Topics included.

1- Area determination

2- *First moment of area*.

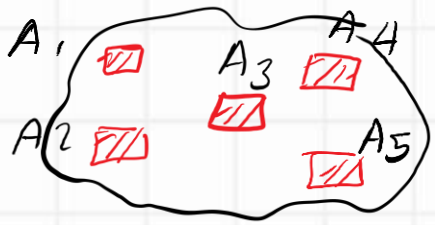
3- 2nd moment of inertia.

4- Product of Inertia.

Prepared by Eng.Maged Kamel.

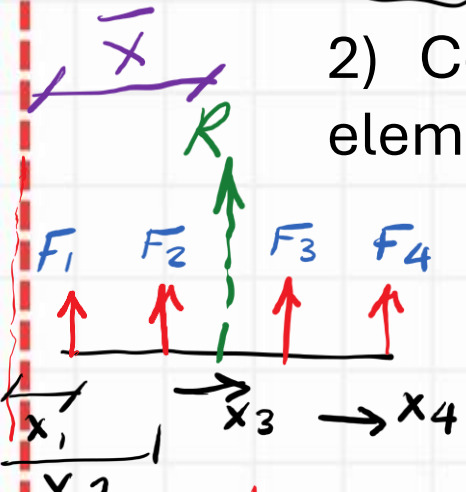
Definitions

1) Area: area enclosed by a boundary line is the sum of all elementary areas enclosed by that boundary line .



$$A_{Total} = \sum_{i=1}^{i=5} A_i$$

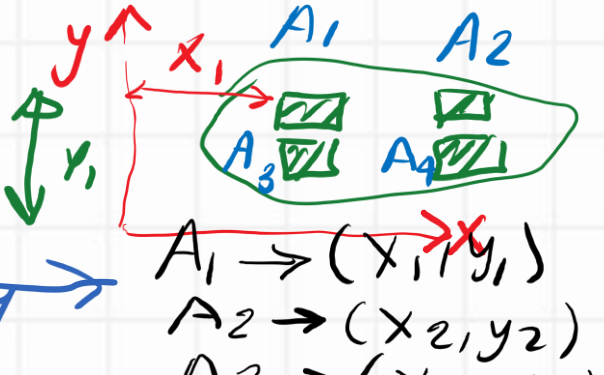
2) Center of gravity: it is the point at which the resultant of all elementary areas passes.



$$R = F_1 + F_2 + F_3 + F_4$$

$$\bar{X} = [F_1 x_1 + F_2 x_2 + F_3 x_3] / R$$

System of Forces



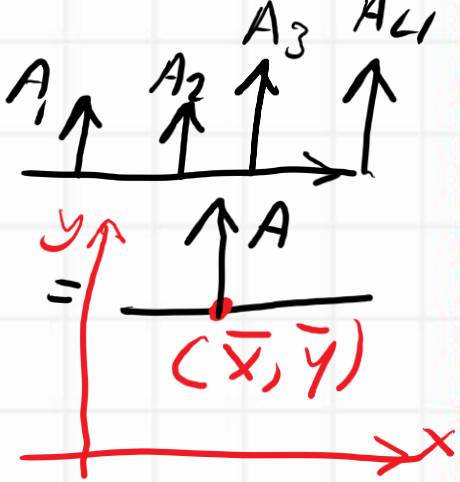
Similarly

$A_1 \rightarrow (x_1, y_1)$

$A_2 \rightarrow (x_2, y_2)$

$A_3 \rightarrow (x_3, y_3)$

$A_4 \rightarrow (x_4, y_4)$

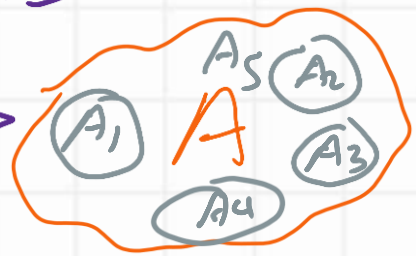


$$A = \Sigma A \quad , \quad \bar{X} = \frac{A_1 x_1 + A_2 x_2 + A_3 x_3 + \cdots}{A}$$

1) Area: area enclosed by a boundary line is the sum of all elementary areas enclosed by that boundary line .

