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MECHANICAL ENGINEERING

2011

FIRST PAPER

Full Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. A 4 m ladder  $AB$  weighing 200 N is placed against a vertical wall at  $B$  at an angle of  $60^\circ$  with the horizontal with  $A$  in the ground. As a man weighing 800 N, reaches a point 2.7 m from  $A$ , the ladder is about to slip. Assuming that the coefficient of friction between the ladder and the wall is 0.2, determine the coefficient of friction between the ladder and the floor. 20

2. (a) In the four-bar mechanism  $ABCD$  as shown in Fig. 1 below, determine the force  $P$  for equilibrium. 10

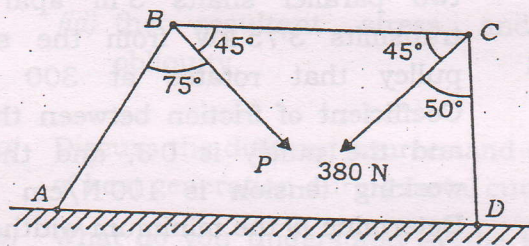


Fig. 1

( 2 )

- (b) Find the forces in members  $BD$ ,  $BE$  and  $DE$  of the truss as shown in Fig. 2 below.

10

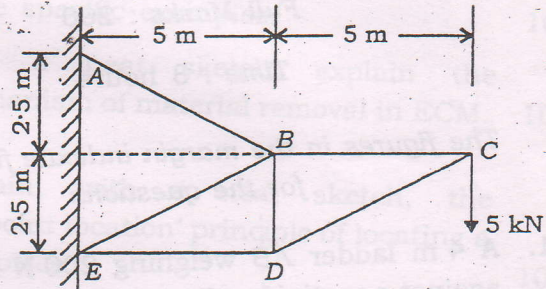


Fig. 2

3. (a) A gun weighing 300 kN fires a 5 kN projectile with a velocity of 300 m/s. With what velocity will the gun recoil? If the recoil is overcome by an average force of 600 kN, how far will the gun travel? How long will it take?

10

- (b) An open belt running over two pulleys 24 cm and 60 cm diameter connects two parallel shafts 3 m apart and transmits 3.75 kW from the smaller pulley that rotates at 300 r.p.m. Coefficient of friction between the belt and the pulley is 0.3, and the safe working tension is 100 N/cm width. Determine (i) the minimum width of the belt and (ii) initial belt tension.

10



4. The internal and external diameters of a thick hollow cylinder are 8 cm and 12 cm respectively. It is subjected to an external pressure of  $40 \text{ N/cm}^2$  when the internal pressure is  $120 \text{ N/cm}^2$ . Calculate the hoop stress at the external and internal surfaces, and determine the radial and hoop stresses at the mean radius. 20
5. (a) Find the deflection at the centre of a simply supported beam of span  $l$  carrying a uniformly distributed load of  $w$  per unit run over the whole span. Assume uniform flexural rigidity. 10
- (b) The principal tensile stresses at a point across two perpendicular planes are  $80 \text{ N-mm}^{-2}$  and  $40 \text{ N-mm}^{-2}$ . Find on a plane at  $20^\circ$  with the major principal plane—
- (i) the normal stress;
  - (ii) the tangential stress;
  - (iii) the resultant stress and its obliquity.  $3+3+4=10$
6. (a) Discuss the different sources and areas of heat generation during metal cutting. 10
- (b) What do you understand by the terms 'machinability' and 'machinability index'? 5

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- (c) Deduce a mathematical expression for chip thickness ratio. 5.
7. (a) Discuss the need of non-conventional machining methods with reference to some specific examples. 10
- (b) With a neat sketch, explain the mechanism of material removal in ECM. 10
8. (a) Explain, with a neat sketch, the 'six-point location' principle of locating a workpiece. 10
- (b) Discuss the use of lasers and plasmas in different fields of application. 10
9. Use two-phase simplex method to  
Maximize  $Z = 3x_1 + 2x_2 + 2x_3$   
subject to the constraints  
 $5x_1 + 7x_2 + 4x_3 \leq 7$   
 $-4x_1 + 7x_2 + 5x_3 \geq -2$   
 $3x_1 + 4x_2 - 6x_3 \geq \frac{29}{7}$   
where,  $x_1, x_2, x_3$  all  $\geq 0$  20
10. (a) Explain the basic principles underlying the various control charts. 10
- (b) Discuss ABC analysis principle as used in production engineering. 10