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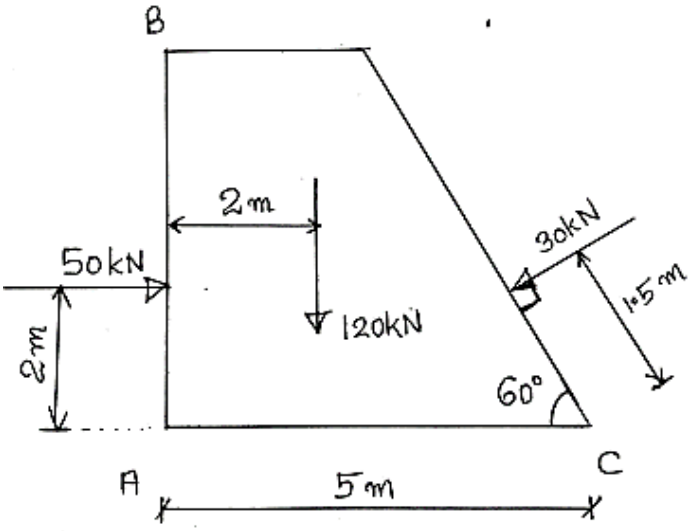
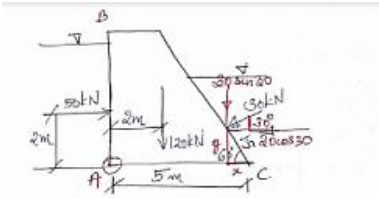
Internal Assessment Test 2 – April 2019

Sub:	Elements of Civil Engineering and Mechanics					Sub Code:	17CIV23	Branch:	
Date:	16/4/2018	Duration:	90 mins	Max Marks:	50	Sem / Sec:	**D & G**		OBE

Answer any FIVE FULL Questions

		MARKS	CO	RBT
1	A dam is subjected to the following forces. Determine the resultant of all forces and locate its point of intersection with the base AC? Take the reference point as C.	[10]	CO3	L4





$\Sigma F_x = 50 - 30\cos 30 = 24\ kN$

$\Sigma F_y = -120 - 30\sin 30 = -135\ kN$

$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2} = 137.12\ kN$

$\theta = \tan^{-1}\frac{\Sigma F_y}{\Sigma F_x} = 79.9°$

The same problem can be solved w.r.t C

Taking moment about C (Easier)

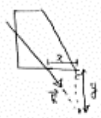
$M_c = 50\times 2 - 120\times 3 - 30\times 1.5$

$= -305\ kNm\ (\circlearrowleft)$

$\vec{R}\times d = 305$

$d = \frac{305}{137.12}$

$= 2.22\ m$

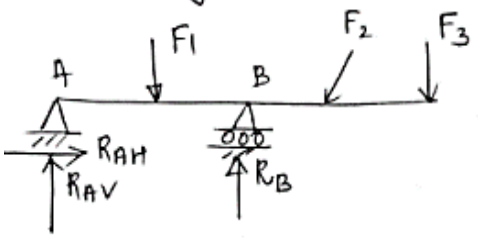


$x = \frac{M_c}{\Sigma F_y} = 2.25\ m$

$y = \frac{M_c}{\Sigma F_x} = 12.71\ m$

2 (a) Explain briefly with figures the different types of beams. [06] CO3 L4

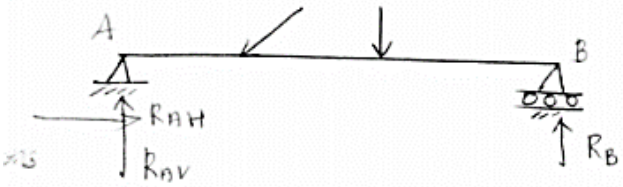
Overhanging beams



Cannot be stable if both supports are rollers.

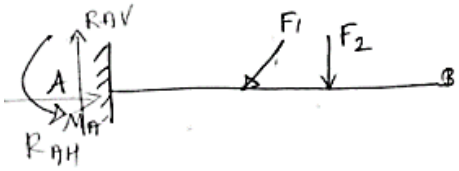
R_{AH}, R_{AV}, R_B can be solved by $\Sigma F_x = 0$, $\Sigma F_y = 0$, $\Sigma M = 0$
3 equations and 3 unknowns.