$$\text{Total area} = \sum_{i=1}^{5} A_i$$

$$A = A_1 + A_2 + A_3 + A_4 + A_5$$



A1

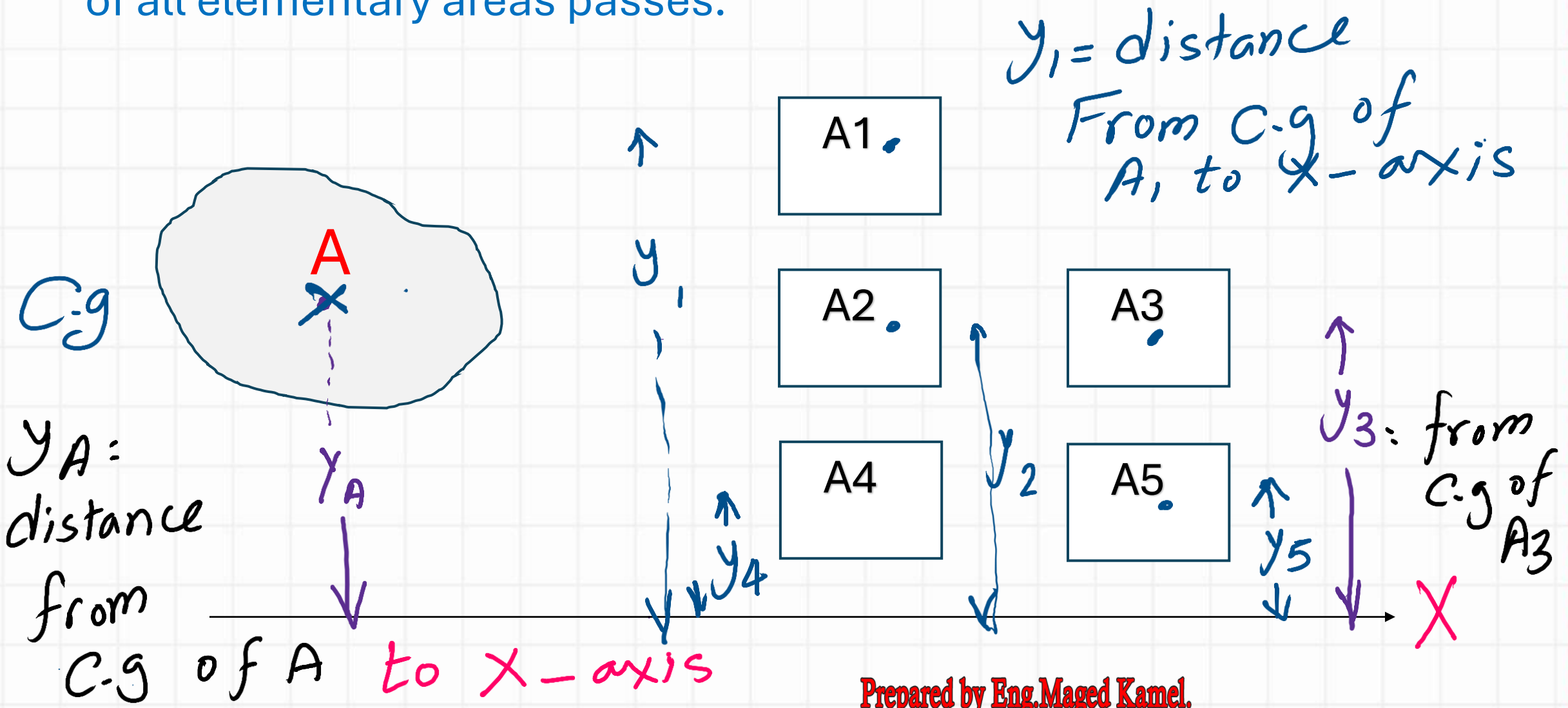
A2

A3

A4

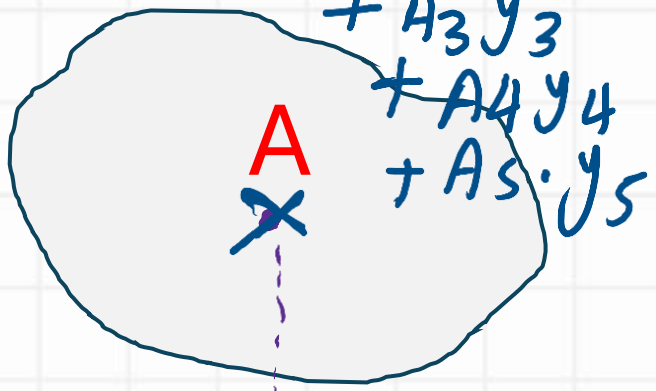
A5

2) Center of gravity: it is the point at which the resultant of all elementary areas passes.

