

November 2022

**ENGINEERING MECHANICS**

Time Allowed: 2.5 Hours

Full Marks: 60

**Group-A****1. Choose the correct alternatives (Answer any ten)**

[1 × 10 = 10]

**(i)** Moment of a force

(a) Varies directly with its distance from the pivot, (b) Varies inversely with its distance from the pivot, (c) Is independent of its distance from the pivot, (d) None of the above.

**(ii)** A couple consist of

(a) Two like parallel forces of same magnitudes, (b) Two like parallel forces of different magnitudes, (c) Two unlike parallel forces of same magnitudes, (d) Two unlike parallel forces of different magnitudes.

**(iii)** Lami's theorem is applicable to

(a) Coplanar forces; (b) Concurrent forces; (c) Coplanar and concurrent forces; (d) Like parallel forces.

**(iv)** In linear motion, the rotational analogue of force is

(a) Torque, (b) Couple, (c) Moment of inertia, (d) None of the above.

**(v)** If a body is in equilibrium, we may conclude that

(a) No force is acting on it is zero, (b) The moment of the forces about any point is zero, (c) The resultant of all the forces acting on it is zero, (d) Both (b) and (c)

**(vi)** Co-efficient of friction is the ratio of

(a) Normal reaction to limiting friction  
 (b) Limiting friction to the weight of the body to be moved  
 (c) Limiting friction to normal reaction  
 (d) None of the above.

**(vii)** Friction always

(a) Opposes motion (b) Helps in moving the objects, (c) Opposes relative motion, (d) None of these.

**(viii)** Axis passing through the centroid is known as

(a) Parallel axis, (b) Perpendicular axis, (c) Centroidal axis, (d) None of these.

**(ix)** To find out the centroid of the given triangular area (height = 90, base = 60),  $\bar{y} =$ 

(a) 30 (b) 20 (c) 45 (d) 15

**(x)** The velocity ratio of a simple wheel and axle with 'D' and 'd' as the diameters of effort wheel and load axle, is (a)  $D + d$ , (b)  $D - d$ , (c)  $D \times d$ , (d)  $D/d$ **(xi)** In simple lifting machine, Load vs. Effort graph is –

(a) Straight-line (b) Parabolic curve (c) Hyperbolic curve (d) none of these.

**(xii)** In a simple lifting machine, the following parameter remains constant –

(a) Efficiency (b) velocity ratio (c) mechanical advantage (d) All of these.

~~(xiii)~~ Newton's first law of motion gives the concept of (a) Work; (b) Force; (c) Inertia; (d) Energy.

~~(xiv)~~ A jet engine works on the principle of conservation of (a) Mass; (b) Energy; (c) Linear Momentum; (d) Angular Momentum

## 2. Fill in the blanks (Answer any ten)

**[1 × 10 = 10]**

~~(i)~~ \_\_\_\_\_ relates to bodies in motion without any reference to forces.

~~(ii)~~ A body which does not deform under the action of applied forces is called the \_\_\_\_\_.

~~(iii)~~ \_\_\_\_\_ is a method of designating a force by writing two capital letters on either side of the force.

~~(iv)~~ Maximum value of static friction is known as \_\_\_\_\_ friction.

~~(v)~~ The maximum angle which an inclined surface makes with horizontal when a body placed freely on it, is just on the verge of moving down; is called angle of \_\_\_\_\_.

~~(vi)~~ A lifting machine is said to be reversible if its efficiency is \_\_\_\_\_ than 50%.

~~(vii)~~ Efficiency of a self-locking lifting machine is \_\_\_\_\_.

~~(viii)~~ The centre of gravity a T-section 100 mm × 150 mm × 50 mm from its bottom is \_\_\_\_\_.

~~(ix)~~ Frictional force encountered after commencement of motion is called \_\_\_\_\_.

~~(x)~~ In actual machines, Mechanical advantage is \_\_\_\_\_ than velocity ratio.