Beams with one end hinged and the other roller



The reactions R_{AH}, R_{AV}, R_B can be found by $\boxed{\Sigma F_x = 0,\ \Sigma F_y = 0,\ \Sigma M = 0}$. The problem will simplify to the first case if inclined loads are not present.

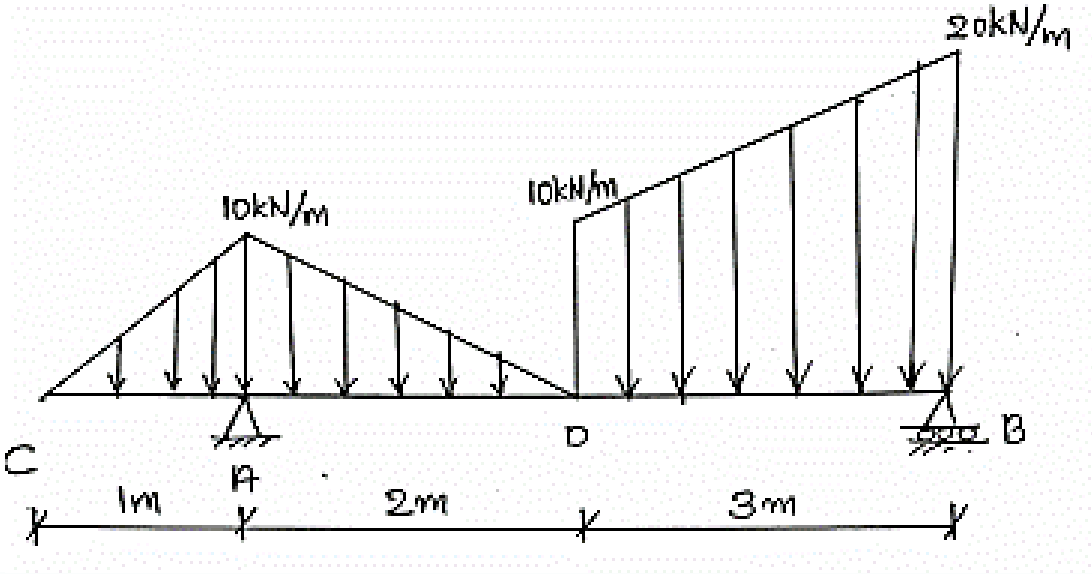
Cantilever Beams.



R_{AV}, R_{AH}, M_A can be solved by $\Sigma F_x = 0$, $\Sigma F_y = 0$, ΣM
3 equations and 3 unknowns

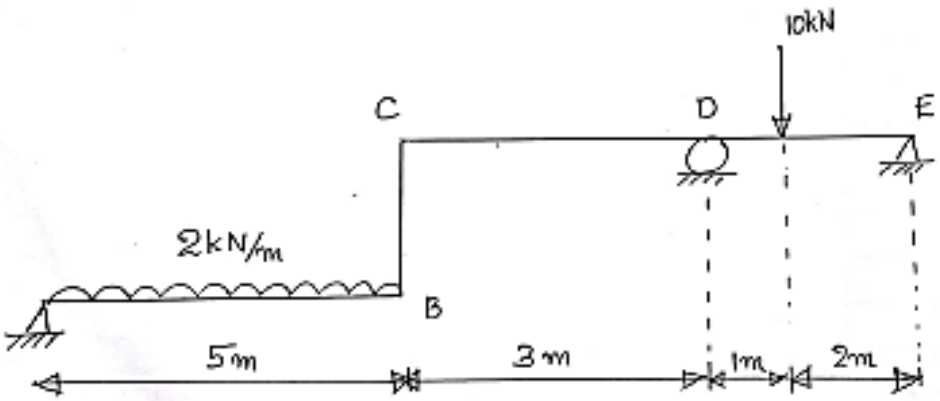
In all the above case the number of unknown is equal to the number of equations Hence all the above type of beams are

(b)	Draw the free body diagram of the beam.	[04]	CO3	L2



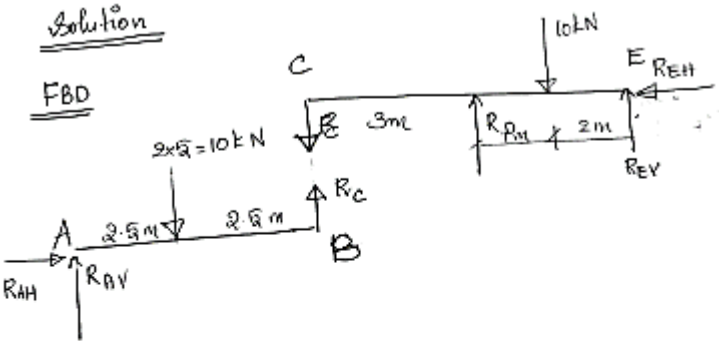
3.	Derive the centroid of a right angled triangle OR a quarter circle. (ANY ONE)	[10]	CO3	L3

4	Find the reaction at the supports. CB is a flexible link.	[10]	CO3	L4



Solution

FBD



Equilibrium of AB.