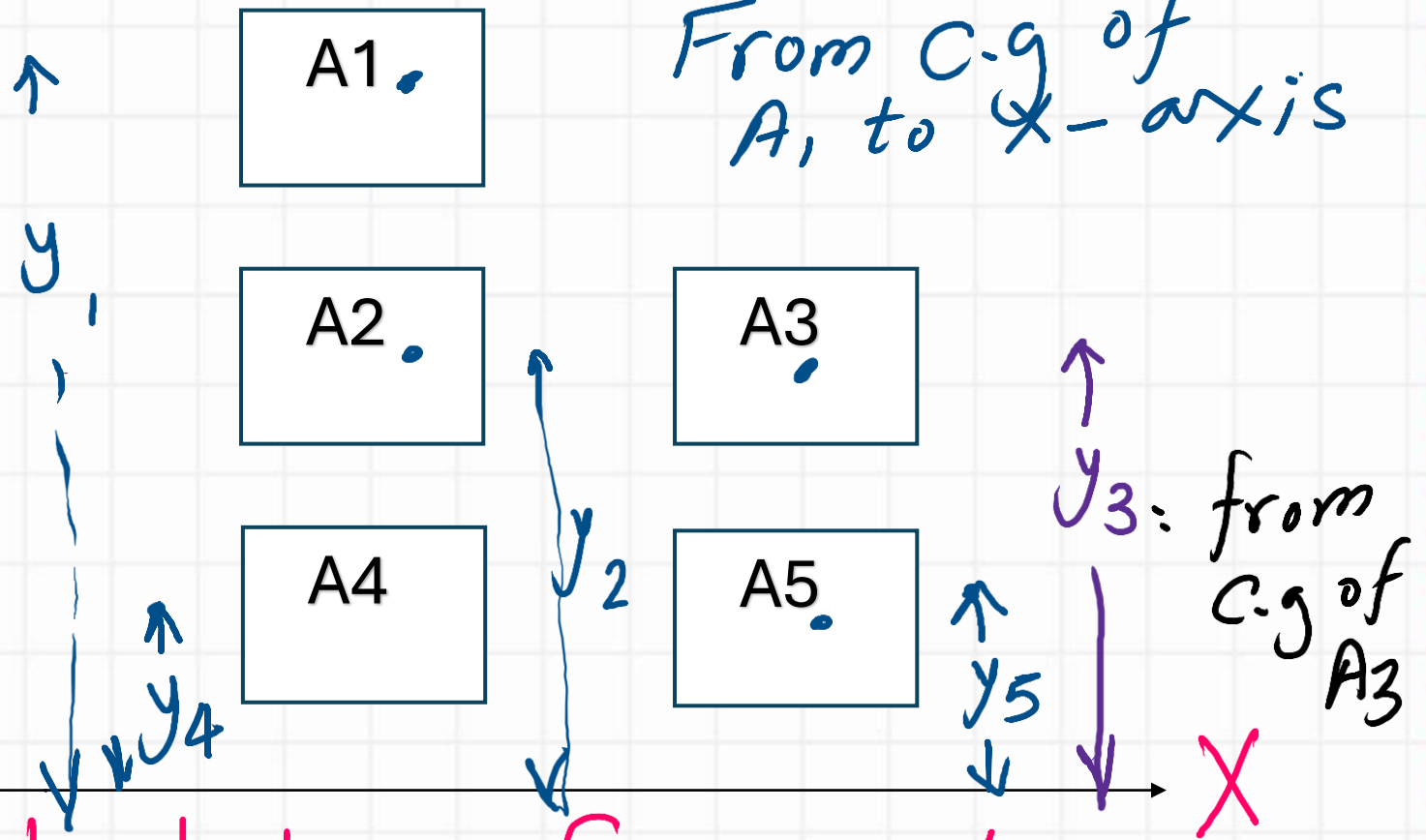


2) Center of gravity: it is the point at which the resultant of all elementary areas passes.

