Semester & Branch: II - Civil & Mechanical Engineering
Subject Code & Name: GE6253 - Engineering Mechanics
Question Bank

PART-A

UNIT-I (BASICS AND STATICS OF PARTICLES)

1. A vector F starts at point (2,-1,2) and passes through the point (-1,3,5). Find its unit vector.
2. State the principle of transmissibility.
3. Give the static equilibrium equations.
4. State Lami's theorem.
5. Two forces 60N and 65N acts on a screw at an angle of 25^0 and 85^0 from the base. Determine the magnitude and direction of their resultant.
6. State the necessary and sufficient condition for equilibrium of a particle in two dimensions.
7. Find the unit vector of a force F=4i-5j+8k.
8. Define the term "Vector quantity".
9. What is the difference between a resultant force and equilibrant force?
10. State the parallelogram law of forces.
11. Distinguish between concurrent and coplanar force system.
12. Find the magnitude of the resultant of the two concurrent forces of magnitude 60KN and 40KN with an included angle of 70° between them.
13. A force of magnitude 500N is passing through the origin and a point A (0.2,1,0). Write the vector form of the force.
14. Determine the angle between two equal forces F, when their resultant is R=F/2.
15. Find the resultant force when a 50N force acting along the positive X-direction and 25N force acting at an angle of 135^0 to the positive X-direction act on a point.
16. Find the displacement vector when a point moves from position (6, 3, 7) to position (10, -3, 4).
17. Define free body diagram.
18. Define unit vector.
19. What is single equivalent force?
20. Determine the resultant of the three concurrent forces F_1=2i+3j+2.5k, F_2=-i+5j-3k and F_3=7i-7j+6k.The forces are in Newton.
21. Find the unit vector of the force F=4i-5j+8k.
22. Distinguish between space diagram and body diagram.
23. State the triangular law of forces.

24. A force of magnitude 700N is directed about PQ where P is (0.8,0.1,1.2)m and Q is (1.4,1.2,0)m. Write the vector form of the force.
25. Write the names of various laws in mechanics.
26. A force F=240 KN passes through the points A(-2,3,0) and B(-1.5,6,1).Find the components of the force along X,Y and Z direction.
27. Give the equations of a particle in space.

UNIT-II (EQUILIBRIUM OF RIGID BODIES)

28. List the different supports used to support structural components.
29. Define couple.
30. State Varignon's theorem.
31. Define the term "support reaction". What are the different types of support?
32. What is meant by a force-couple system?
33. Distinguish between a couple and a moment.
34. A force of magnitude 100N is passed from A(1,3,4)m to B(5,3,8)m. Calculate its moment about an axis passing from origin to C(3,3,3).
35. Explain the concept of reducing a system of forces to an equivalent force-couple system.
36. What is the general condition of equilibrium of a rigid body?
37. What is the moment of force about an axis?
38. Three couples +12 Nm,-35 Nm and +100 Nm are acting in the xy, yz and xz. Write the vector form.
39. A cantilever beam of length 12m is subjected to a UDL of 10KN/m over the entire length and a concentrated load of 50KN at 5m from support. Determine the reactions at support.
40. Mention the different types of forces with examples.

UNIT-III (PROPERTIES OF SURFACES AND SOLIDS)

41. Find the radius of gyration of a rectangular area of MI about its base 9×10^4 cm^4 and area 300 cm^2.
42. State perpendicular axis theorem.
43. State parallel axis theorem.
44. Define principle moment of inertia.
45. Define centre of gravity and centroid.
46. What do you meant by polar moment of inertia?.
47. When will the centroid and centre of mass coincides?.
48. Define radius of gyration with respect to x-axis of an area.
49. Define first moment of an area about on axis.
50. State Pappus and Guldinus theorem.
51. What is the physical significance of first moment of area?
52. Determine the moment of inertia of a rectangular laminar of base "b" and height "h" about its base.
53. How would you out the centroid of a composite area?.

54. Express the centroidal coordinates of quadrant or a circle.
55. State the conditions at which the product of inertia of a plane figure with respect to its centroidal axis is zero.
56. Express the moment of inertia of a semi circular section about centroidal axis.
57. Express the rectangular components of the moment of a force in space.
58. How will you find moment of a force about a given axis in three dimensions?.
59. A semi circular lamina having a radius 100 mm is located in the xy plane such that its diametric edge coincides with y-axis. Determine the x coordinates of its centroid.

UNIT-IV (DYNAMICS OF PARATICLES)

60. A particle is projected into space at an angle of 30^0 to the horizontal at a velocity of 40 m/s. Find the maximum height reached by the projectile.
61. Distinguish between perfectly plastic impact and perfectly elastic impact.
62. Define Newton's law (second law) of motion.
63. Give the equation of work energy for a rectilinear motion.
64. A car is moving with a velocity of 15 m/s. The car is brought to rest by applying brakes in 5 seconds. Determine the distance travelled by the car after applying brakes.
65. Define the coefficient of Restitution.
66. State impulse – momentum principle.
67. State D'Alembert's principle.
68. A car runs with an initial velocity of 30 m/s and uniform acceleration of 3 m/s^2.Find its velocity after 5 seconds.
69. Define the term "kinematics".
70. Differentiate particle and rigid body.
71. A body moves along a straight line so that its displacement from a fixed point on the line is given by $s=3t^2+2t$.Find the velocity and acceleration at the end of 3 seconds.
72. A particle of mass 10kg falls vertically from a height of 100m from ground. What is the change in potential energy when it has reached a height of 50m?
73. A point P moves along a straight line according to the equation $x=4t^3-2t-5$, where x is in meters, t is in seconds. Determine the velocity and acceleration when t=3 sec.
74. Equation of motion of a body: $S=7t^3+3t^2+t+9$.Find the acceleration when t=3 seconds.
75. Write the equations for tangential and normal acceleration.
76. The motion of a particle is defined by the relation $s=t^3-9t^2+24t-2$ where s is the distance in cm and t is in sec. Determine the position, velocity and acceleration when t=5?
77. The range of projectile is maximum when the angle of the projectile is ----------.
78. A particle moves from rest along a straight line defined by the relationship $x=t^3-6t^2-15t$ where "x" is the distance travelled and "t" is time in second. Find the velocity and acceleration at end of the 10 seconds.
79. A body of mass 10kg is dropped from a building of height of 200m.Find the velocity when the body reaches the ground.
80. Define law of conservation of energy.
81. Define uniformly accelerated motion.

