

Subject Code: R13110/R13

Set No - 1

I B. Tech I Semester Regular Examinations Jan./Feb. – 2015

**ENGINEERING MECHANICS**

(Common to CE, ME, CSE, PCE, IT, Chem E, Aero E, AME, Min E, PE, Metal E)

Time: 3 hours

Max. Marks: 70

Question Paper Consists of **Part-A** and **Part-B**  
Answering the question in **Part-A** is Compulsory,  
Three Questions should be answered from **Part-B**

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**PART-A**

- 1.(i) What is the principle of transmissibility?
- (ii) State triangular law of forces. What is the use of this law?
- (iii) Locate the centroid of a semicircle of radius  $r$ .
- (iv) Find the mass moment of inertia of a slender rod.
- (v) State D'Alembert principle giving equations.
- (vi) Explain the concept of work? What are the units of work?

[3+4+4+5+3+3]

**PART -B**

- 2.(a) Two smooth circular cylinders, each of weight  $W = 1000\text{N}$  and radius  $15\text{cm}$ , are connected at their centres by a string  $AB$  of length  $40\text{cm}$  and rest upon a horizontal plane, supporting above them a third cylinder of weight  $2000\text{N}$  and radius  $15\text{cm}$  as shown in fig1. Find the force in string  $AB$  and the pressure produced on the floor at the points of contact  $D$  and  $E$ .

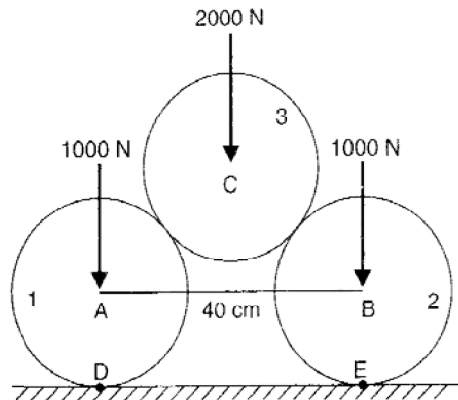
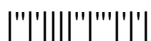
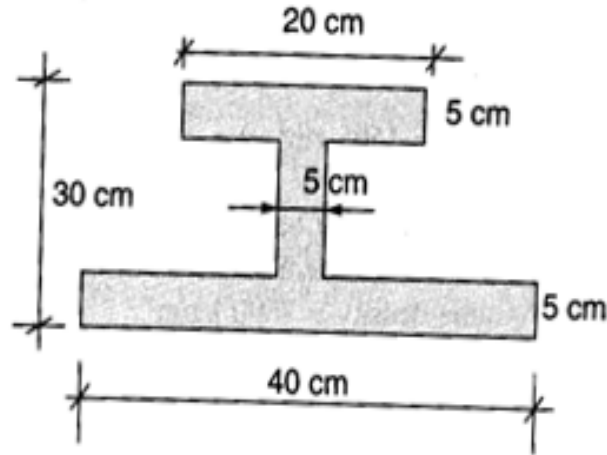


Fig: 1

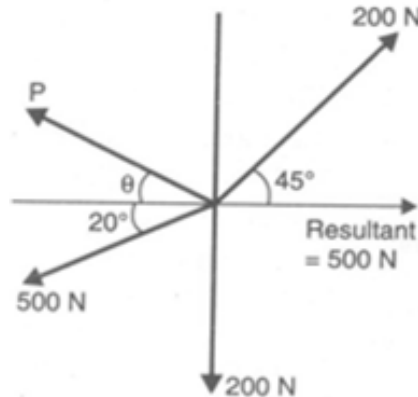


- 2.(b) State and prove the parallel axis theorem. [8+8]
- 3.(a) A small block of unknown weight is placed on an inclined plane which makes an angle of  $30^\circ$  with the horizontal plane. The component of this weight parallel to the inclined plane is 100N. Find the weight of the block.
- (b) Find the area moment of inertia about the centroidal axes for a given area shown in the fig 2.

