Total No. of Questions : 12] [Total No. of Printed Pages : 11

[3361]-108

F. E. Examination - 2008

ENGINEERING MECHANICS

(2003 Course)

Time : 3 Hours] **[Max. Marks : 100**

Instructions :

(1) Answer Q.1 or Q.2, Q.3 or Q.4 and Q.5 or Q.6 from section I and Q.7 or Q.8, Q.9 or Q.10 and Q.11 or Q.12 from section II.

*(2) Answers to the **two sections** should be written in **separate answer-books**.*

(3) Figures to the rights indicate full marks.

(4) Neat diagrams must be drawn wherever necessary.

(5) Use of electronic pocket calculator is allowed.

(6) Assume suitable data, if necessary and clearly state them.

(7) Use of cell phone is prohibited in the examination hall.

SECTION - I

Q.1) (A) Four forces acting on a triangle ABC are shown in Fig. 1(A). The sum of moments of these forces at point C is 2000 N-mm clockwise. If resultant of force system is in horizontal direction, find its magnitude and point of application. **[10]**

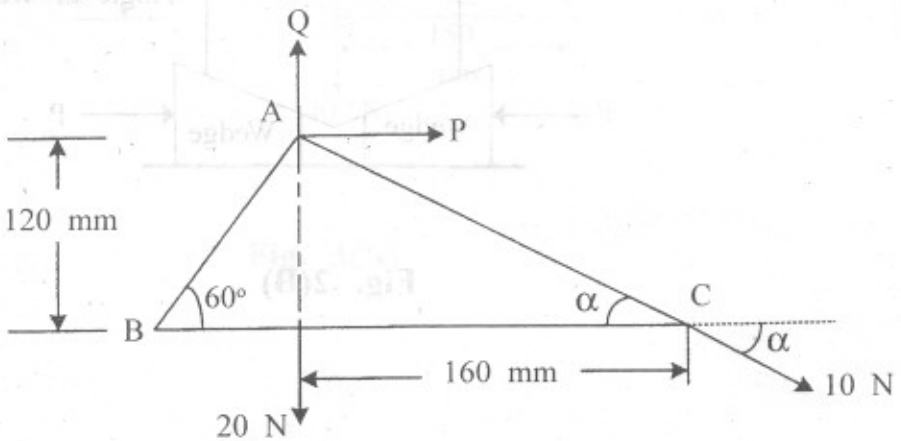

Fig. 1(A)

(B) A beam AB of 5 m length is supported as shown in Fig. 1(B). If AD, AE and BF carry equal axial force, determine the location x of load 1000 N. **[08]**

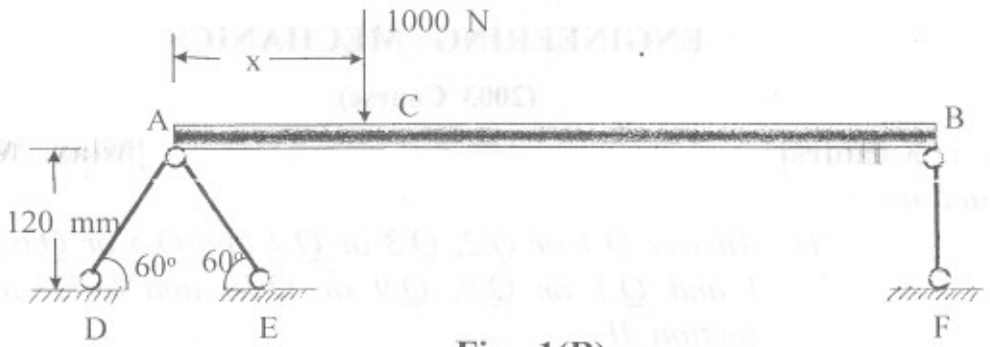

Fig. 1(B)

OR

Q.2) (A) Show that for a body sliding freely down the inclined plane, angle of repose is equal to the angle of friction. **[04]**

(B) A block of 1000 N is to be raised up by means of force P each acting on wedges as shown in Fig. 2(B). If angle of friction at all rubbing surfaces is 15°, determine P. Ignore weight of wedge. **[08]**

