Total No. of printed pages = 6

ME 181104

Roll No. of candidate | | | | | | | | | | |

2023

B.Tech. 1st Semester (Regular) End-Term Examination

ENGINEERING MECHANICS

(New Regulation and New Syllabus)

Full Marks – 70 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. Choose the correct option : $(1 \times 10 = 10)$

(i) If the resultant of two equal forces has the same magnitude as either of the forces, then the angle between the two forces is

(a) 30°

(b) 60°

(c) 90°

(d) 120°

(ii) In a framed structure, as shown in the Fig. 1, the force in the member BC is

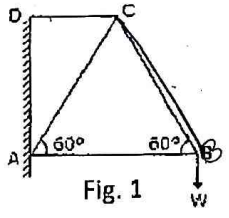


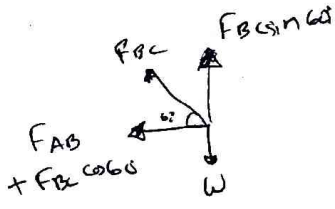
Fig. 1

(a) $W/\sqrt{3}$ (compression)

(b) $W/\sqrt{3}$ (tension)

(c) $2W/\sqrt{3}$ (compression)

(d) $2W/\sqrt{3}$ (tension)



$F_{BC}\sin 60^\circ = W$

$F_{BC} = \frac{W}{\frac{\sqrt{3}}{2}} = \frac{2W}{\sqrt{3}}$

[Turn over

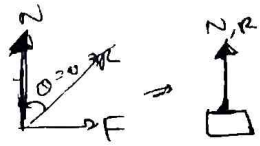
(iii) If the angle of friction is zero, then body will experience a force which is

(a) Reverse friction force

(b) Zero friction force

(c) Normal to the plane

(d) In the direction of motion



(iv) On a ladder resting on smooth ground and leaning against vertical wall, the force of friction will be

(a) Towards the wall at its lower end

(b) Away from the wall at its upper end

(c) Upwards at its upper end

(d) Downwards at its upper end

(v) The Centre of gravity of a quarter circle lies at a distance from both the central axes

(a) $4\pi/3R$

(b) $3R/4\pi$

(c) $4R/3\pi$

(d) 0

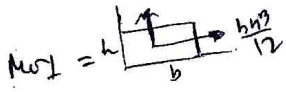
(vi) The moment of inertia of a solid of mass 'm' and radius 'r' is

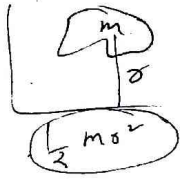
(a) $2mr^2/3$

(b) $2mr^2/5$

(c) mr^2

(d) $mr^2/2$





(vii) A weight of 1000 N can be lifted by an effort of 80 N. If the velocity ratio is 20, the machine is

(a) Reversible

(b) Non reversible

(c) Ideal

(d) None of these

(viii) In the lever of third order, load 'W', effort 'P' and fulcrum 'F' are oriented as follows

(a) W between P and F

(b) F between W and P

(c) P between W and F

(d) W, P and Fall on one side

(ix) A particle of mass 10 Kg starts moving in a straight line following the equation of motion $S = 2t^3 - t^2 - 1$ due to the application of P force for 1 second. The force on the particle is

(a) 40 N

(b) 60 N

(c) 80 N

(d) 100 N

(x) D' Alembert's principle is used for

(a) Determining stresses in the truss

(b) Designing safe structures

(c) Reducing the problem of kinetics to equivalent static problem

(d) Stability of floating bodies

2. (a) Define Lami's theorem.

A roller of radius 40 cm, weighing 3000 N is to be pulled over a rectangular block of height 20 cm as shown in Fig. 2, by a horizontal force P applied at the centre of the roller. Find the magnitude of the force which will just turn the roller over the corner of the rectangular block. (1 + 4= 5)

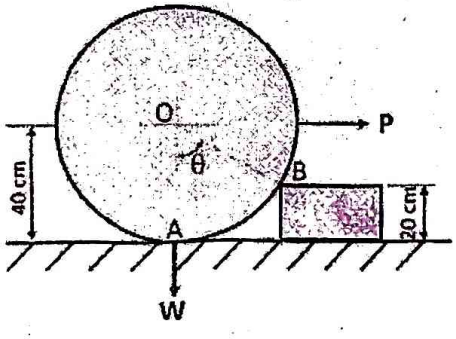


Fig. 2

(b) Four coplanar forces are acting at a point E as shown in Fig. 3. Determine the magnitude and direction of the resultant force. Verify the analytical result with graphical results. (5 + 5 = 10)

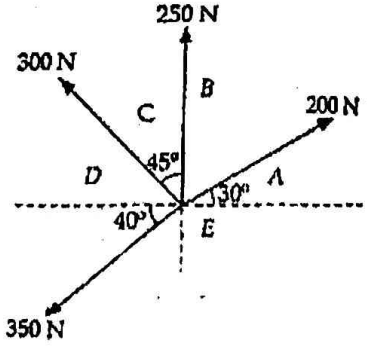


Fig. 3

3. (a) State Varignon's theorem.

