53 (ME 201) ENMC

2014

ENGINEERING MECHANICS

Paper : ME 201

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer ***question No. 1*** *and* ***any four*** *from the rest.*

1. *(a)* Choose the correct option : 1×5=5

   (i) The resultant of two forces is equal to each of the force. The angle between them is

   (A) 0°

   (B) 90°

   (C) 180°

   (D) 120°.

(ii) Coplanar forces may be

(A) Concurrent

(B) Non-concurrent

(C) either concurrent or Non-concurernt

(D) None of these.

(iii) The coefficient of friction depends on

(A) Nature of surface

(B) Area of contact

(C) Shape of surface

(D) Strength of surface.

(iv) The moment of inertia about centroidal X-axis of a rectangle having width 'b' and height 'h' will be

(A) $\frac{bh^3}{12}$

(B) $\frac{bh^3}{3}$

(C) $\frac{hb^3}{12}$

(D) $\frac{hb^3}{3}$.

(v) When trying to turn a key into a lock, the following is applied

(A) Coplanar force

(B) Concurrent force

(C) lever

(D) Couple.

(b) State the following terms : 2×5=10

(i) Composition of force

(ii) Non-coplanar concurrent force.

(iii) Angle of repose

(iv) Law of transmissibility of force

(v) Perpendicular axis theorem.

(c) Fill in the blanks : 1×5=5

(i) Displacement is a _____ quantity.

(ii) One kilogram force is equal to _____ Newton.

(iii) The resultant of two parallel forces, 'P' and 'Q' acting in the same direction is equal to _____ .

(iv) _____ is the maximum value of static friction.

(v) The friction experienced by a body at rest is known as _____ .

2. (a) What do you mean by moment of force ? State Varignon's principle of moment. 1+2=3

(b) Determine the resultant and the direction of the three forces as shown in *Figure-2(b)*. 6

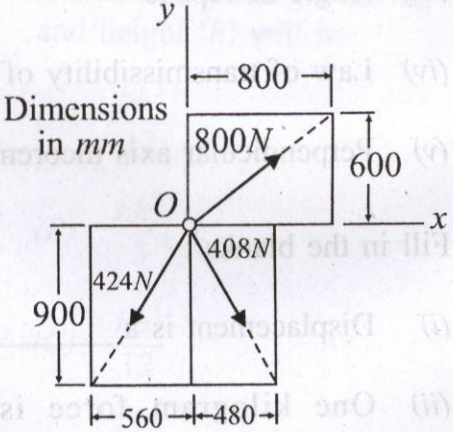


Figure-2(b)

(c) Two forces are applied at the point B of beam AB *[Figure-2(c)]*. Determine 'graphically' the magnitude and direction of their resultant using

(i) The parallelogram law of force

(ii) The triangular law of force. 3+3=6

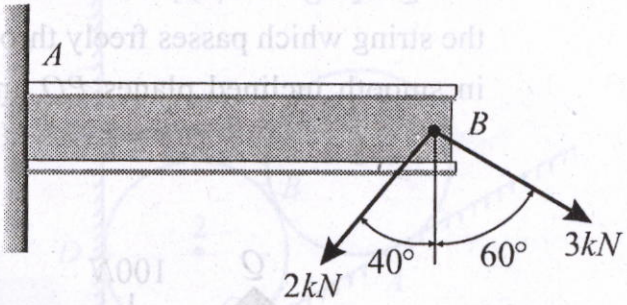


Figure-2(c)

(d) The resultant of two forces, one of which is double the other is 260N. If the direction of the larger force is reversed and the other remains unaltered, the resultant reduces to 180N. Determine the magnitude of the forces and angle between the forces. 5

3. *(a)* What is a free body diagram ? What are the conditions of equilibrium of a body ? State Lami's theorem. 1+2+2=5

(b) Two spheres weighing $60N$ and $100N$ are connected by a flexible string AB and rest on two mutually perpendicular phases PQ and QR [*Figure-3(b)*]. Find the tension in the string which passes freely through slots in smooth inclined planes PQ and QR. 7