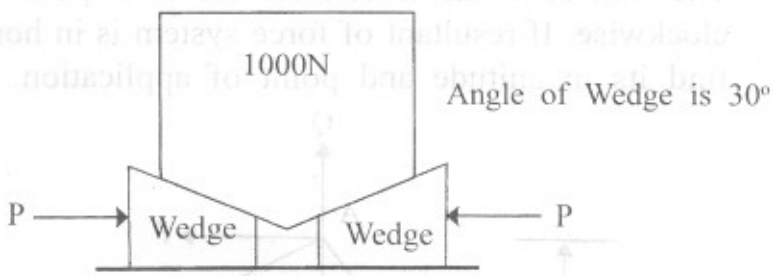

Fig. 2(B)

(C) Locate the centroid of reamining lamina with respect to O, if shaded part is removed. Refer Fig. 2(C). **[06]**

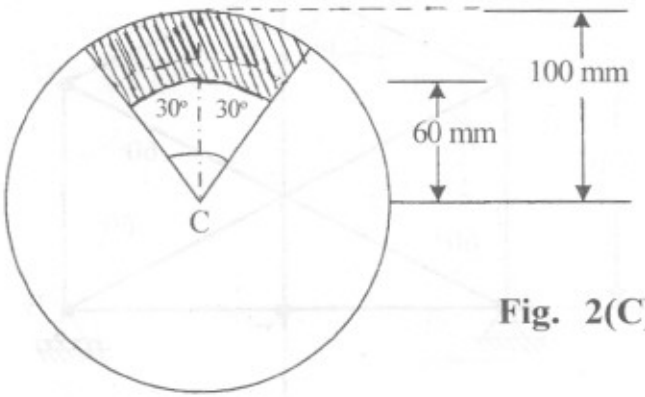

Fig. 2(C)

Q.3) (A) A Z-shaped lamina of uniform width of 20 mm is subjected to four forces as shown in Fig. 3(A), find equilibrant in magnitude and direction. **[06]**

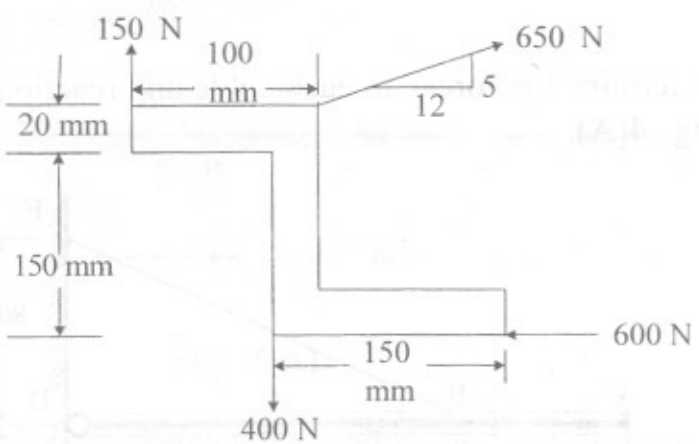

Fig. 3(A)

(B) Determine the forces in all members of truss shown in Fig. 3(B). A, B, C, D, E and F are pinned joints. **[10]**

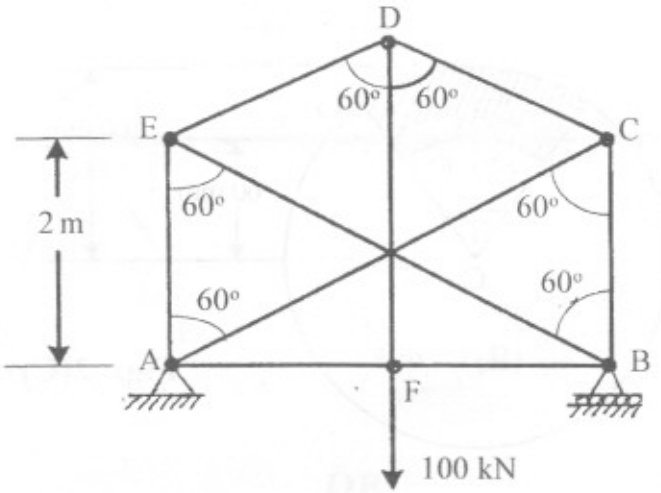

Fig. 3(B)

OR

Q.4) (A) Determine the forces in each cable and reaction at roller D. Refer Fig. 4(A). **[06]**