$A(\bar{y}) = A_1y_1 + A_2y_2 + A_3y_3 + A_4y_4 + A_5y_5$

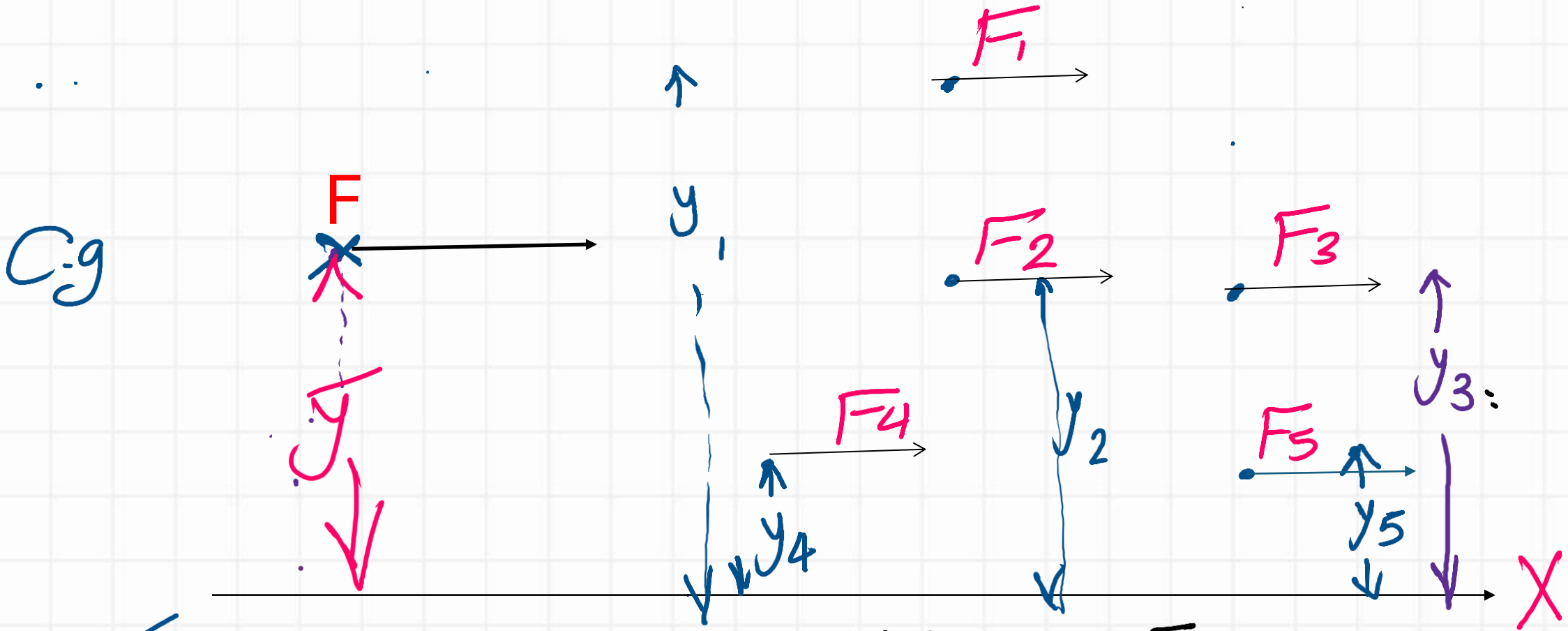


y_1 = distance From C.g of A_1 to X-axis



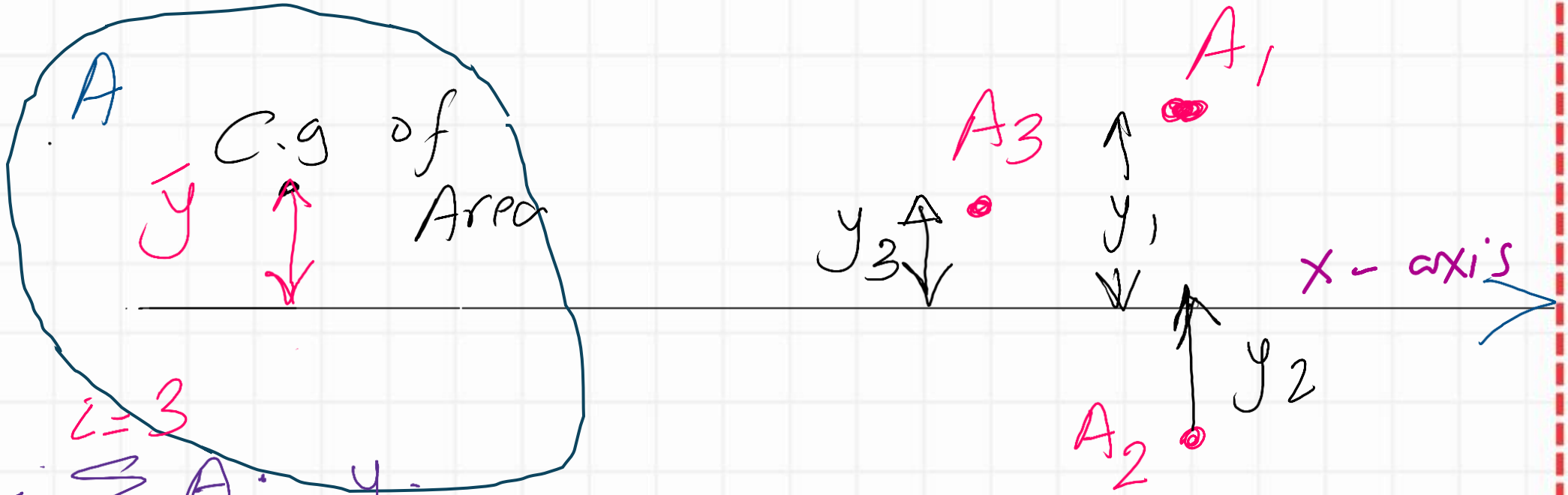
$\bar{y}$ is the vertical distance from C.g to X-axis

