DEPARTMENT OF CIVIL ENGINEERING

Subject (Name and Code): MOS (CIE 1071) **Semester:** I

Date of the Examination: 26 / 09 /2023 **Month/Year:** September 2023

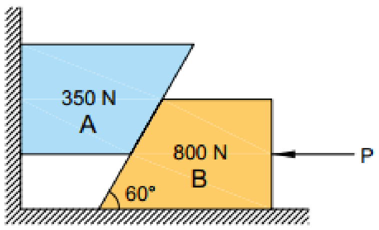
Dr. Kiran Kumar Shetty & Dr. Lathashri U. A.
Name of the Faculty Members

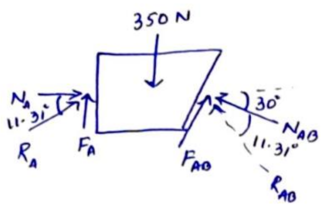
Dr. Purushotham G. S.
Head of the Department

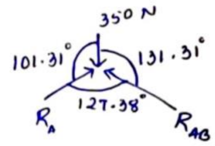
SCHEME OF EVALUATION (Mid-term Exam)

<table>
<tr><td>Q.No.</td><td><u>PART A</u></td><td>Marks</td></tr>
<tr><td>1</td><td>$\Sigma F_X = 0$</td><td>0.5</td></tr>
<tr><td>2</td><td>collinear forces</td><td>0.5</td></tr>
<tr><td>3</td><td>180°</td><td>0.5</td></tr>
<tr><td>4</td><td>F = 19.5 kN, M = 31.5 kN-m</td><td>0.5</td></tr>
<tr><td>5</td><td>area of contact surface</td><td>0.5</td></tr>
<tr><td>6</td><td>Continuous beam</td><td>0.5</td></tr>
<tr><td>7</td><td>upward along the wall</td><td>0.5</td></tr>
<tr><td>8</td><td>six</td><td>0.5</td></tr>
<tr><td>9</td><td>first moment of area about the axis is zero</td><td>0.5</td></tr>
<tr><td>10</td><td>$\frac{a^4}{6}$</td><td>0.5</td></tr>
<tr><td>11</td><td>Two blocks A and B are resting against a wall and the floor as shown in the figure. Find the minimum value of horizontal force P applied to the resist the motion of the block A. Given the coefficient of friction between all contact surfaces is 0.2.</td><td></td></tr>
<tr><td></td><td>
FBD of A

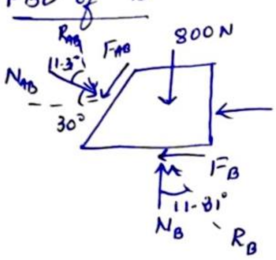
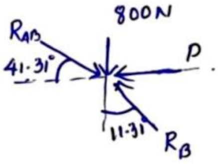
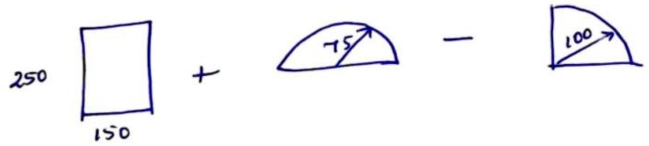
$\phi = \tan^{-1}(0.2) = 11.31°$



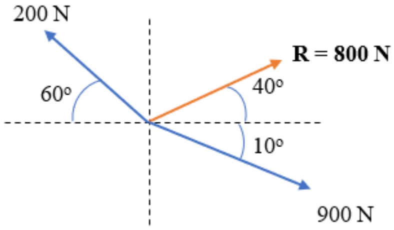


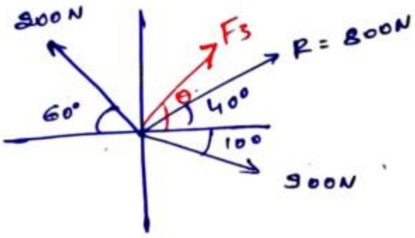


</td><td>0.5</td></tr>
<tr><td></td><td>$$\frac{350}{\sin 127.38} = \frac{R_{AB}}{\sin 101.31}$$</td><td>1</td></tr>
<tr><td></td><td>$R_{AB} = \underline{431.905}$ N</td><td>0.5</td></tr>
</table>