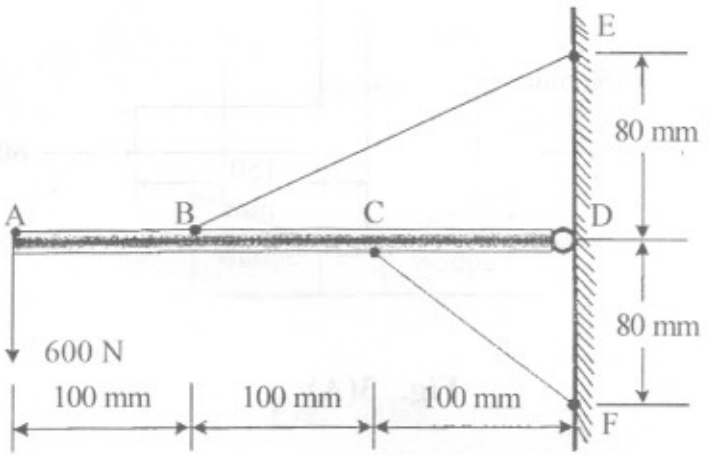

Fig. 4(A)

(B) Two bars ABC and DBE are pinned together at B. Ends A and D are hinged. Under loading as shown in Fig. 4(B), determine reaction at A and D. Neglect weight of bars. **[10]**

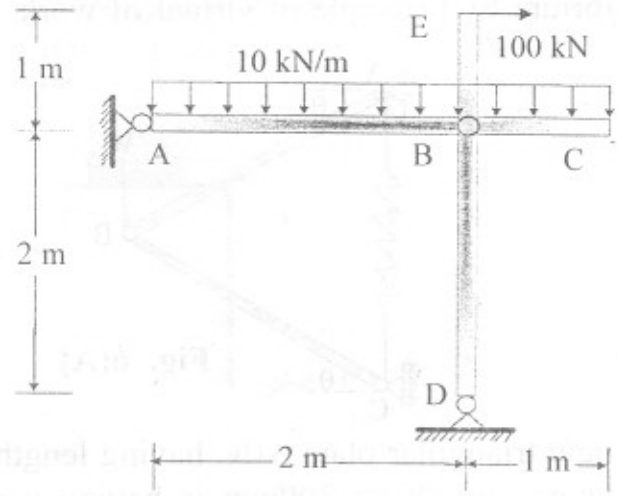

Fig. 4(B)

Q.5) (A) Two beams AB and BCD are pin connected together at B as shown in Fig. 5 (A). Determine by virtual work principle, fixing moment and reaction at A. Verify the result using principle of statics. **[10]**

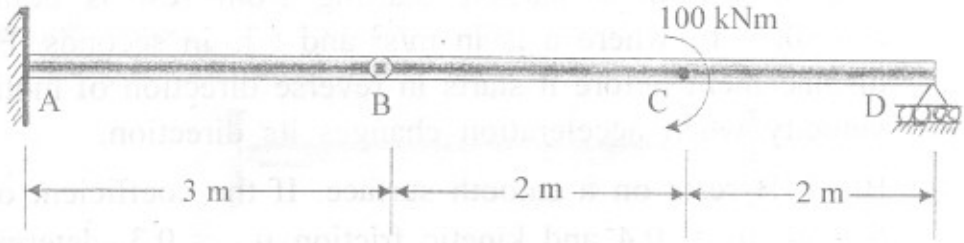

Fig. 5(A)

(B) Explain with neat sketches the following terms related to space forces : **[06]**

(1) Representation of force in vector form

(2) Condition of equilibrium for concurrent and parallel forces

OR

Q.6) (A) Two bars AB and BC of equal length L are pinned at B. Ends A and C are connected by means of spring of stiffness k. Unstreched length of spring is S. Show that $\sin\theta = (W + 2kS)/4kL$, for equilibrium by principle of virtual of work, Refer Fig. 6(A). **[08]**

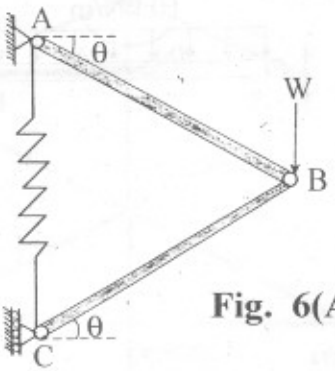

Fig. 6(A)

