Code :9A01101

B.Tech I Year (R09) Regular & Supplementary Examinations, May/June 2011
ENGINEERING MECHANICS
(Common to Aeronautical Engineering, Biotechnology, Civil Engineering, Mechanical Engineering, Mechatronics)

Time: 3 hours **Max Marks: 70**

Answer any FIVE questions
All questions carry equal marks

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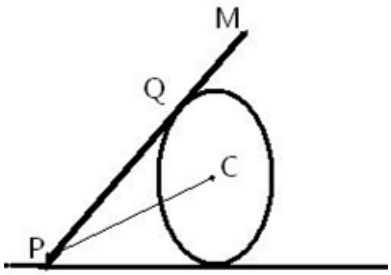
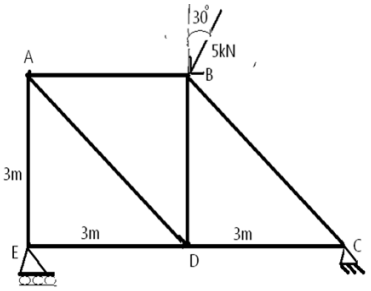
1. A smooth right circular cylinder of radius 16cm rests on horizontal plane and is kept from rolling by an inclined string PC of length 32cm. A prismatic bar PQM of length 48cm and weight 530N is hinged at P and leans against the cylinder, as shown in fig. Determine the tension in the string PC.



2. Find the axial forces of simply supported frame as shown in the below figure.



3. A screw jack raises a load of 40 KN. The screw is square threaded having 3 threads per 20 mm length and 40 mm in diameter. Calculate the force required at the end of a lever 400 mm long measured from axis of screw, if coefficient of friction between screw and nut is 0.12.

4. (a) To determine centriod for the rectangle lamina, having a width of"b" and height of "h"
   (b) To determine the centriod for triangular lamina, having a base "b" and height "h".

5. (a) Define mass moment of inertia and explain transfer formula for mass moment of inertia.
   (b) Determine the mass moment of inertia of slender rod of length 'l' about its centroidal axis normal to the rod.

6. (a) An electric train which starts from one station is uniformly accelerated for the first 10 seconds during which period it covers 150 m. It then runs with constant speed until it is finally retarded uniformly in the last 40 m. Calculate the maximum speed and the time taken over the journey to the next stopping station which is 600 m from the previous station.
   (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 speed.

7. (a) What is the advantage of work-energy theorem?
   (b) A shaft of radius 'r' rotates with constant angular speed 'w' in bearings for which are coefficient of friction is μ. Through what angle '$\emptyset$' will it rotate after the driving force is removed.

8. (a) Differentiate between free and damped vibrations
   (b) The amplitude of a simple harmonic motion is 0.5 m and the period is 1 sec. Determine the max. velocity and max. acceleration.

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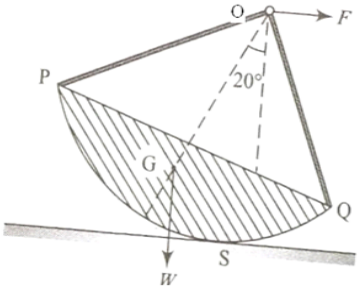
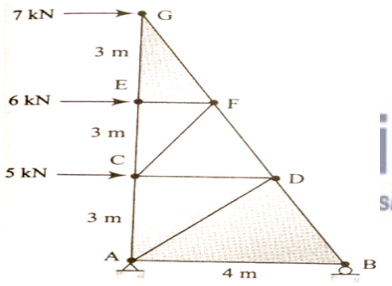
1. A rocker of weight 20kg has a circular shoe of radius 45cm rests on smooth horizontal floor at S and is pulled by a force F. If the position of the equilibrium is defined by an angle 20^0 [show in figure below], determine the equilibrant force F. Take OG = 29cm.



2. Compute the induced axial forces in all the members of the loaded frame as shown in the below figure.



3. A block weighing 100 N is resting on a rough plane inclined 20 degrees to the horizontal. It is acted upon by a force of 50N directed upward at angle of 14^0 above the plane. Determine the friction. If the block is about to move up the plane, determine the co-efficient of friction

4. A steel ball of diameter 150 mm rests centrally over a concrete cube of size 150mm. Determine the center of gravity of the system, taking weight of concrete=25000N/m^2 and that of steel 80000N/m^2.

5. Derive the expression for mass moment of inertia of a homogeneous sphere of radius 'r' and mass density 'w', with reference to its diameter.

6. (a) A train is uniformly accelerated and passes successive kilometer stones with velocities of 18 Kmph and 36 Kmph respectively. Calculate the velocity when it passes the third kilometer station. Also find the time taken for each of the two intervals of one kilometer.
   (b) A homogeneous sphere of radius of a = 100 mm and weight W = 10 N Can rotate freely about a diameter. If it starts from rest and gains with constant angular acceleration, angular speed N = 180 rpm, in12 revolutions, find the action moment.

7. (a) What is the energy of the motion for a rigid body rotating about a fixed axis?
   (b) A 70 kg sprinter starts from rest and accelerate uniformly for 5.8 s over a distance of 34.5 m. Neglecting air resistance, determine the average power developed by the sprinter.

8. A particle is moving in SHM has a frequency of 10 oscillations per minute. At a distance of 8 cm from the mean position, its velocity is 3/5 th of the max. velocity. Find the:
   (a) Amplitude oscillations.
   (b) Max. acceleration.
   (c) Velocity of the particle. When it is at a distance of 5 cm from mean position.