82. Distinguish between curvilinear motion and projectile motion.
83. What is meant by projectile?
84. A body is rotating with an angular velocity of 5 rad/sec, after 4 seconds, the angular velocity of the body becomes 13 rad/sec. Determine the angular acceleration of the body.
85. Define variable angular acceleration of rigid body.
86. Bring out the difference between direct central impact and oblique central impact.
87. Write down the expression for acceleration of a particle moving along circle of radius 'r'.
88. A particle starting from rest moves in a straight line and its acceleration is given by $a=40-46t^2$ m/sec^2 where t is in sec. Determine the velocity of the particle when it has travelled 52m.
89. A steel ball is thrown vertically upwards from the top of a building 25m above the ground with an initial velocity of 18m/s. Find the maximum height reached by the ball from the ground.
90. What do you understand by kinetics?

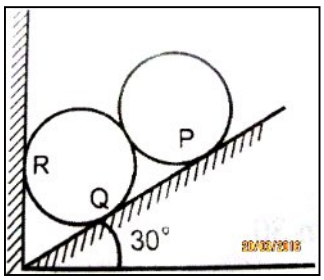
UNIT-V (FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS)

91. What is angle of repose?
92. A wheel of radius 50 cm subjected to a load of 300N rolls on a level ground at constant speed. If the wheel is pushed by a tractive force of 60N applied horizontally at the centre of the wheel, find the co-efficient of rolling resistance.
93. Define limiting friction.
94. Define instantaneous centre of rotation.
95. If the coefficient of friction between all surfaces is 0.2,what is the horizontal force required to get the 500kg block placed below the 200kg block for moving to the right?
96. State the coulomb's law of dry friction.
97. Give the causes of rolling resistance.
98. What is general plane motion? And Give two examples.
99. A flywheel has a mass moment of inertia of 11 kg m^2 about the axis of rotation. It runs at a constant angular velocity of 94.25 rad/s. Find the kinetic energy of the flywheel.
100. State Newton's first law of motion.
101. How do at any given instant the velocity and acceleration of different points of a rigid body vary when it is undergoing translation?
102. Define: Coefficient of static friction.
103. Define angle of friction and write its relationship with coefficient of friction.
104. The ratio between tensions on the tight end and the loose end of a pulley is ----------.
105. List any four engineering application of friction.
106. Define the expression for distance traveled by a particle in n^{th} second. Assume 'u' as initial velocity and 'a' as acceleration.

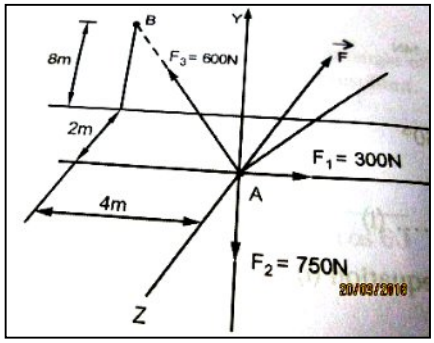
PART-B

UNIT I BASICS AND STATICS OF PARTICLES

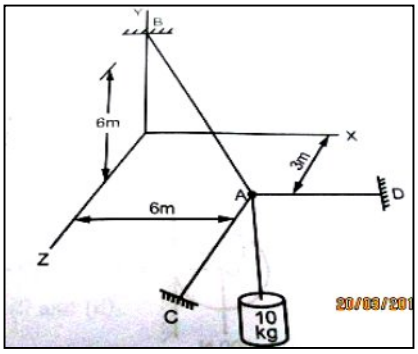
1. Two identical rollers each of weight 2.5 kN rest in between an inclined wall and a vertical wall as shown in Fig. Determine the reactions at the points of contact P, Q and R. Assume the wall surfaces to be smooth.



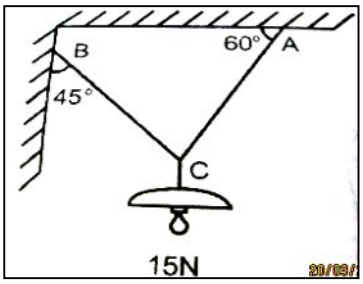
2. Determine the magnitude and direction of forces F shown in Fig. so that particle 'A' is in equilibrium.



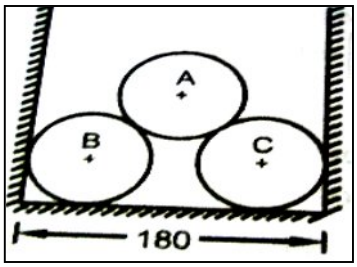
3. Three cables are used to support the 10 kg cylinder shown in Fig. determine the force developed in each cable for equilibrium.



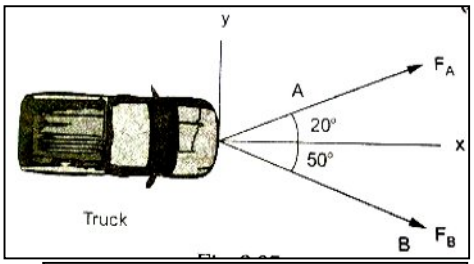
4. An electric light fixture weighing 15N hangs from a point C, by two strings AC and BC. The string AC is inclined at 60^o to the horizontal and BC at 45^o to the vertical as shown in Fig. Determine the forces in the strings.



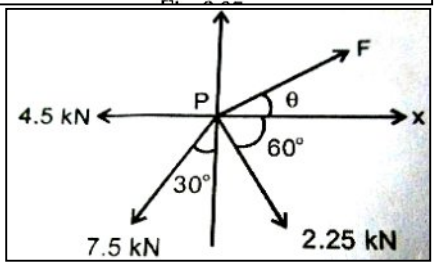
5. Three cylinders weighing 100N each and of 80mm diameter are placed in channel of 180mm width as shown in Fig. Determine pressure exerted by (1) the cylinder A on B at the point of contact; (2) the cylinder B on the base and (3) the cylinder B on the wall.



