B.Tech 1st Semester End Semester Examination - 2015
Engineering Mechanics

[UCE/EE/CS/EC/PE/CH/EI 01C05/UME 01B01]

Full Marks: 100 Time: 3 hours

The figures in the margin indicate full marks for the questions

I. Answer all the questions: [5 X 1= 5]

1. Force can be characterized by:
   a) Point of application c) direction
   b) magnitude, direction d) point of application, magnitude and direction

2. The resultant of two forces can be defined as a force that:
   a) keeps the system in equilibrium c) has the same effect as the two forces
   b) has the greatest magnitude in the system d) has the same effect as one force

3. The necessary condition of equilibrium of a body is:
   a) $\sum F_x = 0$ c) $\sum F_x = 0$ and $\sum F_y = 0$
   b) $\sum F_y = 0$ d) none

4. Consider the following statements.
   i. Three nonparallel forces can be in equilibrium only when they lie in one plane, intersect in one point, and their free vectors build a closed triangle.
   ii. The reaction from an ideal smooth surface must be directed along the normal at the point of contact.
   Of these Statements.
   a) i alone is correct c) both are correct
   b) ii alone is correct d) both are incorrect

5. The moment of a force defined as:
   a) The tendency of a force to produce rotation of a body about a fixed point.
   b) The tendency of a force to produce translation of a body about a fixed point.
   c) The tendency of a force to produce rotation & translation about a fixed point.
   d) None of the above.

II. Answer any five from the following: [5 X 4 = 20]

6. Define the following:
   i) Free Body Diagram
   ii) Rigid Body
   iii) Particle
   iv) Equilibrant

7. i) State Lami's Theorem
   ii) State Varignon's Theorem

8. i) Why co-efficient of friction is less than that of static friction?

ii) State the laws of Friction

9. i) State the theorems of Pappus

ii) Explain at least two main importances of the assumptions made in the analysis of truss.

10. i) Define "Radius of Gyration".

ii) State Parallel axis Theorem

11. i) Explain the term 'Direct Central Impact'

ii) Define the term 'co-efficient of restitution'.

12. i) State the work-energy theorem and write the work-energy equation, for curvilinear motion of a particle.

ii) Why the tangential component of acceleration is not considered (inertia force) in dynamic equilibrium of a particle for curvilinear motion?

[5 X 15 = 75]

III. Answer any five from the following:

13. i) Locate the centroid C of the shaded area obtained by cutting a semicircle of diameter a from the quadrant of a circle of radius a as shown in *Fig. 1* [05]

ii) A homogeneous body consists of a right circular conical portion attached to a hemispherical portion of radius r as shown in *Fig. 2*. Determine the altitude h of the cone if the centre of gravity of the composite body coincides with the centre C of the circular base of the cone. [10]

14. i) A small car of weight W starts from rest at A and rolls without friction along the loop ACBD (*Fig. 3*). What is the least height h above the top of the loop at which the car can start without falling off the track at point B. Neglect Friction [06]

ii) The arrangement shown in the *Fig. 4* rotates about the vertical axis *yy* at constant rpm. The weight of the vertical bar AB, hinged at C, is 15 N and the weight of the ball at the top is 30 N. When the system is at rest, the initial tension in the spring DE is 100 N. At what rpm will the contact at A be broken? Assume the frame and bar to be absolutely rigid. [09]

15. i) A homogeneous sphere of radius r and weight W slides along the door under the action of a constant horizontal pull P applied to a string (*Fig. 5*). Determine the height h during this motion if the co-efficient of friction between sphere and floor is μ. [06]

ii) Two blocks of weights P and Q are connected by a flexible but inextensible cord and supported as shown in *Fig. 6*. If the coefficient of friction between the block P and the horizontal surface is μ and all other friction is negligible, find the tensile force S in the cord. Given, P= 53.4N; Q= 26.7 N and $\mu=\frac{1}{3}$. [09]

16. In *Fig. 7*, a small car of weight W starts from rest at A and rolls without friction along an inclined plane to B where it strikes a block also of weight W and initially at rest. Assuming a plastic impact at B, the car and block will move from B to C as one particle. If the co-efficient of friction between the block and plane is μ = 0.5, calculate the distance *x* to point C where the bodies comes to rest. [15]

Determine the axial force S, in each bar of the plane truss supported and loaded as shown in *Fig. 8* [15]

Determine the Moment of Inertia of the 'I' as shown in the *Fig. 9* about the centroidal X-axis and centroidal Y-axis [15]

19. Two heavy right circular rollers of diameters D and d, respectively, rest on a rough horizontal plane as shown in *Fig. 10*. The larger roller has a string wound around it to which a horizontal force P can be applied. Assuming that the coefficient of friction μ has the same value for all the surfaces of contact, determine the necessary condition under which the large roller can be pulled over the small one. [15]