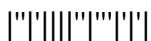


**Fig.2**

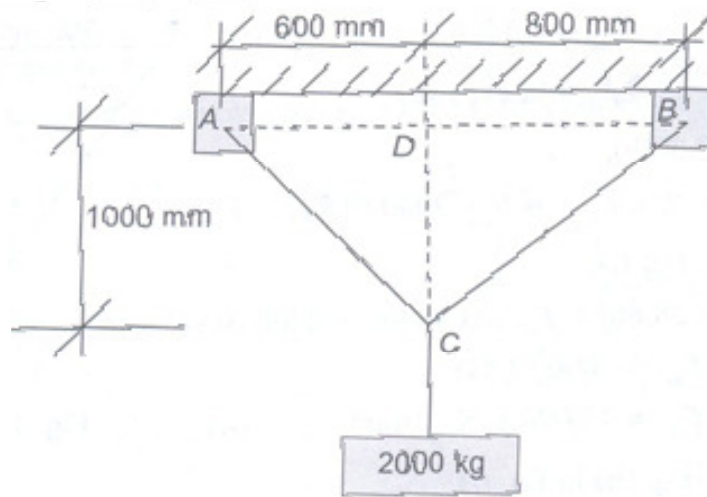
- 4.(a) A tower is 100m in height. A particle is dropped from the top of the tower and at the same time another particle is projected upward from the foot of the tower. Both the particles meet at height of 40m. Find the velocity with which the second particle is projected upward. [5+11]
- (b) What do you understand by Potential Energy and Kinetic Energy of a body? [8+8]
- 5.(a) The four coplanar forces are acting at a point as shown in the fig.3. One of the forces is unknown and its magnitude is shown by P. The resultant is having a magnitude of 500N and acting along x-axis. Determine the unknown force P and its inclination with x-axis.



**Fig.3**

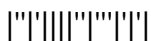


- 5.(b) A body weighing 196.2N slides up a  $60^\circ$  inclined plane under the action of applied force 400N acting parallel to the inclined plane. The coefficient of friction is equal to 0.2. The body moves from rest. Determine
- (i) Acceleration of the body
  - (ii) Distance travelled by the body in 5 seconds
  - (iii) Work done by the body in 5 seconds.
  - (iv) Momentum of the body after 5 seconds.
- [4+12]
- 6.(a) Explain and define the term Free Body diagram. Draw the free body diagram and calculate the tensions in AC and BC shown in fig.4.



**Fig.4**

- (b) Prove that of moment of inertia of a circular section about an horizontal axis and passing through C.G of the section is given by  $\frac{\pi D^4}{64}$ .
- [8+8]
- 7.(a) State and prove Pappus theorems I and II.
- (b) Distinguish between area moment of inertia, polar moment of inertia and mass moment of inertia.
- [8+8]



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**PART-A**

- 1.(i) A force of 200N is acting at a point and makes an angle of  $120^\circ$  and  $60^\circ$  with the x and y axes respectively. Find the component of the force and express it as vector.
- (ii) Explain and define the term Free Body Diagram.
- (iii) Define radius of gyration. What is the radius of gyration of a circle of diameter d about its diameter?
- (iv) Derive the expression for the product of inertia for a rectangle with B x D about the axes through the edges.
- (v) State the condition for the dynamic equilibrium of a body under translation.
- (vi) State the work energy principle for the body rotating about fixed axis.
- (vii) State any two important laws of friction.

[4+3+4+4+2+3+2]

**PART-B**

- 2.(a) A body weighing 600N is lifted by two ropes passing over a smooth pulley as shown in fig1. Determine  $F_1$  and  $F_2$ .

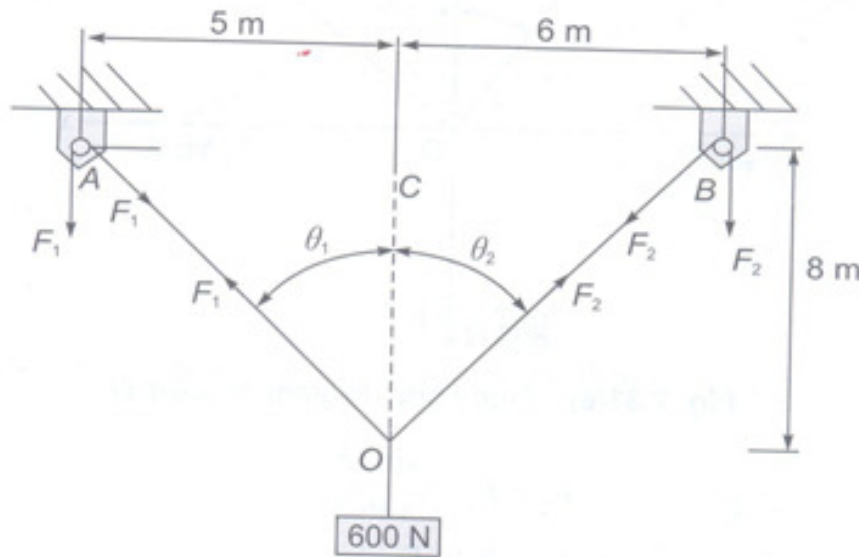
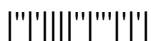


Fig.1



- 2.(b) A cone of height 20cm and radius of base 5cm is truncated from its apex by a height of 5cm. Locate the centre of gravity of the truncated cone. [6+10]
- 3.(a) For the system shown in the fig 2., determine the magnitude P so that the system just starts to move down. Assume that the pulley is smooth and coefficient of friction as 0.26 for horizontal and inclined planes.