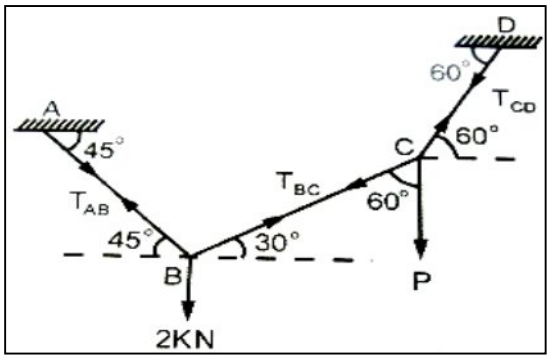
6. The truck shown is to be towed using two ropes. Determine the magnitudes of forces F_A and F_B acting on each rope in order to develop a resultant force of 950N directed along the positive X-axis.



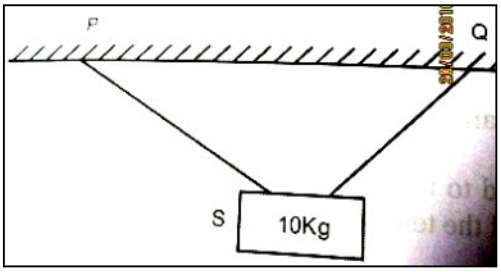
7. Determine the magnitude and angle Θ of F so that particle P, shown in Fig. is in equilibrium.



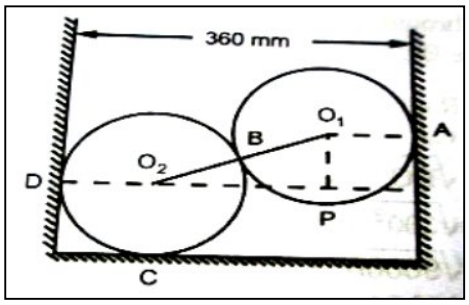
8. A string is subjected to the forces 2KN and P as shown in Fig. Determine the magnitudes of P and the tensions in the various portion of the string.



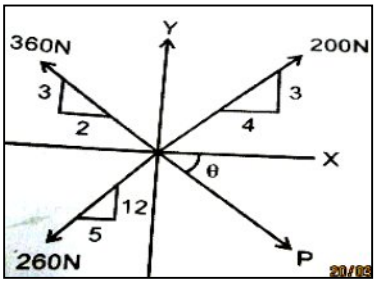
9. A particle of mass 10kg is attached at S to the ends of two light inextensible strings PS and QS as shown in Fig. The other ends of the string are attached to two fixed points P and Q on a horizontal ceiling. The particle hangs in equilibrium with PS and QS inclined to the horizontal at angles of 25 and 60 degrees respectively. Determine the tension in the strings PS and QS required holding the 10kg mass.



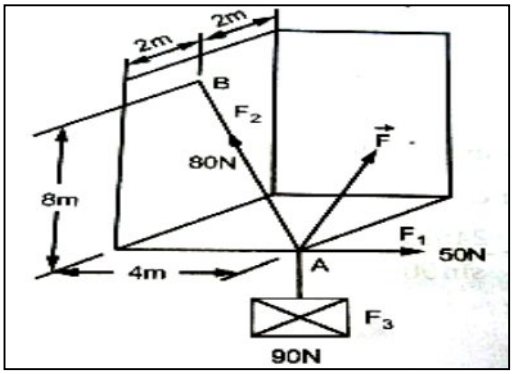
10. Two smooth spheres each of radius 100mm and weight 100N, rest in a horizontal channel having vertical walls, the distance between which is 360mm. Find the reactions at the points of contacts A, B, C and D shown in Fig.



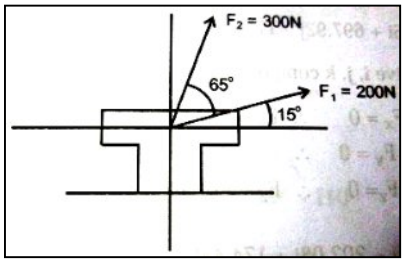
11. The resultant of force system shown in Fig. is 520N along the negative directions of Y axis. Determine P and Θ.



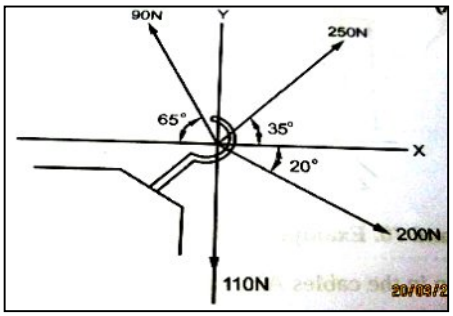
12. Three concurrent forces in space, F_1, F_2 and F_3 are acting at A as shown in Fig. An unknown force F, attached to the system makes the particle A in equilibrium. Find the magnitude and direction of the unknown force F



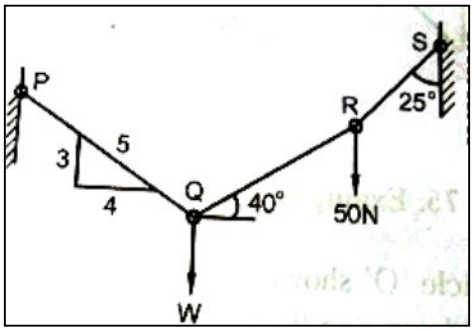
13. Determine the magnitude and direction of the resultant of the two forces acting on the bolt shown in Fig.



14. Determine the magnitude and direction of the resultant of the forces acting on the hook shown in Fig.

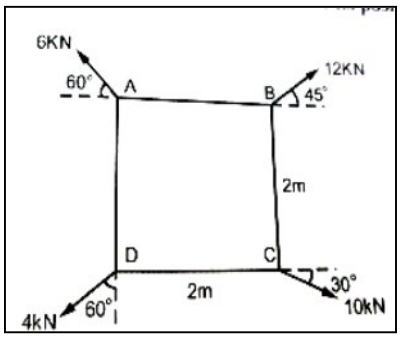


15. Three links PQ, QR and RS connected as shown in Fig. support loads W and 50N. Find the weight W and the force in each link if the system remains equilibrium.