2) Center of gravity: if areas are represented as forces then the first moment of these forces can be written as..



$$F \cdot \bar{y} = F_1 \cdot y_1 + F_2 \cdot y_2 + F_3 \cdot y_3 + F_4 y_4 + F_5 \cdot y_5$$

We can choose the x_axis Location at any place, thus the first moment of area can be written as follows:

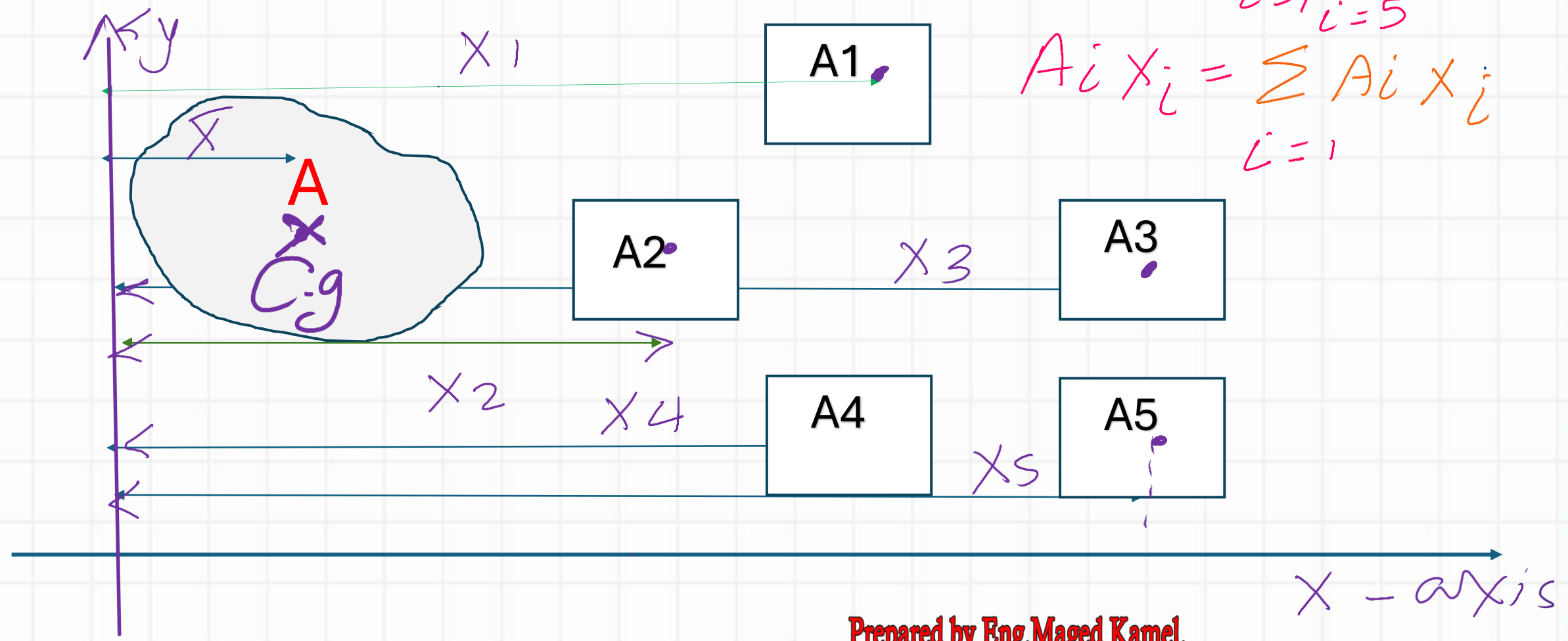


