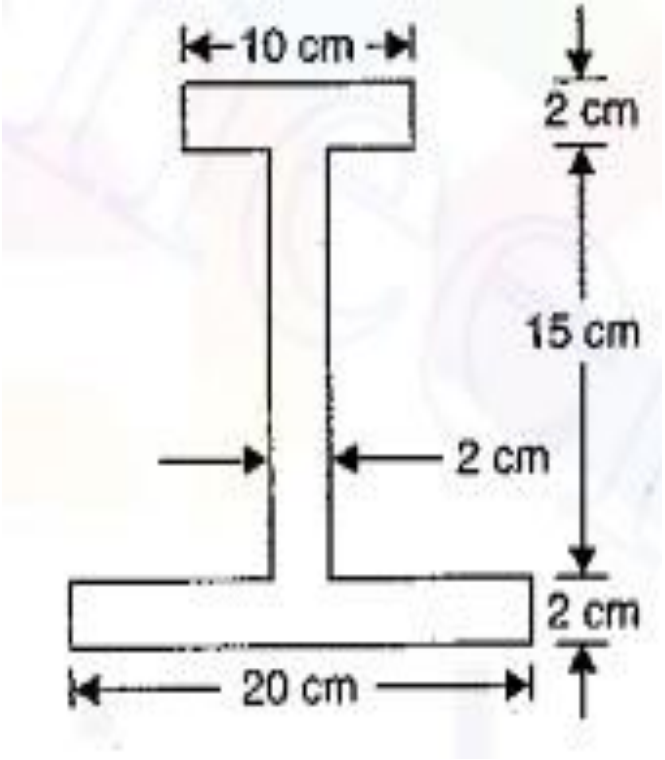
7. Find the moment of inertia about the horizontal centroidal axis.



8. Determine the mass moment of inertia of sphere about its diametrical axis

9. Determine moment of inertia of a quarter circle having the radius 'r'

10. Locate the centroid and calculate moment of inertia about horizontal and vertical axis through the centroid as shown in figure.



11. Determine the value of young's modulus and poison's ratio of a metallic bar of length 30 cm, breadth 4 cm, and depth 4 cm when the bar is subjected to an axial compressive load of 400 KN. The decrease in length is given as 0.075 cm and increase in breadth is 0.003 cm.

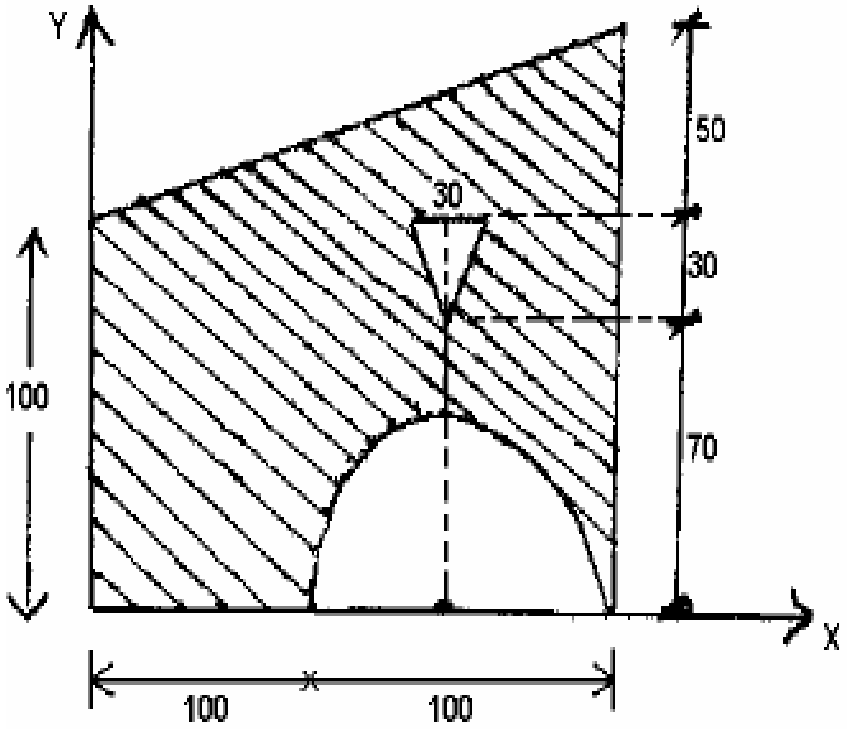
12. Explain stress – strain diagram for Mild steel material with neat sketch?