$\sum M_A = 0 \Rightarrow 10\times 2.5 - R_C \times 5 = 0$

$R_C = 5\,kN$

$\sum F_x = 0 \Rightarrow R_{AH} = 0$

$\sum F_y = 0 \Rightarrow R_{AV} - 10 + R_C = 0$

$R_{AV} = 5\,kN\ (\uparrow)$

For the equilibrium of CE

$\Sigma M_E = 0$

$-R_C \times 6 + R_D \times 3 - 10 \times 2 = 0$

$\Rightarrow R_D = 16.67\ kN$

$\Sigma F_x = 0$

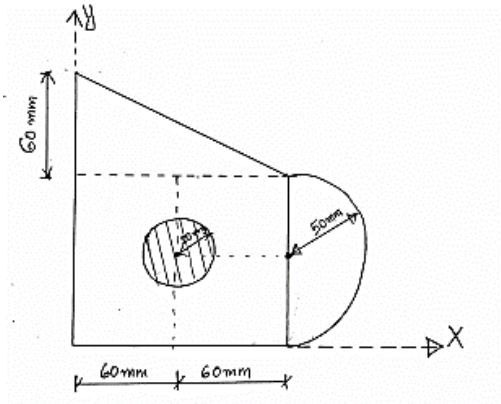
$\Rightarrow R_{EH} = 0$

$\Sigma F_y = 0$

$-R_C + R_D - 10 + R_{EV} = 0$

$R_{EV} = -1.67\ kN$

5	Find the centroid of the given composite with reference to the given X and Y axes. The radius of semi-circle is 50 mm. Height of triangle is 60 mm and the base of rectangle is 120 mm. The radius of inner circle is 20 mm. NOTE: THE INNER CIRCLE IS CUT OUT.	[10]	CO5	L3



Component	Area (mm^2)	$\bar{x}$ (mm)	$\bar{y}$ (mm)
1	$\frac{\pi (50)^2}{2} = 3926.99$	$120 + \frac{4\times50}{3\pi} = 141.22$	30
2 (will be subtracted)	$-\pi (20)^2 = -1256.6$	60	30
3	$120 \times 100 = 12000$	60	30
4	$\frac{1}{2} \times 120 \times 60 = 3600$	$\frac{120}{3} = 40$	$\frac{60}{3} + 100 = 120$
	$\Sigma A = 18270.39$		

Taking moment of area.

$\bar{x} = \frac{A_1\bar{x}_1 + A_2\bar{x}_2 + A_3\bar{x}_3 + A_4\bar{x}_4}{\Sigma A}$

$= \frac{3926.99}{2} \times 141.22 - 1256.6 \times 60 + 12000 \times 60 + 3600 \times 40$

18270.39

$= 73.52\ mm$

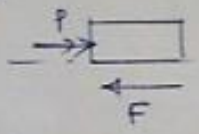
$\bar{y} = \frac{3926.99}{2} \times 50 - 1256.6 \times 30 + 12000 \times 30 + 3600 \times 120$

18270.39

$= 63.74\ mm$

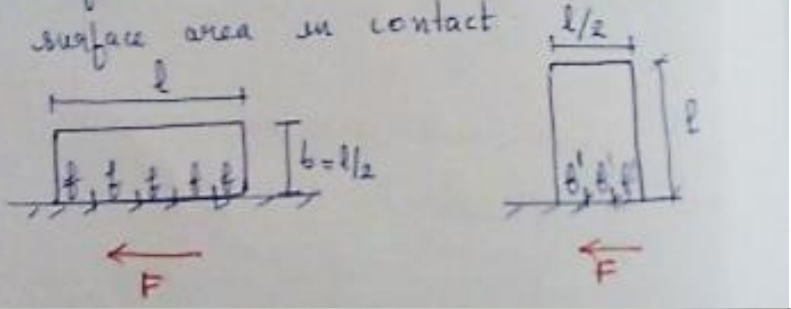
6. (a) State Coulomb's laws of friction. [5] | CO4 | L1