(B) A right angle triangular plate ABC having lengths AB = 400mm, AC = 300mm and BC = 300mm is having weight 50 N. It is held in Equilibrium by means of three parallel wires connected to points A, B and C in such a way that plate ABC remains in horizontal plane. Determine the tension in three wires. **[08]**

SECTION - II

Q.7) (A) The motion of a particle starting from rest is defined by $a = 10t - t^2$, where a is in m/s^2 and t is in seconds. Find the displacement before it starts in reverse direction of motion and velocity when acceleration changes its direction. **[08]**

(B) Block B rests on a smooth surface. If the coefficient of static friction $\mu_s = 0.4$ and kinetic friction $\mu_k = 0.3$, determine the acceleration of each block if A is pushed by a force :
(a) P = 30 N, (b) P = 250 N. Refer Fig. 7(B) **[08]**

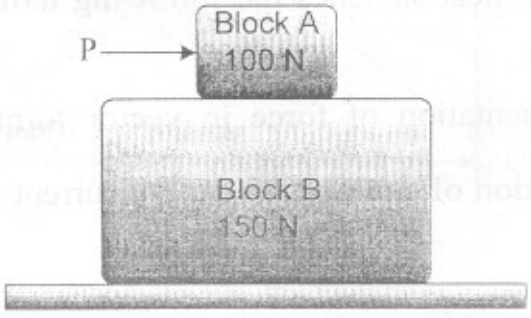

Fig. 7(B)

OR

Q.8) (A) Block B starts from rest and moves downward with a constant acceleration. Knowing that after slider block A has moved 400mm, its velocity is 4 m/s, determine (a) acceleration of blocks A and B, (b) the velocity and change in position of block B after 2s. Refer Fig. 8(A). **[08]**

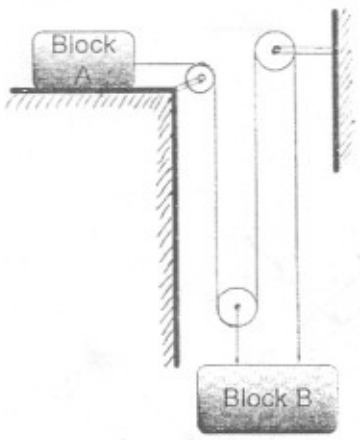

Fig. 8(A)

(B) A smooth 10N collar C fits loosely on the horizontal shaft as shown in Fig. 8(B). If the spring is unstreched at x = 0, the collar is given an initial velocity of 4.5 m/s. Determine the velocity of collar when x = 1m. Also find the value of x at which velocity of collar becomes zero. **[08]**

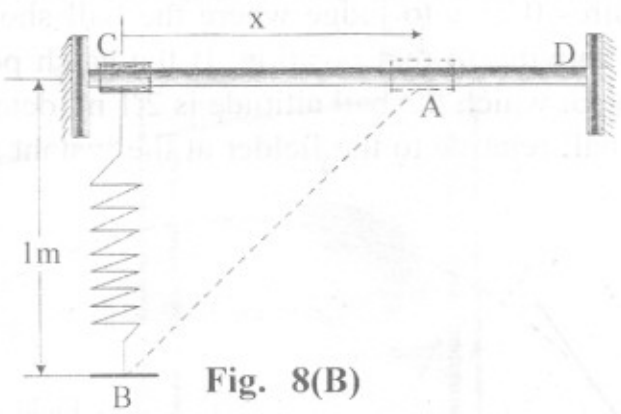

Fig. 8(B)

Q.9) (A) The train travels along a track having the shape of spiral, $r = (1000/\theta)$, where θ is in radian. If the angular rate is constant $\dot{\theta} = 0.2$ rad./s, determine the radial and transverse components of its velocity and acceleration when $\theta = 9\pi/4$ rad. **[08]**

(B) A 0.3 kg collar D can slide on portion AB of a rod which is bent as shown in Fig. 9(B). Knowing that $\alpha = 40^{\circ}$ and that the rod rotates about the vertical AC at a constant rate of 5 rad./s, determine the value of radius r for which the collar will not slide on the rod if the effect of friction between the rod and collar is neglected. **[08]**