13. 13.Explain the following

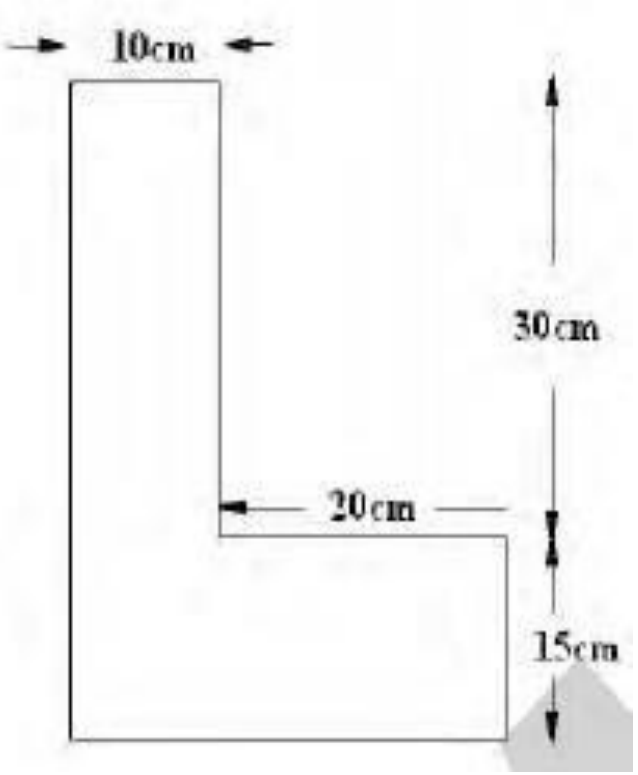
(i) Working stress (ii.) Factor of safety (iii.) Poisson's Ratio (IV) Volumetric Strain (v.) Hooks Law

14.Determine the centre of gravity of solid cone of base Radius 'R' and height 'h'

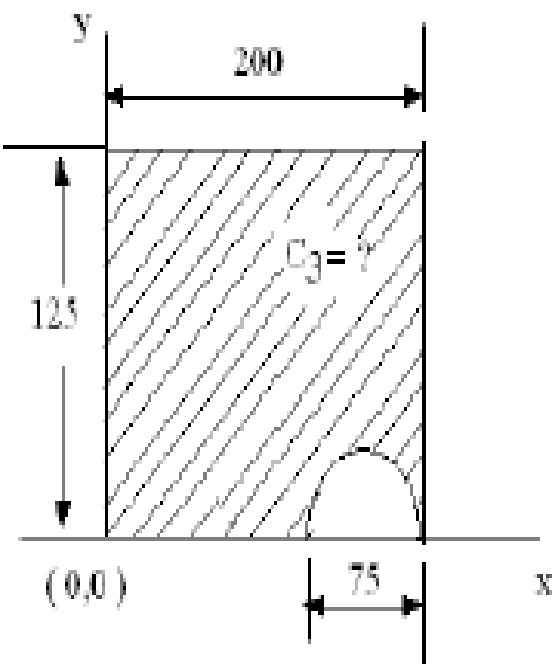
15. Locate the centroid of the shaded area and also find the moment of inertia about horizontal . centroidal axis shown in figure. All dimensions in mm.



16. Determine the centroid of the figure

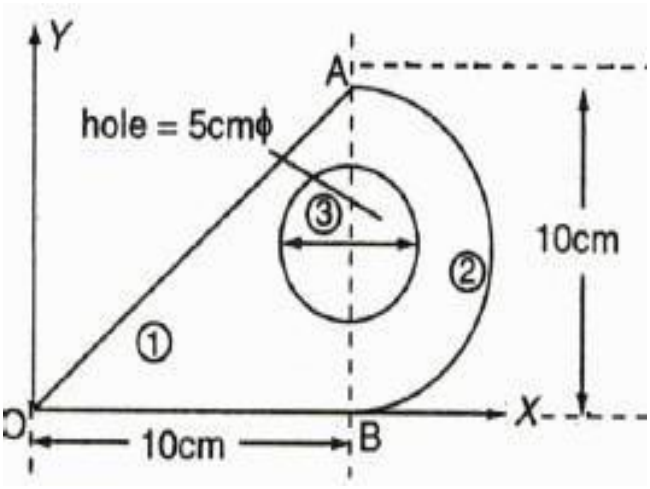


17. Determine the centroid of the shaded area as shown in figure



18. A.) Determine the Centre of gravity of right solid circular cine of radius R and height h

B.) Find the moment of Inertia of the given figure

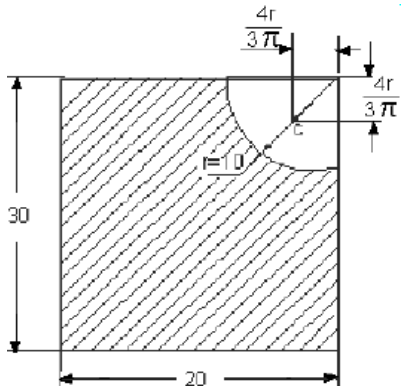


19.A.) Find the mass moment of inertia of a circular plate about centroidal axis

B.) Determine the Mass moment of inertia a solid sphere of Radius R about its diametrical axis