	FBD of B   $\Sigma F_y = 0 \Rightarrow R_B \cos 11.31 - 800 - R_{AB} \sin 41.31 = 0$ $R_B = \underline{1106.604}$ N $\Sigma F_x = 0 \Rightarrow -P + R_{AB}\cos 41.31 - R_B \sin 11.31 = 0$ $\Rightarrow P = \underline{108.94}$ N	0.5 1 0.5 **4 M**
12	Find the centroid of the shaded area with respect to OX and OY axes.  $\bar{x} = \dfrac{(250\times150\times75) + (\frac{\pi}{2}\times75^2\times75) - (\frac{\pi}{4}\times100^2\times\frac{4\times100}{3\pi})}{(250\times150) + (\frac{\pi}{2}\times75^2) - (\frac{\pi}{4}\times100^2)} = \dfrac{3.142\times10^6}{3.848\times10^4}$ $\bar{x} = \underline{81.653}$ mm $\bar{y} = \dfrac{(250\times150\times125) + (\frac{\pi}{2}\times75^2\times281.831) - (\frac{\pi}{4}\times100^2\times\frac{4\times100}{3\pi})}{(250\times150) + (\frac{\pi}{2}\times75^2) - (\frac{\pi}{4}\times100^2)} = \dfrac{6.844\times10^6}{3.848\times10^4}$ $\bar{y} = \underline{177.87}$ mm	0.5 × 3 0.5 0.5 × 3 0.5 **4 M**

13 A system of coplanar concurrent forces has three forces of which only two forces are shown in the Fig. If the resultant is a force R = 800N acting as indicated, obtain the unknown third force.





ΣF_x : $800 \cos 40^\circ = 900 \cos 10^\circ - 200 \cos 60^\circ + F_3 \cos\theta$ $-\frac{1}{2}$

$F_3 \cos\theta = -173.55N$ $-\frac{1}{2}$

ΣF_y : $800 \sin 40^\circ = -900 \sin 10^\circ + 200 \sin 60^\circ + F_3 \sin\theta$ $-\frac{1}{2}$

$F_3 \sin\theta = 497.31\ N$ $-\frac{1}{2}$

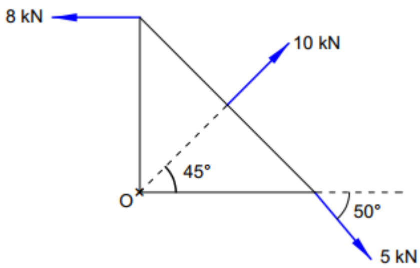
$\frac{F_3 \sin\theta}{F_3 \cos\theta} = \frac{497.31}{173.55}$ $\Big\}\ \frac{1}{2}$

$F_3 = 526.72N$ $-\frac{1}{2}$

$\theta = 70.76^\circ$

3 marks

14 Determine the resultant and its position w.r.to 'O' of the non-concurrent system of forces shown in the figure if height and base of the triangle is 4m.



$\Sigma F_x = -8 + 5 \cos 50^\circ + 10 \cos 45^\circ$ $\Big\}\ \frac{1}{2}$

$= 2.28\ kN$

$\Sigma F_y = -5 \sin 50^\circ + 10 \sin 45^\circ$ $\Big\}\ \frac{1}{2}$

$= 3.24\ kN$

$$R = \sqrt{2.28^2 + 3.24^2} \quad \Big\} \tfrac{1}{2}$$

$$= \underline{3.96\,kN}$$

$$\theta = \tan^{-1}\frac{3.24}{2.28}$$

$$= \underline{54.86^\circ}$$

$$\left.\begin{aligned} R \times d &= 5 \sin 50^\circ \times 4 - 8 \times 4 \\ 3.96 \times d &= -16.68 \end{aligned}\right\} 1$$

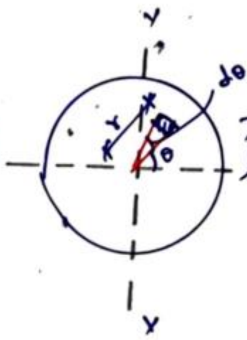
$$d = \underline{4.21\,m} \quad - \tfrac{1}{2}$$

3 marks

15 Derive the moment of inertia of circle about the centroidal axis by direct integration.

$$I_{xx} = \int da \cdot y^2 \quad - \tfrac{1}{2}$$

$$= \int_0^R \int_0^{2\pi} (r \cdot d\theta \cdot dr)\, r^2 \sin^2\theta \quad - \tfrac{1}{2}$$



$y = r\sin\theta$ $- \tfrac{1}{2}$

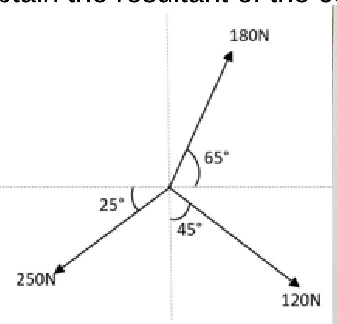
$$\left.\begin{aligned} &= \int_0^R \int_0^{2\pi} r^3 \cdot dr \cdot \sin^2\theta \cdot d\theta \\ &= \int_0^R r^3 \cdot dr \int_0^{2\pi} \sin^2\theta \cdot d\theta \end{aligned}\right\} \tfrac{1}{2}$$

