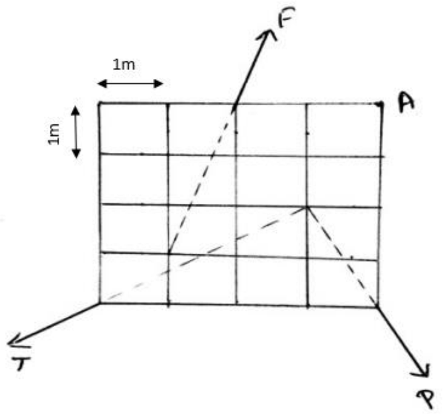
MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
*(A constituent unit of MAHE, Manipal)*

## Mechanics of Solids (CIE 1051)

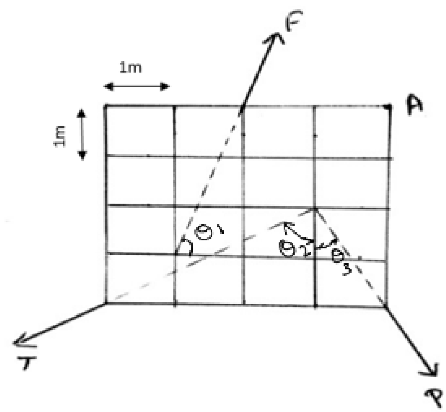
# Assignment 1

Date: 6/5/2021 Time: 2.00pm to 2.45pm

1. The three forces T, F and P acting in a grid system as shown in figure below induce a vertical resultant acting through point A. If T is known to be 300kN, compute the values of F and P. Consider grid size as 1m.




Solution:




$\theta_1 = 71.56$, $\theta_2 = 56.3$ $\theta_3 = 26.56$

$\Sigma H = 0$

$F\cos\theta_1 - T\sin\theta_2 + P\sin\theta_3 = 0$

$F\cos 71.56 - 300 \times \sin 56.3 + P\sin 26.56 = 0$

$0.3163F + 0.447P = 249.586$

$F \mp 1.413P = 789.08$ —— ①

$\Sigma M_A = 0$ ↻+ve

$F\sin\theta_1 \times 2 - T\cos\theta_2 \times 4 + T\sin\theta_2 \times 4 - P\sin\theta_3 \times 4 = 0$

$1.8973F + 665.813 + 998.345 = 0$

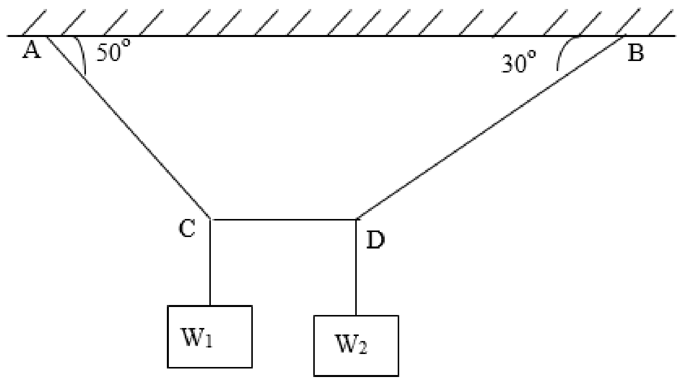
$F - 0.9426P + 175.265 = 0$ — ②

Eq① - ②

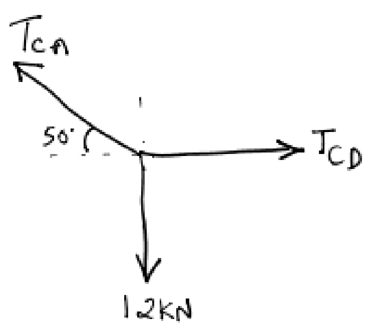
$P = 409.384$ kN

$F = 210.620$ KN

2. For the cable system as shown in the figure, find the value of $W_2$ so that the segment CD remains horizontal. Also, determine tension in each segment. Take $W_1 = 12kN$




Solution :




