وزارة التعليم العالي والبحث العلمي
الجامعة التقنية الجنوبية
المعهد التقني العمارة
قسم التقنيات المدنية

الحقيبة التدريسية لمادة

الميكانيك الهندسي

المرحلة الاولى

تدريسي المادة
م. علي عبد الزهرة حسن

وزارة التعليم العالي والبحث العلمي
الجامعة التقنية الجنوبية
التخصصات / التكنولوجية
القسم تقنيات المدنية الفرع / بناء وانشاءات

اسم المادة	السنة الدراسية	الساعات الأسبوعية		
الميكانيك الهندسي (علم السكون) Engineering Static Mechanics	السنة الدراسية 1st.stage الأولى	نظري th.	عملي pra.	المجموع total
		2	3	5

Theoretical Subjects

Week No.	Subject Topics
1	Static, fundamental concepts , Force , Scalars and , Vectors , Units , Force polygon , Cartesian Components .
2	Analysis of Forces
3	Resultant of Concrrent , Coplanar Force system (2-D)
4	Moments
5	Moments
6	Couples, the transformation of the Couple and the force
7	Equilibrium, free body diagram (F.B.D.)
8	Equilibrium Conditions (2-D)
9	Equilibrium Conditions (2-D)
10	Friction, type of friction, Dry Friction
11	Center of Gravity, Centroid (length, area), Centroid of Simple area
12	Centroids of Composite areas.
13	Centroids of Composite areas.
14	Moment of inertia (Simple and Composite areas).
15	Moment of inertia (Simple and Composite areas).

الساعات الأسبوعية			السنة الدراسي	اسم المادة
totalالمجموع	pra.عملى	th.نظرى	1st.stage الأولى	الميكانيك الهندسي (علم الحركة) Engineering Dynamic Mechanics
5	3	2		

Theoretical Subjects	
Week No.	**Subject Topics**
1	Newton's Second Law
2	Type of motion, Linear motion with constant speed.
3	Linear motion with Constant acceleration.
4	Curvilinear motion
5	Angular motion, Relative Motion
6	Work, Energy, Power
7	Strength of material: Fundamental concept
8	Loads, Stress, Strain, Elasticity, Plasticity, and Deformation.
9	Hook's Law, Stress -strain curve, type of stress.
10	Normal stress due to an axial load on 1-Uniformam Cross section area 2- Variable cross section area .
11	Shear Stress
12	Torsional Stress
13	Thermal Stress
14	Beams, types of loads, types of beams
15	Shear force (S.F.) & bending moment (B.M.) of Simple supported beam under an –axial load .

الهدف من دراسة مادة :

الهدف من دراسة الميكانيك الهندسي هو تمكين المهندسين من تحليل وتصميم وتصنيع وتطوير الأنظمة والآلات والمعدات الميكانيكية المختلفة .يركز هذا المجال على تطبيق مبادئ الفيزياء، وخاصة قوانين الحركة والقوة والطاقة، لفهم كيفية عمل الأشياء وكيفية تحسينها .يهدف المهندسون الميكانيكيون إلى إنشاء تقنيات تلبي الاحتياجات البشرية، من خلال تصميم وتصنيع منتجات وخدمات مبتكرة وفعالة في مختلف المجالات مثل الطاقة، والنقل، والرعاية الصحية، وغيرها.

الفئة المستهدفة

طلبة الصف الاول /قسم التقنيات الميكانيكية

التقنيات التربوية المستخدمة :

- سبورة واقلام
- السبورة التفاعلية
- عارض البيانات Data show
- جهاز حاسوب محمول Laptop

Ministry of Higher Education
And Scientific Research
Southern Technical University
Technical Institute Of Amara

Engineering Mechanics

The References

- **Engineering-Mechanics-Statics-R.C.-Hibbeler**
- **Singer, "Engineering-Mechanics"**
- **Hidgon and Stile "Engineering-Mechanics"**

Ministry of Higher Education
And Scientific Research
Southern Technical University
Technical Institute Of Amara

Engineering Mechanics

First stage

Civil Techniques Department

By
Ali Abdul-zahra Hasan

2024-2023

The References

- **Engineering-Mechanics-Statics-R.C.-Hibbeler**
- **Singer, "Engineering-Mechanics"**
- **Hidgon and Stile "Engineering-Mechanics"**

Mechanics define:-

Mechanics is the physical science that deals with the behavior of bodies under the influence of forces.

Mechanics can be divided into:

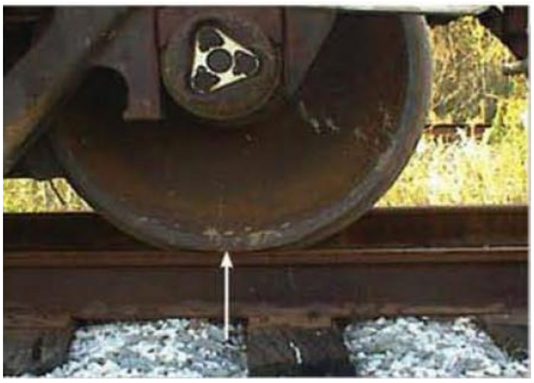
1. Rigid-body Mechanics
2. Deformable-body Mechanics
3. Fluid

Rigid-body Mechanics deals with

- Statics – Equilibrium of bodies; at rest or moving with constant velocity
- Dynamics – Accelerated motion of bodies.

Basic Quantities

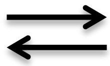
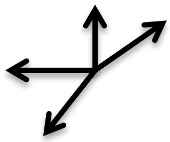
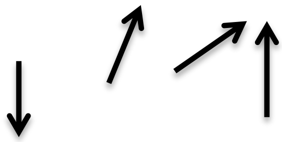
- Length - locate the position of a point in space
- Mass - measure of a quantity of matter
- Time - succession of events
- Force - any action which change or try to change the shape ,volume or the motion of a body.
- Particle - has a mass and size can be neglected
- Rigid Body - a combination of a large number of particles
- Concentrated Force - the effect of a loading



Physical Quantities is classified to:-

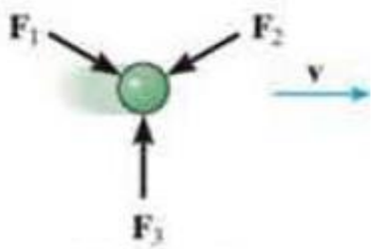
1. Scalar quantities :have only magnitude(mass ,volume)
2. Vector quantities :have both magnitude and direction(couple,force)

Classification of forces :

1. Collinear 
2. Parallel forces 
3. Concurrent forces 
4. Non parallel , non -concurrent forces 

Newton's Laws of Motion

• First Law - A particle originally at rest, or moving in a straight line with constant velocity, will remain in this state provided that the particle is not subjected to an unbalanced force.



Equilibrium

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• Second Law - A particle acted upon by an unbalanced force F experiences an acceleration a that has the same direction as the force and a magnitude that is directly proportional to the force.

$$F = ma$$

Accelerated motion

• Third Law - The mutual forces of action and reaction between two particles are equal and, opposite and collinear.

Action – reaction

Unit Measurement

1- SI

The International System of Units (abbreviated as SI, from the French System international) is the modern form of the metric system, and is the most widely used system of measurement. ($g = 9.81\ m/s^2$)

2- U.S customary

United States customary units are a system of measurements commonly used in the United States. The United States customary system developed from English units which were in use in the British Empire before the U.S. became an independent country. ($g = 32.2\ ft/s^2$)

TABLE 1–1 Systems of Units

Name	Length	Time	Mass	Force
International System of Units SI	meter m	second s	kilogram kg	$\boxed{\text{newton*}}$ N $\left(\frac{kg \cdot m}{s^2}\right)$
U.S. Customary FPS	foot ft	second s	$\boxed{\text{slug*}}$ $\left(\frac{lb \cdot s^2}{ft}\right)$	pound lb

*Derived unit.

TABLE 1–2 Conversion Factors

Quantity	Unit of Measurement (FPS)	Equals	Unit of Measurement (SI)
Force	lb		4.448 N
Mass	slug		14.59 kg
Length	ft		0.304 8 m

❖ **Resultant the vector :**

The resultant force is the force which can replace the original system without changing its external effects on rigid bodies .There are two methods for founding the resultant force:-

1- **Parallelogram law.**

The parallelogram of forces is a method for solving the results of applying two forces to an object.

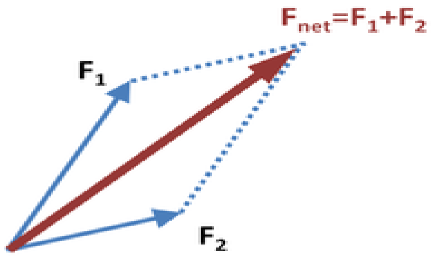


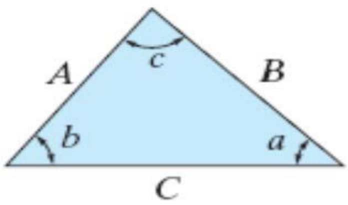
Figure 1: Parallelogram construction for adding vectors

2- **Trigonometry.**

Triangle law of forces states that, If two forces acting at a point are represented in magnitude and direction by the two adjacent sides of a triangle taken in order, then the closing side of the triangle taken in the reversed order represents the resultant of the forces in magnitude and direction.

Procedure for Analysis

- Redraw half portion of the parallelogram
- Magnitude of the resultant force can be determined by the law of cosine
- Direction if the resultant force can be determined by the law of sine
- Magnitude of the two components can be determined by the law of sine



Cosine law:-

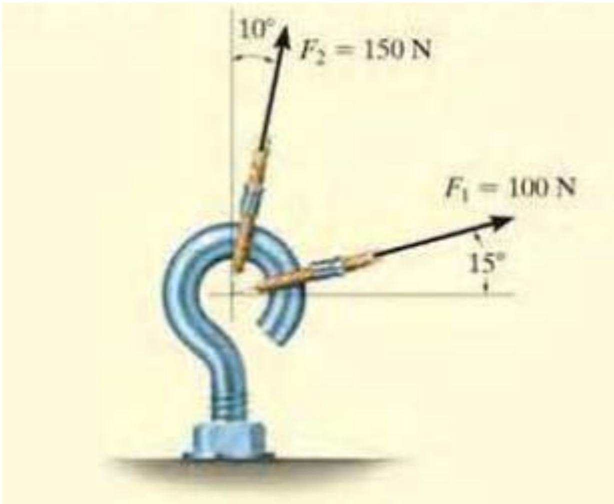
$$C = \sqrt{A^2 + B^2 - 2AB\cos c}$$

Sine law:-

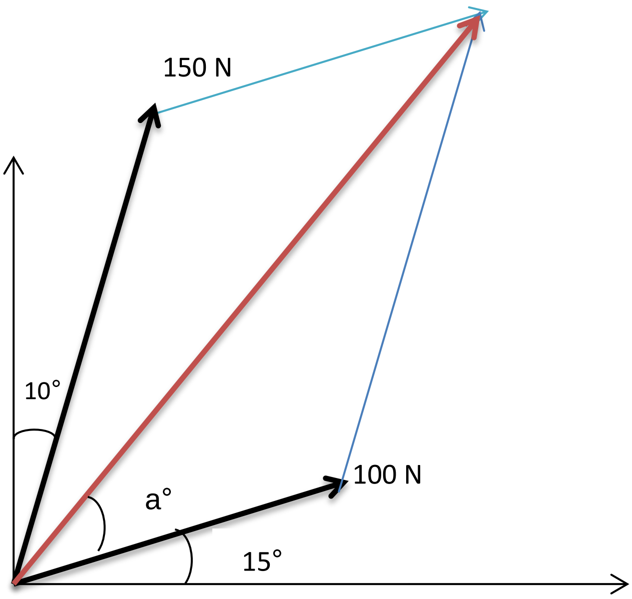
$$\frac{A}{\sin a} = \frac{B}{\sin b} = \frac{C}{\sin c}$$

Ex1

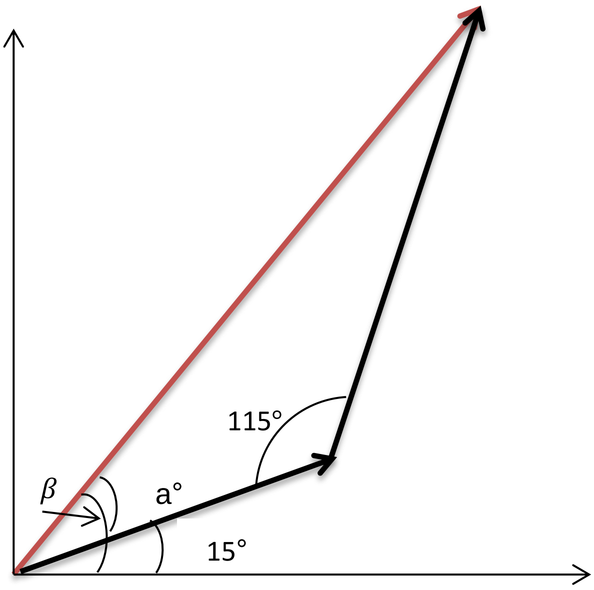
The screw eye in Fig. below is subjected to two forces, F_1 and F_2. Determine the magnitude and direction of the resultant force.



Solution:-



a- Parallelogram



b- Trigonometry

$$R = \sqrt{A^2 + B^2 - 2AB\cos c}$$

$$R = \sqrt{100^2 + 150^2 - 2*100*150\cos(115°)}$$

R= 213 N

Sine law:-

$$\frac{A}{\sin a} = \frac{R}{\sin c} \longrightarrow \frac{150}{\sin a} = \frac{213}{\sin(115°)}$$

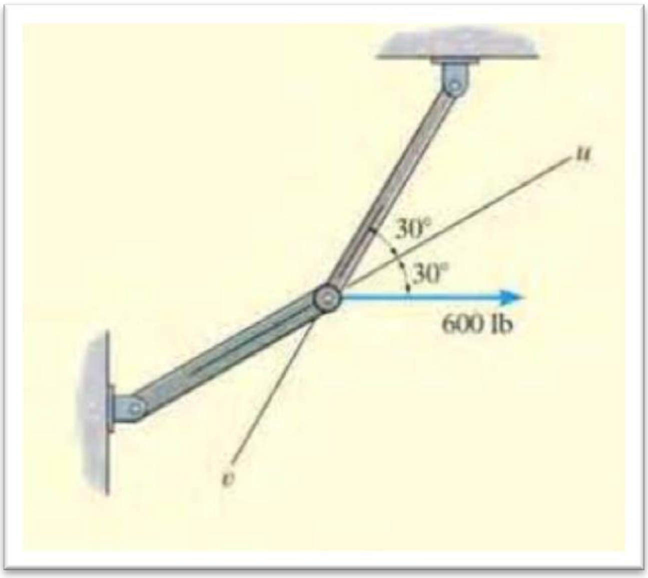
a° = 40

direction R measured from the horizontal. Is

β° =40° + 15° = 55°

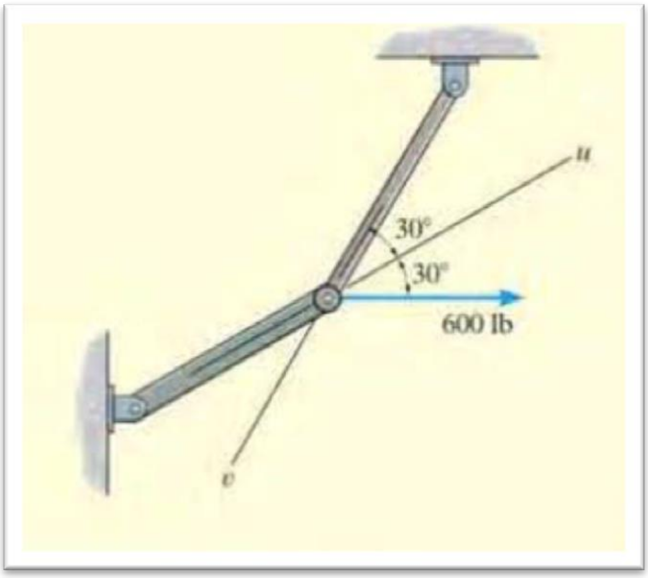
<u>Ex 2</u>

Resolve the horizontal 600-lb force in Fig below into two components acting along the u and v axes and determine the magnitude of these components.

