MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

DEPARTMENT OF CIVIL ENGINEERING

Subject (Name and code) : Mechanics of Solids (CIE1071) Semester : I

Date of the Examination : 27-09-2024 Month/Year Sept 2024

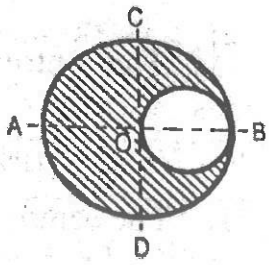
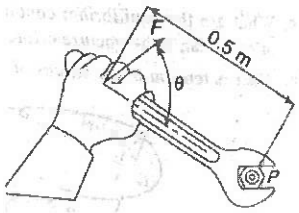
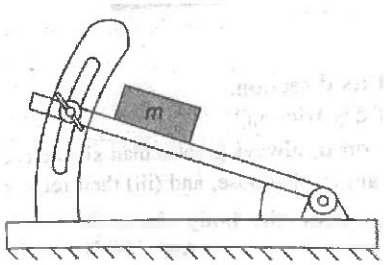
Name of the Faculty Member : DR. LATHASHRI UA, MR. M PRASSANNA KUMAR Head of the department

PROFESSOR & HEAD
Dept. of Civil Engineering
MANIPAL INSTITUTE OF TECHNOLOG
Manipal - 576 104

27/9/24

SCHEME OF EVALUATION (~~Sessional~~ MIDTERM EXAM)

Q.No.		Marks

Sl.No.	Question and Answer	Marks
1	500 N force is applied at an angle of 30° to the horizontal on a body. A vertical reaction force at the point of contact prevents vertical motion. What horizontal force is required to keep the body in equilibrium? **Ans :** 433 N	1
2	The effect of a couple on a rigid body depends on: **Ans:** Both magnitude of the forces and the distance between their lines of action	1
3	A circular hole of 50 mm diameter is cut out from a circular disc of 100 mm diameter as shown in Figure below, The centroid of the section will lie _____.  **Ans :** in the shaded area	1
4	A moment of 100 N-m about point P is required to tighten the nut. Determine the smallest magnitude of the force F and the corresponding angle θ that will turn the nut as shown in Figure below  **Ans:** 200 N, 90°	1
5	Find the inclination of the block in Figure below, at which it will start to slip down if the coefficient of friction between the block and the surface is 0.24  **Ans:** 13.49°	1

Q No	Answers	Mark

6

Sl No.	Shape	Area (mm^2)	$\bar{y}$ (mm)	$A\bar{y}$ (mm^3)
1	Rectangle	$230 \times 210 = 48300$	$\frac{210}{2} = 105$	5071500
2	Triangle (−)	$-\frac{1}{2} \times 180 \times 75 = -6750$	$75 \div 3 = 25$	−168750
3	circle (−)	$-\frac{\pi \times 60^2}{4} = -2827.4$	$75 + 68 = 143$	−404318.2

$\Sigma A = 38722.6\ mm^2$ $\quad \Sigma A\bar{y} = 4498431.8$

$$\bar{y} = \frac{\Sigma A\bar{y}}{\Sigma A} = \frac{4498431.8}{38722.6}$$

$$= 116.170\ mm$$

01 01 01 01 — 4m

7.

$$\xrightarrow{+} \Sigma F_x = 30 \sin 30^\circ = 15\ N \rightarrow$$

$$+\uparrow \Sigma F_y = -80 - 30\cos 30 = -105.98\ N$$

$$= 105.98\ N\ (\downarrow)$$

$$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$$

$$= 107.36\ N$$

$$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) = 81.94^\circ$$

0.5 0.5 0.5

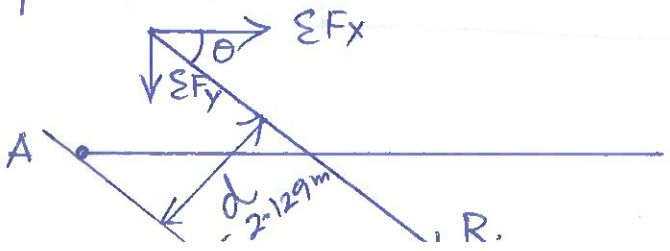
$$(+)\Sigma M_A = (80 \times 1) + (30 \sin 30 \times 1 \times \sin 30) + 30\cos 30 \times (3 + 1\cos 30) + 40$$