$$A \cdot \bar{y} = \sum_{i=1}^{i=3} A_i \cdot y_i$$

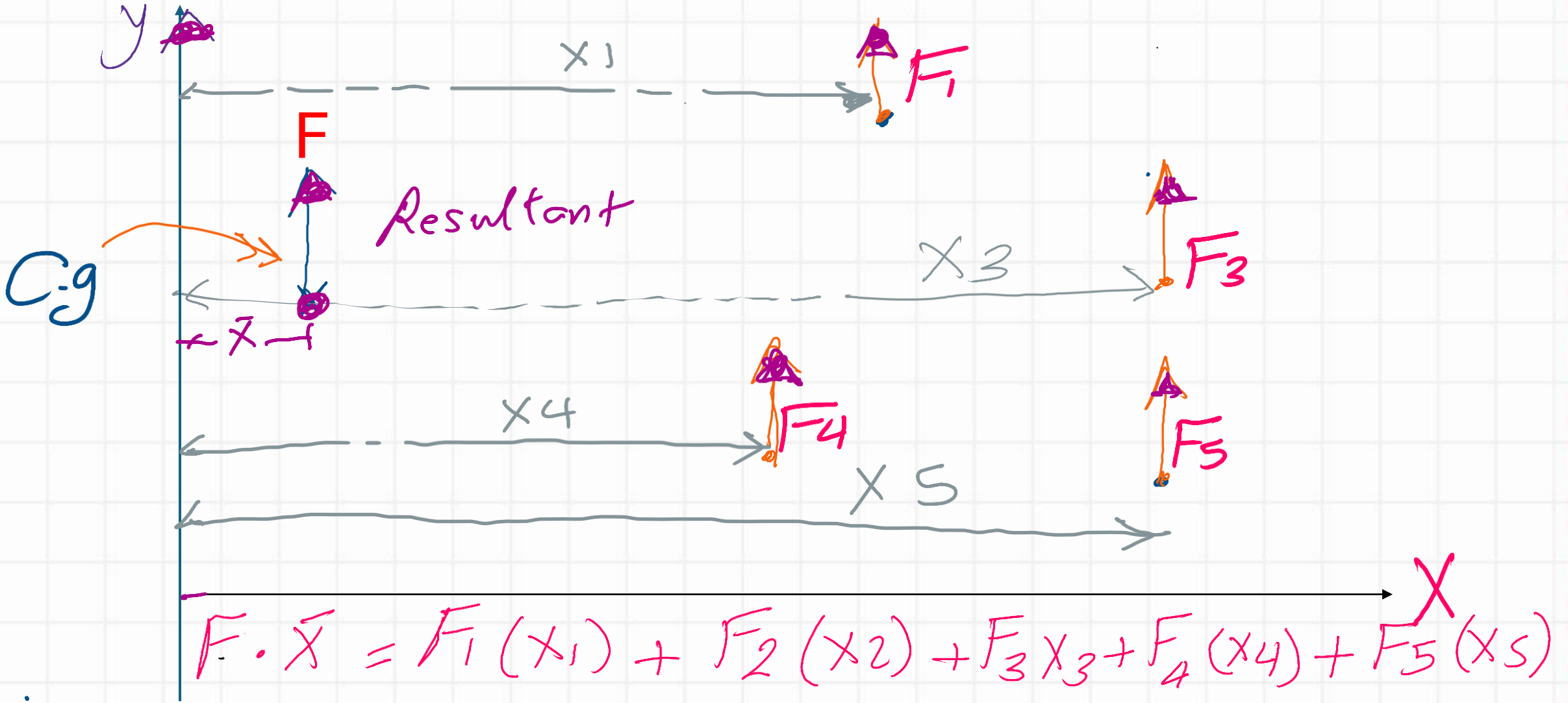
2) Center of gravity: it is the point at which the resultant of all elementary areas passes.

$$A = \sum_{i=1}^{i=5} A_i$$

$$A_i x_i = \sum_{i=1}^{i=5} A_i x_i$$



2) Center of gravity: if areas are represented as forces then the first moment of these forces can be written as..