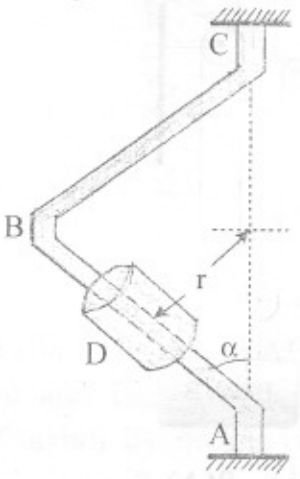

Fig. 9(B)

OR

Q.10) (A) A batsman hits the ball A with an initial velocity of 30 m/s at an angle of 30° to the horizontal as shown in Fig. 10(A). The initial position of the ball is 0.9 m above the ground level. Fielder B requires 0.25 s to judge where the ball should be caught and begins moving to that position. If the catch position is the field location at which the ball altitude is 2.1 m, determine the velocity of the ball relative to the fielder at the instant the catch is made. **[08]**

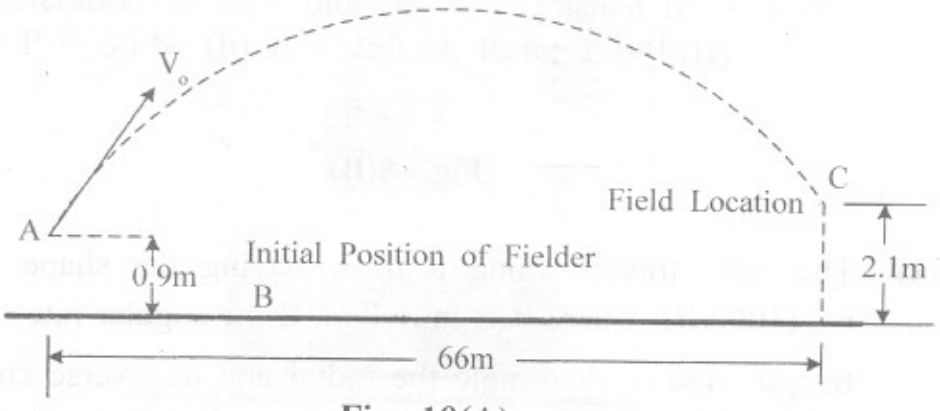

Fig. 10(A)

(B) The simple pendulum as shown in Fig. 10(B) is released from rest at A with the string horizontal and swings downward under the influence of gravity. Express the velocity v of the bob and the tension T in the string as a function of θ. **[08]**

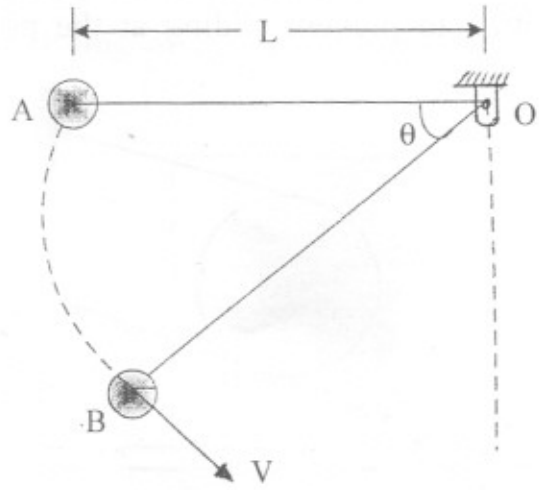

Fig. 10(B)

Q.11)(A) The sliding rails A and B engage the rims of the double wheel without slipping as shown in Fig. 11(A). For the specified velocities of A and B, determine the angular velocity ω of the wheel and the magnitude of the velocity of point P. **[08]**

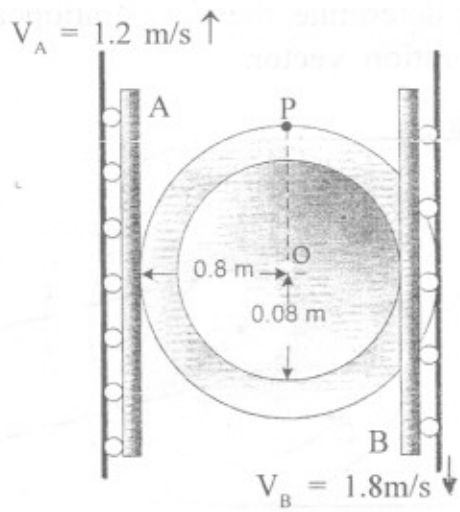

Fig. 11(A)