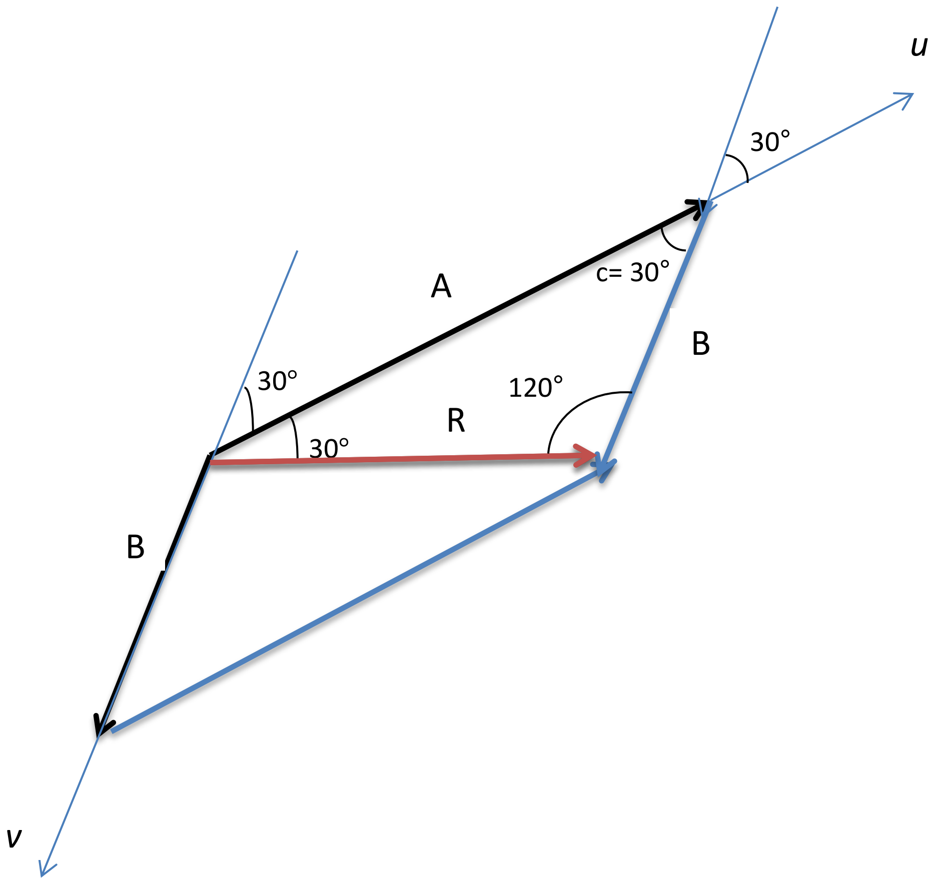


Ex 2

Resolve the horizontal 600-lb force in Fig below into two components acting along the u and v axes and determine the magnitude of these components.



SOL:-



Sine law:-

$$\frac{A}{\sin a} = \frac{R}{\sin c} \longrightarrow \frac{A}{\sin(120°)} = \frac{600\ Ib}{\sin(30°)}$$

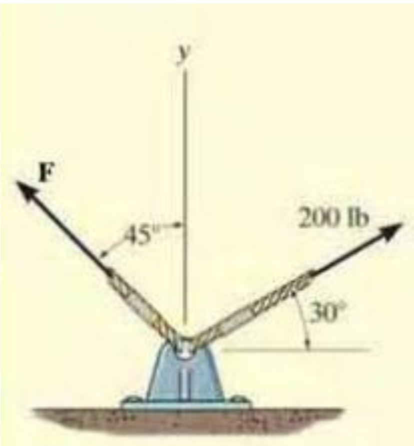
A = 1039 Ib

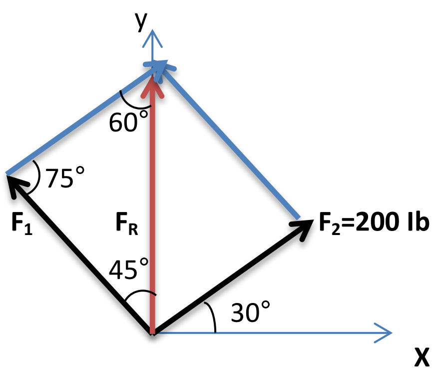
$$\frac{B}{\sin a} = \frac{R}{\sin c} \longrightarrow \frac{B}{\sin(30°)} = \frac{600\ Ib}{\sin(30°)}$$

A = 600 Ib

<u>Ex 3</u>

Determine the magnitude of the component force **F** in Fig. below and the magnitude of the resultant force **FR** if **FR** is directed along the positive y axis.





SOL:-

Sine law:-

$$\frac{F_1}{\sin a} = \frac{F_2}{\sin b} \longrightarrow \frac{F_1}{\sin(60°)} = \frac{200}{\sin(45°)}$$

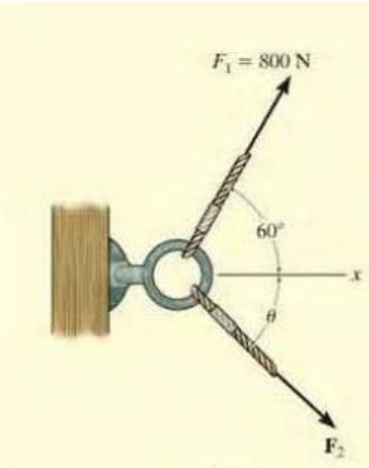
F_1 = 244 Ib

$$\frac{F_2}{\sin b} = \frac{F_R}{\sin c} \longrightarrow \frac{200}{\sin(45°)} = \frac{F_R}{\sin(75°)}$$

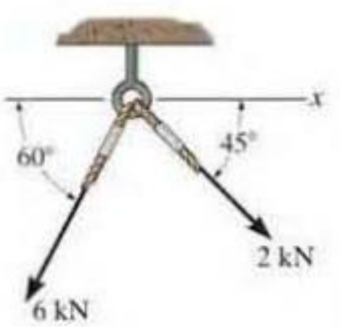
F_R = 273 Ib

H.W

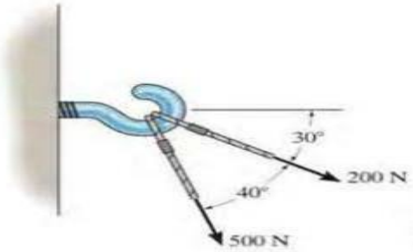
1- It is required that the resultant force acting on the eyebolt in Fig. below be directed along the positive x axis and that F_2 have a minimum magnitude. Determine this magnitude the angle θ, and the corresponding resultants force.



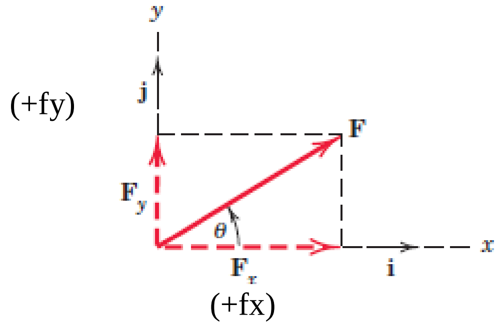
2-Determine the magnitude of the resultant force acting on the screw eye and its direction measured clockwise from the x axis.



3-Two forces act on the hook. Determine the magnitude of the resultant force.



Rectangular Components



$fx = F \sin \theta°$

$fy = F \text{ cosine } \theta°$

$F = \sqrt{fx^2 + fy^2}$

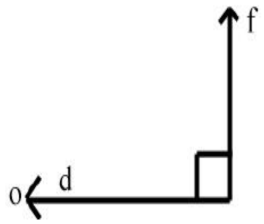
$\theta = \tan^{-1} (\frac{fy}{fx})$

note :- fy = $\uparrow$ + $\downarrow$ - fx = $\rightarrow$ + - $\leftarrow$

Moment of force

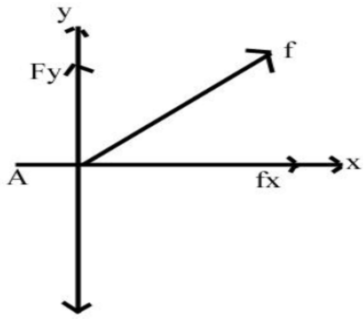
Define :- the product of the magnitude of the force by the perpendicular distance (arm) from the point to the action line of the force. It's units are N.m, lb. ft, ect.

$M_o = f \cdot d$



Varignon's theorem:-

that the moment of a resultant of two concurrent forces about any point is equal to the algebraic sum of the moments of its components about the same point.



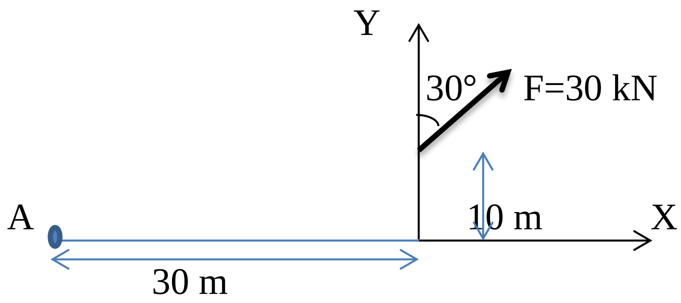
$MA = MA^{fx} + MA^{fy}$

Note:- moment its **(-)** value ,if the force rotates **clockwise**.

moment its **(+)**value ,if the force rotates **counter clockwise**

Clockwise Counter clockwise

<u>Ex :-</u> Find the moment of force (f) about point (A) as shown in the following figure below.



Sol:-

fx = F sin 30°

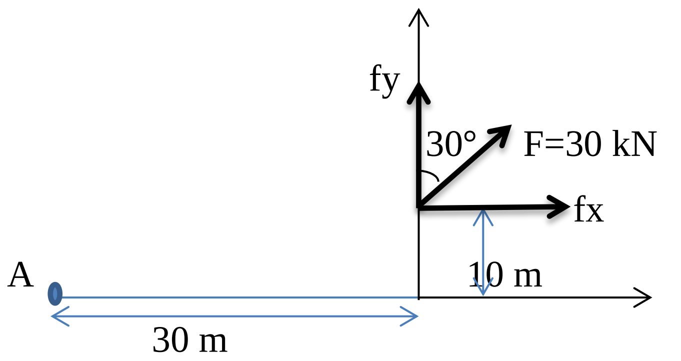
= 30 sin 30°

= 15 kN

fy = F cosin 30°

= 30 cosin 30°

= 25.9 kN



$MA = MA^{fx} + MA^{fy}$

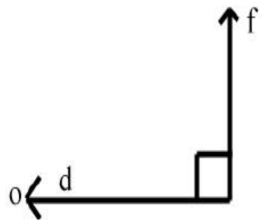
$= fx * ry + fy * rx$
$= -(15 * 10) + 25.9 * 30$
$= 627$ kN.m

Another method?

Moment of force

Define :- the product of the magnitude of the force by the perpendicular distance (arm) from the point to the action line of the force. It's units are N.m, lb. ft, ect.

$$M_o = f \cdot d$$



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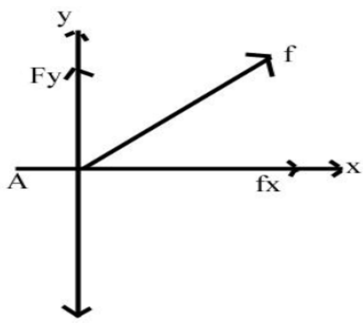
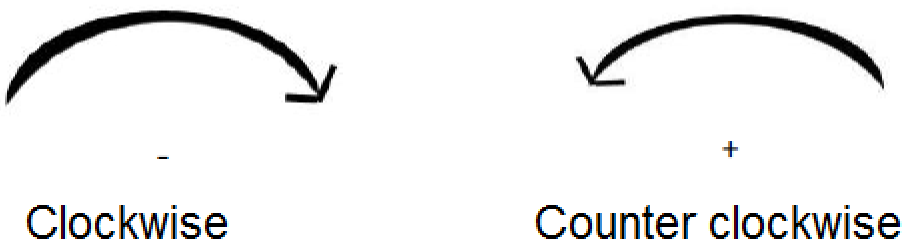


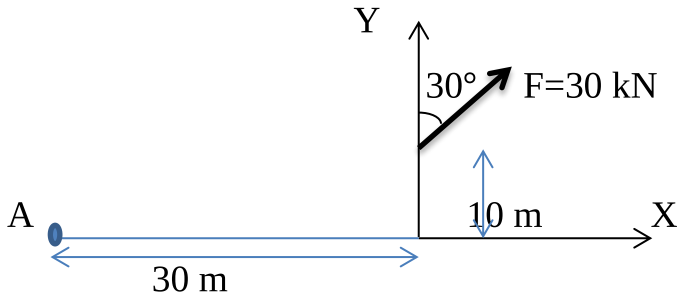
$$MA = MA^{fx} + MA^{fy}$$

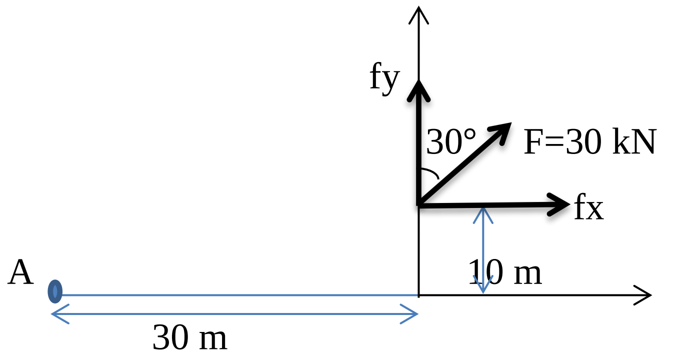
Note:- moment its **(-)** value ,if the force rotates **clockwise**.

moment its **(+)**value ,if the force rotates **counter clockwise**



Ex 1:- Find the moment of force (f) about point (A) as shown in the following figure below.





Sol:-

fx = F sin 30°

= 30 sin 30°

= 15 kN

fy = F cosin 30°

= 30 cosin 30°

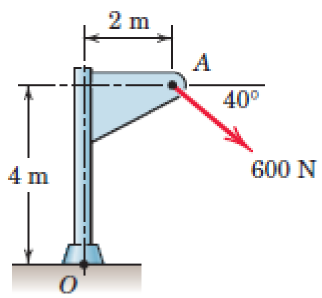
= 25.9 kN

$MA = MA^{fx} + MA^{fy}$

= fx * ry + fy * rx
= - (15 * 10) + 25.9 * 30
= 627 kN.m

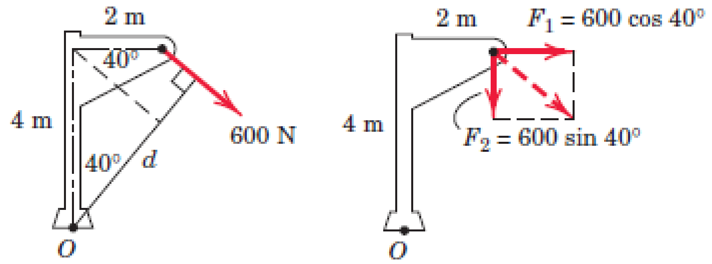
Another method?

Ex 2
Calculate the magnitude of the moment about the base point O of the 600-N force.



Ali Abdul-zahra Hasan

sol :-



Replace the force by its rectangular components at A,

F_1 = 600 cos (40) = 460 N,

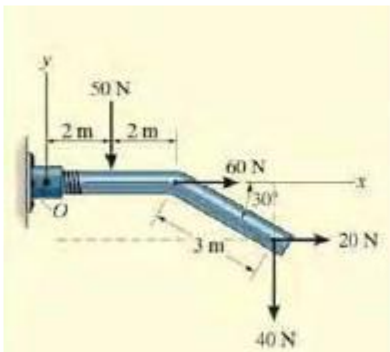
F_2 = 600 sin (40) = 386 N

By Varignon's theorem, the moment becomes

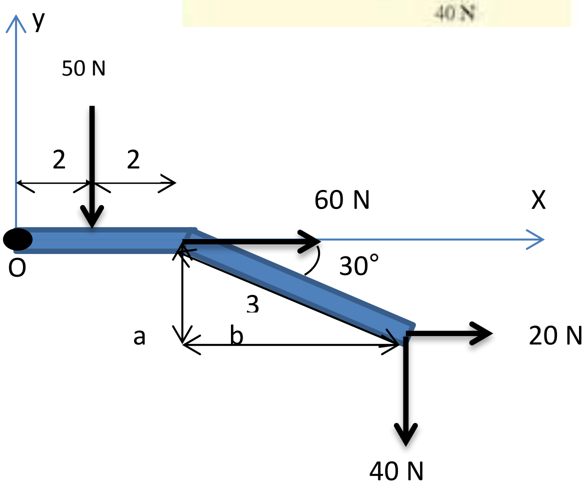
*MO = 460 *(4) + 386 *(2) = 2610 N.m*

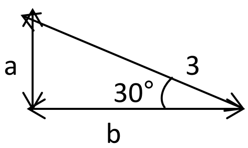
Ex 3

Determine the rcsu1tant moment of the four forces acting on the rod shown in Fig. below about point *0* .