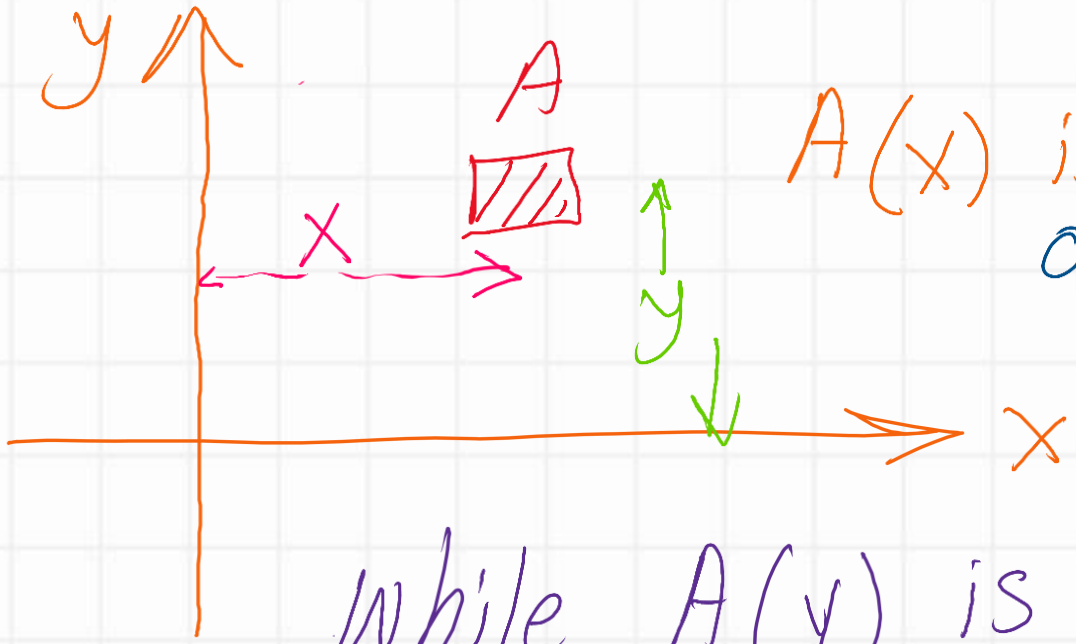


$$F \cdot \bar{x} = F_1(x_1) + F_2(x_2) + F_3 x_3 + F_4(x_4) + F_5(x_5)$$

Definitions

First moment of Area

3) Statical moment or first moment of Area: The first moment of area about an axis is the product of each elementary area by the normal distance from that axis.

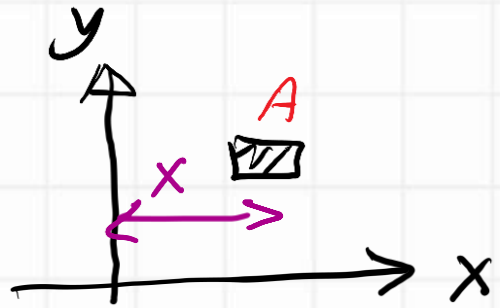


A(x) is the First moment of area at y-axis

while A(y) is the first moment of area about x-axis

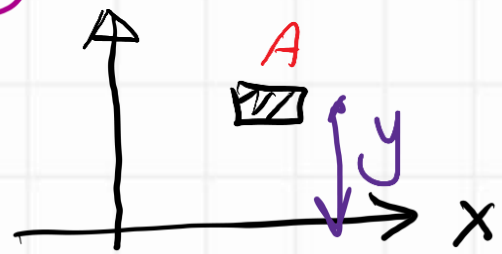
Definitions

3) Statical moment or first moment of Area: The first moment of area about axis is the product of each elementary area by the normal distance from that axis.



A(x) First moment of area about y-axis

x-distance is ⊥er to y-axis



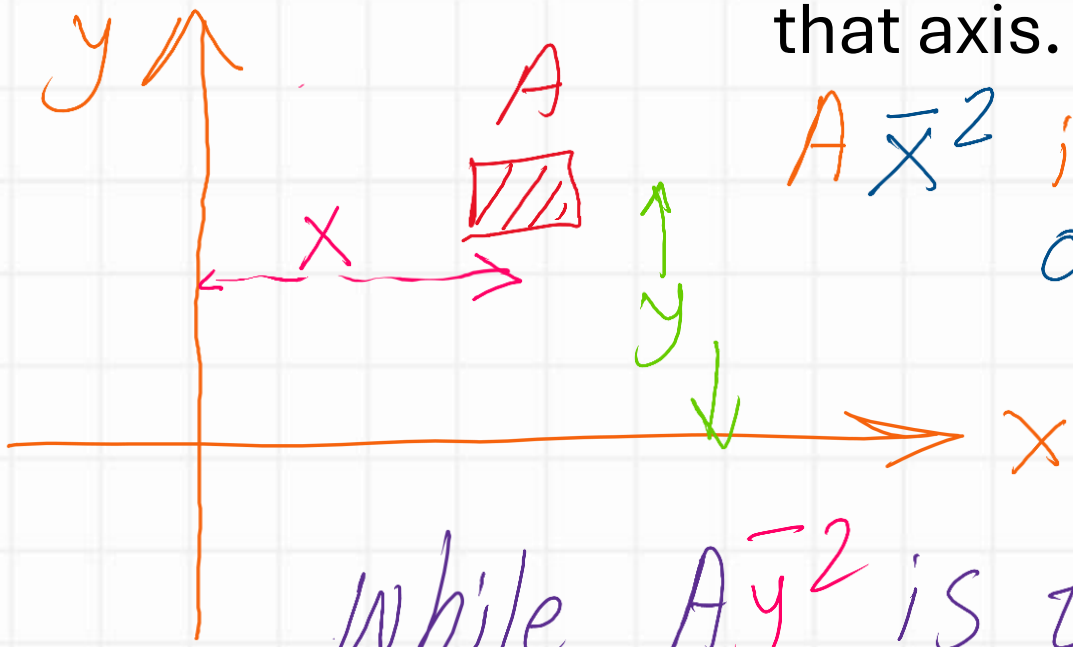
A(x) First moment of area about x-axis

y-distance is ⊥er to x-axis

Definitions

2nd moment of area

4) Moment of inertia or Second moment of Area: The second moment of area about axis is the product of each elementary area by the square of the Normal distance from that axis.