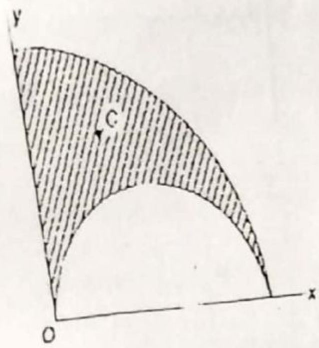

Fig.1

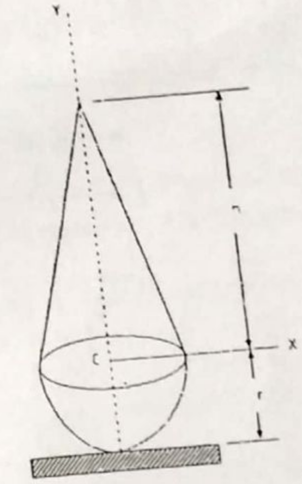

Fig.2

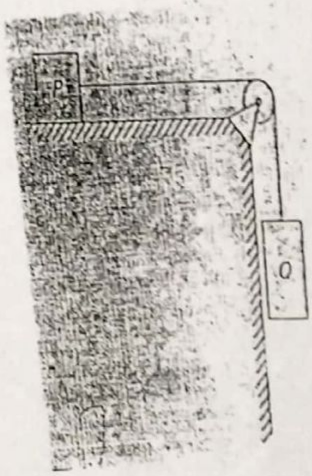

Fig.6

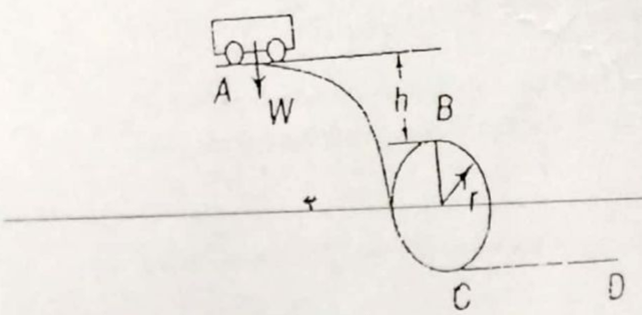

Fig.3

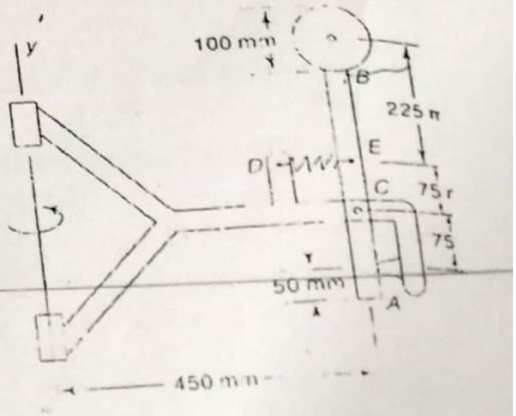

Fig.4

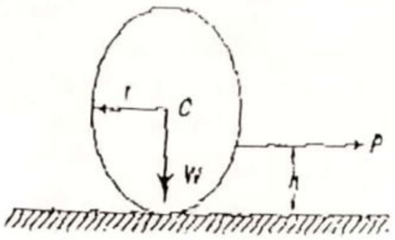

Fig.5

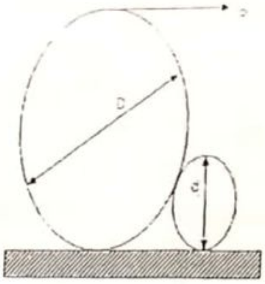

Fig.10

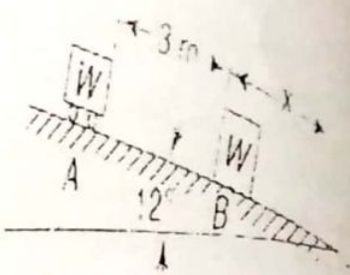

Fig.7

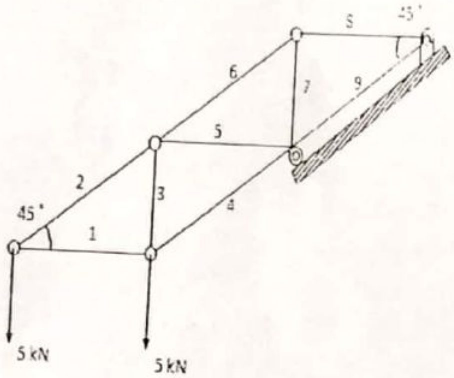

Fig.8

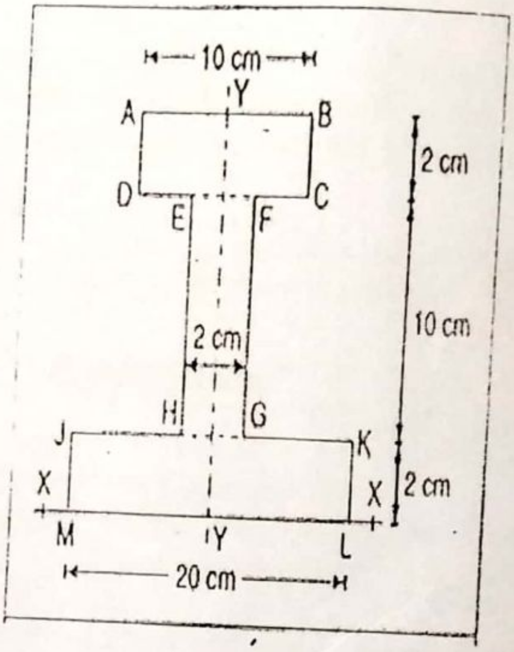

Fig.9