,sol :-





Mo = -(50 * 2) + (60 * (0)) + (20 * a) - (40 * (b + 4))

$\cos 30 = \frac{b}{3} \longrightarrow b = 2.59$

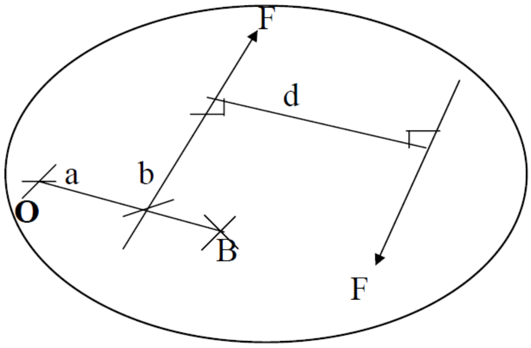
$\sin 30 = \frac{a}{3} \longrightarrow a = 1.5$

$Mo = -(50 * 2) + (60 * (0)) + (20 * 1.5) - (40 * (2.59 + 4))$

$Mo = - 333.6$ N.m

Moment of a Couple
(عزم الازدواج)

A Couple is defined as two parallel forces that have the same magnitude. but opposite directions. and arc separated by a perpendicular distance (d). Fig. below.



$M_o = -F * a + F (a+ d)$

$= -F*a + F*a + F * d$

$= F * d$

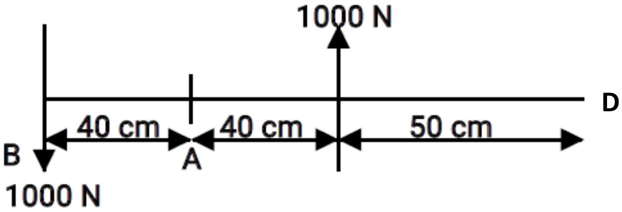
$M_B = F * d + F (d – b)$

$= F * b + F * d – F * b$

$= F * d \longrightarrow \boxed{M_c = F*d}$

Ex1:-

Determine the moment of the couple shown in figure about the axis through Points A,B,D.



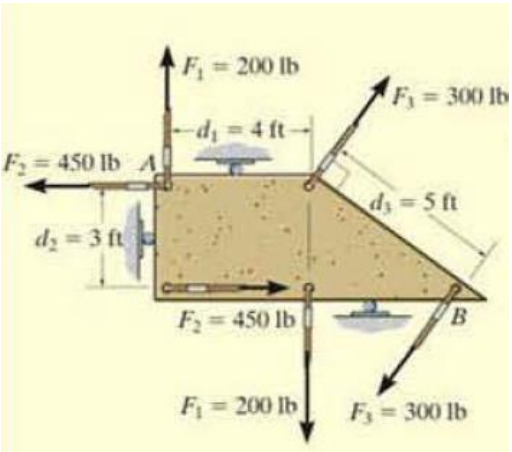
Sol:-

Mc(A)=1000× 40+1000× 40 = 80000 N.Cm

Mc(B)=1000× (40+40) = 80000 N.Cm

Mc(D)=1000× (40+40+50)-1000× 50 = 80000 N.Cm

Ex 2 Determine the resultant couple moment of the three couples acting on the plate in Fig. below.



Sol:-

MR = - M1 + M2 - M3

= -(200 * 4) + (450 * 3) – (300 * 5)

= -800+1350-1500

MR = -950 Ib.ft (clockwise)

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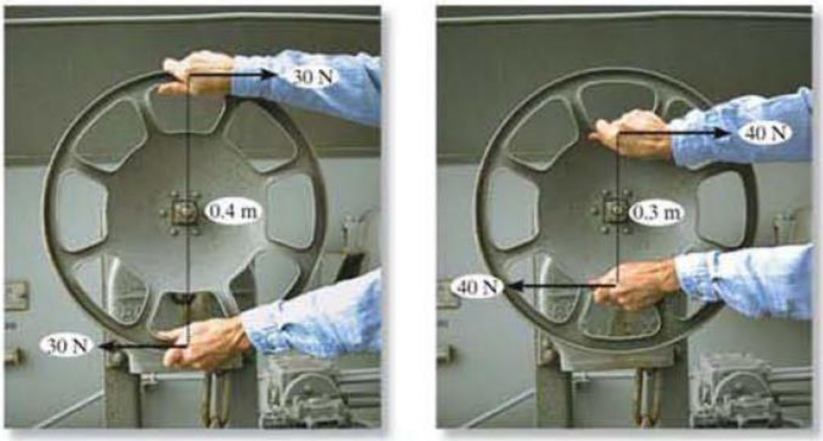
Equivalent Couples.
(عزم الازدواج المتكافئ)

If two couples produce a moment with the same magnitude and direction then these two couples are Equivalent For example. The two couples shown in Fig, below are Equivalent because each couple moment has a magnitude of $M = 30\ N * 0.4\ m = 40\ N * 0.3\ m = 12\ N \cdot m$



Ex 4:

Replace the following couples shown in figure by a single couple its forces effects horizontally at points B,D.

Sol:-

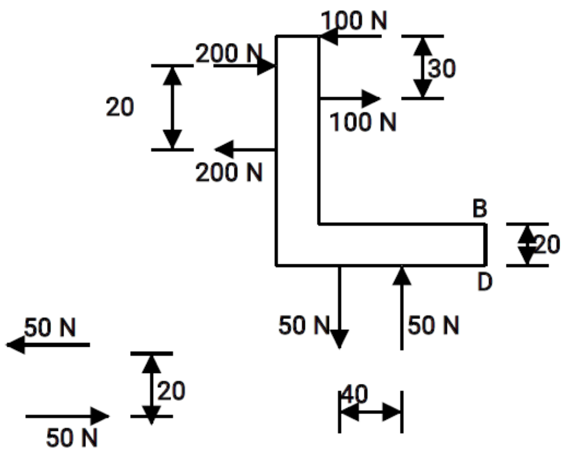
Mc=-200× 20+100× 30+50× 40

=1000N.Cm

Mc=F . d

1000=F × 20

F=50N



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Resultant Non-Concurrent Coplanar Forces
(محصلة القوى الغير متلاقية الواقعة في نفس المستوى)

1- Resolve the forces in to x and y compent

2- $Rx = \sum Fx$

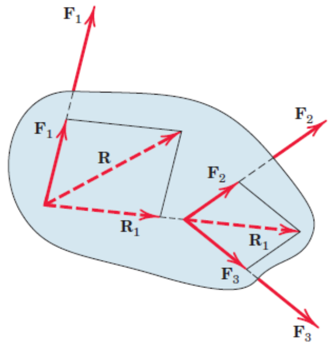
3- $Ry = \sum Fy$

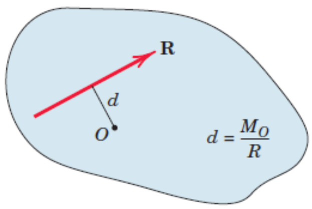
4- $R = \sqrt{Rx^2 + Ry^2}$

5- $\theta = \tan^{-1} (\frac{Ry}{Rx})$

6- $M_O = \sum M$

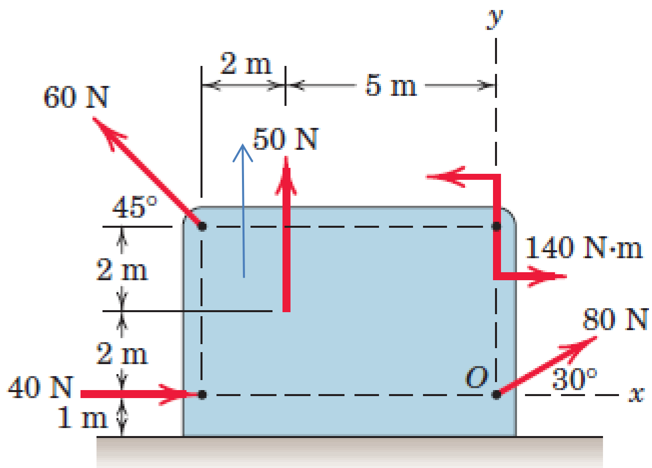
7- $M_O = R * d$ $\longrightarrow$ $d = \frac{MO}{R}$





Ex1 :-

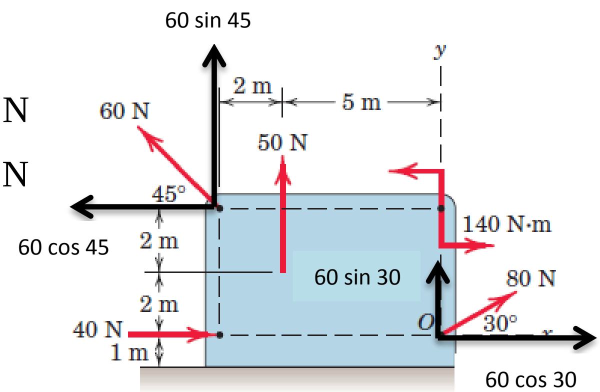
Determine the resultant of the four forces and one couple which act on the plate shown.



sol :-

$Rx = \sum Fx = 40 + 80 \cos(30) - 60 \cos(45) = 66.9$ N

$Ry = \sum Fy = 50 + 80 \sin(30) + 60 \sin(45) = 132.4$ N



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$$R = \sqrt{Rx^2 + Ry^2}$$

$$R = \sqrt{66.9^2 + 132.4^2} = 148.3 \text{ N}$$

$$\theta = \tan^{-1}\left(\frac{Ry}{Rx}\right)$$

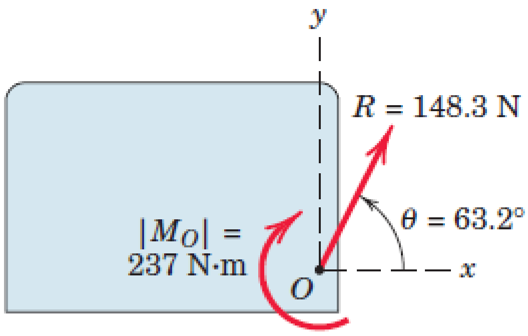
$$\theta = \tan^{-1}\left(\frac{132.4}{66.9}\right) \longrightarrow \theta = 63.2°$$

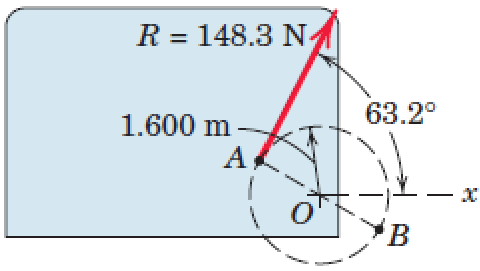
$$M_O = \sum M$$

$$M_O = 140 - 50*5 + 60\cos(45)*4 - 60\sin(45)*7 = -237 \text{ N.m}$$

$$M_O = R * d$$

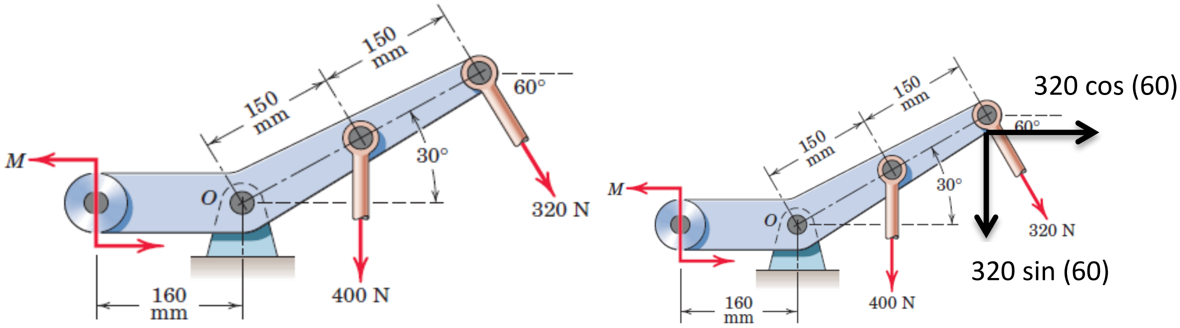
$$237 = 148.3 * d \longrightarrow d = \frac{237}{148.3} = 1.6 \text{ m}$$





Ex 2:-

If the resultant of the two forces and couple *M* passes through point O, determine the resultant ***(R)*** and *M*.

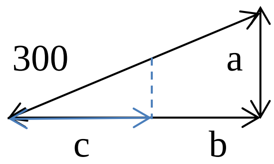


Sol :-

$\sin 30 = \frac{a}{300} \longrightarrow a = 300 * \sin 30 = 150$ mm

$\cos 30 = \frac{b}{300} \longrightarrow b = 300 * \cos 30 = 259.8$ mm

$\cos 30 = \frac{c}{300}$ $\quad c = 300 * \cos 30 = 129.9$ mm



$R_x = \sum F_x = 320 \cos(60) = 160$ N

$R_y = \sum F_y = -400 - 320 \sin(60) = -677$ N

$R = \sqrt{Rx^2 + Ry^2}$

$R = \sqrt{160^2 + (-677)^2} = 695.65$ N

For the resultant to pass through O the moment about O must be zero.

$\sum M_O = 0$

$M_O = M - 400*129.9 - 320\cos(60)*150 - 320\sin(60)*259.8 = 0$

$M = -147957$ N.mm $\longrightarrow$ $= 148$ N.m

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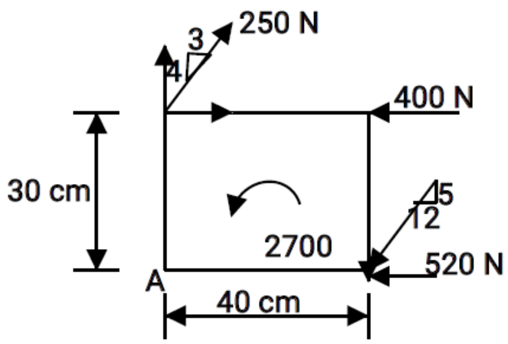
Ex 3:-

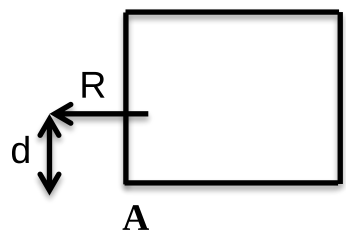
Determine the resultant of the forces and the couple shown in figure and locate it with respect to point (A).



Sol :-

Rx =250 * 3/5 - 520 * 12/13 - 400

=-730 N=730N ←



Ry=250 * 4/5 – 520 * 5/13 = 0

$$R = \sqrt{Rx^2 + Ry^2}$$

$$R = \sqrt{(-730)^2 + (0)^2} = -730 \text{ N} \leftarrow$$

R=730 N

R * d= ΣMa

730 * d=-250 * 3/5 * 30+400 * 30 - 520 * 5/13 * 40+ 2700

d =3 Cm

Equilibrium
(التوازن)

When a body is in equilibrium, the resultant of all forces acting on it is zero. Thus, the resultant forces Rx, Ry and the resultant moment M are both zero, and we have the equilibrium equations.