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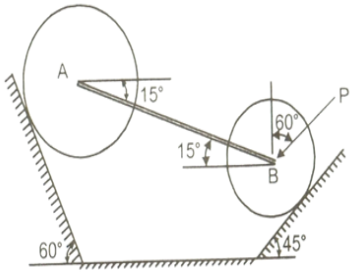
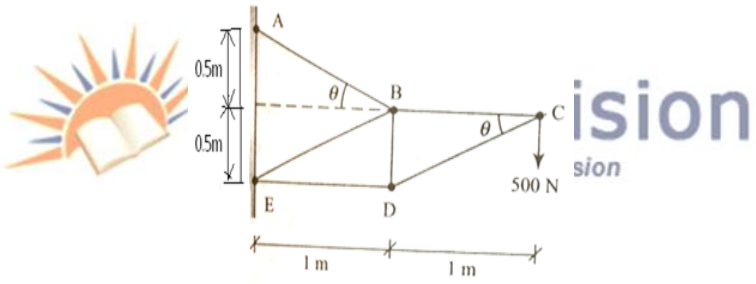
1. Two cylinders, A of weight 4000 N and B of weight 2000 N rest on smooth inclines as shown in fig. Below .they are connected by a bar of negligible weight hinged to each cylinder at its geometric center by smooth pins. Find the force P to be applied as shown in figure such that it will hold the system in the given position.



2. Determine the axial forces in the members of plane frame as shown in the below figure.



3. (a) Explain the working principle of screw jack with neat sketch.
   (b) Explain laws of friction.

4. A steel cylinder of diameter 200 mm and height of 300mm rests centrally over a concrete rectangle of 1000 X 800 X 600 mm size. Determine the center of gravity of the system, taking weight of concrete=28500N/m^2 and that of steel 81000N/m^2 .

5. 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 geometrical axis.

6. (a) The distance covered by a freely falling body in the last one second of its motion and that covered in the last but one second are in the ratio 5:4. Calculate the height from which the body was dropped and the velocity with which it strikes the ground.
   (b) A ball projected vertically upward attains a maximum height of 400 m. Calculate the velocity of projection and compute the time of flight in air. At what altitude will this ball meet a second ball projected vertically upward 4 seconds later with a speed of 120 m/sec.

7. A solid cylinder of weight 'w' and radius 'r' rolls, down an inclined plane which makes an angle θ with the horizontal axis. Determine the minimum coefficient of friction and the acceleration of the mass center for rolling, without slipping.

8. A particle with a simple harmonic motion has an amplitude of 375 mm and a period of $\pi/2$ sec. Find the velocity and acceleration of the particle when it has traveled 225 mm to the right of the center of its path. What time is required for this displacement?

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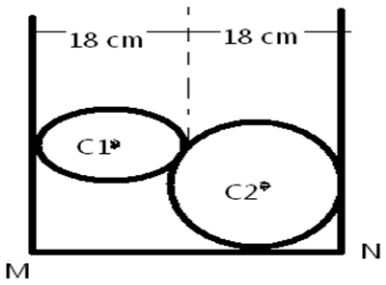
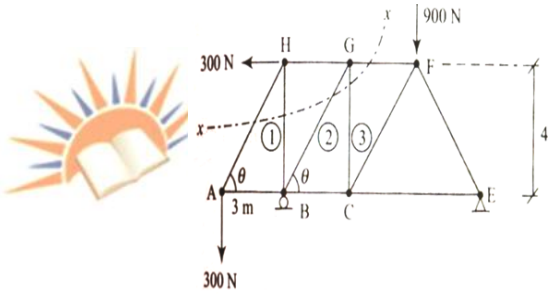
1. Two balls of weight 100kg and 150 kg having radius 10cm and 15 cm, respectively, are placed one above another inside a hallow circular cylinder of radius 18cm, open at both ends, as shown in fig. Neglecting the effect of friction, determine the self weight of cylinder so that it will not tip over.



2. Using method of section, find the forces in BH, BG and CG of the given frame as shown in the below figure.



3. Write short notes on:
(i) Cone friction (ii) Rolling friction (iii) Limiting friction (iv) Condition for self locking in a simple screw jack.

4. Determine the center of gravity of solid hemisphere of radius 'r' from the diametral axis.

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 the mass moment of inertia of a right circular cone of base radius 'R' and mass 'M' about the axis of the cone.

6. (a) A fighter plane is directly over an aircraft gun at time t = 0 and an altitude of 1800m. The plane is moving with a speed of 600 Kmph. A shell is fired at a time t = 0 in an attempt to hit the plane. If the muzzle velocity is 1000m/sec, Find out the angle at which the gun should be held.
   (b) A 600 mm diameter flywheel is brought uniformly from rest to a speed of 350 rpm in 20 seconds. Determine the velocity and acceleration of a point on the rim 2 seconds after starting from rest.

7. (a) State the principle of the conservation of momentum.
   (b) A golfer hits a 46 g ball with an initial velocity of 48 m/sec at an angle of 24^0 with the horizontal. Determine:
   (i) The initial KE of the ball (ii) The KE of the ball when it reaches its max. height.

8. A simple pendulum is suspended from the roof of an elevator which is accelerating at 'a' m/sec^2. Assuming that the vibrations are small, determine the period of oscillation of the pendulum when the elevator is
(i) Accelerating upward (ii) Accelerating downward (iii) Falling freely.

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