

June 2021

**ENGINEERING MECHANICS**

Time Allowed: 3 Hours

Full Marks: 70

**Answer to Question No.1 is compulsory and Answer any five questions from the rest.**

1. A. State whether the following statements are True or False (any ten): 10x1
- i) A roller support has reaction normal to the support plane.
  - ii) If the law of lifting machine is  $P = 0.04W + 20$ , the maximum mechanical advantage is 25.
  - iii) If two equal forces each of magnitude  $P$  act at an angle  $\theta$ , then their resultant will be  $P\sqrt{2(1-\cos\theta)}$ .
  - iv) In SI, the unit of co-efficient of friction is  $Nm^{-1}$ .
  - v) Centroid of a triangular lamina lies at a point where its three medians meet.
  - vi) The normal force of an object lying on an inclined plane will be lesser than the normal force acting on it, when it rests horizontally.
  - vii) Mechanical advantage is the ability of a machine to multiply force.
  - viii) A body isolated from all other members which are connected to it is called Free body.
  - ix) In case of a lifting machine load vs. effort graph is a curve.
  - x) In locating centroid of a body, we apply principle of moments.
  - xi) The C.G. of a semicircle lies at a distance from its base measured along the vertical radius is  $\frac{4r}{3\pi}$ .
  - xii) Rotational tendency of a force is called resultant.
- B. Fill in the blanks (any ten): 10x1
- i) The angle which an inclined surface makes with the horizontal when a body placed on it is on the point of moving down is known as \_\_\_\_\_.
  - ii) Instead of simple wheel and axle, differential wheel and axle gives \_\_\_\_\_ V.R.
  - iii) In the equation  $P=mW+C$  of a lifting machine, 'C' indicates the effort required to overcome friction under \_\_\_\_\_.
  - iv) The C.G. of an equilateral triangle with each side 'a' is at a distance \_\_\_\_\_ from any of the three sides.
  - v) If the resultant of two forces  $P$  and  $Q$  (acting at an angle  $\theta$ ) makes an angle  $\alpha$  with  $P$ , then  $\tan \alpha =$  \_\_\_\_\_.
  - vi) If the arm of a couple is doubled, its moment will be \_\_\_\_\_.
  - vii) Maximum value of static friction is known as \_\_\_\_\_.
  - viii) The units which are used for measurement of fundamental quantities i.e. mass, length and time, are known as \_\_\_\_\_.
  - ix) The body which does not deform under the action of applied forces is known as \_\_\_\_\_.
  - x) If for a number of coplanar concurrent forces the force polygon is closed the forces are in \_\_\_\_\_.
  - xi) When frictional force ( $F$ ) increases, the ratio between  $F$  and normal reaction ( $N$ ) \_\_\_\_\_.
  - xii) If efficiency of a lifting machine is kept constant, its velocity ratio is directly proportional to its \_\_\_\_\_.
2. a) State and explain Varignon's theorem.  
 b) An oil drum of 400mm diameter and 1.5m long is to be rolled across a footstep of 100mm high. Find the minimum push required at the top of the drum. Take density of oil as 1 kg/litre. Neglect weight of the drum. 4+6

3. A body resting on a rough horizontal plane, required a pull of 180N inclined at  $30^\circ$  to the plane just to move it. It was found that a push of 200N inclined at  $30^\circ$  to the plane just removed the body. Determine the weight of the body and the coefficient of friction. 10
4. a) Define centre of gravity and centroid.  
 b) An I-section has the following dimensions in mm units:  
 Bottom flange = 250x100  
 Top flange = 150x50  
 Web = 400x50  
 Determine mathematically the position of centre of gravity of the section. 4+6
5. An uniform ladder 5m long rests on a horizontal ground floor and leans against a smooth vertical wall at angle of  $60^\circ$  with the horizontal. The weight of the ladder is 900N acts at the middle. The ladder is at the point of sliding, when a man weighing 750N stands on a rung 1.5m from the bottom of the ladder. Calculate the coefficient of friction between the ladder and the floor. 10
6. a) Define velocity ratio, mechanical advantage and efficiency of a simple lifting machine.  
 b) In a differential wheel and axle, the diameter of the effort wheel is 40cm. The radii of the axles are 15cm and 10cm respectively. Find the load which can be lifted by an effort of 100N, assuming the efficiency of the machine to be 75%. 4+6
7. In a simple machine, whose velocity ratio is 40, a load of 1500N is lifted by an effort of 100N and a load of 2500N is lifted by an effort of 160N. Find the law of machine. Also calculate the load that could be lifted by an effort of 200N. 10
8. a) Define and explain parallelogram law of forces.  
 b) Two forces act an angle of  $120^\circ$ . The bigger force is of 40N and the resultant is perpendicular to the smaller one, find the smaller force. <https://www.wbscteonline.com> 4+6
9. a) State and explain Lami's theorem.  
 b) Determine the horizontal force P to be applied to a block of weight 450N to hold it in position on a smooth inclined plane which makes an angle  $30^\circ$  with horizontal. 4+6
10. A simply supported beam AB of span 4m is carrying point loads of 5, 2 and 3KN at 1, 2 and 3m from the support A. Calculate the reactions at the supports A & B. 10

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