Three equation equilibrium :-

$\sum Fx = 0$

$\sum Fy = 0$

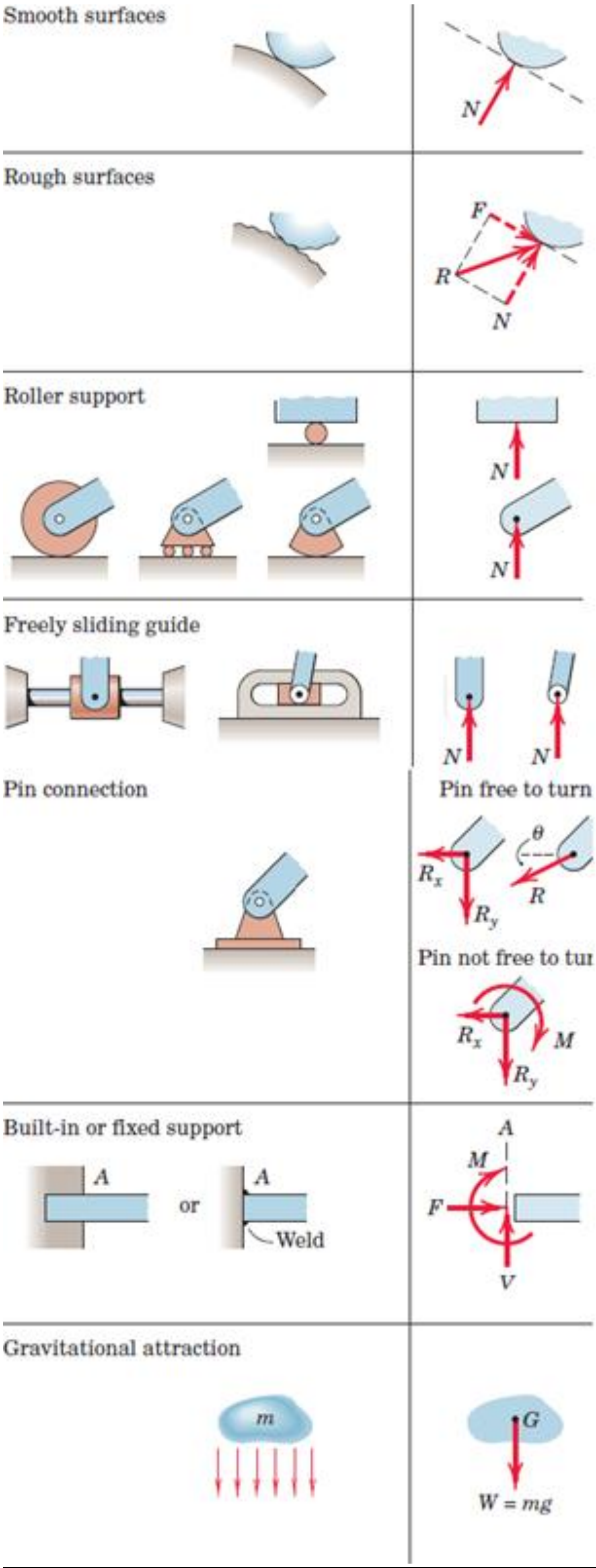
$\sum Mo = 0$

Support reaction

A reaction force is a force that acts in the opposite direction to an action force. Friction is the reaction force resulting from surface interaction and adhesion during sliding. Reaction forces and reaction moment are usually the result of the actions of applied forces.

Figures shows types support reaction

- **Type of support**



Rollor reaction

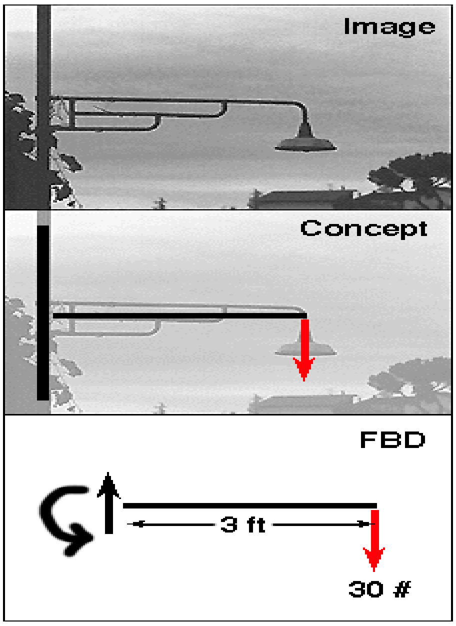
Hinge reaction

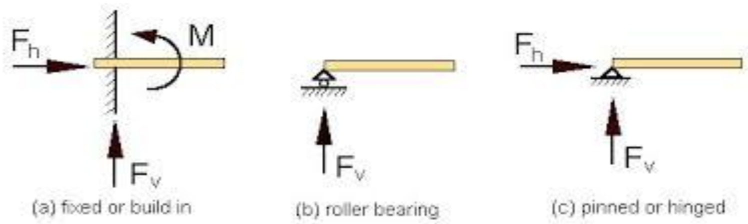
Fixed reaction

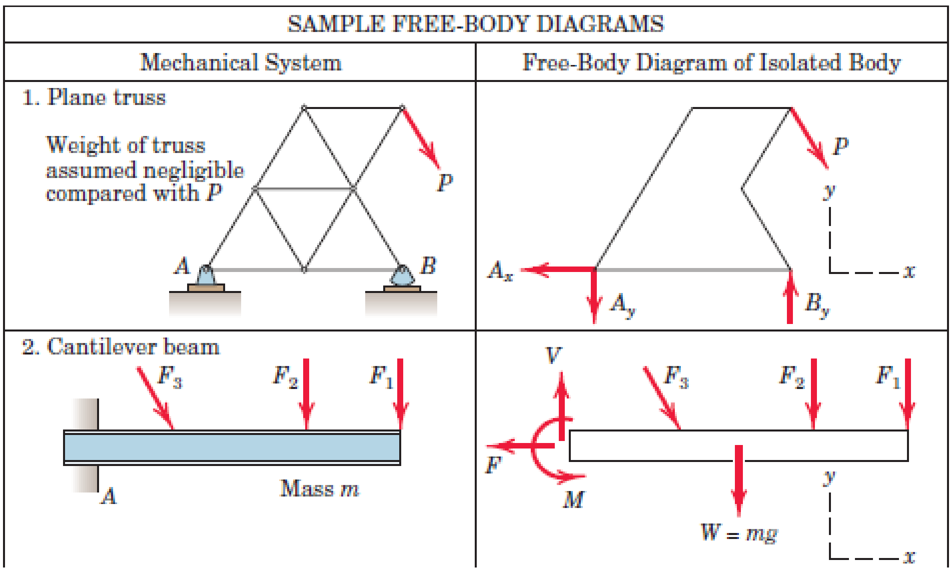
Free body diagram (FBD) (مخطط الجسم الحر)

The diagram shows all forces applied to objects and forces of reaction to the body after removal of supports.

(ويمثل الرسم البياني لجميع القوى المسلطة على الاجسام و قوى رد الفعل للجسم بعد ازالة الاسناد)







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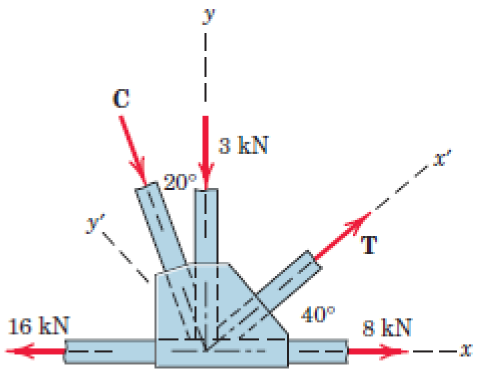
Ex 1

Determine the magnitudes of the forces C and T, which, along with the other three forces shown, act on the bridge-truss joint.

[∑Fx = 0]
[ΣFy = 0]
[ΣMo = 0]



SOL:-

[∑Fx = 0]

$8 + T\cos 40 + C\sin(20) - 16 = 0$

$0.766T + 0.342C = 8 \longrightarrow$ (a)

[ΣFy = 0]

$T\sin 40 - C\cos 20 - 3 = 0$

$0.643T - 0.940C = 3 \longrightarrow$ (b)

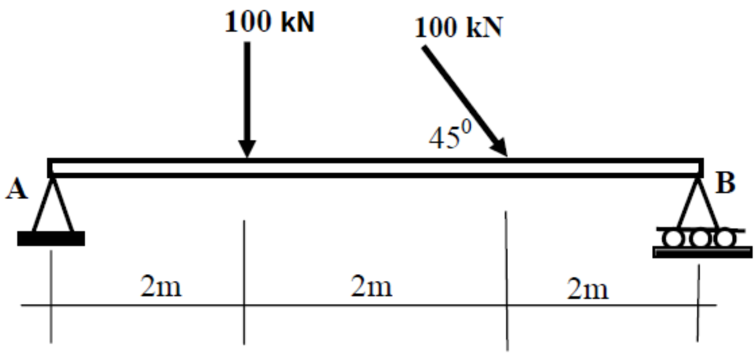
From (a) and (b)

T = 9.09 kN

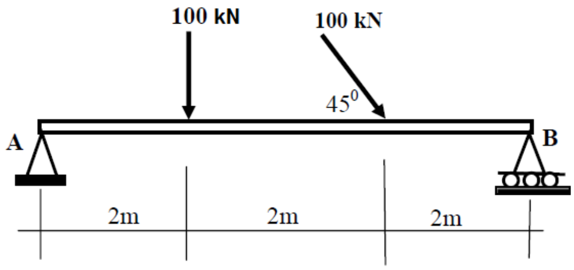
C = 3.03 kN

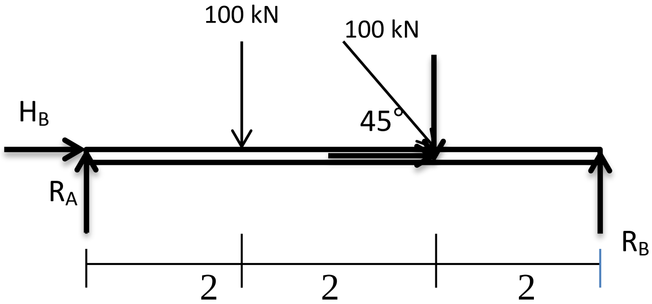
Ex 2

Find supports reaction at support (A , B) for the beam shown below.



Sol:-





F.B.D

SOL:-

$[\sum Fx = 0]$, $[\Sigma Fy = 0]$, $[\Sigma Mo = 0]$

$[\sum Fx = 0]$

$H_B + 100 \cos(45) = 0$

$H_B = -70.71$ kN $\longleftarrow$

$\Sigma Fy = 0$

$R_A + R_B - 100 - 100 \sin(45) = 0$

$R_B = 170.71 - R_A$ eq (1)

$[\Sigma M_A = 0]$

$R_A * 6 - (100 \sin 45) * 4 - 100 * 2 = 0$

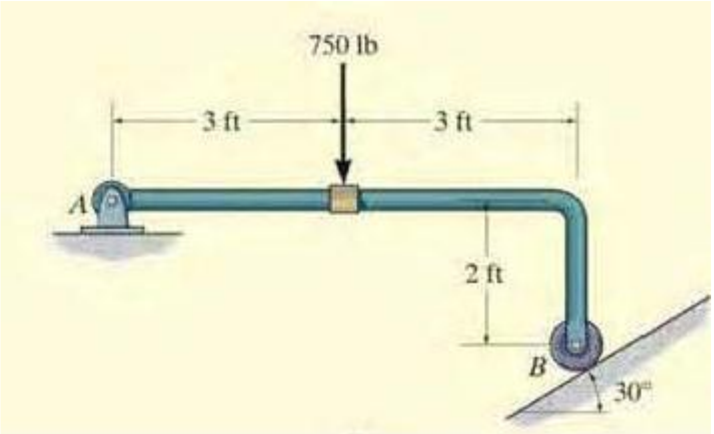
$R_A = 80.47$ kN

By solve (1)

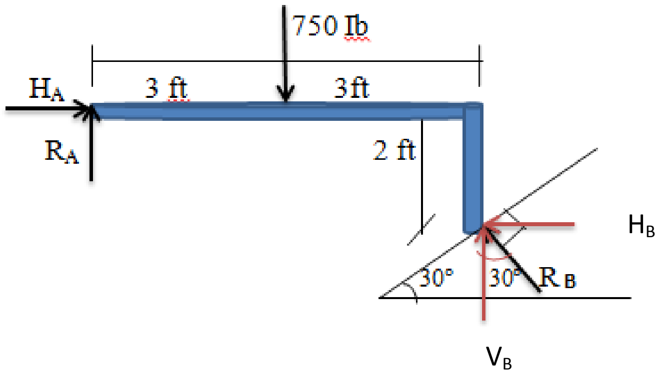
$R_A = 90.23$ kN

Ex 3

Determaine the horizontal and verlical components of reaction on the member at the pin ***A***, and the normlal rcaction at the roller ***B*** in figure below.



SOL:-



$H_B = R_B \sin 30$

$V_B = R_B \cos 30$

$[\Sigma M_A = 0]$

$(R_B \cos30)* 6 - (R_B \sin 30) * 2 - 750 * 3 = 0$

$R_B = 536.2$ Ib

$[\sum Fx = 0]$

$H_A - H_B = 0 \longrightarrow H_A - 536.2 \sin 30 = 0$

$H_A = 268$ Ib

$\Sigma Fy = 0$

$R_A + V_B - 750 = 0$

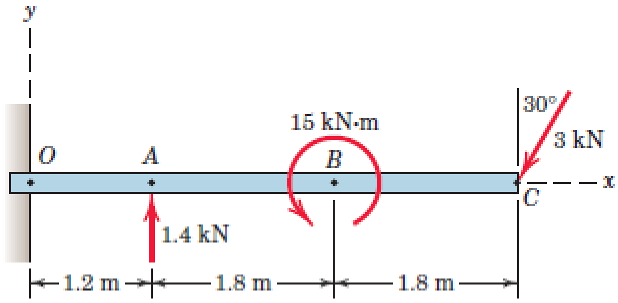
$R_A + 536.2 \cos(30) - 750 = 0$

$R_A = 285.6$ Ib

H . W

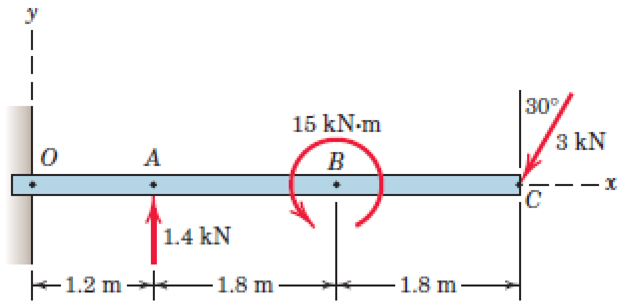
Q1

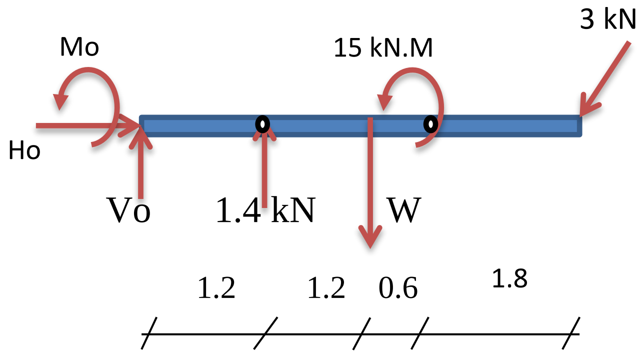
The 500-kg uniform beam is subjected to the three external loads shown. Determine the reactions at the support point O. The x-y plane is vertical.



Ex1

The 500-kg uniform beam is subjected to the three external loads shown. Determine the reactions at the support point O. The x-y plane is vertical.





F.B.D

sol :-

$W = m.g$

$= 500 * 9.81 = 4905 \text{ N} = 4.905 \text{ kN}$

$[\Sigma M_o = Mo]$

$- [(3 \cos 30) * 4.8] - [(4.9) * 2.4] + 1.4 * 1.2 + 15 = Mo$

$Mo = -7.55$ kN.m (counter clockwise)

$[\sum Fx = 0]$

$H_o - 3 \sin(30) = 0$

$H_o = 1.5$ kN

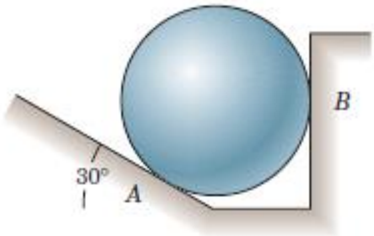
$\Sigma Fy = 0$

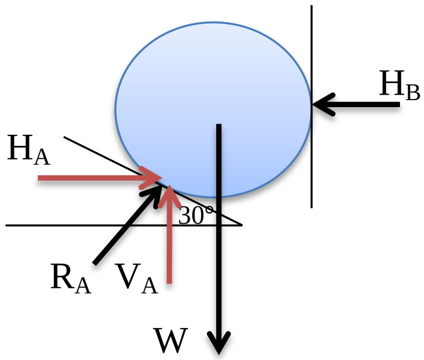
$V_O + 1.4 - 4.9 - 3\cos(30) = 0$

$V_O = 6.1$ kN

Ex2

The 50-kg homogeneous smooth sphere rests on the incline ***A*** and bears against the smooth vertical wall ***B.*** Calculate the contact forces at ***A*** and ***B.***





Sol :-

$W = m.g$

$= 50 * 9.81 = 490.5\ N$

$\Sigma Fy = 0$

$V_A - W = 0$

$V_A - 490.5 = 0$

$V_A = 490.5\ N$

$V_A = R_A \cos 30$

$490.5 = R_A \cos 30$

$R_A = 566.38\ N$

$H_A = R_A \sin(30)$

$= 566.38 \sin(30) = 283.2$

$[\sum Fx = 0]$

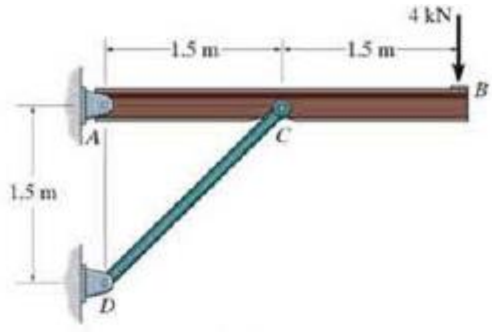
$H_A - H_B = 0$

$283.2 - H_B = 0$

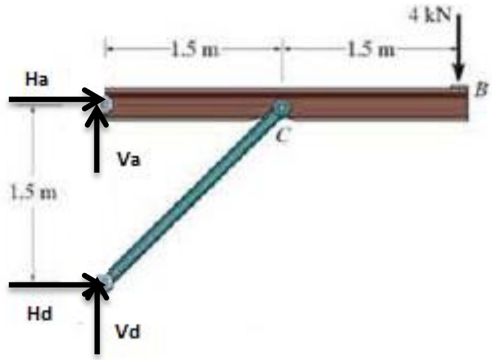
$H_B = 283.2\ N$

Ex3

Determine the horizonal and vertiacl reaction at the pin A and the reaction on the beam at C.