20. Determine the mass moment of Inertia of Rod of Length L

21. Find the Moment of inertia of the shaded area shown in figure about Centroidal X and Y axis. All dimensionsare in cm.



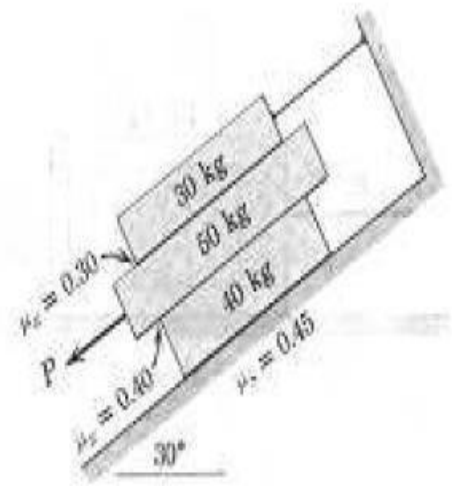
22. what is stress and Strain? Explain different types of stresses and strains.

23. Determine the changes in length, breadth and thickness of a steel bar which is 4 m long ,30 mm wide and20 mm thick and is subjected to an axial pull of 30 KN in the direction of its length. Take E = $2x10^5$ N/mm^2 and poison's ratio 0.3.

UNIT-3

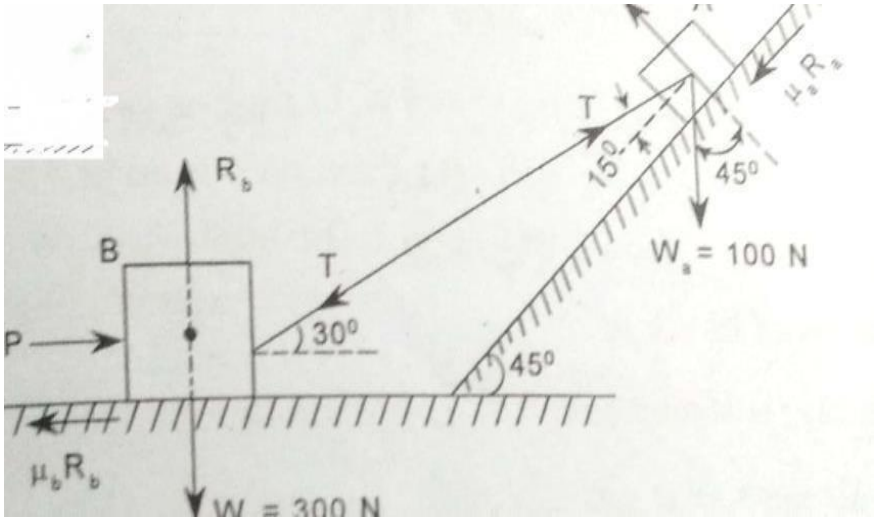
1. A block weighing 50 N is resting on a horizontal plane. A horizontal force of 10 N is applied to startthe sliding of the block. Find i. coefficient of friction
   ii. angle of friction
   iii. resultant force.

2. The three flat blocks are positioned on the 300 inclines as shown in Figure, and a force P parallel to the incline is applied to the middle block. The upper block is prevented from moving by a wire which attaches it to the fixed support. The coefficient of static friction for each of the three pairs of mating surfaces is shown. Determine the maximum value which P may have before any slipping takes place

