Code :9A01101

1

B.TECH. I Year(R09) Regular Examinations, May/June 2010
ENGINEERING MECHANICS
(Common to Aeronautical Engineering, Biotechnology, Civil Engineering, Mechanical Engineering)
Time: 3 hours **Max Marks: 70**

Answer any FIVE questions
All questions carry equal marks
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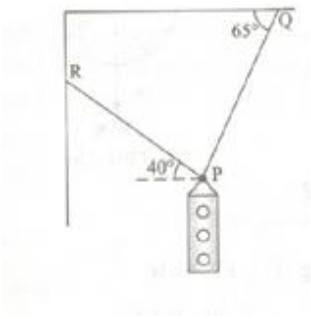
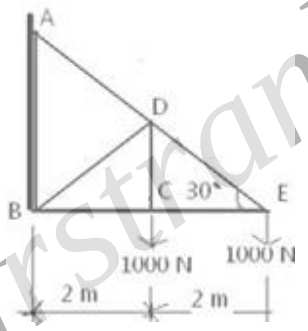
1. A traffic signal of mass 50kg is hung with the help of two strings, as shown in fig. below. Find the forces induced in both the strings.



2. For the frame AEDCB as shown in the below figure, determine the induced axial forces in members AE, BE and BC.



3. (a) Explain the principles of operation of a screw-jack with a neat sketch.
   (b) Outside diameter of a square threaded spindle of a screw jack is 40mm. The screw pitch is 10mm. If the coefficient of friction between the screw and the nut is 0.15, neglecting friction between the nut and collar, determine
   i. Force required to be applied at the screw to raise a load of 2000N,
   ii. The efficiency of screw jack,
   iii. Force required to be applied at pitch radius to lower the same load of 2000N and
   iv. Efficiency while lowering the load,
   v. What should be the pitch for the maximum efficiency of the screw and what should be the value of the maximum efficiency.

4. (a) Determine the centroid of the quarter circle whose radius is R.
   (b) Determine centroid of semicircle whose radius is R.

5. (a) Define the terms centroid, moment of inertia and radius of gyration.
   (b) Find the area moment of inertia of an equilateral triangle of side 'a' with respect to one of its side.

6. (a) A stone dropped into well is heard to strike the water in 3.5 sec. Find the depth of the well assuming the velocity of the sound is 335 m/sec.
   (b) Maximum range of a field gun is 2000 m. If a target at a distance of 1200 m is to be hit, what should be the angle of projection?

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) Explain how a simple pendulum differs from a compound pendulum, briefly with the help of differential mathematical equations.
   (b) Determine the stiffness in N/cm of a vertical spring to which a weight of 50 N is attached and is set vibrating vertically. The weight makes 4 oscillations per second.

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Answer any FIVE questions
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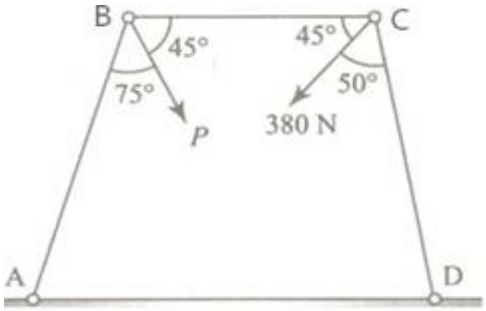
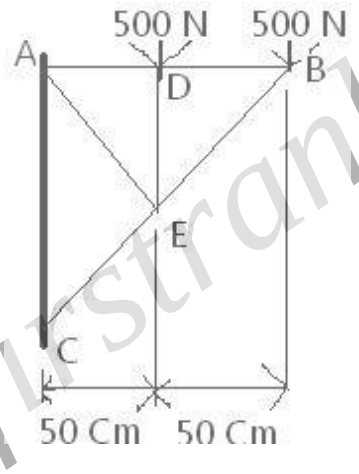
1. In the four bar mechanism ABCD, as shown in fig. below, determine the force P for equilibrium.



2. Find the axial forces in each member of the loaded frame ADBEC as shown in the below figure.



3. (a) Explain the types of friction with examples.
   (b) Two equal bodies A and B of weight 'W' each are placed on a rough inclined plane. The bodies are connected by a light string. If $\mu_A = 1/2$ and $\mu_B = 1/3$, show that the bodies will be both on the point of motion when the plane is inclined at $\tan^{-}1$ (5/12).