Sol :-



F.B.D

$[\Sigma M_A = 0]$

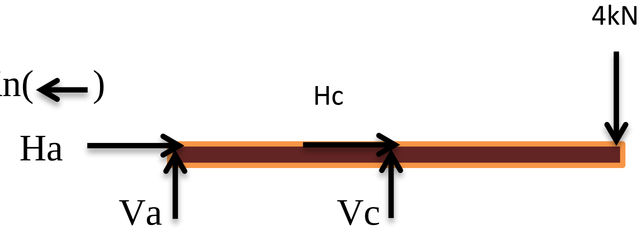
$[H_A * 1.5] - [4 * 3] = 0$

$H_A = 8$ kN

$[\sum Fx = 0]$

$H_A + H_D = 0$

$8 + H_D = 0 \longrightarrow H_D = -8$ Kn($\leftarrow$)



$[\Sigma M_A = 0]$

$[Vc * 1.5] - [4 * 3] = 0 \longrightarrow Vc = 8$ kN

$\Sigma Fy = 0$

$V_a + V_c - 4 = 0$

$V_a + 8 - 4 = 0$

$V_a = -4$ kN ↓

$[\sum Fx = 0]$

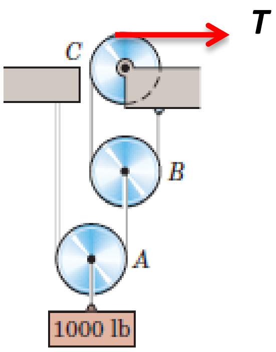
$H_A + H_c = 0$

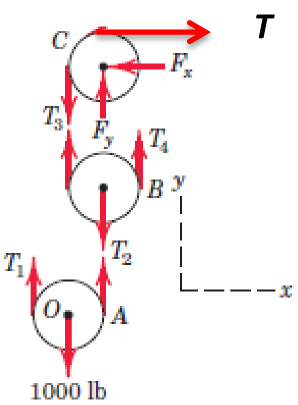
$8 + H_c = 0 \longrightarrow H_c = -8$ kN ←

Equilibrium of pulley

Ex1

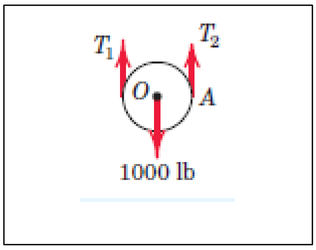
Calculate the tension *T* in the cable which supports the 1000-lb load with the pulley arrangement shown. Each pulley is free to rotate about its bearing, Find the magnitude of the total force on the bearing of pulley *C*.





F.B.D

Sol :-



Pulley A

$[\Sigma M_O = 0]$

$T_1 * r - T_2 * r = 0 \longrightarrow T_1 = T_2$

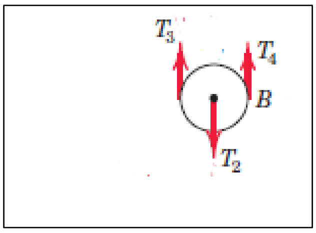
$\Sigma Fy = 0$

$T_1 + T_2 - 1000 = 0 \longrightarrow 2T_1 = 1000$

$T_1 = 500$ Ib

$T_1 = T_2 = 500$ Ib

<u>Pulley B</u>



$[\Sigma M_B = 0]$

$T_3 * r - T_4 * r = 0 \longrightarrow T_3 = T_4$

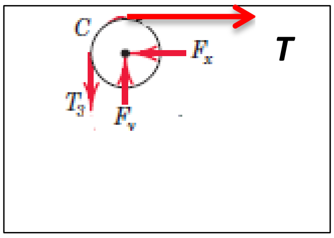
$\Sigma Fy = 0$

$T_3 + T_4 - T_2 = 0 \longrightarrow 2T_3 = 500$

$T_3 = 250$ Ib

$T_3 = T_4 = 250$ Ib

<u>Pulley C</u>

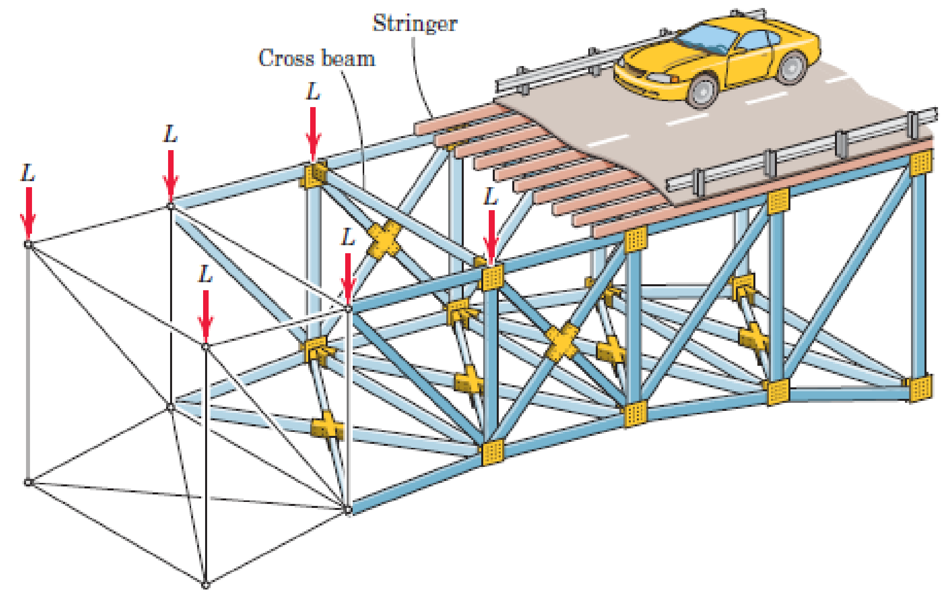


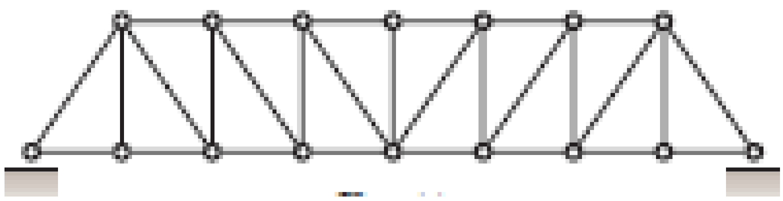
$[\Sigma M_C = 0]$

$T_3 * r - T * r = 0 \longrightarrow T_3 = T = 250$ Ib

The Trusses

In this chapter we analyze the internal forces acting in the trusses and machines.

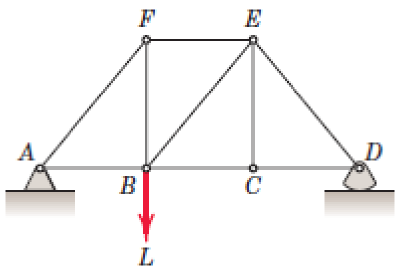


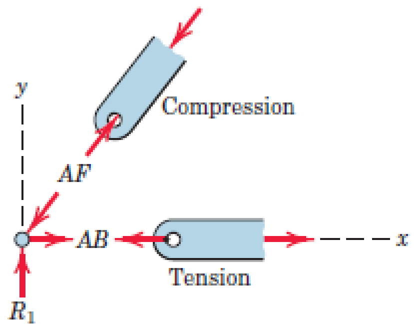


There are two method for finding the forces in each members of truss :-

<u>Method of Joints:-</u>

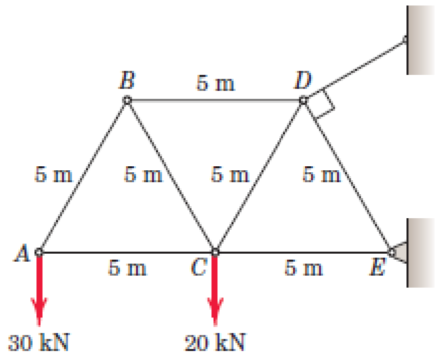
This method for finding the forces in the members of a truss consists of satisfying the conditions of equilibrium for the forces acting on the connecting pin of each joint. The method therefore deals with the equilibrium of concurrent forces, and only two independent equilibrium equations are involved.





<u>Ex 1</u>

Compute the force in each member of the loaded cantilever truss by the method of joints.



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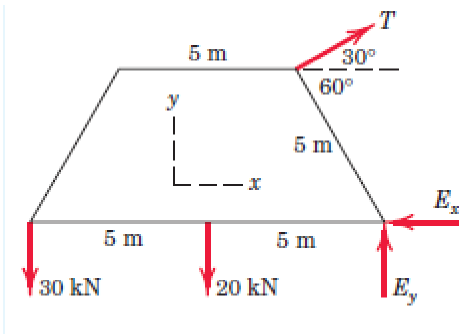
Solution:-



F.B.D

[$\sum M_E = 0$]

$5T - 20(5) - 30(10) = 0 \longrightarrow T = 80$ kN

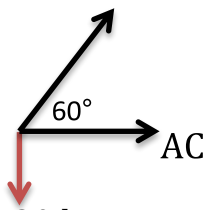
[$\Sigma Fx = 0$]

$80 \cos 30° - Ex = 0 \longrightarrow Ex = 69.3$ kN

[$\Sigma Fy = 0$]

$80 \sin 30° + Ey - 20 - 30 = 0 \longrightarrow Ey = 10$ kN

Joint A



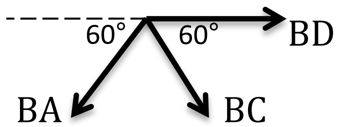
[$\Sigma Fy = 0$]

$AB \sin 60° - 30 = 0 \longrightarrow AB = 34.6$ kN *T*

[$\Sigma Fx = 0$]

$AB \cos 60° + AC = 0 \longrightarrow AC = -17.32$ kN *c*

Joint B



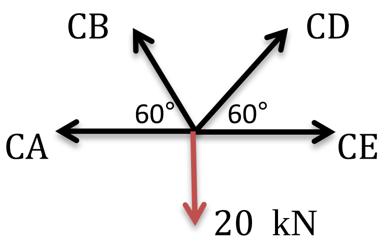
$[\Sigma Fy = 0]$

$-BA \sin 60^\circ - BC \sin 60^\circ = 0 \longrightarrow BC = -34.6\ kN$ *C*

$[\Sigma Fx = 0]$

$BD - BA \cos 60^\circ + BC \cos 60^\circ = 0 \longrightarrow BD = 34.6\ kN$ *T*

Joint C



$[\Sigma Fy = 0]$

$CB \sin 60^\circ + CD \sin 60^\circ - 20 = 0$

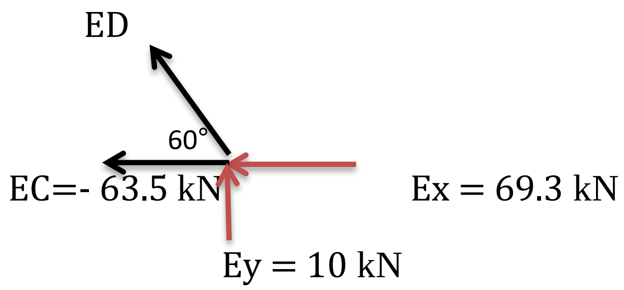
$-34.6 \sin 60^\circ + CD \sin 60^\circ - 20 = 0 \longrightarrow CD = 57.7\ kN$ *T*

$[\Sigma Fx = 0]$

$CE + CD \cos 60^\circ - CB \cos 60^\circ - CA = 0$

$CE + 57.7 \cos 60^\circ + 34.6 \cos 60^\circ + 17.32 = 0 \longrightarrow CE = -63.5\ kN$ *C*

Joint E

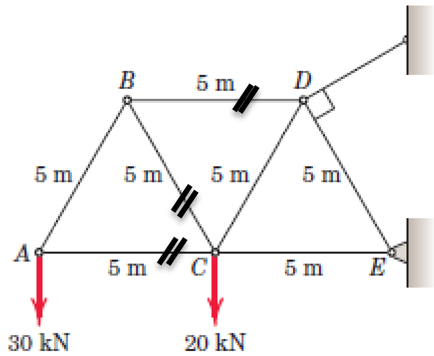


[ΣFy = 0]

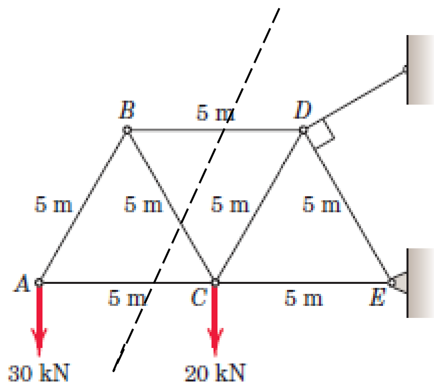
$ED \sin 60° + 10 = 0 \longrightarrow ED = -11.55$ kN *c*

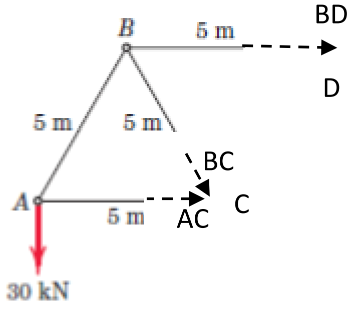
Ex 2

Compute the force in BD,BC and AC members of the loaded cantilever truss by the method of sections.



Solution :-





$[\sum M_C = 0]$

$30(5) - BD(4.33) = 0 \longrightarrow BD = 34.6\ kN\ T$

$[\Sigma Fy = 0]$

$- BC \sin 60° -30 = 0 \longrightarrow BC = -34.6\ kN\ \ c$

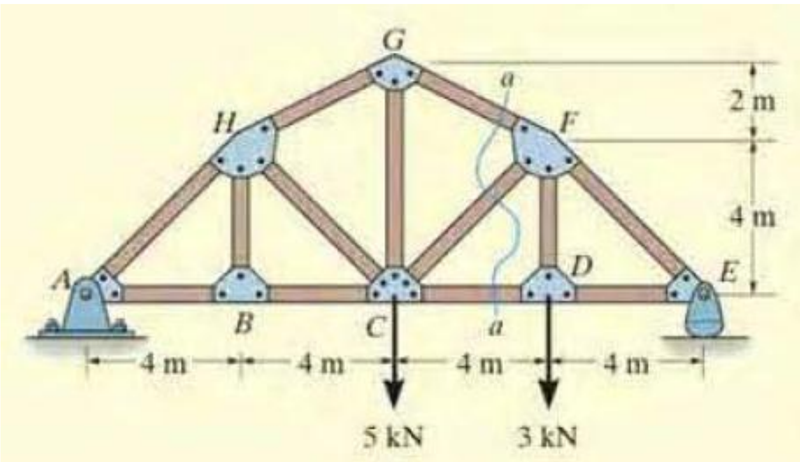
$[\Sigma Fx = 0]$

$BD + BC \cos 60° + AC = 0$

$34.6 - 34.6 \cos 60° + AC = 0 \longrightarrow AC = -17.3\ kN\ \ c$

Ex 3

Compute the force in CD member of the loaded cantilever truss by the method of sections.