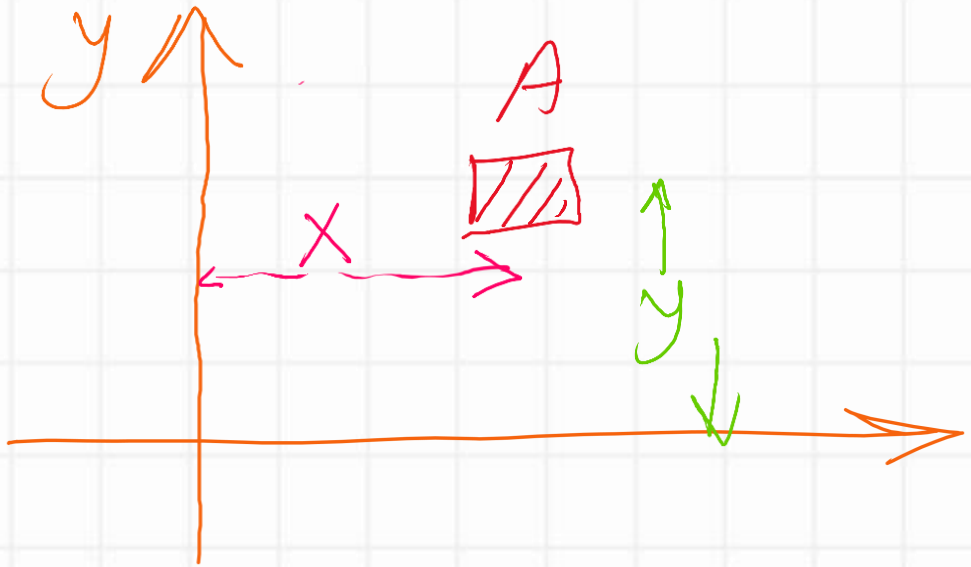
$A\bar{x}^2$ is the second moment of area at y-axis

while $A\bar{y}^2$ is the second moment of area about x-axis

Definitions

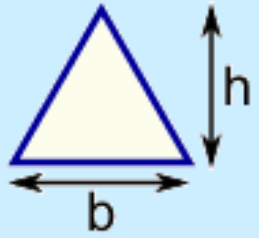
Product of inertic

5) Product of inertia : the product of an area about any two axes in its plane, is the product of Area by its corresponding coordinates referred to these two axes.



A (x)(y) Product of inertia for area A about x & y axes.

Area of plane shapes

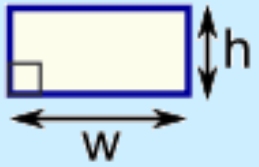


Triangle

Area = ½ × b × h

b = base

h = vertical height

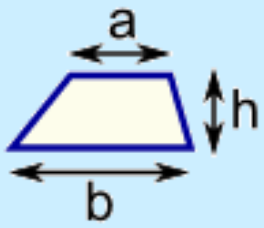


Rectangle

Area = w × h

w = width

h = height

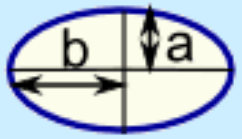


Trapezoid (US)

Trapezium (UK)

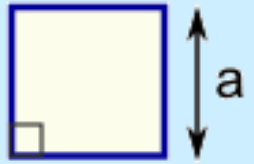
Area = ½(a+b) × h

h = vertical height



Ellipse

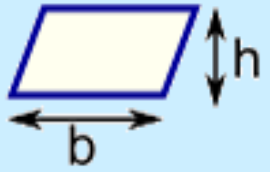
Area = πab



Square

Area = a^2

a = length of side



Parallelogram

Area = b × h

b = base

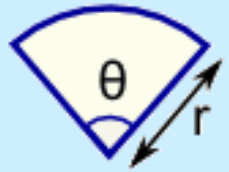
h = vertical height

Circle

Area = π × r^2

Circumference = 2 × π × r

r = radius



Sector

Area = ½ × r^2 × θ

r = radius

θ = angle in **radians**