$\Sigma H = 0$

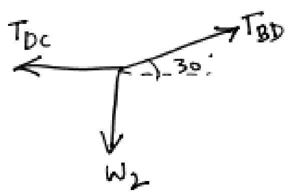
$T_{CD} - T_{CA} \cos 50 = 0$

$\Sigma V = 0$

$T_{CA} \sin 50 - 12 = 0$

$\underline{T_{CA} = 5.664 \text{ kN}}$

$\underline{T_{CD} = 10.069 \text{ kN}}$




$\Sigma H = 0$

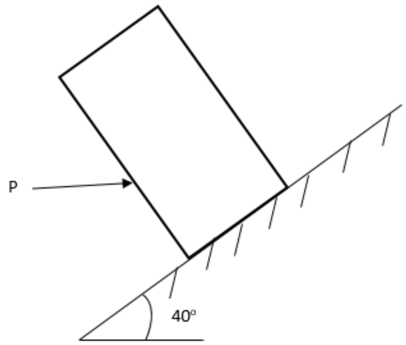
$-T_{DC} + T_{DB} \cos 30 = 0$

$T_{DB} = 11.626 \text{ kN}$

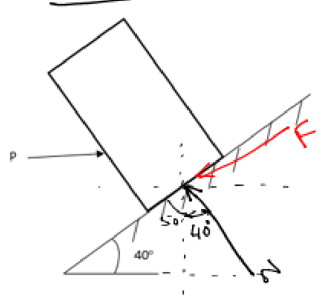
$\Sigma V = 0$

$-W_2 + T_{DB} \sin 30 = 0 \Rightarrow \underline{W_2 = 5.813 \text{ kN}}$

3. A 2000 N block shown in figure is in contact with 40° incline plane. The coefficient of friction between the contact surface is 0.3. Compute the value of the horizontal force P necessary to (a) just move the block up the incline (b) just prevent motion down the incline.

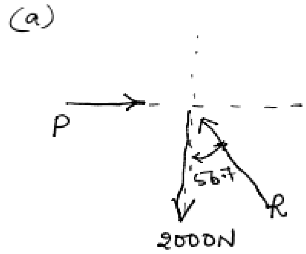



Solution :-




$\phi = \tan^{-1}(0.3) = 16.7°$

(a)




$\Sigma H = 0$

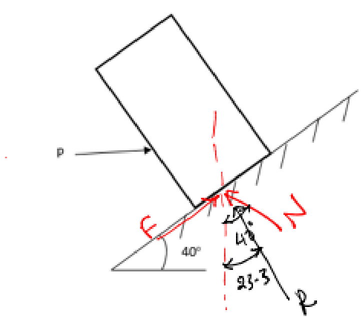
$P - R \sin 56.7 = 0$

$\Sigma V = 0$

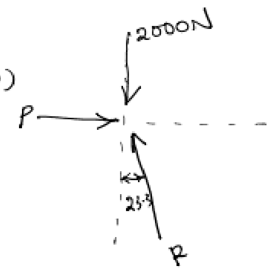
$R \cos 56.7 - 2000 = 0$

$R = 3642.83 N$

$P = 3044.704 N$




(b)