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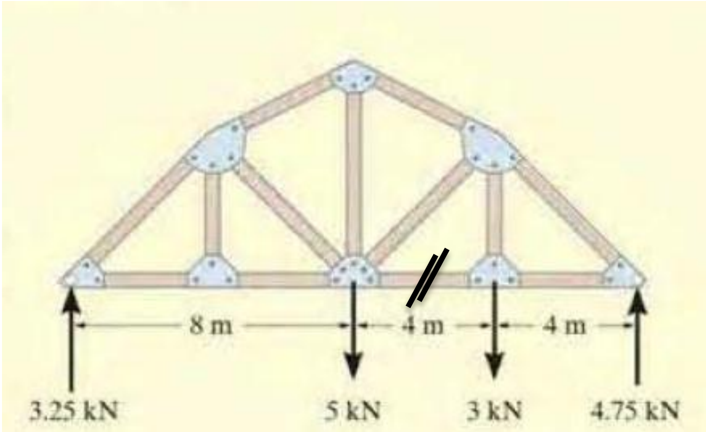
Sulston:-

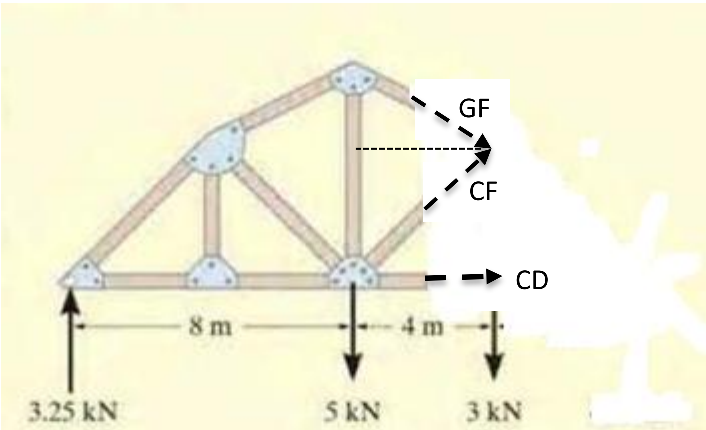


$[\sum M_E = 0]$

$5(8) + 3(4) - R_A(16) = 0 \longrightarrow R_A = 3.25\ kN$

$[\Sigma Fy = 0]$

$3.25\text{-}5\text{-}3 + R_E = 0 \longrightarrow R_E = 4.25\ kN$



$[\sum M_F = 0]$

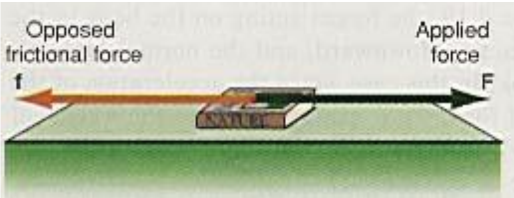
$5(4) - 3.25(12) + CD(4) = 0 \longrightarrow CD = 4.75\ kN\quad T$

The Friction

الاحتكاك

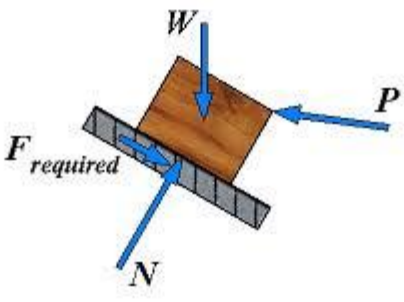
❖ Definition :-

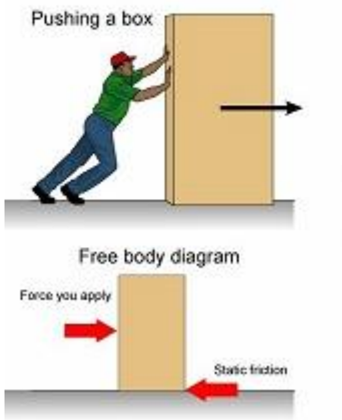
Whenever we try to slide one body over another body there is a force that opposes that motion. This opposing force is called the force of ***friction.*** For example, if this book is placed on the desk and a force is exerted on the book toward the right, there is a force of friction acting on the book toward the left opposing the applied force, as shown in figure below.



❖ Types of Friction

(a) Dry Friction. Dry friction occurs when the not oiled surfaces of two solids are in contact under a condition of sliding or a slope to slide. A friction force tangent to the surfaces of contact occurs both during the interval leading up to impending slippage and while slippage takes place.





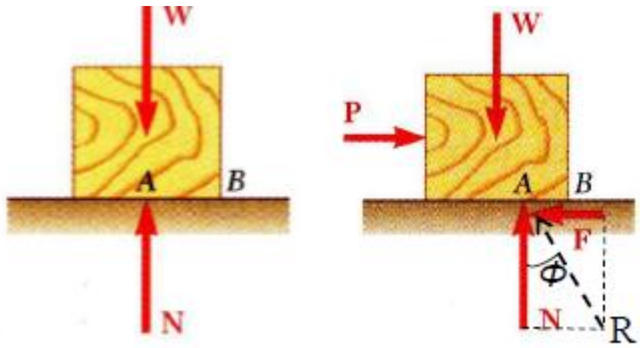
(b) Fluid Friction. Fluid friction occurs when adjacent layers in a fluid (liquid or gas) are moving at different velocities. This motion causes frictional forces between fluid elements, and these forces depend on the relative velocity between layers. When there is no relative velocity,
there is no fluid friction.

<u>Static Friction</u>

As P increases, static-friction force F increases as well until it reaches a maximum value F.

$$F = \mu * N$$

$$\mu = \frac{F}{N}$$



Where:

F = friction force

N =Normal reaction

μ = Coefficient of friction

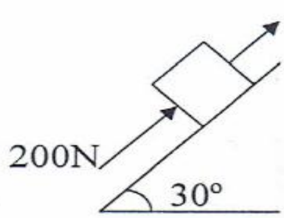
Angle of friction (Ø):

It's the angle between the total reaction (R) and its normal component, when limiting friction.

The tangent of this angle is equal to the coefficient of Friction (μ).

$$\tan \emptyset = \frac{F}{N} \longrightarrow \mu = \tan \emptyset$$

Example: Calculate the force (P) required to move the (500N) block weight up the inclined surface shown in figure ,if the block is subjected to (200N)force assume (μ=0.5) .



Solution:

Wx=500× Sin30=250N

Wy=500× Cos30=433N

$\sum$Fy=0

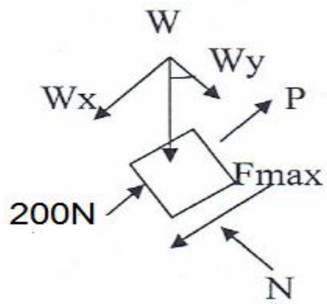
N-433=0 $\Rightarrow$ N=433N

Fmax.=μ*N=0.5×433=216.5N

$\sum$Fx =0

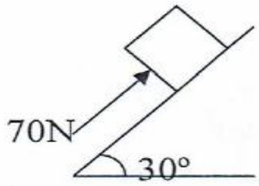
200+p-250-216.5=0

P.=266.5N



Example: Determine the frictional force exerted on the (200N) block weight by the Inclined surface shown in figure if the block is subjected to (70N) force (μ=0.2) .

Solution:



Wx=200× Sin30=100N

Wy=200× Cos30=173.2N

Assume the block will move upward

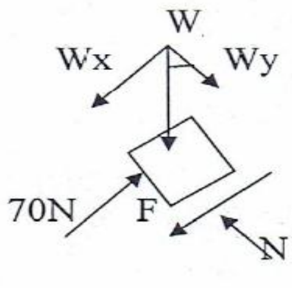
$\sum$Fx=0

70-100-F=0

F=-30N

That means the block is try to move downward

(F) must be equal or less than(Fmax.)



Fmax.=μ*N

$\sum$Fy=0

N - 173.2 = 0 $\Rightarrow$ N = 173.2 N

Fmax.=0.2× 173.2=34.64N $>$ 30N

F=30N

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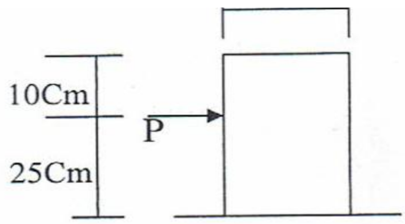
Example: Explain if the block (400 N) weight turns or slides if pushed by force **P** ($\mu = 0.34$)



Solution:

The block is either slides or overturn

1-the block is slides

From (F.B.D 1)

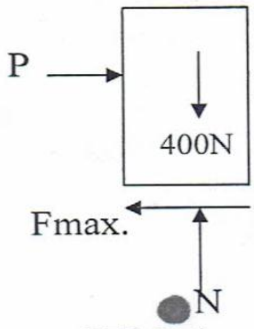
$\sum Fx = 0$

$P = Fmax.$

$\sum Fy = 0 \Rightarrow N=400N$

$Fmax. = \mu * N = 0.34 \times 400 = 136N$

$P=136N$



F.B.D 1

2-the block is overturn

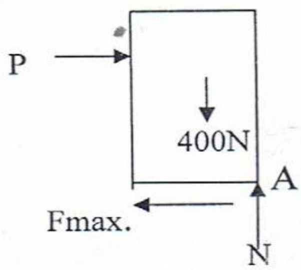
From (F.B.D 2)

$\sum MA = 0$

$25 \times p - 400 \times 10 = 0$

$P=160N$

The block is slides and P= 136N



F.B.D 2

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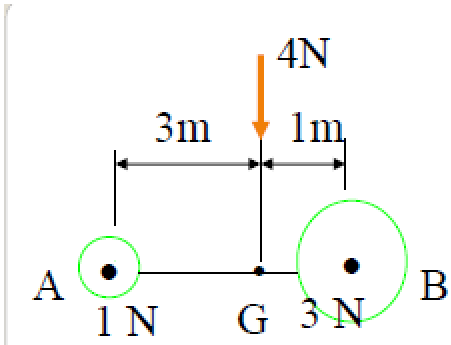
Center of Gravity , Center of Mass
And Center of body

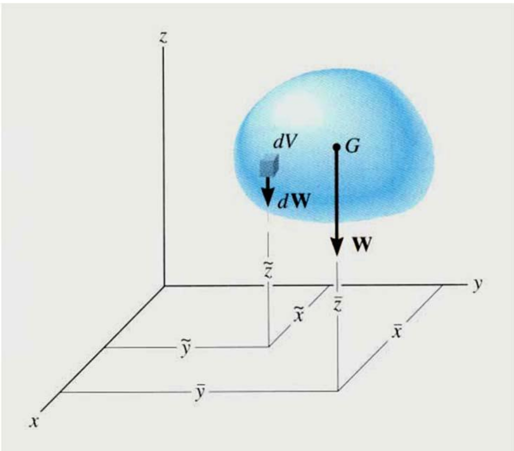
مركز ثقل الاجسام ومركز ثقل الكتلة، و مركز ثقل الجسم

❖ **Definition** :-

The center of gravity (G):- is a point which locates the resultant weight of a system of particles or body.



From the definition of a resultant force, the sum of moments due to individual particle weight about any point is the same as the moment due to the resultant weight located at G. For the figure above, try taking moments about A and B.



Similarly, **the center of mass** is a point which locates the resultant mass of a system of particles or body. Generally, its location is the same as that of **G**.

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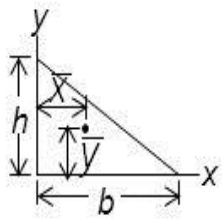
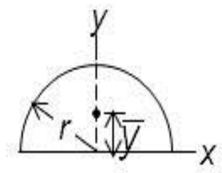
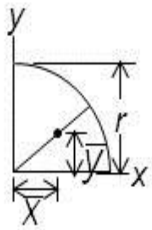
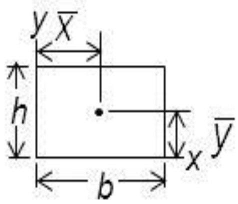
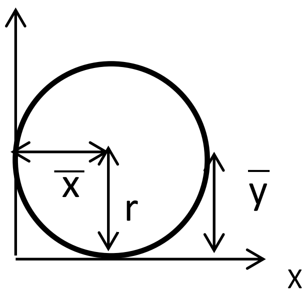
❖ Centroid of simple shapes:-

	Shape	$\bar{x}$	$\bar{y}$	Area A
1. Triangle		$\frac{b}{3}$	$\frac{h}{3}$	$\frac{1}{2}bh$
2. Semicircle		0	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{2}$
3. Quarter circle		$\frac{4r}{3\pi}$	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{4}$
4. Rectangle		$\frac{b}{2}$	$\frac{h}{2}$	bh
5- Circle		r	r	πr^2

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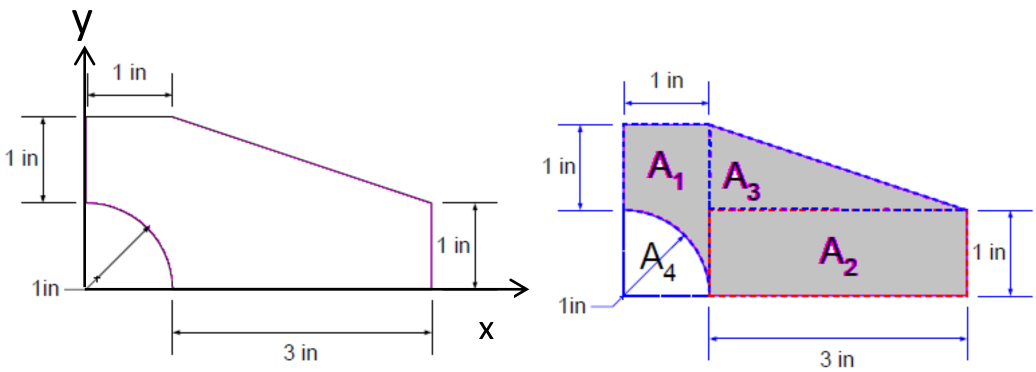
Centroid of complex shapes:- When a body or figure can be conveniently divided into several parts whose centroid are easily determined.

$$\bar{x} = \frac{\Sigma \tilde{x} A}{\Sigma A} \qquad \bar{y} = \frac{\Sigma \tilde{y} A}{\Sigma A}$$

Ex1 Find the centroid of the given area



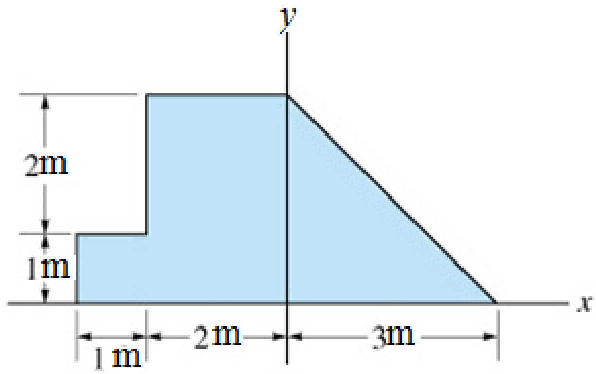
Soulstion:-

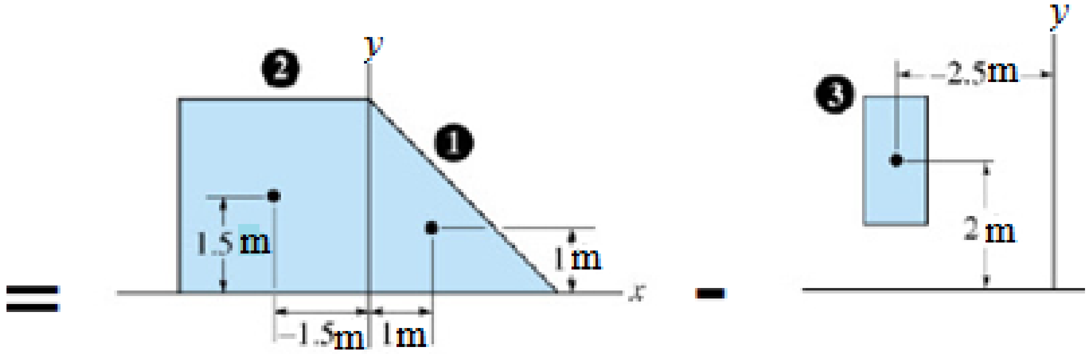
ID	Area	x_i	x_i*Area	y_i	y_i*Area
	(in^2)	(in)	(in^3)	(in)	(in^3)
A_1	2	0.5	1	1	2
A_2	3	2.5	7.5	0.5	1.5
A_3	1.5	2	3	1.333333	2
A_4	-0.7854	0.42441	-0.33333	0.42441	-0.33333
	5.714602		11.16667		5.166667

$$\bar{x} = \frac{\Sigma \tilde{x} A}{\Sigma A} = \frac{11.16}{5.71} = 1.95 \text{ in}$$

$$\bar{y} = \frac{\Sigma \tilde{y} A}{\Sigma A} = \frac{5.16}{5.71} = 0.904 \text{ in}$$

Ex2 Locate the centroid of the plate area shown in Figure below.



