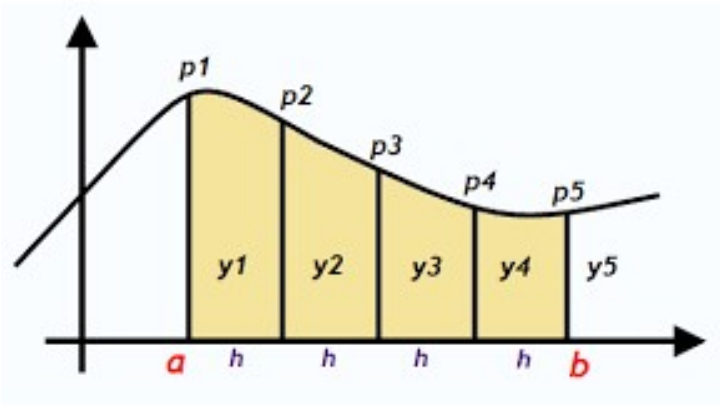
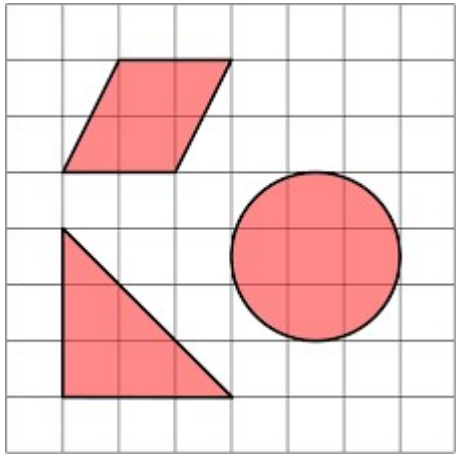
AMIRAJ

COLLEGE OF ENGINEERING & TECHNOLOGY

Module - 5
Area & Volume





Subject:- Surveying **Code:-3140601**	**Prepared by:** **Asst.Prof. Janki Patel** **(Civil Department, ACET)**	AMIRAJ COLLEGE OF ENGINEERING & TECHNOLOGY

Introduction

- In civil engineering the area calculation is the most important.
- Road and railway land is to be acquire on the bass of area.
- Finding the area is the essential part of the surveying.

Computation of the area by taking offset

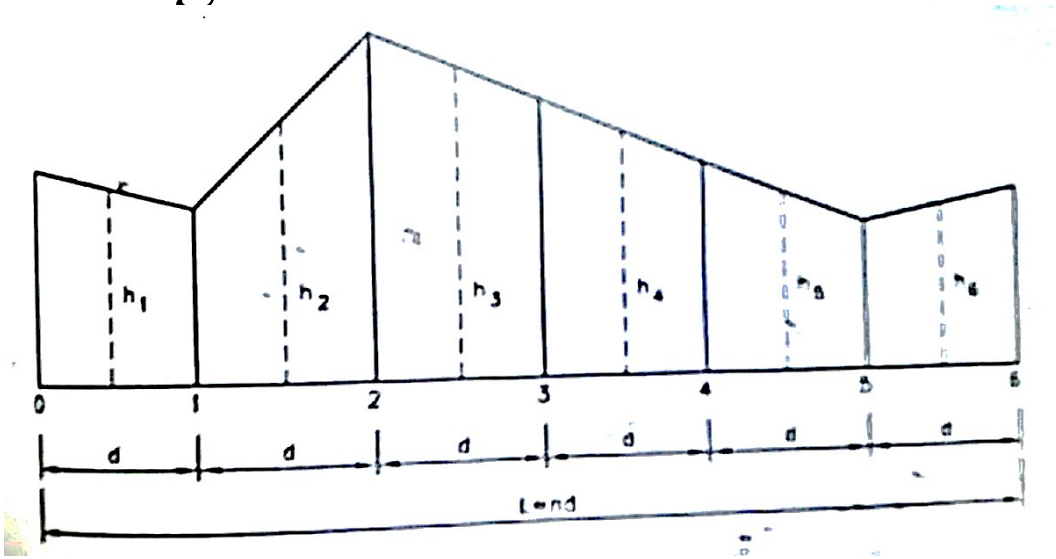
- There are main four method of computation of the area by taking offset.

Area calculation Method
Mid Ordinate rule
Average Ordinate rule
Trapezoidal rule
Simpson’s rule

AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

1. Mid Ordinate rule

- Base line divided in to number of divisions.
- The ordinate are measured at the mid points of each division.
- Boundary between the offset are considered straight line.



AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

- Area = $\frac{(h_1+h_2+h_3+ \ldots\ldots\ldots\ldots\ldots+hn)}{n}$ X L

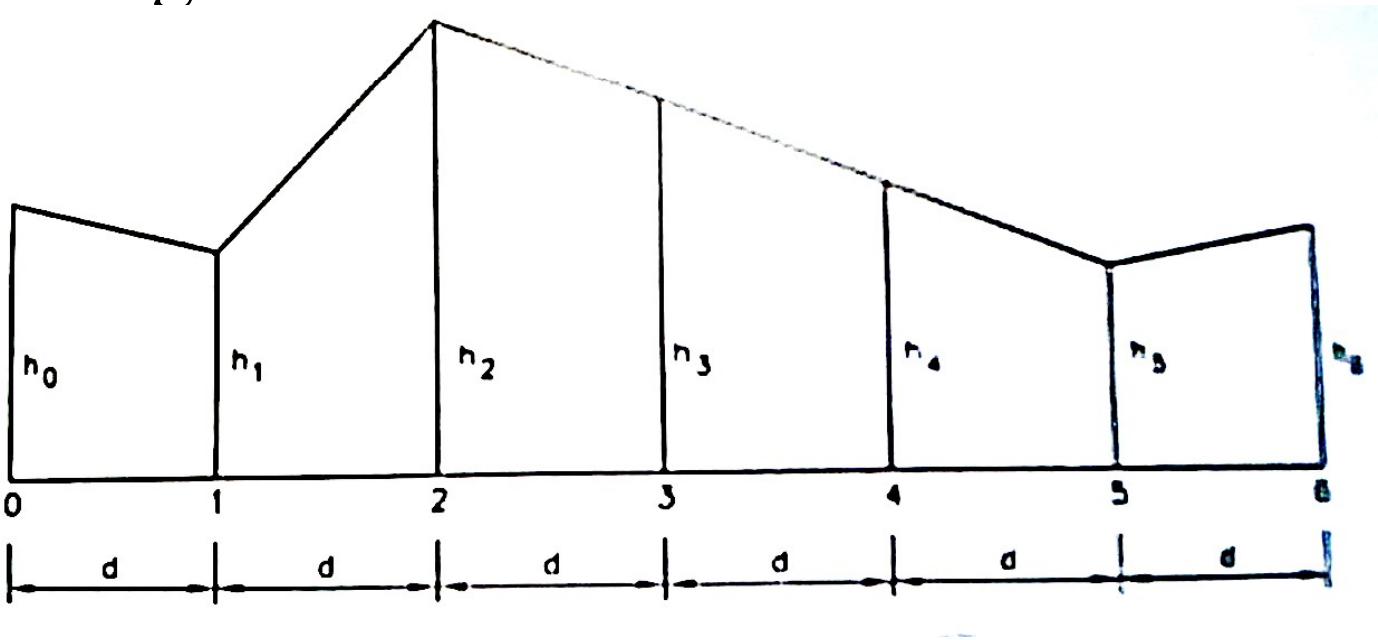
- Area = $\frac{(h_1+h_2+h_3+ \ldots\ldots\ldots\ldots\ldots+hn)}{n}$ X nd

- Area = $(h_1 + h_2 + h_3 + \ \ldots\ldots\ldots\ldots\ldots+hn)$ X d
- Where $h_1 + h_2 + h_3 + \ \ldots\ldots$ = mid ordinate
- d = distance of each division
- L = Length of base line = nd
- n = number of division

AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

2. Average Ordinate rule

- This rules also assumed that the boundary between the extremities of the ordinates are straight line.



AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

- Area = $\frac{(h_0+h_1+h_2+h_3+ \ldots\ldots\ldots h_n)}{(n+1)}$ X L

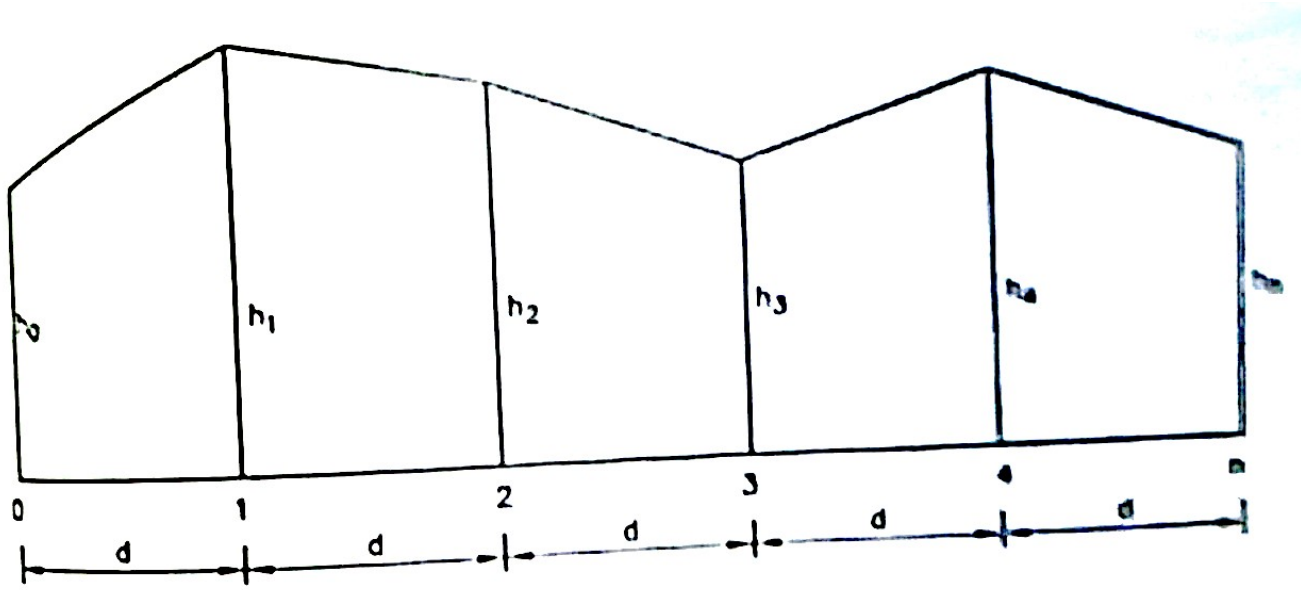
- Area = $\frac{(h_0+h_1+h_2+h_3+ \ldots\ldots\ldots hn)}{(n+1)}$ X nd

- Where h_0, h_1, h_2, h_3, … … = Ordinates or offset
- d = distance of each division
- n = number of division
- n +1 = number of offset
- l = length of base line = nd

AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

3. Trapezoidal rule

- In this method entire area is divided in to number of trapezoids.
- This rule is more accurate than previous two rule.



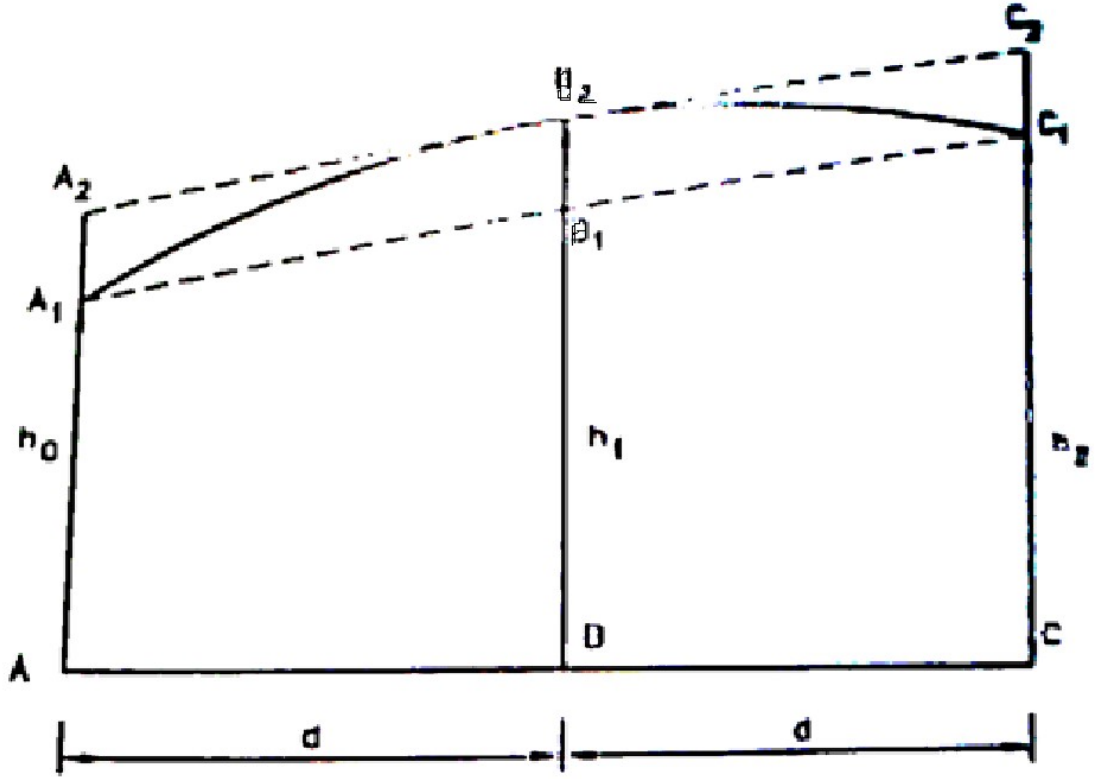
- Let h_1, h_2, h_3, …….. h_n be the ordinates at equal interval.
- d = common distance
- 1 st area = $\frac{(h_0+h_1)}{2}$ X d
- 2 nd area = $\frac{(h_1+h_2)}{2}$ X d
- 3 rd area = $\frac{(h_2+h_3)}{2}$ X d
- Last area = $\frac{(h_{n-1}+h_n)}{2}$ X d
- Total area = $A_1 + A_2 + A_3 + \ldots\ldots\ldots + A_n$