(B) A solid homogeneous right circular cylinder of weight W and radius r is supported on an inclined plane as shown in Fig. 11(B). The string wound around the circumference is attached to fixed support at A and is parallel to the plane. Find the acceleration of mass center C of the cylinder down the plane if the coefficient of kinetic friction to prevent sliding at the point of contact B is $\mu_k = 1/3$. **[10]**

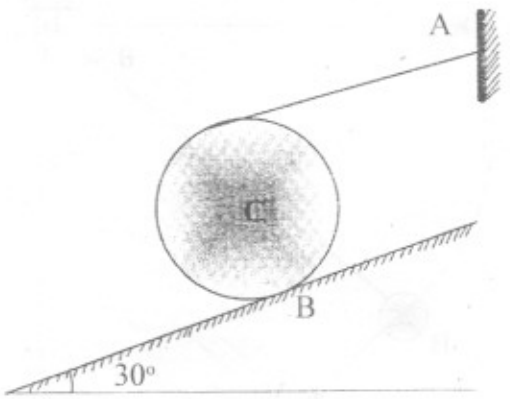

Fig. 11(B)

OR

Q.12)(A) The compound pulley rotates about the fixed axis at O. At a certain instant, point A on the belt of the smaller pulley has a velocity of $V_A = 1.5$ m/s and point B on the belt of the larger pulley has on acceleration $a_B = 45$ m/s^2 as shown in Fig. 12(A). For this instant determine the acceleration a_C of point C and draw the acceleration vector. **[09]**

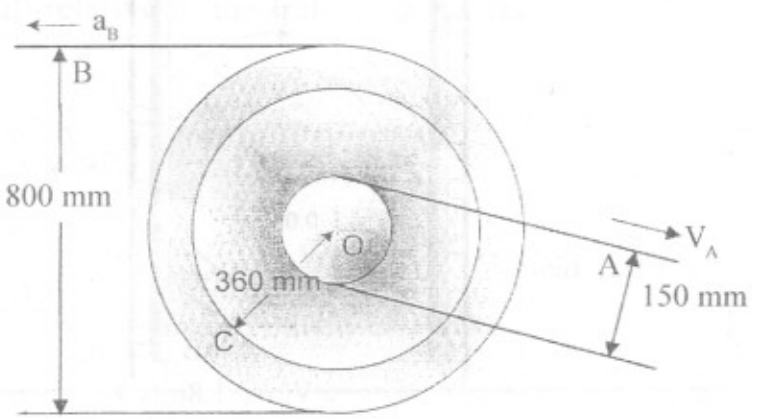

Fig. 12(A)

(B) Solid homogeneous cylinder 400 mm high and 250 mm in diameter is supported by a flat conveyor belt which moves horizontally. If the speed of the belt increases according to $v = 1.2 + 0.9t^2$ m/s, where t is in seconds. Calculate the value of t for which the cylinder begins to tip over and the displacement of the cylinder during time t. Cleats on the belt prevent the sliding of cylinder from slipping. Refer Fig.12(B). **[09]**

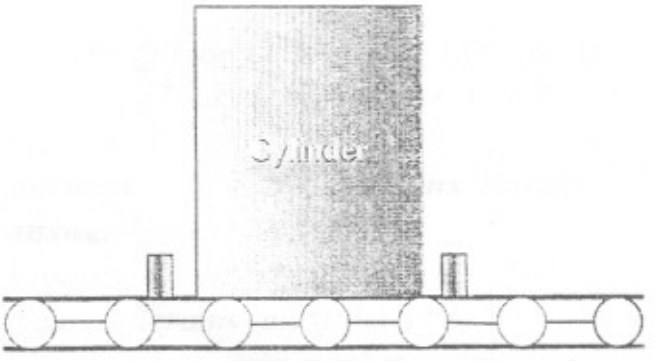

Fig. 12(B)