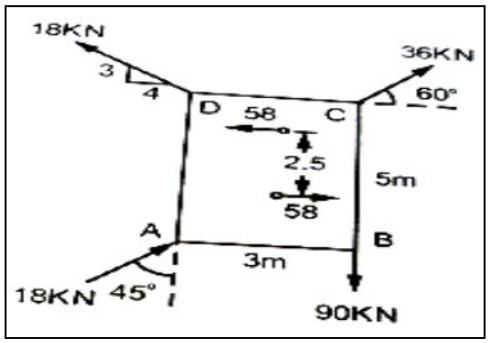


UNIT II EQUILIBRIUM OF RIGID BODIES

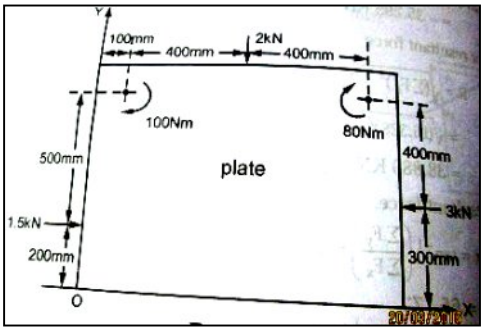
16. Determine the resultant of the coplanar non-concurrent force system shown in Fig. Calculate its magnitude and direction and locate its position with respect to the sides AB and AD.



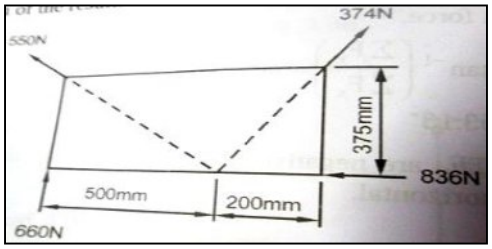
17. Determine the resultant of the coplanar non-concurrent force system shown in Fig. Calculate its and direction and locate its position with respect to the sides AB and AD.



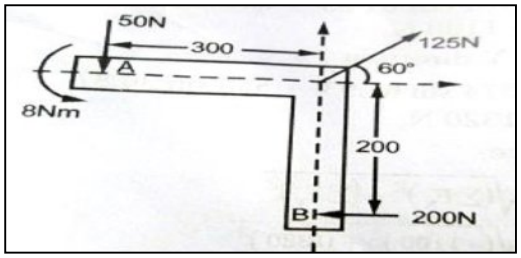
18. A plate is acted upon by 3 forces and 2 couples as shown in Fig. Determine the resultant of these force couple system and find co-ordinate x of the point on the X axis through which the resultant passes.



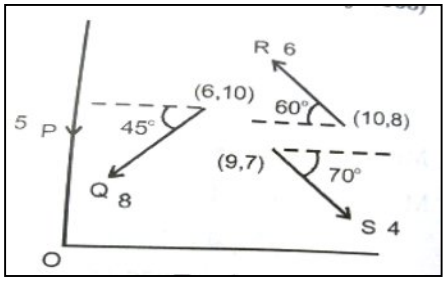
19. In fig below, a plate of 700 x 375mm dimension is acted upon by four forces as shown in Fig. 1) Find the resultant of these forces 2) Locate the two points where the line action of the resultant intersects the edge of the plate.



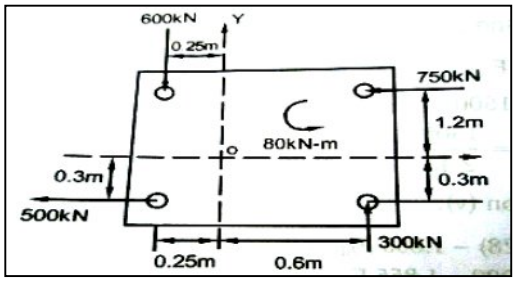
20. The three forces and a couple shown in Fig. are applied to an angle bracket. Find 1) the resultant of this system forces 2) Locate the points where the line of action of the resultant intersects.



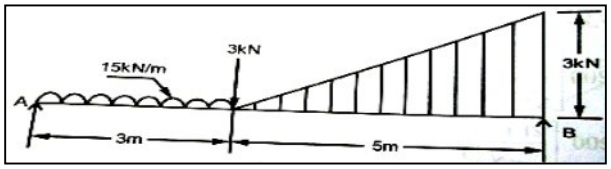
21. A system of four forces P,Q,R and S of magnitude 5 kN, 8 kN, 6 kN and 4kN respectively acting on a body are shown in rectangular coordinates as shown in Fig. Find the moments of the forces about the origin O. Also, find the resultant moment of the forces about O. The distances are in meters.



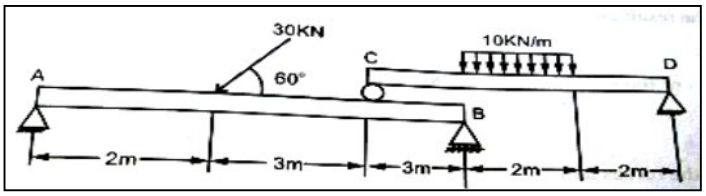
22. Four forces and a couple are applied to rectangular plate as shown in Fig. Determine the magnitude and direction of the resultant force-couple system. Also determine the distance x from O along X-axis where the resultant intersects.



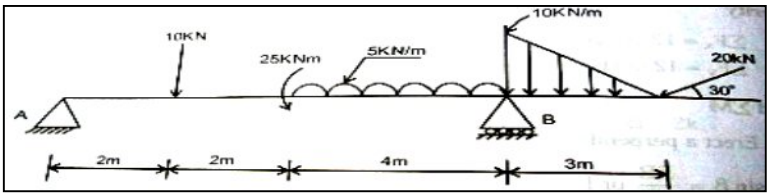
23. Determine the support reaction of the simply supported beam shown in Fig.



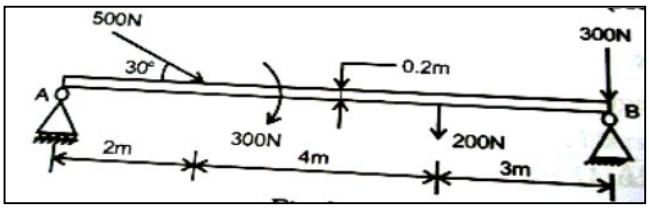
24. Two beams AB and CD are shown in Fig. A and D are hinged supports. B and C are roller supports.