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

5. (a) Explain the terms:
   (i) Moment of inertia
   (ii) Polar moment of inertia
   (iii) Product of inertia
   (b) Find the maximum and minimum moments of inertia with respect to axes through the centroid of the 9 cm by 6 cm triangular area.

6. (a) A particle under a constant deceleration is moving in a straight line and covers a distance of 20 m in first two seconds and 40 m in the next 5 seconds. Calculate the distance it covers in the subsequent 3 seconds and total distance covered, before it comes to rest.
   (b) Deduce the general expression to determine the maximum height and horizontal range of projectile.

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 'Ø' will it rotate after the driving force is removed.

8. Derive an expression for the equation of motion of a simple pendulum employing the principle of conservation of energy. Also find the frequency and time period.

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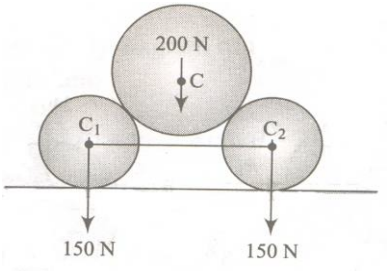
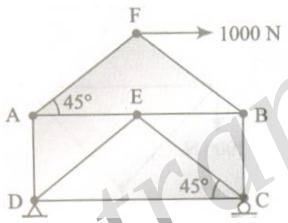
1. Two identical iron spheres each of radius 5cm and weight 150 N is connected with a string of length 16cm, and rest on a horizontal smooth floor. Another sphere of radius 6cm and weight 200N rest over them. Determine the tension in the string and reaction at all contact surfaces [shown in below figure]



2. Determine the induced axial force in the bottom tie member DC of loaded frame.



3. A screw jack has square threads 50 mm mean diameter and 10 mm pitch. The load on the jack revolves with the screw. The coefficient of friction at the screw threads is 0.05.
i) Find the tangential force required at the end of 300mm lever to lift a load of 6000N.
ii) State whether the jack is self locking. If not, find the torque which must be applied to keep the load from descending.

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. (a) State and prove parallel axis theorem.
   (b) Derive the expression to determine moment of inertia of a semicircular area about its diametral axis.

6. (a) Explain the terms displacement, velocity and acceleration connected to rectilinear translation.
   (b) An auto is accelerated from rest to top speed of 100 Kmph. And then immediately decelerated to a stop if the total elapsed time is 20 seconds, Determine the distance covered. The acceleration and deceleration are both constant, but not necessarily of the same magnitude.

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) 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 maximum velocity and maximum acceleration.

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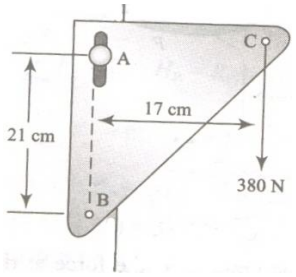
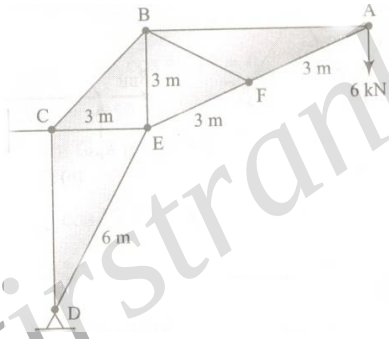
1. In the triangular bracket as shown in fig, the bolt A fits loosely in a vertical slot. Determine the reaction at A and B.



2. Find the forces induced in the each members of plane 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. Determine the center of gravity of solid hemisphere of radius 'r' from the diametral axis.

5. (a) State and prove the perpendicular axis theorem of moment of inertia.
   (b) From basic principles, determine the moment of inertia of a rectangle about the centroidal x-axis as well as centroidal y-axis.

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 wagon weighing 500 KN starts from rest runs 30 m down one percent grade and strikes the bumper post. If the rolling resistance of the track is 5 N/KN, find the velocity of the wagon when it strikes the post. If the bumper spring which compresses 1 mm for every 15 KN, determine by how much this spring will be compressed.

8. A vertical shaft 100 mm in diameter and 1 m in length has its end fixed to the ceiling. At the other end, it carries a disc of mass 500 kg having a radius of gyration of 450 mm. The modulus of rigidity for the material of shaft is 80 GPa. Determine the frequency of torsional vibrations.

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