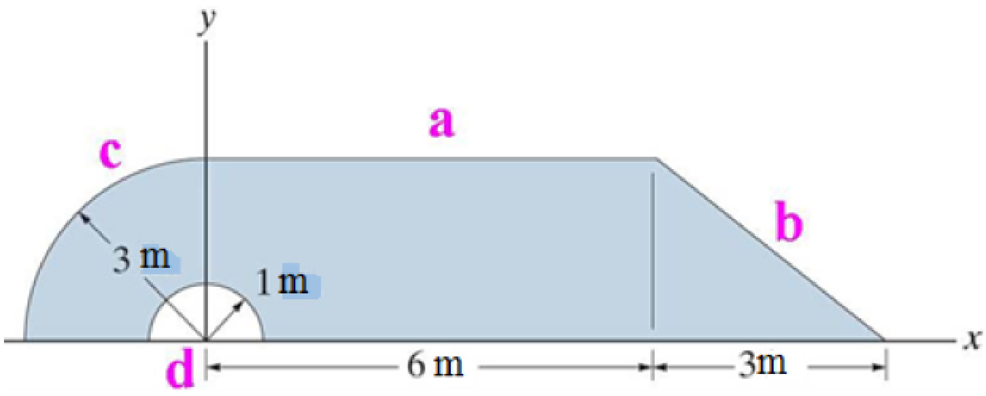


Segment	A (m^2)	$\tilde{x}$(m)	$\tilde{y}$(m)	$\tilde{x}A$(m^3)	$\tilde{y}A$(m^3)
1	$0.5 \times 3 \times 3 = 4.5$	1	1	4.5	4.5
2	$3 \times 3 = 9$	-1.5	1.5	- 13.5	13.5
3	$-2 \times 1 = -2$	-2.5	2	5	-4
Σ	$\Sigma A = 11.5$			$\Sigma\tilde{x}A = -4$	$\Sigma\tilde{y}A = 14$

$$\bar{x} = \frac{\Sigma\tilde{x}A}{\Sigma A} = \frac{-4}{11.5} = -0.348\, m$$

$$\bar{y} = \frac{\Sigma\tilde{y}A}{\Sigma A} = \frac{14}{11.5} = 1.22\, m$$

Ex2 Find the centroid of the part.



Solution:

1. This body can be divided into the following pieces:

rectangle (a) + triangle (b) + quarter circular (c)—semicircular area (d).
(Note the negative sign on the hole!)

Steps 2 & 3: Make up and fill the table using parts a, b, c, and d.

Segment	A (m^2)	$\tilde{x}$(m)	$\tilde{y}$(m)	$\tilde{x}A$(m^3)	$\tilde{y}A$(m^3)
Rectangle	18	3	1.5	54	27
Triangle	4.5	7	1	31.5	4.5
Q. Circle	$9\pi/4$	$-4\times 3/3\pi$	$4\times 3/3\pi$	-9	9
Semi-Circle	$-\pi/2$	0	$-4\times 1/3\pi$	0	-2/3
Σ	28.0			$\Sigma\tilde{x}A$ =76.5	$\Sigma\tilde{y}A$ =39.83

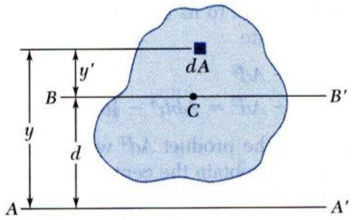
$$\bar{x} = \frac{\Sigma\tilde{x}A}{\Sigma A} = \frac{76.5}{28.0} = 2.73\ m$$

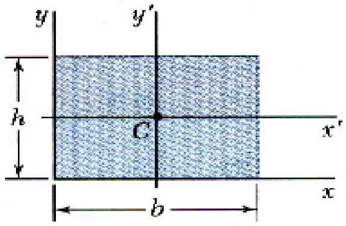
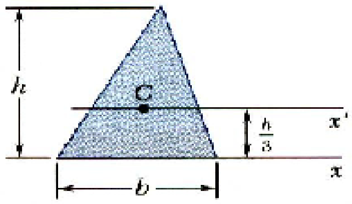
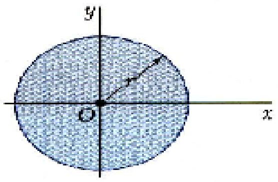
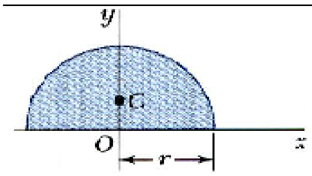
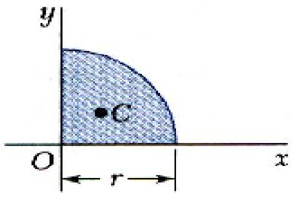
$$\bar{y} = \frac{\Sigma\tilde{y}A}{\Sigma A} = \frac{39.83}{28.0} = 1.42\ m$$

Moment of Inertia (عزم القصور الذاتى)

- It is a measure of an object's resistance to changes to its rotation.
- Also defined as the capacity of a cross-section to resist bending.
- The sum of the products of the mass of each particle in the body and the square of its perpendicular distance from the axis of rotation I.

$$I = \bar{I} + Ad^2$$



shape	Moment of Inertia at C	Moment of Inertia at base
	$I_{x'} = \frac{1}{12} bh^3$	$I_x = \frac{1}{3} bh^3$
	$I_{x'} = \frac{1}{36} bh^3$	$I_x = \frac{1}{12} bh^3$
	$I_x' = \frac{1}{4}\pi r^4$	$I_0 = \frac{1}{2}\pi r^4$
	$I_x' = I_y' = \frac{1}{8}\pi r^4$	$I_0 = \frac{1}{4}\pi r^4$
	$I_x' = I_y' = \frac{1}{16}\pi r^4$	$I_0 = \frac{1}{8}\pi r^4$

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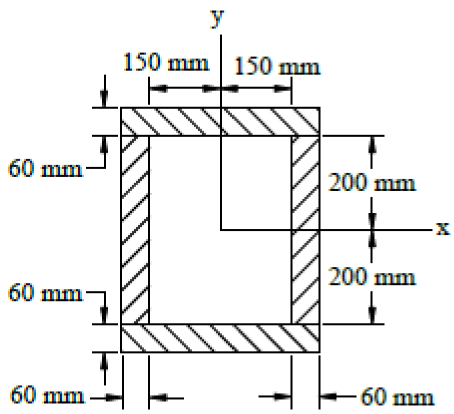
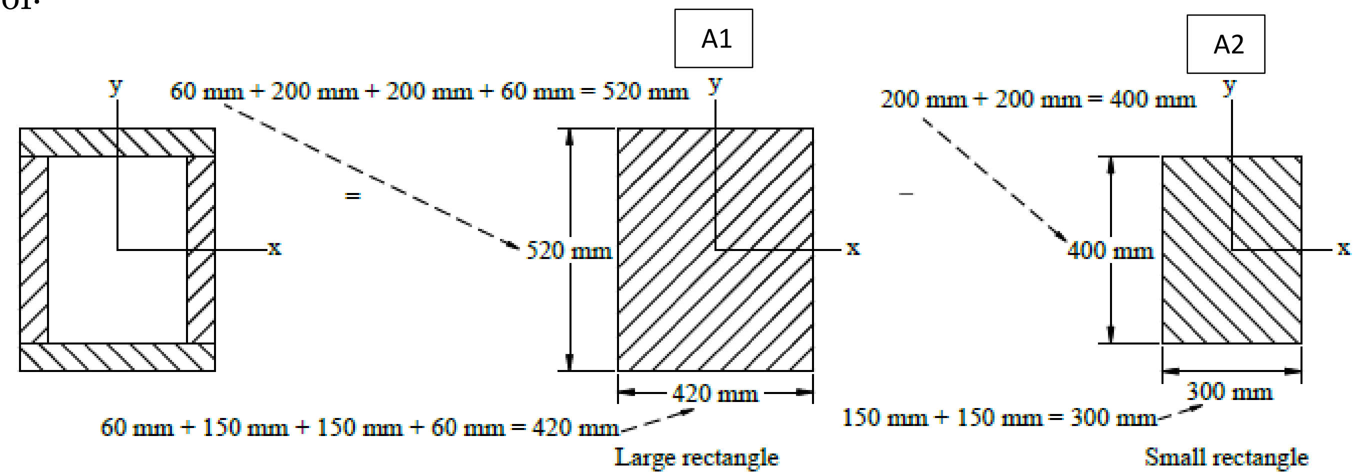
EX 1

The figure shows the cross section of a beam made by gluing four planks together. Determine the moment of inertia of the cross section about the x axis.



Sol:-

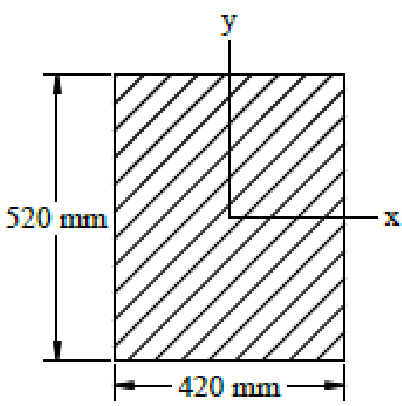


1- A1

$$\text{Large rectangle } I_x = \frac{bh^3}{12}$$

$$= \frac{(420\text{ mm})(520\text{ mm})^3}{12}$$

$$= 4.9213 \times 10^9\text{ mm}^4$$

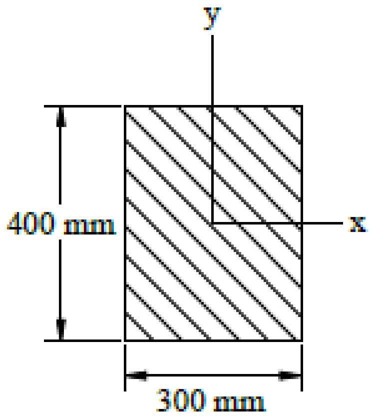


2- A 2

Small rectangle $I_x = \dfrac{bh^3}{12}$

$$= \frac{(300\text{ mm})(400\text{ mm})^3}{12}$$

$$= 1.6000 \times 10^9\text{ mm}^4$$



For the composite region, subtracting gives

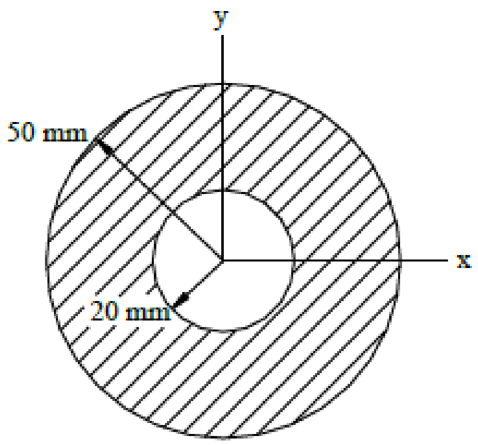
$$I_x = \text{Large rectangle } I_x - \text{Small rectangle } I_x$$

$$= 4.9213 \times 10^9\text{ mm}^4 - 1.6000 \times 10^9\text{ mm}^4$$

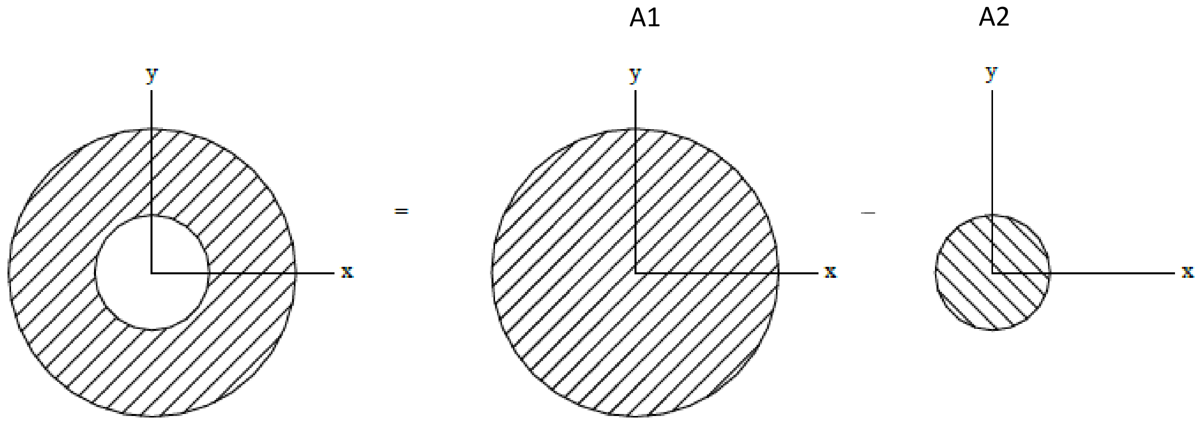
$$= 3.32 \times 10^9\text{ mm}^4 \qquad \leftarrow \text{Ans.}$$

<u>EX 2</u>

Determine the moment of inertia of the cross section about the x axis.



Sol;-



A1 Large circle $I_x = \frac{1}{4}\pi(50\text{ mm})^4$

$$= 4.9087 \times 10^6\text{ mm}^4$$

A2 Small circle $I_x = \frac{1}{4}\pi(20\text{ mm})^4$

$$= 0.1257 \times 10^6\text{ mm}^4$$

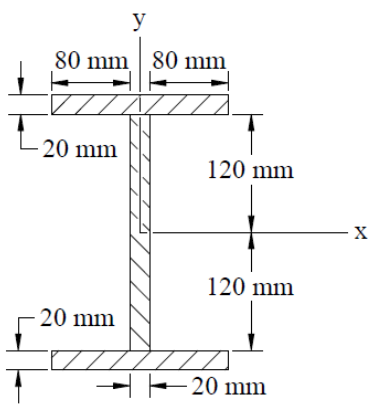
For the composite region, subtracting gives

$$I_x = \text{Large circle } I_x - \text{Small circle } I_x$$

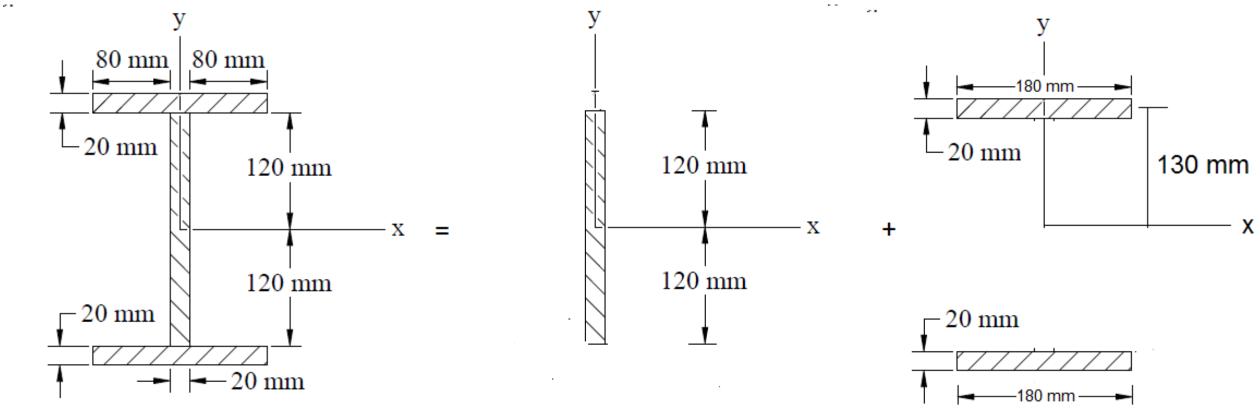
$$= 4.9087 \times 10^6\text{ mm}^4 - 0.1257 \times 10^6\text{ mm}^4$$

$$= 4.78 \times 10^6\text{ mm}^4 \qquad \leftarrow \text{Ans.}$$

Ex3 Determine the moment of inertia of the beam cross section about the x centroid axis.