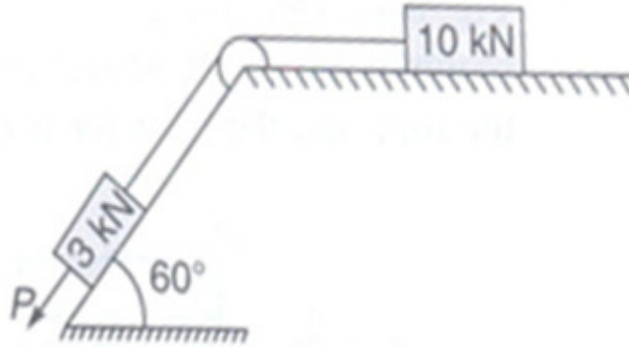
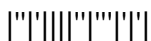


Fig.2

- (b) Compute the mass moment of inertia of a circular plate. [6+10]
- 4.(a) A stone dropped into a well is heard to strike the water after 7secs. Find the depth of the well, if the velocity of sound is 450m/s.
- (b) The weight of a body on earth is 980N. If the acceleration due to gravity on earth is 9.80 m/s<sup>2</sup>, what will be the weight of the body on
  - (i) The moon, where gravitational acceleration is 1.6 m/s<sup>2</sup> and
  - (ii) The sun, where gravitational acceleration is 270 m/s<sup>2</sup>.[10+6]
- 5.(a) State and prove Varignon's theorem.
- (b) A body weighing 20N is projected up a 20° inclined plane with a velocity of 12m/s, coefficient of friction is 0.15. Find the maximum distance S that the body will move up the inclined plane. [8+8]



- 6.(a) Two spheres, each of weight 1000N and radius 25cm rest in a horizontal channel of width 90cm as shown in the fig.3. Find the reactions on the points of contact A, B and C.

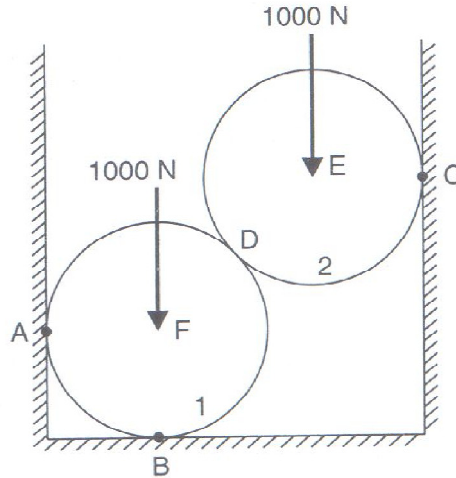


Fig.3.

- (b) Differentiate between rectilinear motion and curvilinear motion. [10+6]
- 7.(a) Locate the centroid of the shaded area as shown in the fig.4

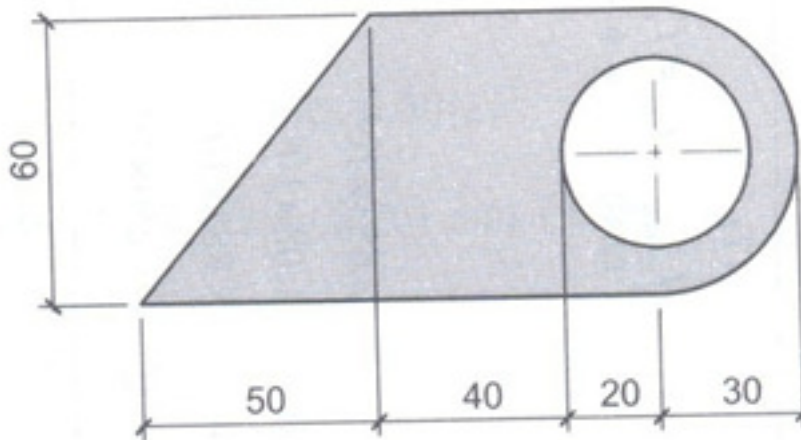
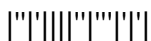


Fig.4

- (b) Determine the second moment of an area of a right angled triangle with respect to its base. [10+6]



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**PART-A**

- 1.(i) State the parallelogram law of forces.
- (ii) What is the principle of transmissibility?
- (iii) What is centroid of a (a) rectangle (b) triangle with respect to base (c) triangle with respect to apex.
- (iv) What is the moment of inertia of triangular lamina (b x h) about its horizontal centroidal axis.
- (v) State the impulse momentum principle. Write its equation.
- (vi) Derive relation between angular velocity and linear velocity.
- (vii) Differentiate between kinematics and kinetics.