A simply supported beam AB of span 4.5 m is loaded with UVL as shown in Fig.4. Find the support reactions at A and B. (1 + 5 = 6)

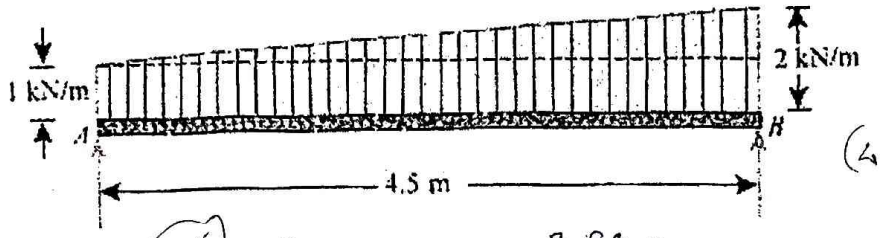


Fig. 4

(b) Determine the forces in all the members of the cantilever truss loaded as shown in Fig. 5 (9)

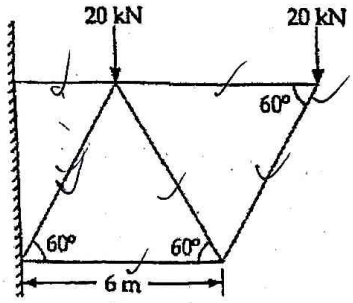


Fig. 5

4. (a) Draw suitable plot of friction force vs. applied force to differentiate between static and kinetic friction. Show that angle of repose is equal to angle of friction. (2 + 3 = 5)

(b) (i) A body resting on a rough horizontal plane required a pull of 25 N inclined at 60° to the plane just to move it. It was also found that a push of 50 N at 60° to the plane was just enough to cause the motion to impend. Make calculations for the coefficient of friction and the weight of body. (8 + 2 = 10)

Or

(ii) A uniform ladder of length of 5 m and weight 500 N rests against a vertical wall in a position where its inclination to the horizontal floor is 60°. A man weighing 60 Kg climbs the ladder. At what position will he induce slipping? (coefficient of friction μ = 0.3 at both the contact surfaces of the ladder). (10)

5. (a) Differentiate between Centroid and Centre of Gravity. From a circular plate of diameter 100 mm, a circular part of diameter 50 mm is cut as shown in Fig. 6. Find the centroid of the remainder. (1 + 4 = 5)

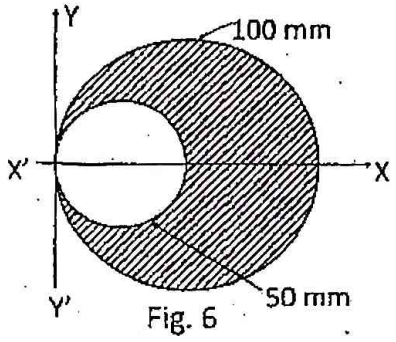


Fig. 6

(b) (i) State and explain Polar moment of inertia. (2 + 8 = 10)

(ii) Determine the polar moment of inertia of the shaded plate shown in Fig. 6.

6. (a) Use law of machine to differentiate between ideal and actual machine with suitable diagram. Prove that a self-locking machine have efficiency less than 50%. (2 + 3 = 5)

(b) Find the law of a machine in which an effort of 12.5 N raised a load of 50-N and an effort of 15.5 N raised a load of 100 N. Find the load that can be raised by an effort of 25 N. If the velocity ratio of the machine is 20, comment on the type (reversible/self-locking) of the machine. (4+ 2 + 4 = 10)

7. (a) State the principle of Virtual work.

A weight W of 1 kN is to be lifted by a system of pulleys as shown in Fig. 7. Using the principle of Virtual work, find the value of force P which can hold the system in equilibrium. (2+ 3 = 5)

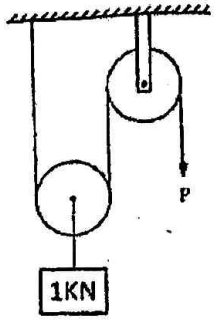


Fig. 7

(b) A train travels from one station to another station along a straight track. First half of the distance is covered with velocity 150 km/hr and the second half is covered with the velocity of 200 km/hr. Determine the average speed of the motor. (5)

(c) A pile hammer of 250 kg mass is made to fall freely on a pile from a height of 6 m if the hammer comes to rest in 0.012 second, determine the change in momentum, impulse and average velocity. (2 + 1 + 2 = 5)

-2711.68 $= 225924$

$v = 10.8$
$v = 0$ $t = 0.12$