$$= 227.94\ N\text{-}m$$

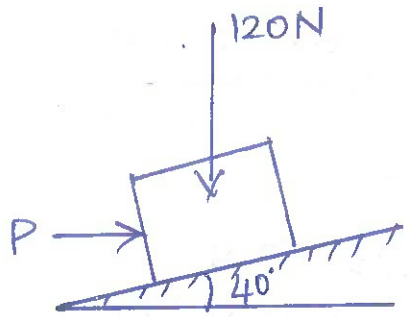
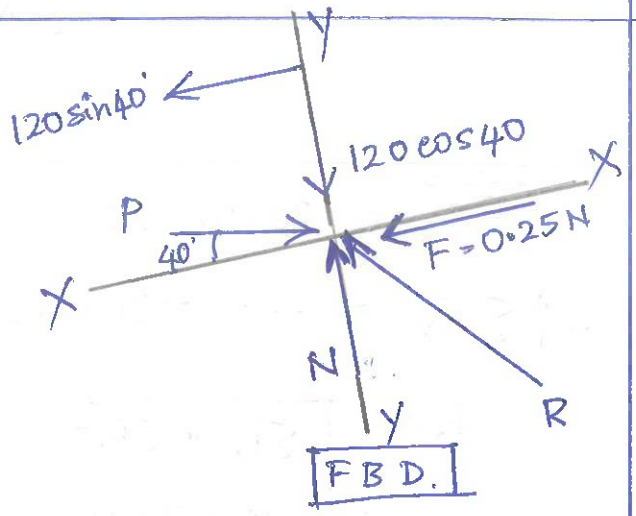
1

$$d = \left|\frac{\Sigma M_A}{R}\right| = 2.129\ m$$

0.5

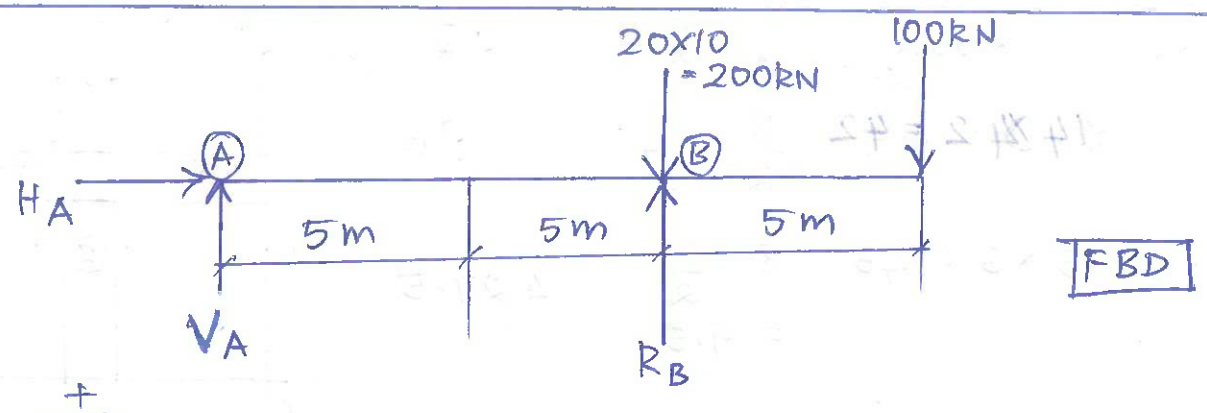


03m

Q No	Answers	Marks
8.	$\xrightarrow{+} \sum F_x = R$	
	$T_1 \cos 30^\circ + T_2 \cos 45^\circ = 8000$ — (1)	01
	$+\uparrow \sum F_y = 0$;	
	$T_1 \sin 30 - T_2 \sin 45 = 0$	01
	$T_1 = 1.414 T_2$ — (2)	
	Solve eq (1) & eq (2)	
	$T_1 = 4141.50\ N$ $T_2 = 5856.98\ N$	01
		3m
9.	 	0.5
	$\xrightarrow{+} \sum F_x = 0$	
	$P \cos 40 - 0.25\ N - 120 \sin 40^\circ = 0$ — (1)	01
	$+\uparrow \sum F_y = 0$	
	$N - P \sin 40 - 120 \cos 40^\circ = 0$ — (2)	01
	Solving eq (1) & eq (2) $P = 165.38\ N$ $N = 198.23\ N$	0.5
		03m