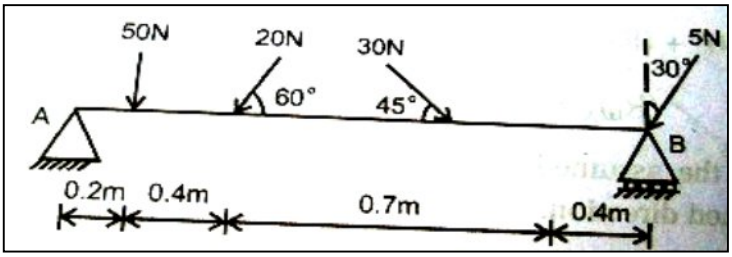
25. Find the reactions are supports A and B of the beam shown in Fig.



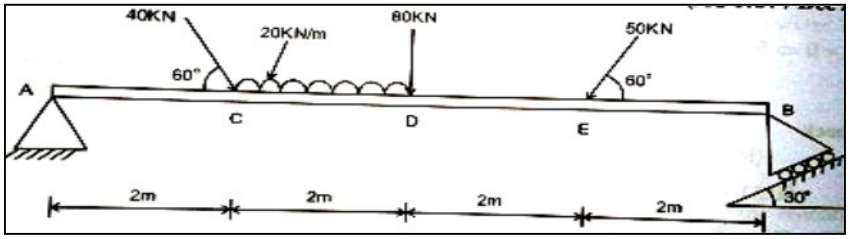
26. Determine the horizontal and vertical components of reactions for the beam loaded as shown in Fig. Neglect the weight of the beam.



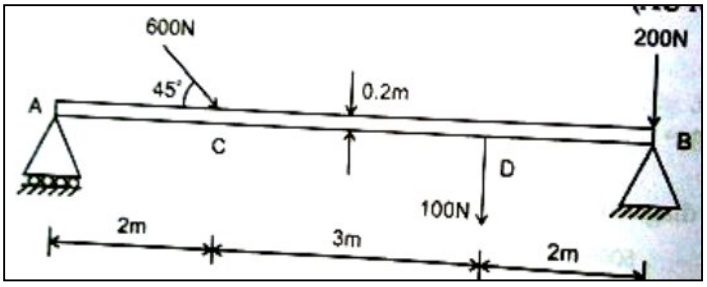
27. A beam AB 1.7m long is loaded as shown in Fig. Determine the reactions at supports A and B.



28. Find the reactions at the supports A and B of the beam shown in Fig.

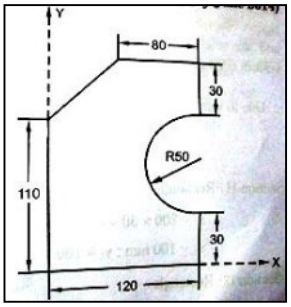


29. Determine the horizontal and vertical components of reaction for the beam loaded as shown in Fig. Neglect the weight of the beam in the calculations.

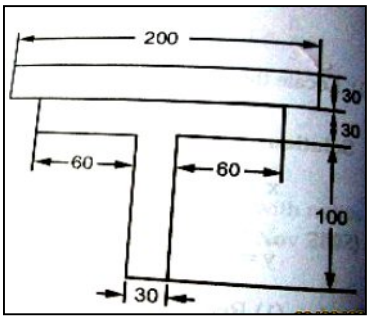


UNIT III PROPERTIES OF SURFACES AND SOLIDS

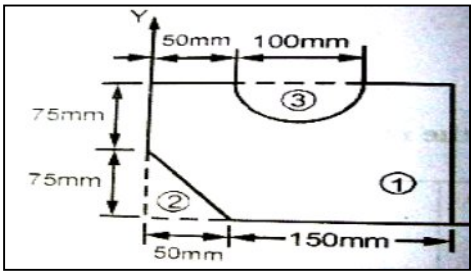
30. Locate the centroid of the area shown in Fig. The dimensions are in mm.



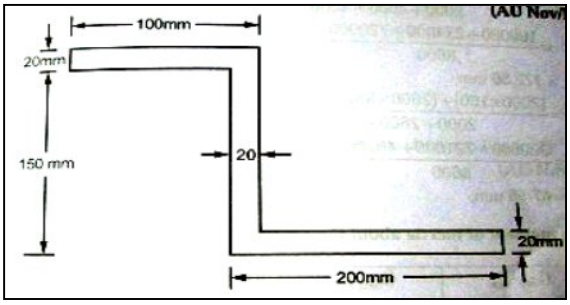
31. Find the moment of inertia of the built up section shown in Fig. about the axis passing through the centre of gravity parallel to the top flange plate.



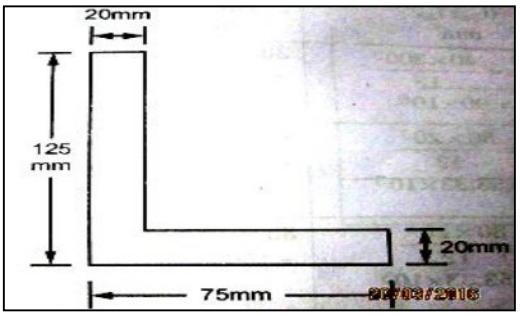
32. For the plane area shown below determine the area moment of inertia and radius of gyration about the X-axis.



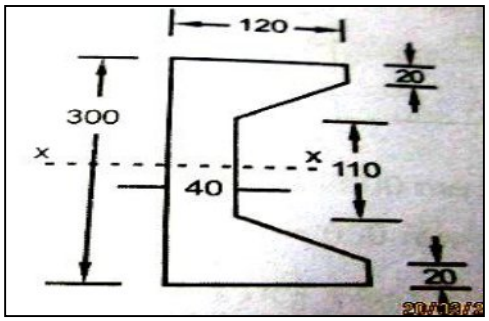
33. Determine the polar moment of inertia of the section shown in Fig.



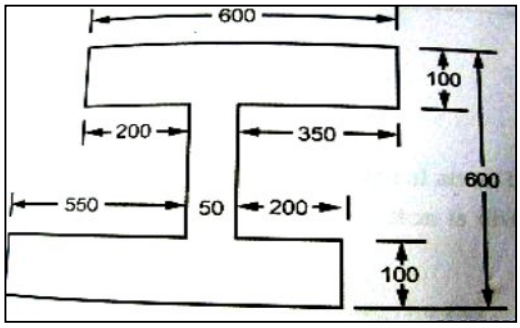
34. Determine the principal moments of inertia of the section shown in Fig.



