Code No: RR10302 **Set No.1**

**I B.Tech. Supplementary Examinations, November/December -2005**
**ENGINEERING MECHANICS**
**( Common to Mechanical Engineering,Mechatronics,Metallurgy & Material Technology,Production Engineering and Aeronautical Engineering)**
**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

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1. A bar AB hinged to the foundation at A and supported by a strut CD is subjected to a horizontal 50 kN load at B, as shown in Figure1. Determine the nature and magnitude of the force in the strut and also the reaction at A. [16]

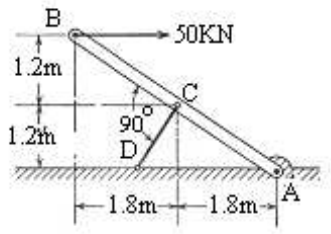


Figure 1:

2. (a) Two blocks having weights $W_1$ and $W_2$ are connected by a string and rest on horizontal planes as shown in figure2. If the angle of friction for each block is $\phi$, find the magnitude and direction of the least force 'P' applied to the upper block that will induce sliding.

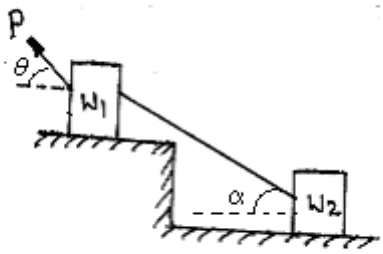


Figure 2:

(b) A 1000N block is raised by forcing a wedge under it as shown in figure3. Determine the minimum value of the force 'P' which must be applied to the wedge. $\mu = 0.3$ at all surfaces of contact. [8+8]

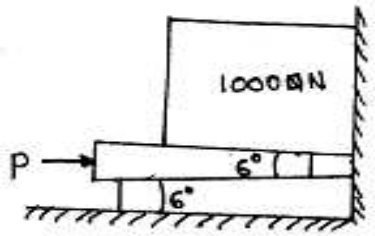


Figure 3:

3. (a) Derive an expression for length of an open belt in standard form.
   (b) A belt is running over a pulley of diameter 1200 mm at 200 r.p.m. The angle of contact is $165^0$ and coefficient of friction between the belt and pulley is 0.3 If the maximum tension in the belt is 3000N, find the power transmitted by the belt. [8+8]

4. (a) From first principles deduce an expression to determine the centroid of a triangle of base ' b' and height ' h'
   (b) Determine the centroidal co-ordinates of the shaded area as shown in figure4. [8+8]

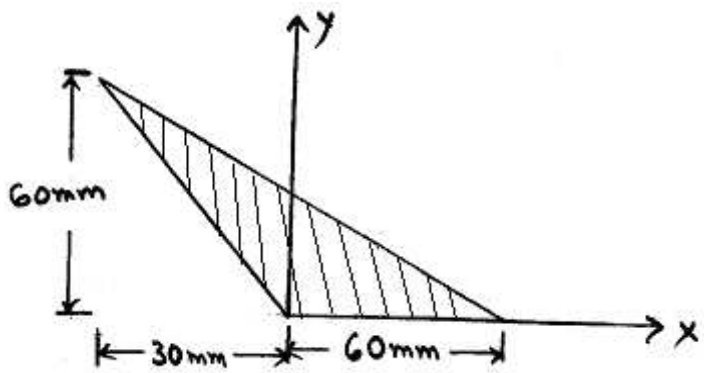


Figure 4:

5. (a) Define mass moment of inertia and explain Transfer formula for mass moments of inertia
   (b) Derive the expression for the moment of inertia of a homogeneous sphere of radius 'r' and mass density' w' with reference to its diameter. [8+8]

6. (a) A stone is thrown from the top of a building upward at an angle of $40^0$ with the horizontal with an initial speed of 30m/s. The height of the building above ground level is 30m. Determine
      i. The horizontal distance from the point of projection to the point where the stone strikes the ground.

ii. The greatest height reached by the stone above the ground level.
iii. The velocity with which the stone strikes the ground
iv. Time of flight.