1. It acts tangential to the surfaces in contact opposing the tendency to slide.



2. Frictional force is equal to external force applied till the limiting value is reached

3. Frictional force ($F_{s\,max}$) depends on the nature of surfaces in contact and is independent of surface area in contact



4. The magnitude of limiting static friction is proportional to the normal reaction between the sliding surface.

$$F_{s\,max} \propto N$$

$$F_{s\,max} = \mu_s N$$

μ_s: coefficient of static friction

5. The magnitude of kinetic friction is proportional to the normal reaction.

$$F_k \propto N$$

$$F_k = \mu_k N$$

μ_k: coefficient of kinetic friction

6. For low velocities F_k is independent of the relative speed with which the surfaces move over each other.

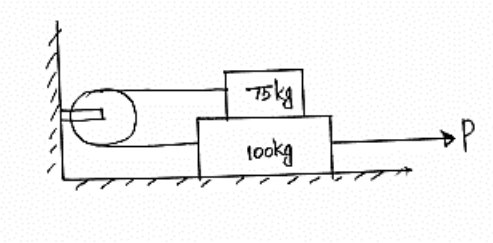
(b) Explain the determination of coefficient of static friction experimentally. [5] CO4 L4

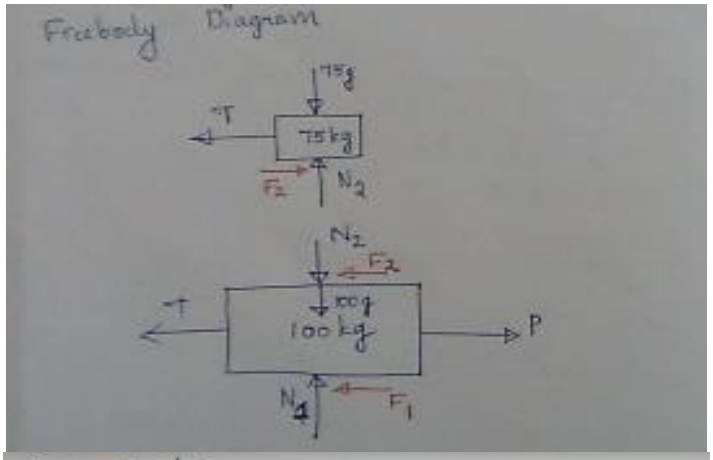
Suppose we need to experimentally find the coefficient of static friction of say metal on wood. Place a metal block on a wooden plane. Tilt it till the metal block just starts to slide. The angle of inclination of the inclined wooden plane is the angle of repose.

For the block not to slide the resultant ~~normal reaction~~ should be equal and opposite to the weight. Since the block is just about to slide the frictional force developed is $F_{s\,max}$. $F_{s\,max}$ and N when added gives $\vec{R}$ @ θ_s to ~~vertical~~ normal reaction. Note

$\Rightarrow \theta_s = \theta_r$ [Angle b/w is = θ_{rs}]

7.	Determine the horizontal force P applied to the lower block (100 kg) to just pull it to the right. The coefficient of friction between the blocks is 0.2 and that between the lower block and floor is 0.25. Assume the pulley to be frictionless. Take g = 10 m/s^2. The upper block is of mass 75 kg.	[10]	CO4 L4





For 75 kg

$\Sigma F_y = 0$

$N_2 - 75g = 0$

$N_2 = 75g$

$= 75 \times 10$

$= 750\ N$

$\Sigma F_x = 0$

$F_2 - T = 0$

$F_2 = T$

For 100 kg

$\Sigma F_y = 0$

$N_1 - N_2 - 100g = 0$

$N_1 = N_2 + (100 \times 10)$

$= 750 + 1000$

$= 1750\ N$

$\Sigma F_x = 0$

$P - F_2 - F_1 - T = 0$

$P = F_2 + F_1 + T$

Note $F_2 = \mu s_2 N_2 = 0.2 \times 750$

$= 150\ N$

$F_1 = \mu s_1 N_1 = 0.25 \times 1750$

$= 437.5$

$P = 737.5\ N$

Signature of CI Signature of CCI Signature of HOD