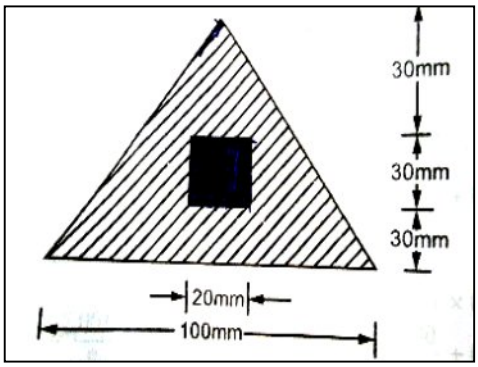
35. Find area moment of inertia about X-X axis of the channel section shown in Fig.



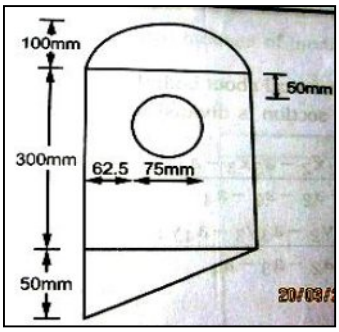
36. For the section shown in Fig. locate the horizontal and vertical centroidal axes. Dimensions are in mm.



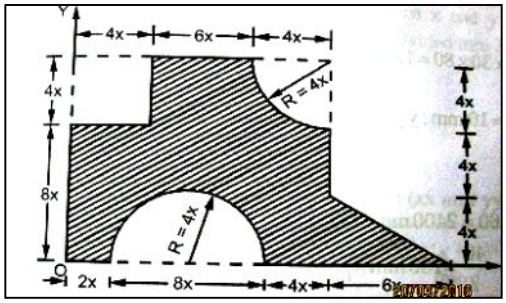
37. Find the moment of inertia of the shaded area shown in Fig. about the vertical and horizontal centroidal axes. The width of the hole is 200mm.



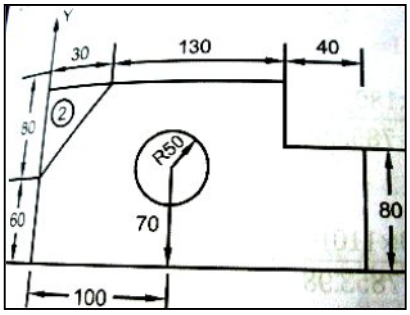
38. Determine the location of the centroid of the plane area shown in Fig.



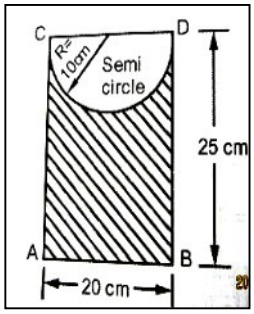
39. Determine the coordinates of the centroid of the plane area shown in Fig. with reference to the axis shown. Take x = 40mm.



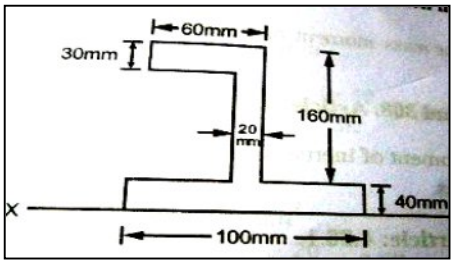
40. Find the Centroid of the plane area shown in Fig.



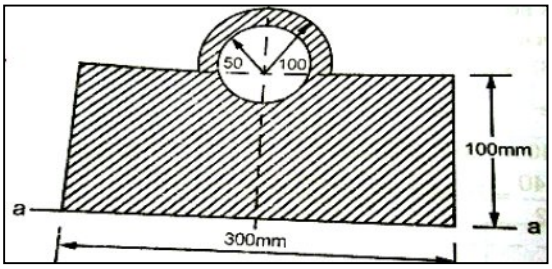
41. Determine the moment of inertia of the shaded shown in the following Fig.



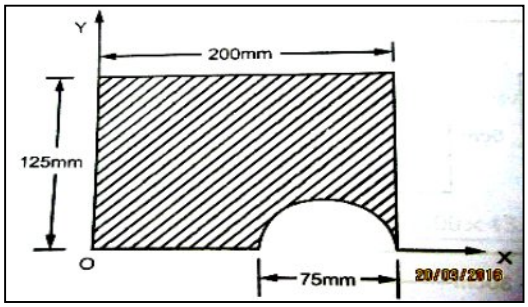
42. Find the second moment of area of the plane lamina shown in Fig. with respect to the given XX-axis.



43. Determine the second moment of area of the section shown in Fig. about its base axis a-a.

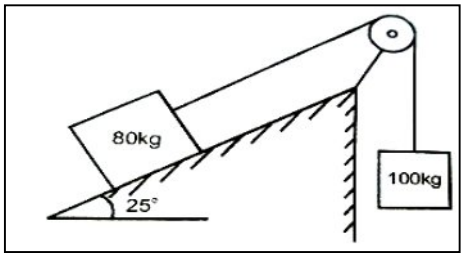


44. Determine the coordinates of the centroid of the shaded area shown in Fig. if the area removed is semicircular.

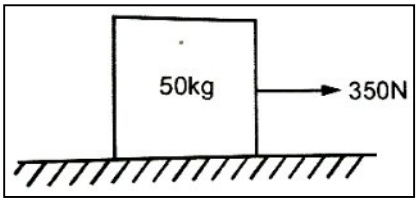


UNIT IV DYNAMICS OF PARTICLES

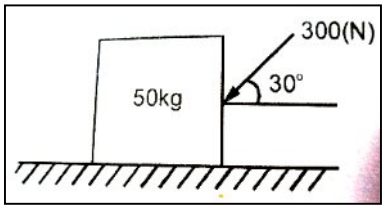
45. A block and pulley system is shown in Fig. The coefficient of kinetic friction between the block and the plane is 0.25. The pulley is frictionless. Find the acceleration of the blocks and the tensions in the string when the system is just released. Also find the time required for 100kg block to come down 2m.