[3+3+3+4+3+3+3]

**PART-B**

2. A force vector is represented by a line AB. The coordinates of point A are (2, 4, 3) and of point B is (1,-5, 2) respectively. If the magnitude of force is 10N, then determine the
    - (i) Components of the forces along x, y and z axis
    - (ii) Angles with the x, y and z axis.
    - (iii) Specify the force vector.
- [16]
- 3.(a) A force of P is directed from a point A (4,1,4) metres towards a point (-3,4,-1) meters. If it causes a moment of  $M_z = 1900\text{Nm}$ , determine the moment of P about x-axis and y-axis.
  - (b) Determine the mass moment of inertia of a right circular cone shown in the fig.1 below

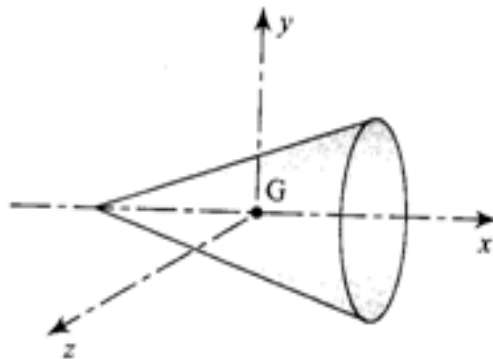
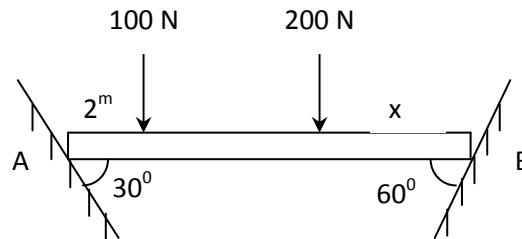


Fig.1

[6+10]

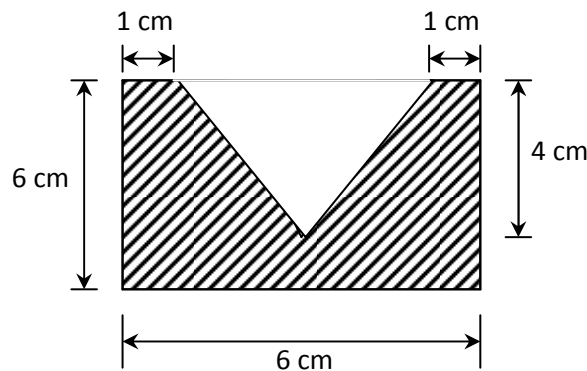


- 4.(a) A tower is 150m height. A particle is dropped from the top of the tower and at the same time another particle is projected upward from the foot of the tower. Both the particles meet at height of 80m. Find the velocity with which the second particle is projected upward.
- (b) Derive work energy equation. [10+6]
- 5.(a) A horizontal bar 10 m long and of negligible weight rests on rough inclined plane as shown in the fig-2. If the angle of friction is  $15^\circ$ , how close to B may the 200N force be applied before motion impends?



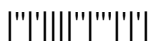
**Fig-2**

- (b) A body weighing 40N is projected up a  $40^\circ$  inclined plane with a velocity of 16m/s, coefficient of friction is 0.20. Find the maximum distance S that the body will move up the inclined plane. [8+8]
- 6.(a) Define the terms: coplanar parallel forces, like parallel forces and unlike parallel forces.
- (b) Derive the equations of motion of a body moving along a circular path with uniform angular acceleration [6+10]
- 7.(a) Determine the volume generated by rotating the shaded area shown in fig-3 about x-x axis.



**Fig-3**

- (b) Determine the centroid of the triangle (b x h) about the base from basic principles. [12+4]





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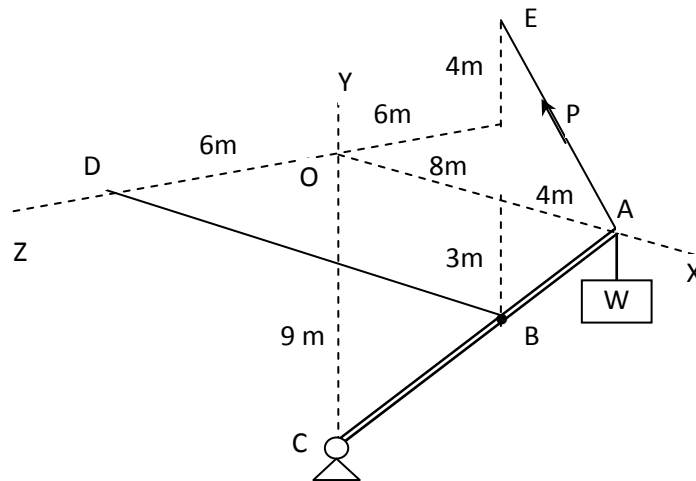
**PART-A**