(b) A flywheel which is at rest attains a constant speed of 300 rpm after accelerating uniformly for 10 seconds. Determine the number of revolutions made by the flywheel during the period. [8+8]

7. (a) A right circular cylindrical drum rotates at an angular speed of 600 rpm,. It is braked by a bar pulled by a force of 12N as shown in the figure5. If the radius of the cylinder 0.35m, with a weight of 445N, find the number of revolutions it will make before coming to rest. Also find the time required for the drum to come to rest. Weight of the drum is1800N and a=0.70m

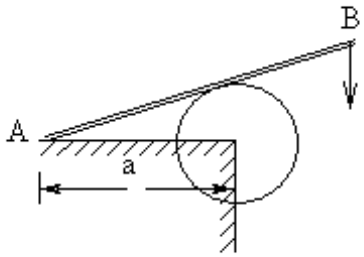


Figure 5:

(b) A homogeneous sphere of radius r =0.30m and weight of 180N rotates about a vertical diameter with initial angular velocity $\omega$=20$\pi$ /sec and is braked by the device shown in figure6. Neglecting friction in bearings, determine the time required for the brake to bring the sphere to rest, if the coefficient of friction at 'B' is 1/3 and P=45N. [8+8]

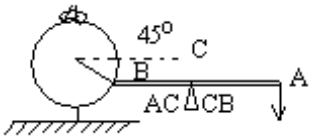


Figure 6:

8. A small ball of weight 'W' is attached to the middle of a tightly stretched perfectly flexible wire AB of length 2$l$, connected between two horizontal rigid surfaces. (arrangement is vertical). Prove that for small lateral displacements and high initial tension in the wire, the ball will have a simple harmonic motion, and calculate the period. [16]

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Code No: RR10302 **Set No.2**

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1. Find the reactions $R_a$ and $R_b$ induced at the supports A and B of the right-angle bar ACB supported as shown in Figure7 and subjected to a vertical load P applied at the mid-point of AC. [16]

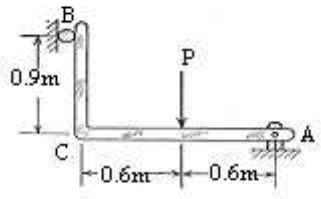


Figure 7:

2. (a) Two blocks, connected by a horizontal link AB are supported on two rough planes as shown in Figure8. The coefficient for friction of block A on the horizontal plane is $\mu = 0.4$. The angle of friction for block B on the inclined plane is $\varphi = 15^0$. What is the smallest weight W of block A for which equilibrium of the system can exist?

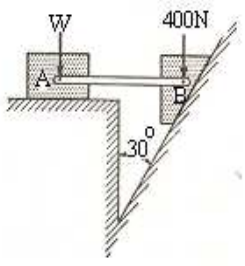


Figure 8:

(b) Two blocks of weight $W_1$ and $W_2$ rest on a rough inclined plane and are connected by a short piece of string as shown in Figure9. If the coefficients of friction are $\mu_1 = 0.2$ and $\mu_2 = 0.3$, respectively, find the angle of inclination of the plane for which sliding will impend. Assume $W_1 = W_2 = 5$ N. [8+8]

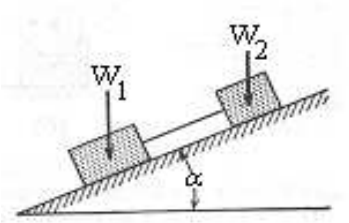


Figure 9:

3. (a) What are the assumptions to be made to derive an expression for the limiting ratio of tension?

   (b) In flat belt, the intial tension is 1800N. The angle of lap on the smaller pulleys is $170^0$. The coefficient of friction between the belt and pulley surface is 0.25. Diameter of pulley is 900mm and it runs at 450 r.p.m. Determine the power that can be transmitted at the above speed Neglect the effect of centrifugal tension. [8+8]

4. (a) Locate the centroid of given parabola bounded by x- axis the line x = a. {As shown in the Figure10}

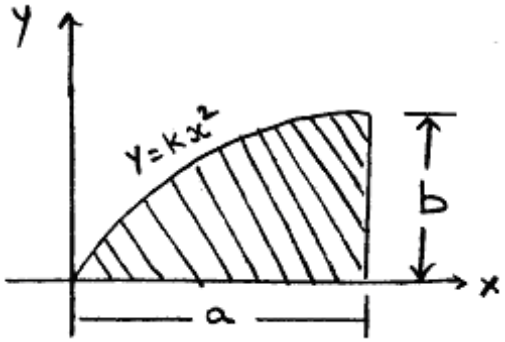


Figure 10:

   (b) Locate the centroid of the wire bent as shown in figure11. [8+8]

5. (a) Determine mass moment of inertia of slender rod of length 'L' about its centroidal axis normal to the rod.