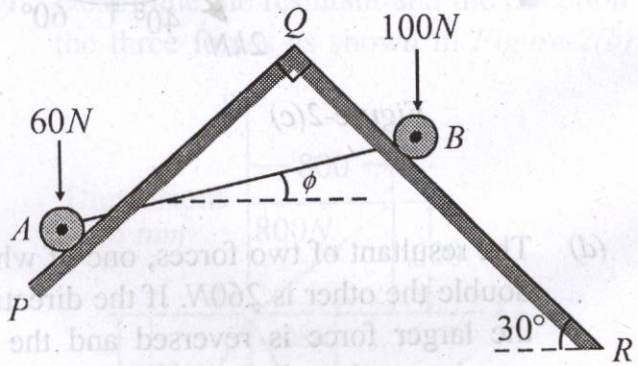


Figure-3(b)

(c) Two identical cylinders, each weighing 500*N* are placed in a trough as shown in *Figure-3(c)*. Determine the reactions developed at the contact points *A, B, C* and *D*. Assume all points of contact are smooth. 8

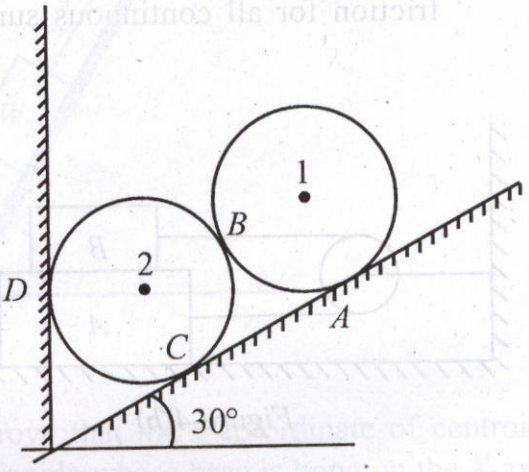


Figure-3(c)

4. (a) What do you mean by the angle of friction ? State the laws of static friction. 4

(b) Block 'A' weighing 240kg resting on rough floor supports Block 'B' weighing 120kg as shown in *Figure-4(b)*. Both the blocks are connected with a rope passing over a smooth pulley. Compute the magnitude of force 'P' at impending motion and tension induced in the rope, if the coefficient of friction for all continuous surface is 0·3. 6

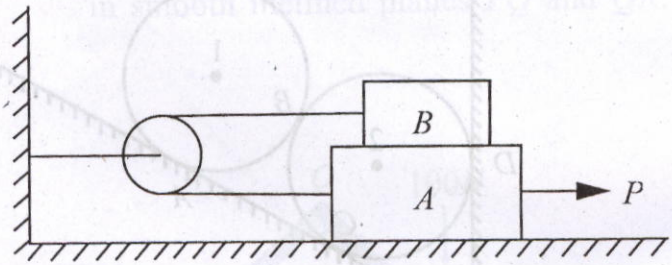
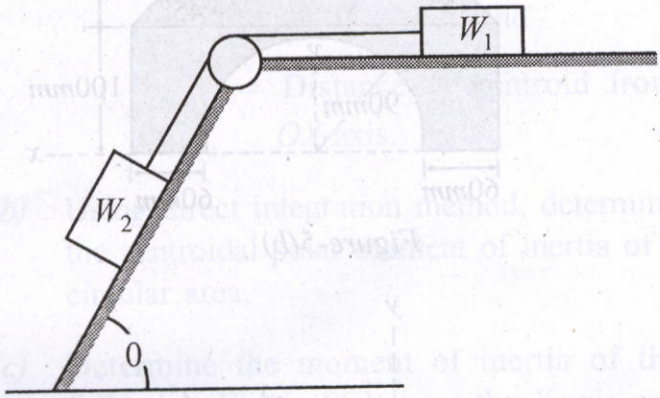


Figure-4(b)

(c) Two rectangular blocks of weights W_1 and W_2 connected by a flexible cord resting upon a horizontal plane and an incline are shown in *Figure-4(c)*. In a particular case when $W_1 = W_2$ and coefficient of static friction 'μ' being same for all contiguous

surfaces, find the angle of inclination of the incline at which motion of the system will impend. 10