46. The 50kg block shown in Fig. Rests on a horizontal place for which the coefficient of kinetic friction is 0.3, if the block is pulled by a 350N force as shown, determine the velocity of the block after it has moved 65m starting from rest. Use the principle of work and energy.

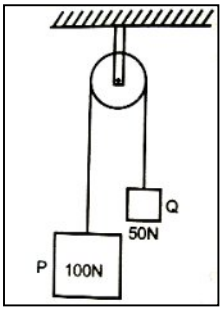


47. The 50kg block shown in Fig. is originally at rest on the smooth horizontal surface. Determine the time needed for the block to attain a velocity of 30m/s if a force of 300(N) is acting on the block as shown. Use principle of impulse and momentum.

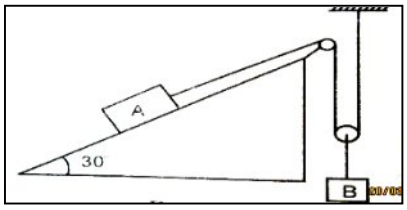


48. A car is moving with a velocity of 20m/sec. The car is brought to rest by applying brakes in 4 sec. Determine (1) the retardation and (2) distance travelled by the car after applying brakes.

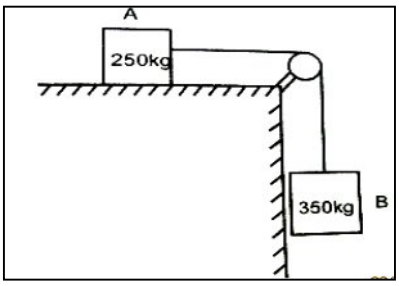
49. Block P of weight 100N and block Q of weight 50N are connected by a cord that passes over a smooth pulley as shown in Fig. Find the acceleration of the blocks and the tension in the cord when the system is released from rest. Neglect the mass of the pulley. Use the Principle of work and energy.



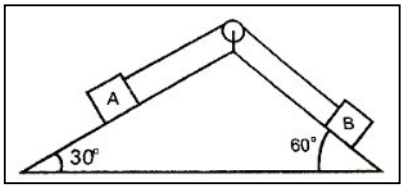
50. Block A and block B of weights 750N and 1500N respectively starts from rest as shown in Fig. The coefficient of friction between block. A and the surface of the inclined plane is 0.2. Determine the acceleration of each block and tensions in the wire assume the pulley to be weightless and friction less.



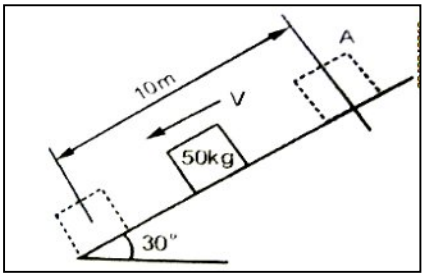
51. An inextensible string passing over a smooth pulley joins two blocks as shown in Fig. The blocks are released simultaneously from rest. Using work energy principle, determine the velocity of block A after it has moved over 2m and the tension in the string. Assume the coefficient of friction at the contact surface is 0.2. Confirm the result Impulse momentum principle also.



52. Two rough planes inclined at 30^o and 60^o to the horizontal and the same height are placed back to back. Masses of 12kg and 24kg are placed on the faces and are connected by a string passing over the pulley on the top of planes as shown in Fig. if $\mu = 0.6$ find the acceleration.



53. If a 50kg block shown in Fig. is released form rest at A, determine its speed after it slides 10m down the plane. Take the coefficient of friction as 0.3. Use principle of work and energy.

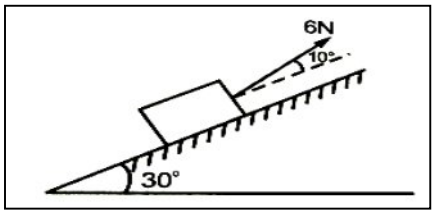


54. A car has weight of 15KN and is travelling horizontally at 20m/s. Determine the time needed to stop the car if the coefficient of friction between the tyres and the pavement is 0.6. Use principle of impulse and momentum.

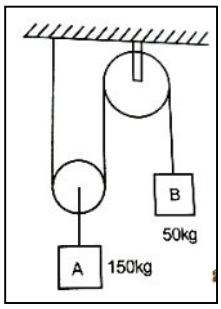
55. The velocity of particle is given by $v = 2t^3 + 6t^2$. Find the distance travelled by it while its velocity increases from 8m/s to 108m/s.

56. A car covers a distance of 30m in 3 seconds and 70m in 5 seconds. Find the initial velocity of the car and the acceleration assuming it to be uniform.

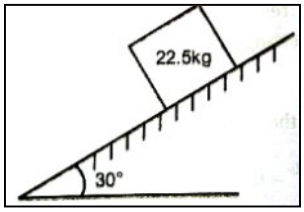
57. A mass of 1kg is pulled up a smooth plane by a 6N force, acting at an angle of 10^o to the plane surface as shown in Fig. If the mass is not loosing its contact with the plane, determine i) the normal reaction offered by the plane on the mass. ii) the acceleration of the mass along the plane.



58. In the Fig. Two masses A and B are connected by a rope and pulley system as shown. The masses are released from rest. Assuming pulleys are frictionless and weightless, determine i) tension in the rope ii) acceleration of the masses A and B.



59. A 22.5kg body is projected up a 30^o plane with initial speed of 6m/s. If the coefficient of friction is 0.25, determine the time required for the body to have an upward speed of 3m/s.

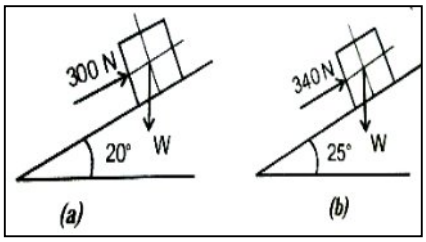


UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS

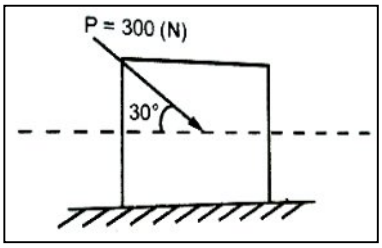
60. A pull of 20N, inclined cat 25^o to the horizontal plane, is required just to move a body placed on a rough horizontal plane. But the push required to move the body is 25N. If the push inclined at 25^o to the horizontal, find the body and coefficient of friction.