   (b) Derive the expression for mass moment of inertia of a cone of height 'h' and base radius 'r' and mass density 'w' with respect to its geometric axis. [8+8]

6. (a) A railway car is moving with a velocity of 20m/s. The diameter of the wheel is 1m. The wheel is running on a straight rail without slipping. Find the velocity of the point on the circumference at $60^0$ in the clockwise direction from the top at any instant.

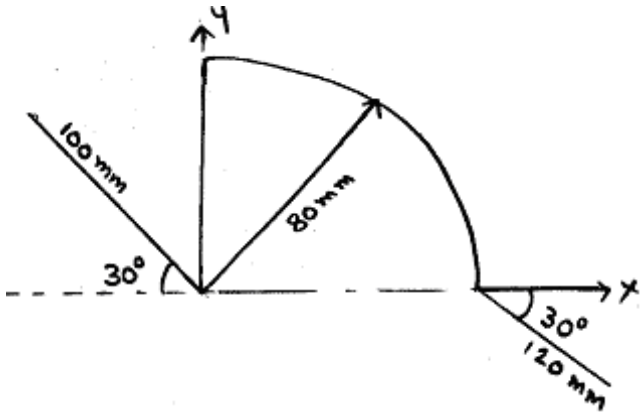


Figure 11:

(b) A 600mm diameter flywheel is brought uniformly from rest to a speed of 350rpm in 20 seconds. Determine the velocity and acceleration of a point on the rim 2 seconds after starting from rest. [8+8]

7. (a) An automobile moving with a uniform velocity of 40Kmph is accelerated by increasing the traction force by 20%. If the resistance to motion is constant, find the distance traveled before it acquires 50Kmph.Use work-energy method.

   (b) A solid cylinder and a sphere are started top of an inclined plane, at the same time, and both roll without slipping down the plane. If, when the sphere reaches the bottom of incline, the cylinder is 12m, what is the total length 'S' of the incline? [8+8]

8. Two springs of stiffness $k_1$ and $k_2$ are connected in series. Upper end of the compound spring is connected to a ceiling and lower end carries a load 'W'. Find the equivalent spring stiffness of the system. If the above two springs are connected in parallel then find the equivalent spring stiffness of the system also. [16]

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Code No: RR10302 **Set No.3**

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1. (a) State and prove lamis theorem of 7m long.
   (b) A prismatic bar AB is hinged at A and supported at B as shown in Figure12. Neglecting friction, determine the reaction $R_b$ produced at B owing to the weight Q of the bar. [8+8]

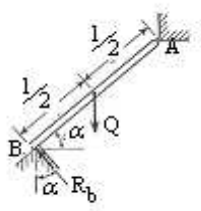


Figure 12:

2. (a) A body resting on a rough horizontal plane required a pull of 82N inclined at $30^0$ to the plane just to move it. It was found that a push of 100N inclined at $30^0$ to the plane just moved the body. Determine the weight of the body and the coefficient of friction.
   (b) Two blocks A and B of weight 100N and 300N respectively are resting on a rough inclined plane as shown in figure13. Find the value of angle ($\alpha$) when the block 'B' is about to slide. Take coefficient of friction between the two blocks as well as block B and the inclined plane as 0.25 [8+8]

3. (a) Derive an expression for length of a crossed belt in standard form.
   (b) An engine drives a shaft by means of a belt. The driving pulley of the engine is 3 meters and that in the shaft 2 meters diameter. If the engine runs at 150.r.p.m. what will be the speed of the shaft when. [8+8]
      i. there is no slip
      ii. there is a slip of 3% ?

4. (a) Derive an expression to determine moment of inertia of a semi circular about its diametric base.
   (b) Find the moment of inertia of the shaded area. As shown in figure14 about 9its centroidal axes parallel to x-axis. [8+8]

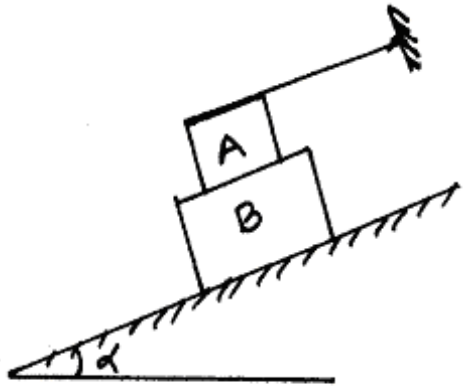


Figure 13:

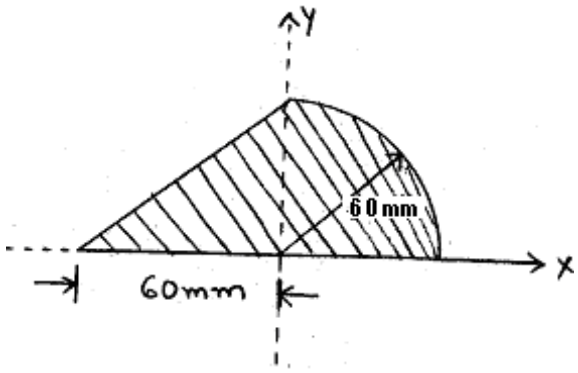


Figure 14:

5. (a) Show that the moment of inertia of a thin circular ring of mass M and mean radius R with respect to its geometric axis is $MR^2$.

   (b) 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. [8+8]

6. (a) A particle moves along straight line. Its motion in represented by the equation $S = 16t + 4t^2 - 3t^3$ where S is in metres and t, in seconds. Determine

      i. displacement, velocity and acceleration 2 seconds after start.

      ii. displacement and acceleration when velocity is zero and

      iii. displacement and acceleration when acceleration is zero.

   (b) A projectile is aimed at a target on the horizontal plane and falls 12m short when the angle of projection is $15^0$ while it overshoots by 24m when the angle is $45^0$. Find the angle of projection to hit the target. [8+8]

7. (a) A solid cylinder and a thin hoop of equal masses 'm' and radii 'r' are connected by a bar . The system rolls down the inclined plane without slipping. Find the acceleration of the system and the tension in the bar.
   {As shown in the Figure15}

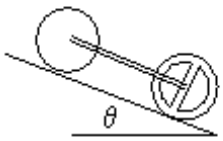


Figure 15:

   (b) A car of mass 800kgs traverses an unbanked curve of 150m radius to 60Kmph. The wheel base width is 2m and the centre of gravity of the car is 500mm above the road. Calculate the normal reaction at each wheel. [8+8]

8. Two springs of stiffness 200N/m are attached to a ball of weight 5N as shown in the (figure16). If the ball is initially displaced by 2.5cm to the left and released, find the period of oscillation of the ball. Find also the velocity of the ball when it passes through the middle position. [16]

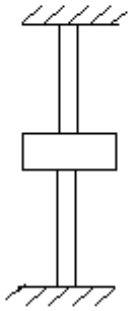

Figure 16:

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Code No: RR10302 **Set No.4**

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1. (a) A ladder supported at A and B, as shown in figure17, a vertical load W can have any position as defined by the distance 'a' from the bottom. Neglecting friction, determine the magnitude of the reaction $R_b$ at B. Neglect the weight of the ladder.

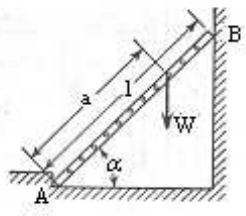


Figure 17:

(b) A rigid bar AB is supported in a vertical plane and carries a load Q at its free end as shown in figure18. Neglecting the weight of the bar itself, compute the magnitude of the tensile force S induced in the horizontal string CD. [8+8]

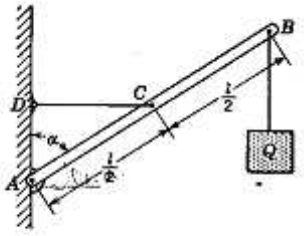


Figure 18:

2. (a) Referring to the figure19, 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.

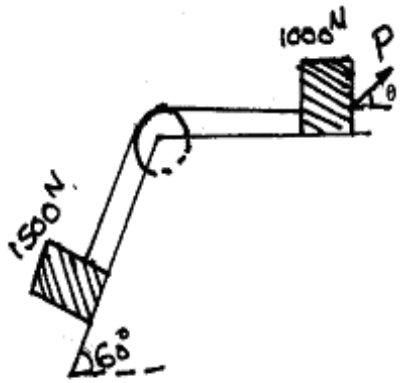


Figure 19:

(b) A block of weight $W_1$=1000N rests on a horizontal surface and supports on top of it another block of weight $W_2$ =250N as shown in figure20. The block $W_2$ is attached to a vertical wall by the inclined string AB. Find the magnitude of the horizontal force 'P' applied to the lower block as shown, that will be necessary to cause slipping to impend. The coefficient of static friction for all contact surfaces is $\mu$=0.3. [8+8]