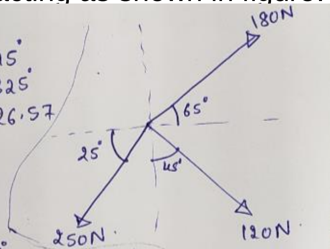
$$\left.\begin{aligned} &= \left[\frac{r^4}{4}\right]_0^R \int_0^{2\pi} \left[(1 - \cos 2\theta)/2\right] d\theta \\ &= \frac{R^4}{4}\left[\theta/2 - \sin 2\theta/4\right]_0^{2\pi} \end{aligned}\right\} \tfrac{1}{2}$$

$$= \frac{R^4}{4}[\pi - 0] = \frac{\pi R^4}{4} \quad - \tfrac{1}{2}$$

3 marks

16 Obtain the resultant of the concurrent coplanar forces acting as shown in figure.





$\Sigma F_x = 180\cos 65^\circ + 120\sin 45^\circ - 250\cos 25^\circ$

$= 76.071 + 84.852 - 226.57$

$\boxed{\Sigma F_x = -65.647\,N}$

$\Sigma F_y = 180\sin 65^\circ - 120\cos 45^\circ - 250\sin 25^\circ$

$= 163.135 - 84.852 - 105.654$

$\boxed{\Sigma F_y = -27.37\,N}$

$\tan\theta = \left|\frac{\Sigma F_y}{\Sigma F_x}\right| = \left|\frac{-27.37}{-65.647}\right|$

$\theta = \tan^{-1}(0.4169)$

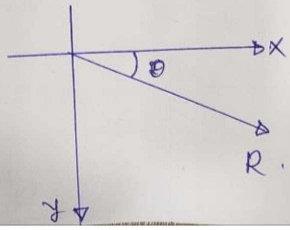
$\theta = 22.63^\circ$

Resultant:-

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

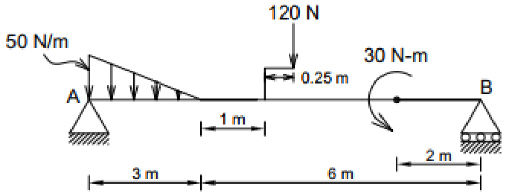
$= \sqrt{65.647^2 + 27.37^2}$

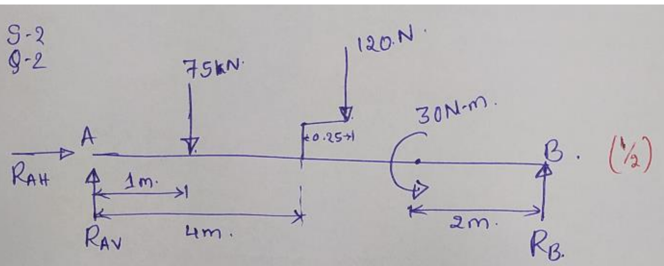
$\boxed{R = 71.124\,N}$



Marks: 0.5, 0.5, 0.5, 0.5, 0.5, 0.5 — **3 M**

17 Find the reaction at support A and B.





$\Sigma F_x = R_{AH} = 0 \quad \rightarrow (i) \quad (½)$

$\Sigma F_y = R_{AV} + R_B - 75 - 120 = 0 \quad (½)$

$R_{AV} + R_B = 195\,N \rightarrow (ii)$

Moment at A,

$-75\times 1 - 120(4.25) + 30 + (R_B \times 9) = 0 \quad (1)$

$9R_B = 75 + 120(4.25) - 30$

$R_B = (555/9) = 61.667\,N$

$\underline{R_B = 61.667\,N}$

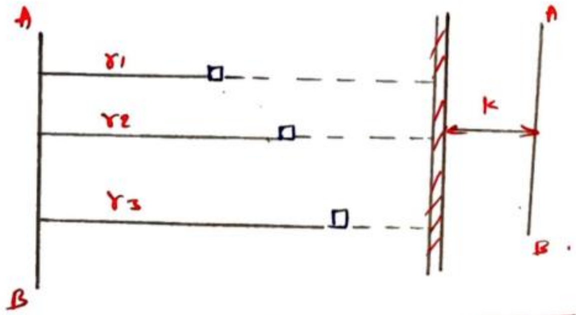
From eqn (ii), $R_{AV} = 195 - R_B = 195 - 61.667$

$\underline{R_{AV} = 133.33 = R_A} \quad (½)$

Marks: 0.5, 0.5, 0.5, 1, 0.5 — **3 M**

<table>
<tr><td>18</td><td>Explain radius of gyration with neat sketch.

Radius of Gyration is defined as constant distance of all elemental areas which have been rearranged without altering the total MI. – 1/2



– 1

$I_{AB} = AK^2$ $K = \sqrt{I_{AB}/A}$ – 1/2

2 marks</td><td></td></tr>
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