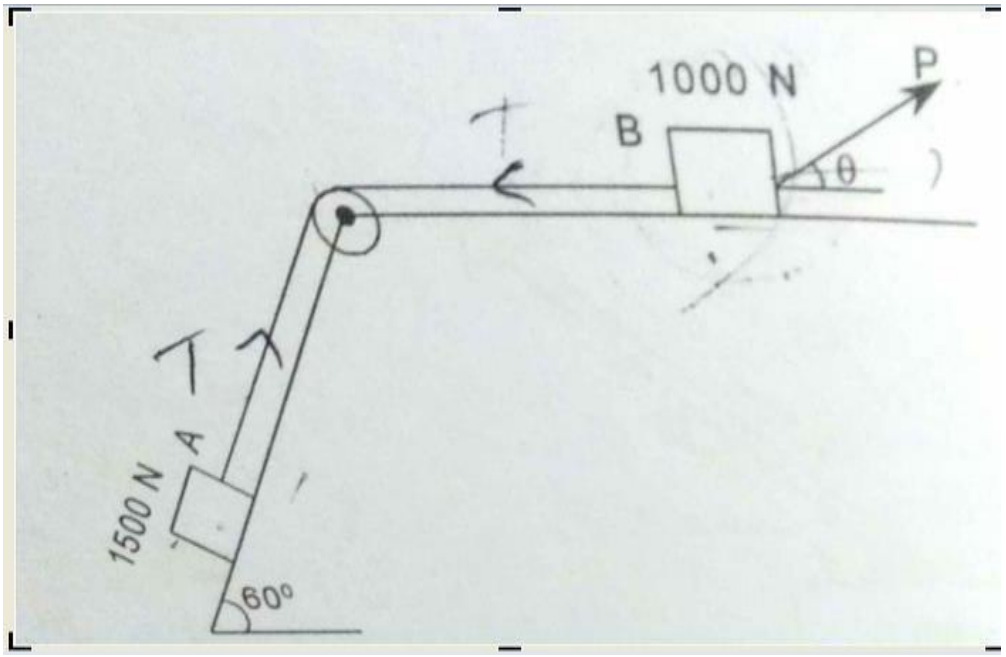


3. A uniform bar AB 10 m long and weighing 280N is hinged at B and rests upon a 400 N block as shown in figure. If the coefficient of friction is 0.4 for all contact surfaces. Find the horizontal force P required

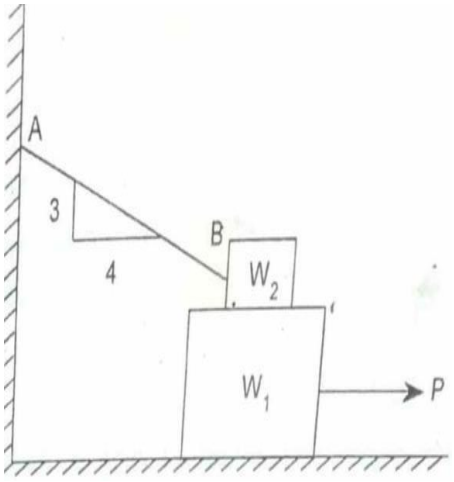
to start moving the 400 N block



4. Referring the blow figure determine the least value of the force P to cause motion to impend rightward. Assume the coefficient of friction under the blocks to be 0.2 and the pulley to be frictionless



5. A block of weight W_1=1290 N on a horizontal surface and supports another block of weighing W_2=570 N on the top of its as shown in figure. The block of weight W_2 is attached to a vertical wall by an inclined string AB. Find the force P applied to the lower block that will be necessary To cause slipping to impend. the Coefficient of friction between block 1 and 2 is 0.25 and between block 1 and horizontal surface is 0.4



UNIT-4

1. Derive Force exerted by a jet of water on an un-symmetrical moving Curved plate when Jet strikes tangentiallyat one of the tips.
2. Derive an expression for force exerted by a moving flat plate held inclined to the direction of jet.
3. A 75mm jet having a velocity of 30m/s strikes a flat plate, the normal of which is inclined at 45 degrees to the axis of the jet. Find the normal pressure on the plate i) when the plate is stationary ii) when the plate is moving with a velocity of 15m/s in the direction of the jet.
4. Explain the Elements of Hydro - power plant with neat sketch.
5. Find the force exerted by a jet of water of diameter 75 mm on a stationary flat plate, when the jet strikes the plate normally with velocity of 20 m/sec.
6. Explain the following i.) Gross Head ii. Net head iii.. Manometric head.
7. Explain different types of efficiencies of a turbine.

UNIT-5

1. Design a Pelton wheel for a head of 80m and speed 300rpm. The Pelton wheel develops 103kW SP. Take Cv = 0.98, speed ratio=0.45 and overall efficiency as 0.80.

2. The following data is given for a Francis turbine. Net head H= 60m, Speed N=700rpm, SP= 294.3kW, overall efficiency= 84%, hydraulic efficiency= 93%, flow ratio= 0.20, breadth ratio n=0.1, outer diameter of the runner = 2 times the inner diameter of runner. The thickness of vanes occupies 5% of circumferential area of the runner, velocity of flow is constant at inlet and outlet and discharge is radial at outlet. Determine: (i) Guide blade angle **(ii)** Runner vane angles at inlet and outlet (iii) Diameters of runner at inlet and outlet (iv) width of wheel at inlet.