SOL:-



A1 A2

1- A1

$$I_x = \frac{bh^3}{12}$$

$$= \frac{(20\ \text{mm})(240\ \text{mm})^3}{12}$$

$$= 2.304 \times 10^7\ \text{mm}^4$$

2- A2

$$I_x = I_{xc'} + d^2A$$

$$I_x' = \frac{bh^3}{12}$$

$$= \frac{(180\ \text{mm})(20\ \text{mm})^3}{12}$$

$$= 1.2 \times 10^5\ \text{mm}^4$$

$$I_x = 1.2 \times 10^5 + d^2A$$

$$= 1.2 \times 10^5 + (130)^2 (180 \text{ X } 20)$$

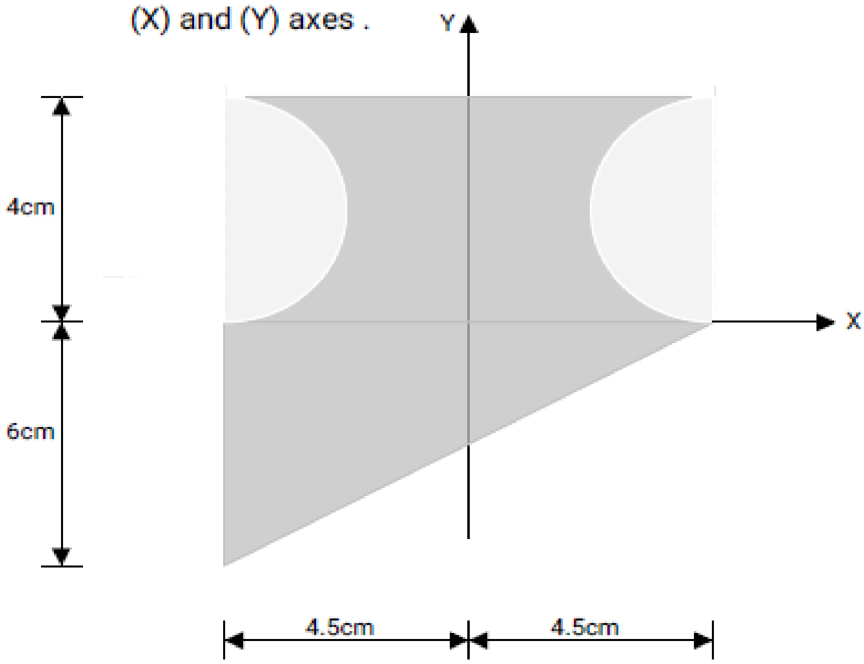
$$= 60960000\ \text{mm}^4$$

$$I_x \text{ (TOTAL)} = \text{A1} + 2\text{ A2}$$

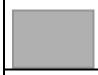
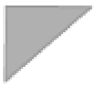
$$= 2.304 \text{ X } 10^7 + 2\ (6.096 \text{ X} 10^7) = 14.5 \text{ X } 10^8\ \text{mm}^4$$

Example : Determine the centroid of the shaded area shown in figure with respect to

(X) and (Y) axes .



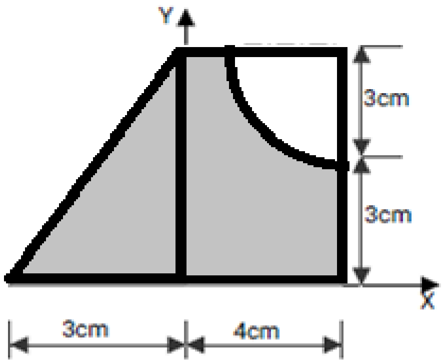
Solution:

Fig.	ai	xi	yi	aixi	aiyi
	4× 9=36	0	2	0	72
	1/2× 6× 9=27	-1.5	-2	-40.5	-54
	$-\pi(2)^2/2=-6.283$	-(4.5-0.424×2) =-3.652	2	22.945	-12.566
	-6.283	3.652	2	-22.945	-12.566
	50.434			-40.5	-7.132

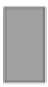
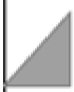
X=-40.5/50.434=-0.803Cm Y=-7.132/50.434=-0.141Cm

Example: Determine the centroid of the shaded area shown in figure with respect to

(X) and (Y) axes .



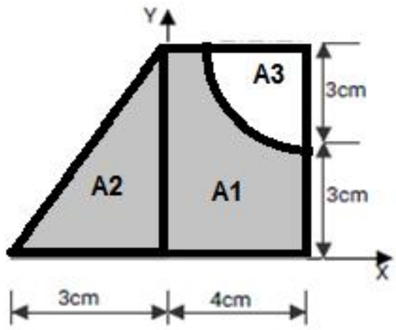
Solution:

Fig.	ai	xi	yi	aixi	aiyi
	4× 6=24	2	3	48	72
	1/2× 3× 6=9	-1	2	-9	18
	-π(3)²/4=- -7.069	4-(0.424×3) =2.728	6-(0.424× 3) =4.728	-19.27	-33.4

Σ 25.931 19.73 56.6

X=19.73/25.931=0.76Cm Y=56.6/25.931=2.18Cm

Example: Determine the moment of inertia of the shaded area shown in figure with respect to(x) axis .



Solution:

$A1=4\times 6=24Cm^2$

$A2=1/2\times 3\times 6=9Cm^2$

$A3=\pi(3)^2/4=7.06Cm^2$

For(A1) :

$Ix=bh^3/12+Ad^2=4*(6)^3/12+24*(3)^2=288Cm^4$ (+)

For(A2) :

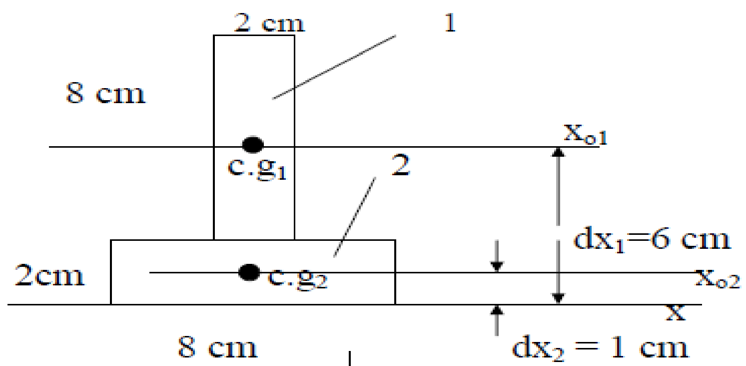
$Ix=bh^3/36+Ad^2=3*(6)^3/36+9*(2)^2=54Cm^4$ (+)

For(A3) :

$Ix=0.196(r)^4+Ad^2=0.196*(3)^4+7.06*(4.728)^2=173.72\ Cm^4$ (-)

$Ix(total)=288+54-173.42=168.27\ Cm^4$

Q/ Find the moment of inertia of T- section show in Fig. About x-axis .



$(Ix)_A = (Ix)_{a1} + (Ix)_{a2}$

1) $Ix_{o1}=\dfrac{2(8)^3}{12}=85.3\,cm^4$

$(Ix)_{a1}=I_{xo1}+a_1 d^2_{x1}$

$(Ix)_{a1}=85.3+(8*2)(6)^2$

$(Ix)_{a1}=661.3\,cm^4$

2) $Ix_{o2}=\dfrac{8(2)}{12}=5.3\,cm\,4$

$(Ix)_{a2}=I_{xo2}+a_2 d^2_{x2}$

$(Ix)_{a2}=5.3+(8*2)*(1)^2$

$(Ix)_{a2}=21.3cm^4$

3) $(Ix)_A=(Ix)_{a1}+(Ix)_{a2}$

$(Ix)_A=661.3+21.3$

$(Ix)_A=682.6\,cm^4$

Strength of Materials

Strength of materials : مقاومة المواد
Is the resistance of materials to the external forces القوى الخارجية acting المؤثرة on it عليها .

Stress : الإجهاد

The resistance per unit area to deformation the symbol of stress is (σ) the unit وحدات of stress is unit of force divide by مقسومة على unit of area (N/m^2) .

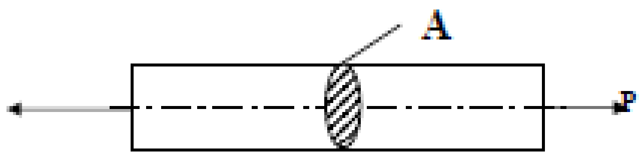
$$\sigma = \frac{P}{A}$$

σ = stress الاجهاد
P = Force القوة
A = Area المساحة

Type of stress أنواع الإجهاد

1. Tensile stress (σ_T) **إجهاد الشد**

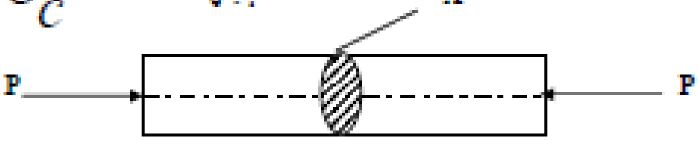
$$\sigma_T = \frac{P}{A}$$



P

P = tensile force قوة شد
A = cross sectional Area مساحة المقطع
ملاحظة : (يجب ان تكون قوى الشد على محور واحد ويجب أخذ المساحة للمقطع عمودية على القوة)

2. Compression stress σ_C إجهاد الضغط

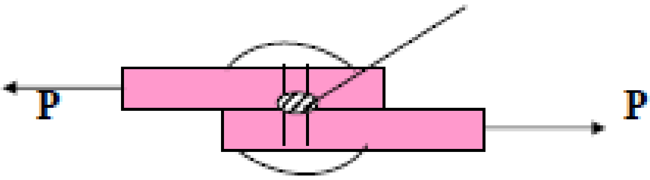


$$\sigma_C = \frac{P}{A}$$

P = Compression force قوة ضغط
A = cross sectional Area مساحة المقطع

ملاحظة : (يجب ان تكون قوى الضغط على محور واحد ويجب أخذ المساحة عمودية على القوة) .

3.Shear stress (σ_s) إجهاد القص



$$\sigma_s = \frac{P}{A}$$

P = shear force قوة قص
A = cross sectional Area مساحة المقطع

ملاحظة : (يجب ان تكون قوى القص على محاور متوازية ويجب أخذ المساحة للمقطع موازية للقوة)

Strain الانفعال

When a force acting عندما تؤثر قوة on a body it underيحدث goes some deformation تغيير the deformation per unit length لوحدة الطول is known as strain .
Strain has no unit الانفعال بدون وحدات
(عندما تسلط قوة على جسم يحصل تغيير وهذا التغيير اذا قسم على وحدات الطول نحصل على الانفعال) .

The sample of strain is (ε)

$$\varepsilon = \frac{\Delta L}{L}$$

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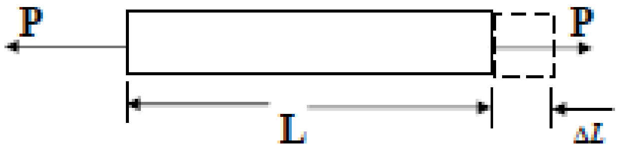
ε = strain الانفعال
ΔL = deformation التغيير في الطول
L = Length of body طول الجسم

Type of strain أنواع الانفعال

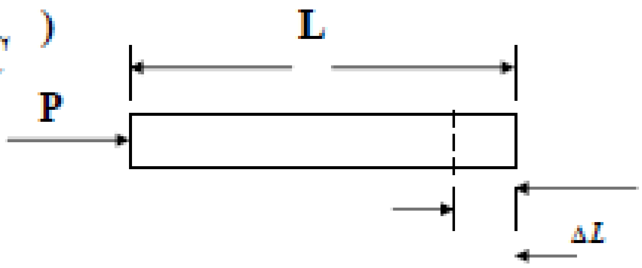
1. Tensile strain (ε_T)



$$\varepsilon_T = \frac{\Delta L}{L}$$

ΔL = Tensile deformation الزيادة في الطول
L = Length of body طول الجسم

2. Compressive strain (ε_C)



P

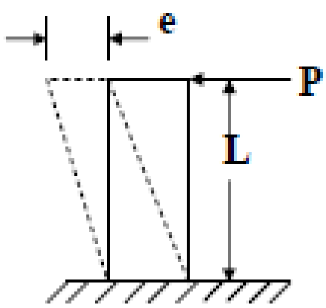
$$\varepsilon_C = \frac{\Delta L}{L}$$

ΔL = Compressive deformation النقصان بالطول
L = Length of body طول الجسم

3. Shear strain (ε_s) انفعال القص

$$\varepsilon_S = \frac{e}{L}$$

e = shear de formation مقدار الحيود بطول



L = Length of body طول الجسم

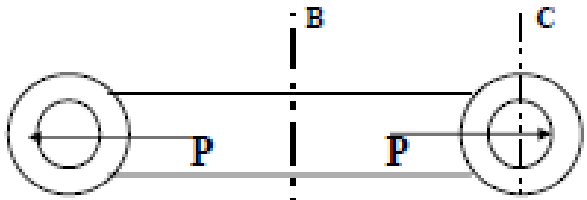
Elasticity المرونـــــــــة

Is the property صفة **of material** المعدن **of returning** الرجوع **back to their original position** الموقع الأصلي **after** بعد **removing** إزالة **the external force** القوة الخارجية **.**

Elastic limit حدود المرونة

When the external force القوة الخارجية **is removed** تزال **the force of resistance** قوة المقاومة **also vanishes** يختفي **and the body spring** يقفز **back to its original position** الوضع الأصلي **. This thing happens** يحدث **in Elastic limits** حدود المرونة **only** فقط **.**

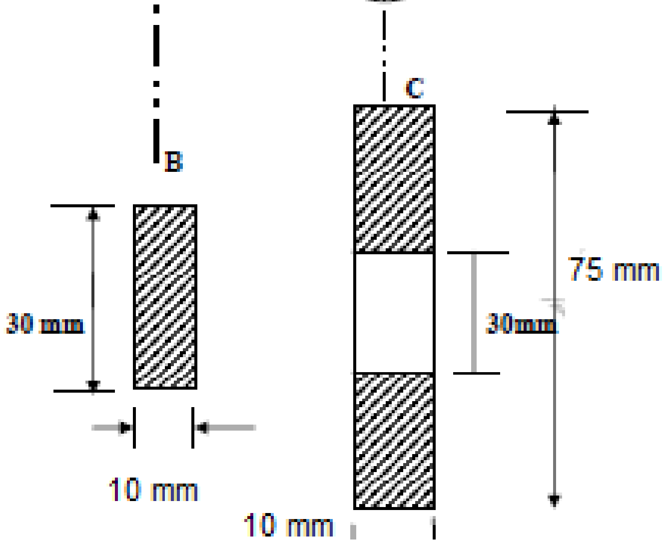
EX 1/ **In Fig find the tensile stress in the section** مقطع **BB , CC if P = 14 400 N .**



Section BB المقطع

$$\sigma_T = \frac{P}{A}$$

$A = 10 * 30 = 300\ mm^2$



$$\sigma_T = \frac{14400}{300}$$

$$\boxed{\sigma_T = 48 N/mm^2}$$

Section CC المقطع

$$\sigma_T = \frac{P}{A}$$

A = 75 * 10 – 30 * 10
A = 750 – 300
A = 450 mm^2

$$\sigma_T = \frac{14400}{450}$$

$$\boxed{\sigma_T = 32 N/mm^2}$$

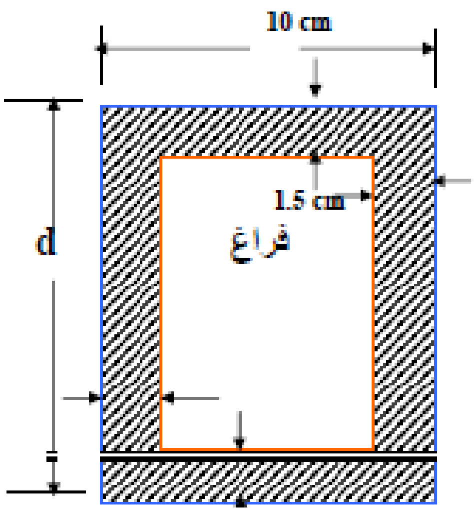
-- EX 2

The section shown in fig . is subjected to compression force of (820 000 N) .IF the compression stress is (12 000 N / cm^2) Find the dimension (d) ?

A = (10 * d) – 7 (d – 3)

A = 10 d – 7d + 21

A = 3 d + 21 ______ 1



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$$\sigma_C = \frac{P}{A}$$

$$A = \frac{P}{\sigma_C} = \frac{820000}{12000}$$

1.5cm

$\boxed{A = 68.33\ cm^2}$

مدرس المادة : علاء محمد مرزة

68.33 = 3d + 21
3d = 63.33 – 21
3d = 47 .33

$$d = \frac{47.33}{3}$$

$\boxed{d = 15 .76\ cm}$

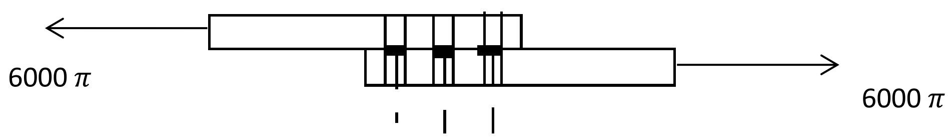
Q / In Fig . Two plates صفيحة are joint by three rivets برشام of (20 mm) diameter قطر . How much the shear stress in the material of rivet if (p = 6000 π N)

A = 3a
A = 3 ($r^2\ \pi$)

مساحة الدائرة = (نصف القطر)2 * النسبة الثابتة

= = نق 2 * النسبة الثابتة

A = 3 ((10) $^2\ \pi$)
A = 300 π mm^2



$$\sigma_s = \frac{P}{A} = \frac{6000\pi}{300\pi}$$

$\boxed{\sigma_s = 20 N/mm^2}$

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