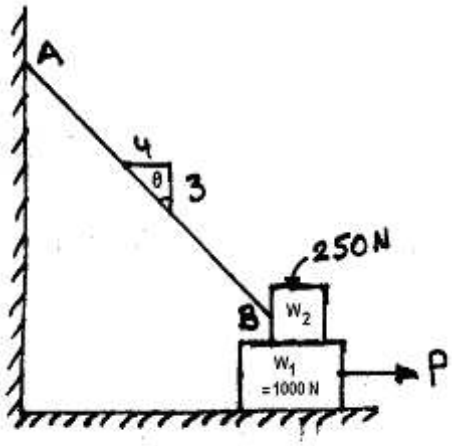


Figure 20:

3. (a) Show that the maximum power can be transmitted at $T_{max} = 3\ T_c$

(b) A belt embraces the shorter pulley by an angle of $165^0$ and runs at a speed of 1700m/min. Dimensions of the belt are width = 200mm and 8mm thickness. It weight 1000 $kg/m^3$. Determine the maximum power that can be transmitted at the above speed, if the maximum permissible stress in the belt is not to exceed $2.5N/mm^2$ and $\mu = 0.25$. [8+8]

4. (a) Deduce an equation for moment of inertia of right circular solid cone about its generating axes of base radius 'R' and altitude 'h'

   (b) Locate the centroid of a shaded area as shown in figure21. [8+8]

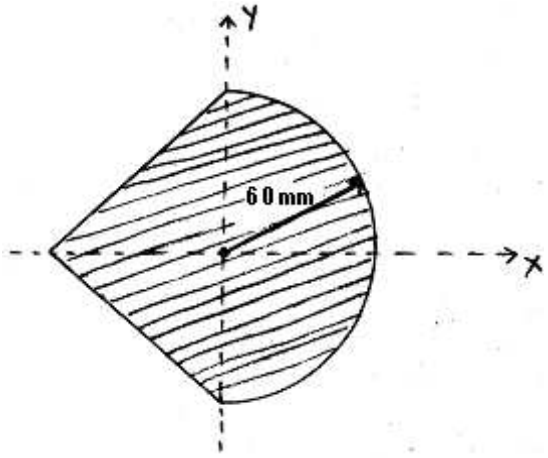


Figure 21:

5. (a) Prove that the mass moment of inertia of a right circular cone of base radius R and height h, with respect to a diameter of the base is $M(3R^2 + 2h^2)/20$ where M is the mass of the cone.

   (b) Calculate the mass moment of inertia of a circular cone of base radius 300mm and height 600mm about a line which passes through the mass centre of the cone and which is parallel to the base of the cone. The mass density of the cone is 2500 $kg/m^3$ [8+8]

6. (a) The motion of a disk rotating about a fixed point is given by the relation $\theta = 2(1 + e^{-3t})$ where $\theta$ is in radians and 't' is in seconds. Determine the angular coordinates, velocity and acceleration of the disk when

      i. t=0 and

      ii. t=2secs.

   (b) A projectile is aimed at a mark on the horizontal plane through the point of projection and falls 12m short when the angle of projection is $15^0$ while it overshoots the mark by 24m when the angle of projection is $45^0$. Find the angle of projection to hit the mark neglecting the resistance of air. Take g = 9.81 $m/s^2$. [8+8]

7. (a) A weight 'P' attached to the end of a flexible rope of diameter d=5mm, is raised vertically by winching the rope on a reel. The reel is turned uniformly at the rate of 2 revolutions per second. Find the tension in the rope. Neglect the inertia of the rope and the lateral motion of the weight 'P'.
   {As shown in the Figure22}

   (b) A right circular cylinder of radius 'r' and weight 'W' is suspended by a cord that is wound around its surface. If the cylinder is allowed to fall, prove that

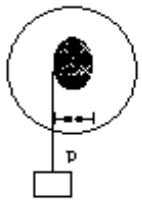


Figure 22:

the center of gravity 'C' will follow a vertical rectilinear path and find the acceleration '$a_c$' along this path. Determine also the tensile force 'S' in the cord. {As shown in the Figure23} [8+8]

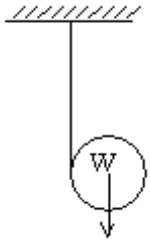


Figure 23:

8. A homogeneous rectangular plate is free to rotate with respect to a fixed axis AB coinciding with one of its edges, along the side of length b=1.25m and inclined to the vertical by an angle $\alpha = 20^0$. Determine the period of small rotational oscillations if the length of the other side a=0.90m. [16]

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