61. A pull of 250N at 25^o to the horizontal plane is required just to move a body kept on a rough horizontal plane. But the push required just to move the body is 300 N. If the push is inclined at 25^o to the horizontal, find weight of the body and the coefficient of friction between the body and the plane.

62. A force of 300N is required just to move a block up a plane inclined at 20^o to the horizontal, the force being applied parallel to the plane Fig. If the inclination of the plane is increased to 25^o, the force required just to move the block up is 340N, (the force is acting parallel to the plane). Determine the weight of the block and the coefficient of friction.

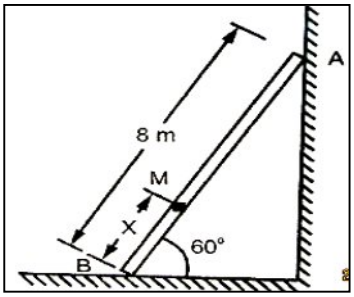


63. Calculate the static coefficient of friction μ_s between the block shown in Fig. having a mass of 75kg and the surface. Also find the magnitude and direction of the friction force if the force P applied is inclined at 45^o to the horizontal and $\mu_s = 0.30$.

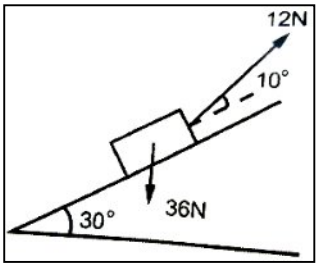


64. A body resting on a rough horizontal plane required a pull of 180N inclined at 30^o to the plane just to move it. It was found that push of 220N inclined at 30^o to the plane just moved the body. Determine the mass of the body and the coefficient of friction.

65. A ladder 8m long weighing 200N is resting against a vertical wall as shown in Fig. A man of 720N climbs the ladder at M. At what position the slipping will be induced? Take the coefficient of friction for all surfaces 0.25.

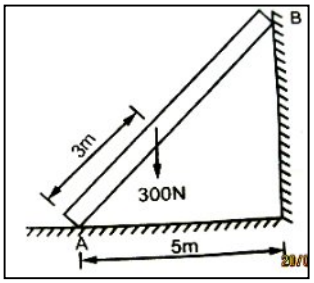


66. A block weighing 36N is resting on a rough inclined plane having an inclination of 30^o. A force of 12N is applied at an angle of 10^o up the plane and the block is just to the point of moving down the plane. Determine the coefficient of friction.



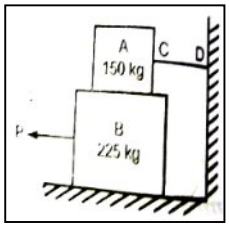
67. A ladder 4m long leans against a smooth vertical wall at an angle 60^o with the horizontal. The weight of the ladder is 700N. When a person weighing 600N stands on a ladder 1.2m from the bottom of the ladder, the ladder is just about to slide. Calculate the coefficient of friction between the ladder and the floor.

68. A ladder is 8m long weighs 300N. The centre of gravity of the ladder is 3m along the length of ladder from the bottom end. The ladder rests against a vertical wall at B and on the horizontal floor at A as shown in Fig. Determine the safe height to which a man weighing 900N can climb without making the ladder slip. The coefficient of friction between

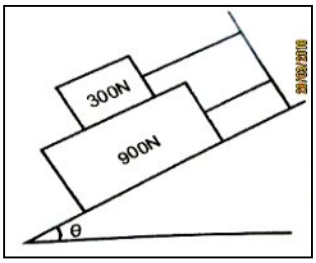


ladder and floor is 0.4 and ladder top and wall is 0.3.

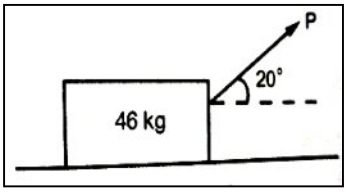
69. Determine the smallest force P required to move the block B shown in Fig, If i) Block A is restrained by cable CD as shown in fig. and ii) Cable CD is removed. Take $\mu_s = 0.3$ and $\mu_k = 0.25$. What should be the value of Θ in Fig. which will make the motion of 900N block down the plane to impend? The coefficient of friction for all contact surfaces is 1/3.



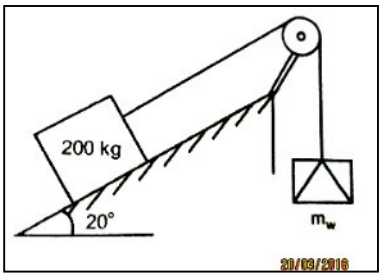
70. What should be the value of Θ in Fig. which will make the motion of 900N block down the plane to impend? The coefficient of friction for all contact surfaces is 1/3.



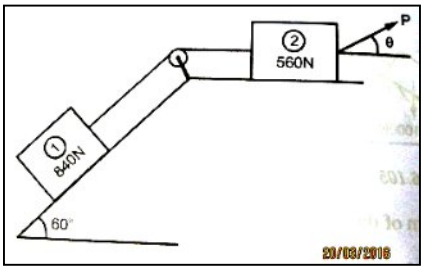
71. A body having mass of 46kg rests on a horizontal plane as shown in Fig. for which $\mu = 0.4$. A force P acts on the body at an angle of 20^o with the horizontal. Find its magnitude for impending motion.



72. Determine the maximum and minimum values of m_w so that the 200kg block shown in Fig. will neither start moving up the 20^o incline nor slip down the incline. Take the coefficient of static friction for the contact surfaces as 0.30.



73. Determine the least value of 'P' required to cause the motion impend the system shown in Fig. Assume coefficient of friction on all contact surfaces as 0.2.



74. Two masses m_1 and m_2 are tied together by a rope parallel to the inclined plane surface as shown in Fig. Their masses are 22.5kg and 14kg respectively. The coefficient of friction between m_1 and the plane is 0.25, while that of mass m_2 and the plane is 0.5. Determine (i) the value of the inclination of the plane surface Θ for which the masses will just start sliding (ii) the tension in the rope.