5. *(a)* Prove that the y-co-ordinate of centroid of triangle whose base is lying on the X-axis is

$$y_c = \frac{h}{3}$$

where $h =$ height of the triangle. 5

(b) Locate the centroid of the following *Figure-5(b)* and *Figure-5(c)*. 7+8=15

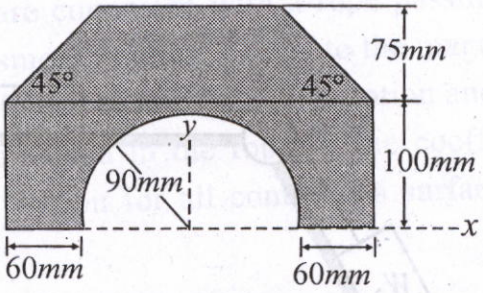


Figure-5(b)

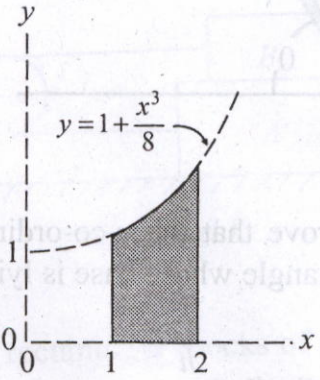


Figure-5(c)

6. *(a)* Prove that, according to the parallel axis theorem the moment of inertia (M.I.) of a body from a reference axis is

$$I_X = \bar{I}_X + d_X^2 A$$

where, I_X = M.I. about OX-axis

$\bar{I}_X$ = M.I. about the centroidal axis

A = Area of a body and

d_X = Distance of centroid from OX-axis. 4

(b) Using direct integration method, determine the centroidal polar moment of inertia of a circular area. 4

(c) Determine the moment of inertia of the following *Figure-6(c)* about the X-axis and *Figure-6(d)* with respect to X-axis and y-co-ordinate axis. 5+7=12

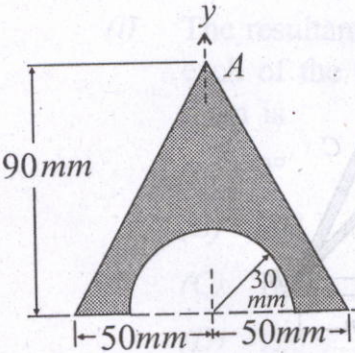


Figure-6(c)

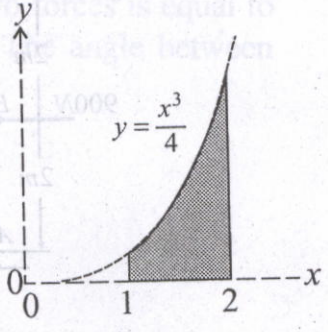


Figure-6(d)

7. *(a)* Determine the forces in each member of the loaded truss as shown in *Figure-7(a).* 10

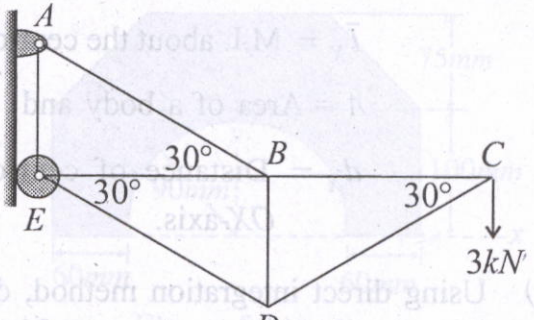


Figure-7(a)

(b) Determine the forces in each member of the truss, and state if the members are in tension or compression. 10

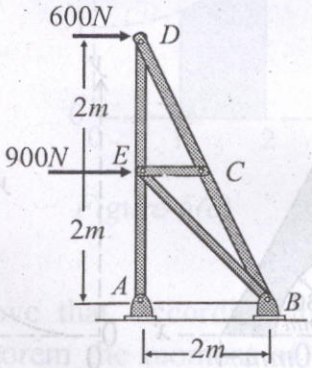


Figure-7(b)