Q No	Answers	Mark

10



FBD — 0.5

$\xrightarrow{+} \Sigma F_x = 0$ — 0.5

$$H_A = 0$$

$\uparrow \Sigma F_y = 0$ — 0.5

$$V_A + R_B = 200 + 100$$

$\circlearrowleft + \Sigma M_A = 0$ — 01

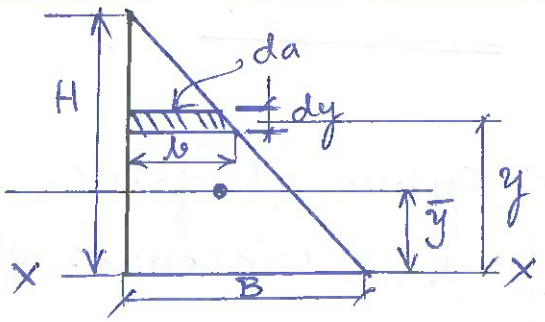
$$(200 \times 10) + (100 \times 15) - (R_B \times 10) = 0.$$

$$R_B = 350 \text{ kN } (\uparrow)$$

$$V_A = -50 \text{ kN or } 50 \text{ kN } (\downarrow)$$ — 0.5

03m

11.



Consider a small elemental area da at a distance 'y' from the base axis x-x. Let the thickness of the elemental area = dy — 01

Area of the element, $da = b \times dy$

From the principle of moments.

$$A\bar{y} = \int y \cdot da.$$

$$A\bar{y} = \int b \cdot dy \cdot xy$$

From similars Δls. — 0.5

$$b = \frac{B(H-y)}{H}$$

$$A\bar{y} = \int_0^H \frac{B(H-y)}{H} \times dy \times y$$ — 01

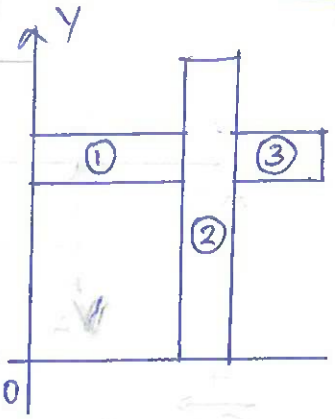
Integrating & simplifying.

$$\bar{y} = \frac{H}{3}$$ — 0.5

Q No	Answers	Mark

12.

Sl. No	Area (cm^2)	$\bar{x}$ (cm)	$A\bar{x}$ (cm^3)
1.	$8 \times 3 = 24$	$\frac{8}{2} = 4$	96
2.	$15 \times 3 = 45$	$8 + \frac{3}{2} = 9.5$	427.5
3.	$3 \times 3 = 9$	$11 + \frac{3}{2} = 12.5$	112.5



0.5
0.5
0.5

$\Sigma A = 78\ cm^2$ $\quad \Sigma A\bar{x} = 636\ cm^3$

$\therefore \bar{x} = \frac{\Sigma A\bar{x}}{\Sigma A} = 8.154$ cm

0.5

2m

13.

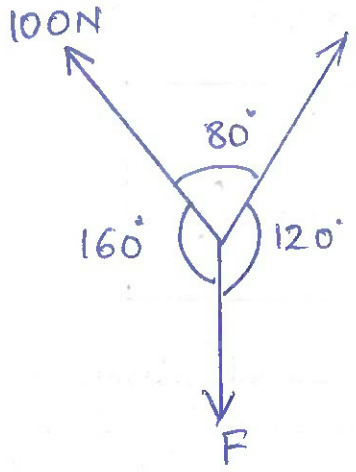


Fig 0.5

$\frac{100}{\sin 120} = \frac{F}{\sin 80} = \frac{39.5}{\sin 160}$ 01

$F = 113.715$ N

0.5

02m

14. Properties of a couple in system of forces:

i) The algebric sum of the components of the 2 forces is zero.

ii) The moment of a couple is constant for any point chosen.

iii) A couple can be balanced by an equal and opposite couple in the same plane.

iv) Two or more couples can be reduced to a single couple of moment equal to the algebric sum of the moments of the given couple.

Any (4) 0.5

2m

2.0