~~(xi)~~ Unit of angular velocity is \_\_\_\_\_.

~~(xii)~~ Final velocity of a stone, falling freely from a height of 5 m to the ground, will be \_\_\_\_\_ m/s.

~~(xiii)~~ Linear velocity is the product of angular velocity and \_\_\_\_\_.

~~(xiv)~~ The energy possessed by a body, for doing work by virtue of its position, is called \_\_\_\_\_.

~~(xv)~~ A man lifts a suitcase of 5 kg mass from ground level to a 10.193 m high rooftop. Change in potential energy in that suitcase is = \_\_\_\_\_ Joules.

## 3. Answer the following questions (Answer any ten)

**[1 × 10 = 10]**

~~(i)~~ Explain Bow's notation.

~~(ii)~~ State the law of superposition.

~~(iii)~~ State the parallelogram law of vector addition.

~~(iv)~~ What do you mean by resolution of a force?

~~(v)~~ State the Lami's theorem.

~~(vi)~~ Define moment of a force.

~~(vii)~~ What do you mean by "angle of limiting friction"?

~~(viii)~~ What is the relationship between angle of repose and angle of friction?

~~(ix)~~ Name the types of loads usually considered on beams.

~~(x)~~ What is law of machine?

~~(xi)~~ If two concurrent forces of 4 N and 6 N are acting at an angle of  $60^\circ$ , find the magnitude of their resultant.  $8.21$

~~(xii)~~ What is an ideal machine?

~~(xiii)~~ Write the law of conservation of momentum.

~~(xiv)~~ What is the centripetal force?

~~(xv)~~ What are the Basic Units?

## Group-B

**[2 × 6 = 12]**

## 4. Answer the following questions (Answer any SIX)

~~(i)~~ Explain the principle of transmissibility.

~~(ii)~~ Write the conditions for equilibrium of forces.

~~(iii)~~ Show with diagram: Uniformly distributed load and Uniformly varying load.

~~(iv)~~ State the Coulomb's laws of friction.

(v) What is cone of friction? Draw the cone.  
 (vi) Write the advantages of friction.  
 (vii) What is Reversible & Non-reversible machine?  
 (viii) What do you mean by 'effort lost in friction' and 'frictional resistance'?  
 (ix) A train was moving at a constant velocity of 80 km/h, as it approached a station, the loco-pilot applied brakes at a constant retardation of  $0.74 \text{ m/sec}^2$  and stopped it at the station. How much time will it take to stop?  
 (x) A ball is thrown vertically upwards from ground, with an initial velocity of 2 m/s. Find the greatest height attained by the ball.

### Group-C

#### 5. Answer any one of the following questions

[6 × 1 = 6]

(a) The resultant of two forces  $P$  and  $Q$  is  $R$ . If  $Q$  is doubled, the new resultant is perpendicular to  $P$ . Prove that  $Q = R$ .  
 (b) Four forces equal to  $P$ ,  $2P$ ,  $3P$  and  $4P$  are respectively acting along the four sides of a square  $ABCD$ , taken in order. Find the magnitude, direction and position of the resultant force.  
 (c) A horizontal bridge ( $AB$ ) of 18 m long weigh 18 kN and rest on two supports at its ends. What will be the pressure on each support when a lorry of weight 5 kN starting from  $A$  is two third of the way across the bridge? <https://www.wbscteonline.com>

#### 6. Answer any one of the following questions

[6 × 1 = 6]

(a) A uniform wheel of diameter 600 mm and weight 3 kN is to be pulled over a rigid rectangular block of height ( $h$ ) 150 mm by a horizontal force  $P$  applied to the end of a string wound around the circumference of the wheel shown in the Figure 6(a). Find the least pull required just to turn the wheel over the corner of the block.