$\Sigma H = 0$

$P - R \sin 23.3 = 0$

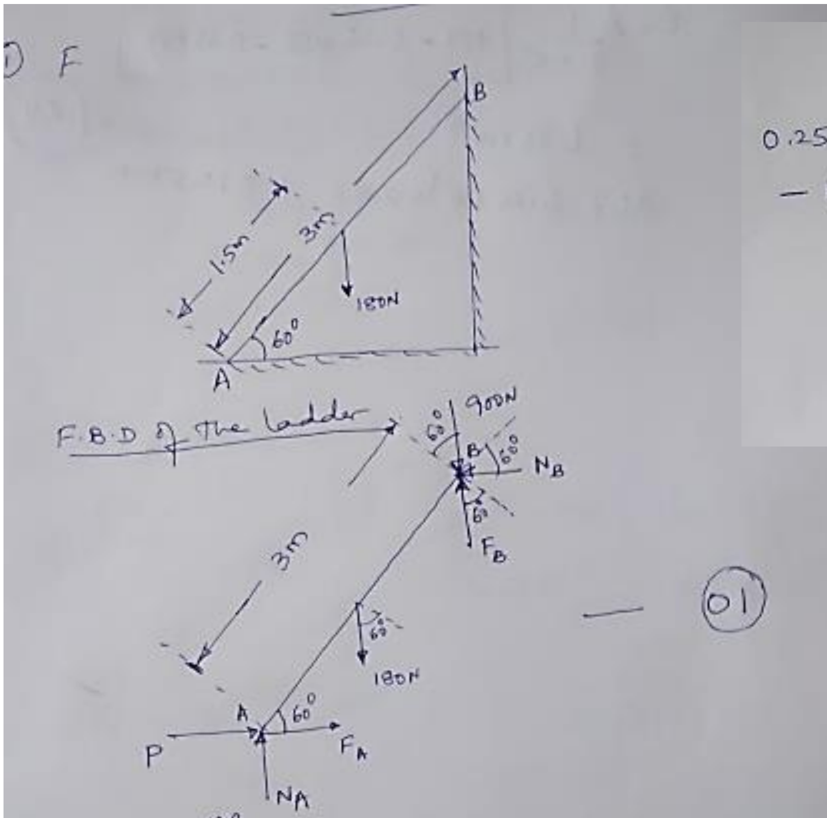
$\Sigma V = 0$

$R \cos 23.3 - 2000 = 0$

$R = 2177.59 N$

$P = 861.36 N$

4. A uniform ladder ‘AB’ of length 3m weighing 180N is placed with its end A at the floor and the other end B against the wall, ladder AB making an angle of 60 ° with the floor. Coefficient of friction between the wall and ladder is 0.25 and between floor and ladder is 0.35. In addition to the self-weight, the ladder has to support a person weighing 900 N at its top B. To prevent from slipping what is the minimum force P required to be applied horizontally at A.




$\xrightarrow{+ve}$

$\Sigma F_H = 0$

$P + F_A - N_B = 0$

$N_B = P + 0.35 N_A$ —— (1)

$\Sigma F_V = 0 \uparrow +ve$

$N_A + F_B - 900 - 180 = 0$

$N_A = 1080 - 0.25 N_B$ —— (2)

(01)

$\Sigma M_A = 0$ (+ve)

$0.25 N_B \cos 60^\circ \times 3 + N_B \sin 60^\circ \times 3 - 900 \cos 60^\circ \times 3$ —— (02)

$- 180 \cos 60^\circ \times 1.5 = 0$

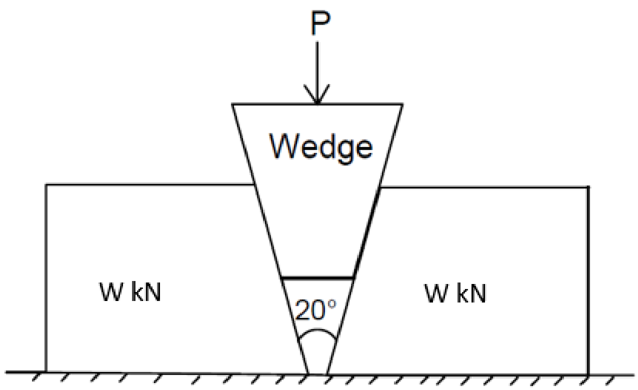
$N_B = 499.48 N$

$N_A = 955.13 N$ } $(0\tfrac{1}{2})$

Sub in (1)

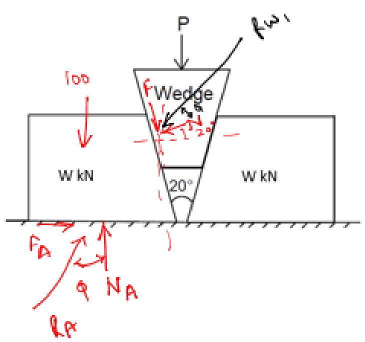
$P = 165.18 N$ —— } $(0\tfrac{1}{2})$

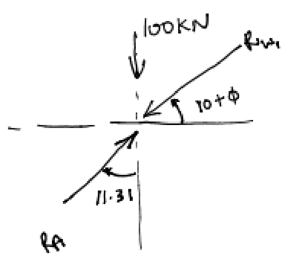
5. Determine the force P required to drive the massless wedge downward between the two blocks of weight W=100kN as shown in figure below. Take coefficient of friction between contact surfaces as 0.2 and wedge angle as $20^0$. Weight of the wedge is ignored.




Solution:

$\mu = 0.2, \quad \phi = \tan^{-1}(0.2) \Rightarrow \phi = 11.31^\circ$



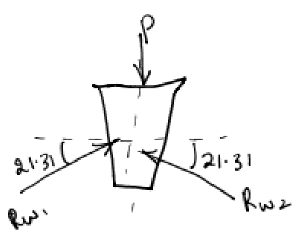




Lamis theorem

$$\frac{100}{\sin 22.62} = \frac{R_{W1}}{\sin 168.69} = \frac{R_A}{\sin 68.69}$$

$R_A = 110.609\ kN$

$R_{W1} = 23.284\ k = R_{W2}$

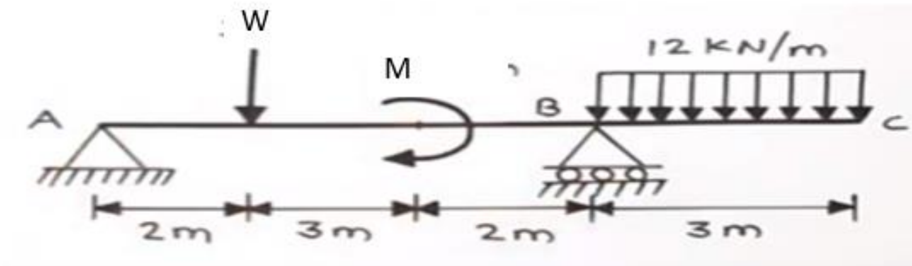


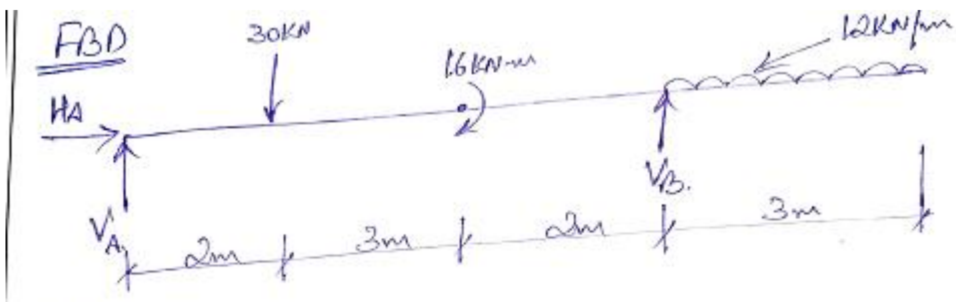

$\Sigma V = 0$

$+R_{W1} \sin 21.31 + R_{W2} \sin 21.31 - P = 0$

$P = 16.92\ kN$

6. Find the reaction at supports A and B for the beam shown in the figure.
   Take W = 30kN , M= 16kN-m




$\xrightarrow{}+$

$\Sigma F_x = 0$

$$H_A = 0$$

$\uparrow +$

$\Sigma F_y = 0$

$$V_A + V_B = 30 + 12(3) = 66$$

$\circlearrowright +$

$\Sigma M_A = 0$

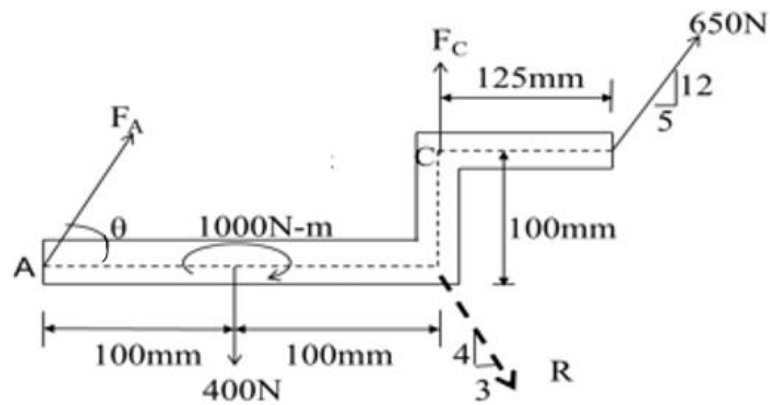
$$12(3)(8.5) - V_B(7) + 16 + 30(2)$$

$$\boxed{V_B = 54.571 \text{ KN}}$$

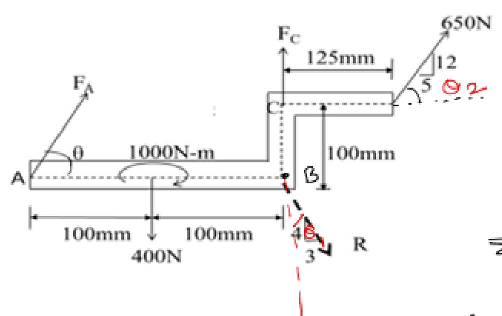
$$V_A = 66 - 54.571$$

$$\boxed{V_A = 11.429 \text{ KN}}$$

7. Determine the unknown forces $\mathbf{F_A}$ and $\mathbf{F_c}$ if the resultant of force system is R =300N located as shown in figure.




**Solution:**




$\theta_1 = 36.869°$ $\theta_2 = 67.38°$

$\xrightarrow{+ve}$

$\Sigma F_x = F_A \cos\theta + 650 \times \cos 67.38 = 300 \sin 36.869°$

$F_A \cos\theta = -70.0005N$ — ①

$\Sigma M_B = 0$ ↻ +ve

$F_A \sin\theta \times 200 - 400 \times 100 + 1 \times 10^6 + 650 \times 100 \times \cos 67.38$
$- 650 \times \sin 67.38 \times 125 = 0$ — ②

$F_A \sin\theta = -9.1 \times 10^5$

Eq ②/①

$\theta = 89.99$

$F_A = 401.073kN$