- 1.(i) Mention the Coulomb's laws of friction.
- (ii) What is the converse law of polygon law of forces.
- (iii) State Pappus theorems I and II.
- (iv) Differentiate between polar moment of inertia and product of inertia.
- (v) Find the force acting on a body of mass 100 kg and producing an acceleration of  $2 \text{ m/s}^2$  in the direction.
- (vi) Find the work done in drawing a body weighing 500N through a distance of 5m along a horizontal surface by force of 300N whose line of action makes an angle of  $30^\circ$  with the horizontal.

[3+4+4+3+4+4]

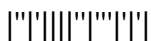
**PART-B**

2. If the force multiplier of a force P acting from A to E is  $P_m = 40\text{N/m}$ , referring Fig-1. Find out the following
  - (i) Component of P along AC
  - (ii) Moment of P about D.



**Fig-1**

[16]



3.(a) Find the centroid of the shaded area shown in fig-2 w. r .t. x and y axes.

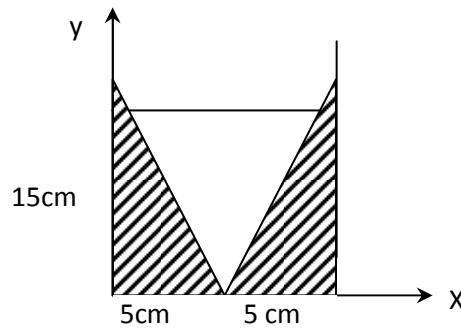


Fig.2

(b) Find the moment of inertia of the area shown in shaded area in fig .3, about edge AB.

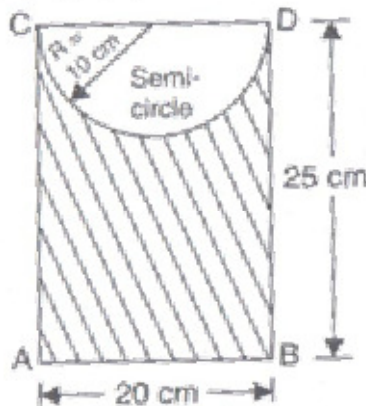


Fig.3

[8+8]

4.(a) Explain the laws of motion for a body in rotational motion.

(b) A wheel rotating about a fixed axis at 20 rpm is uniformly accelerated for 70s during which it makes 50 revolutions. Find the angular velocity at the end of this interval and also the time required for the speed to reach 100rpm.

[8+8]

5.(a) A block is lying over a  $10^\circ$  wedge on a horizontal floor and leaning against a vertical wall and weighing 1500N is to be raised by applying a horizontal force to the wedge. Assuming coefficient of friction between all the forces in contact to be 0.3, determine the minimum horizontal force to be applied to raise the block.

(b) Derive work energy equation.

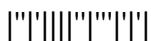
[10+6]

6.(a) Write about the following

- (i) Free body diagram with example
- (ii) Equations of equilibrium.

(b) An automobile travels 800m in 50s when it is accelerated at a constant rate of 0.8m/s. Determine the initial and final velocity and also the distance travelled for the first 14s.

[6+10]



7.(a) Find the moment of inertia of T-section shown in fig: 4 w.r.t. its centroid x and y axes.

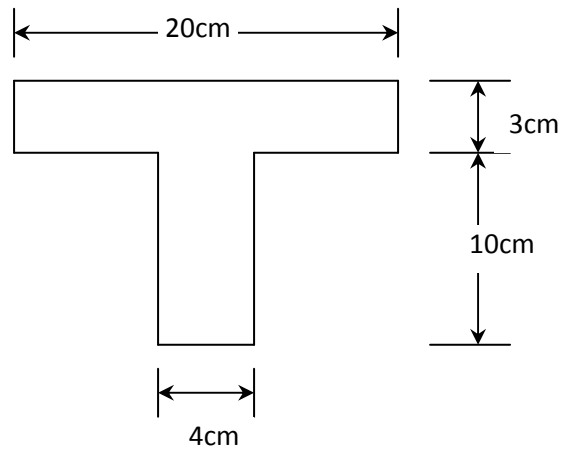


Fig: 4

(b) Determine the centroid of the rectangular section by integration

[10+6]