3. A Pelton wheel is having a mean bucket diameter of 0.8m and running at 1000rpm. The net head on the Pelton wheel is 400m. If the side clearance angle is 150 and discharge through nozzle is 150 litres/s. Find (i) Power available at inlet of the nozzle (ii) hydraulic efficiency of the turbine.

4. A Pelton wheel is to be designed for the following specifications. Power= 735.75 kW S.P head=200m, Speed=800rpm, overall efficiency=0.86 and jet diameter is not to exceed one tenth the wheel diameter. Determine: (i) Wheel diameter, (ii) the no of jets required and (iii) diameter of the jet. Take Cv=0.98 and speed ratio=0.45. 2. A reaction turbine works at 500rpm under a head of 100m. The diameter of turbine at inlet is $100cm^3$. and flow area is 0.365m

8. A Centrifugal pump delivers water against a net head of 10 m at a design speed of 800 rpm. The vanes are curved backwards and make an angle of 300 with the tangent at the outer periphery. The impeller diameter is 30cm and has a width of 5 cm at the outlet. Determine the discharge of the pump if the manometric efficiency is 85%.

9. A fluid is to be lifted against a head of 120m. The pumps that run at a speed of 1200 rpm with rated capacity of 300 liters/sec are available. How many pumps are required to pump the water if specific speed is 700.

10. One of the Kaplan turbine, installed at Gangu wal power house is rated at 25000 kW when working under 30m of head at 180 rpm. Find the diameter of the runner, if the overall efficiency of the turbine is 0.91. Assume flow ratio of 0.65 and diameter of runner hub equal to 0.3 times the external diameter of runner. Also find specific speed of the turbine.

11. A turbine develops 1000 kW under a head of 16 m at 200 rpm, while discharging 9 cubic metres of water/sec. Find the unit power and unit discharge of the wheel. 5. A single acting reciprocating pump having cylinder diameter of 150 mm and stroke 300 mm is used to raise water through a total height of 30m. Find the power required to drive the pump, if the crank rotates at 60 rpm.

12.A centrifugal pump delivers water to a height of 22 m at a speed of 800 rpm. The velocity of flow is constantat a speed of 2m/s and the outlet vane angle is 450. If the pump discharges 225 litres of water / second, find thediameter of the impeller and width of the impeller.

13 A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1200 rpm works against a total head of 75m. The velocity of flow through the impeller is constant and is equal to 3m/s. The vanes are set back at an angle of 300 at outlet. If the outer diameter of the impeller is 600 mm and width atoutlet is 50 mm, determine (i) vane angle at inlet (ii) work done per second by impeller (iii) manometric efficiency.

14 Explain the performance characteristic curves of centrifugal pump?

15 With the help of a neat sketch discuss the main parts of a reciprocating pump.

16 What is the working principle of a reciprocating pump? Explain its working with the help of an indicatordiagram.

17. Derive expression for discharge, work done and power required to drive single acting and double actingreciprocating pump.

18. The angles made by absolute and relative velocities at inlet are 15 0 and 60 degrees respectively with the tangential velocity. Determine: (i) The volume flow rate (ii) the power developed (iii) efficiency. Assume the whirlvelocity as zero.

19. A Francis turbine with an overall efficiency of 70% is required to produce 147.15 kW. It is working under a head of 8m. The peripheral velocity = 0.30 and the radial velocity of flow at inlet is 0.96. The wheel runs at 200 rpm and the hydraulic losses in the turbine are 20% of the available energy. Assume radial discharge, determine:

(i) the guide blade angle, (ii) the wheel vane angle at inlet (iii) the diameter of wheel at inlet and (iv) width of wheel at inlet.

20. One of the Kaplan turbine, installed at Gangway power house is rated at 25000 kW when working under 30 mof head at 180 rpm. Find the diameter of the runner, if the overall efficiency of the turbine is 0.91. Assume flow ratio of 0.65 and diameter of runner hub equal to 0.3 times the external diameter of runner. Also find specific speed of the turbine. (Ans: 2.87m, 405 rpm)

21. A turbine develops 1000 kW under a head of 16 m at 200 rpm, while discharging 9 cubic metres of water/sec.Find the unit power and unit discharge of the wheel. (Ans: 15.6 kW, 2.25 m^3 /s)