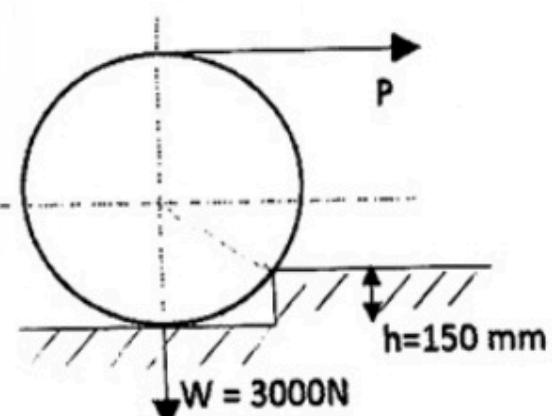


Fig. 6(a)

(b) A weight of 25 N is pulled up a rough inclined plane whose inclination to the horizontal is  $30^\circ$  by a force of 18 N acting parallel to the plane. Calculate the coefficient of friction.  
 (c) Find out the reactions at supports by equations of statics for beam of Figure 6(c).

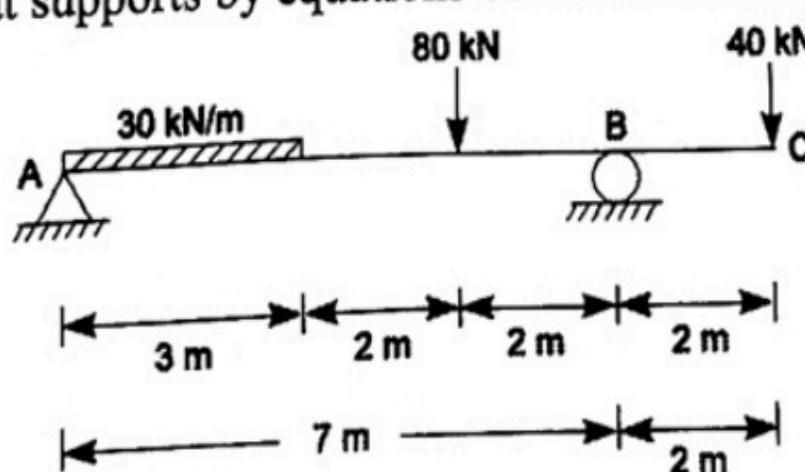


Fig. 6(c)

7. Answer any one of the following questions

[6 × 1 = 6]

(a) Find the centroid of the cross section shown in Figure 7(a). All dimensions are in mm.

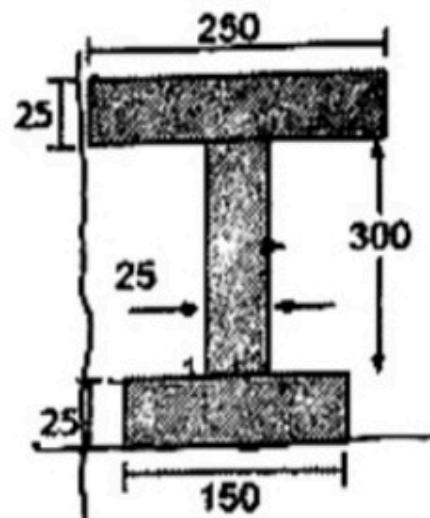


Fig. 7 (a)

(b) What is the minimum effort  $P$  required to lift a load  $W$  by a screw jack when helix angle is  $\alpha$  and coefficient of friction is  $\tan \varphi$  where  $\varphi$  is the angle of friction? A simple screw jack has a thread of pitch of 10 mm, find the mechanical advantage and efficiency, if an effort of 20 N is applied at the end of an arm 500 mm long to lift a load 2.6 kN.

[2 + 4]

(c) A wheel rotating about a fixed axis at 20 revolutions per minute is uniformly accelerated for 70 sec. during which it makes 50 revolutions. Find the (i) angular velocity at the end of this interval and (ii) time required for the velocity to reach 100 revolutions per minute.