- Total area = $\frac{(h_0+h_1)}{2}$ X d + $\frac{(h_1+h_2)}{2}$ X d + $\frac{(h_2+h_3)}{2}$ X d +.....+ $\frac{(h_{n-1}+h_n)}{2}$ X d
- = $\frac{d}{2}$ ($h_0 + 2h_1 + 2h_2 + 2h_3 + \ldots\ldots\ldots + 2h_{n-1} + h_n$)
- A = $\frac{d}{2}$ ($h_0 + h_n$) + 2($h_1 + h_2 + h_3 + \ldots\ldots\ldots + h_{n-1}$)
- A = $\frac{Common\ distance}{2}$ ((1st Ordinates + Last Ordinates) + 2(Sum of other ordinates))

AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

4. Simpson's rule

- This rule assumes that the short lengths of boundary between the ordinates are parabolic arcs.



AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

- Let h_0, h_1, h_2 be the consecutive co-ordinates.
- Area of $AA_1B_2C_1CA$
- = Area of trapezium $AA_1B_1C_1CA$ + Area of Segment $A_1B_2C_1B_1A_1$
- Area of trapezium = $\frac{(h_0 + h_2)}{2}$ X 2d
- Area of segment = $\frac{2}{3}$ X area of parallelogram $A_1A_2C_2C_1$
- = $\frac{2}{3}$ X B_1B_2 X 2d
- = $\frac{2}{3}$ X (h_1 - $\frac{h_0+h_2}{2}$) X 2d

- Area between the first two divisions.
- $A_1 = \frac{(h_0 + h_2)}{2}$ X 2d + $\frac{2}{3}$ X (h_1 - $\frac{h_0+h_2}{2}$) X 2d
- $A_1 = \frac{d}{3}(h_0 + 4h_1 + h_2)$
- Similarly the area between two divisions.
- $A_2 = \frac{d}{3}(h_2 + 4h_3 + h_4)$
- Total area = $A_1 + A_2 + A_3 + \ldots\ldots\ldots + An$
- $= \frac{d}{3}(h_0 + 4h_1 + 2h_2 + 4h_3 + 2h_4 + \ldots\ldots\ldots)$
- $= \frac{d}{3}(h_0 + h_n) + 4(h_1 + h_3 + h_{n-1}) + 2(h_2 + h_4 + h_{n-2})$

$$A = \frac{d}{3}(h_0 + h_n) + 4(h_1 + h_3 + h_{n-1}) + 2(h_2 + h_4 + h_{n-2})$$

$$A = \frac{Common\ distance}{3} \text{ X } (1^{st} \text{ Ordinate + Last Ordinate})$$

$$+ 4(\text{Sum of even ordinate}) + 2(\text{Sum of odd ordinate})$$

AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

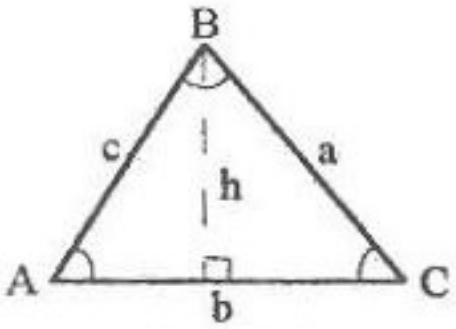
Planimeter

- A Planimeter is a device the determines area by tracing the boundary on a map.
- There are main two type of the planimeter.

a) Amsler Polar Planimeter

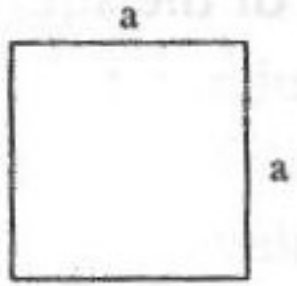
b) Roller planimeter

Mathematical Formulae



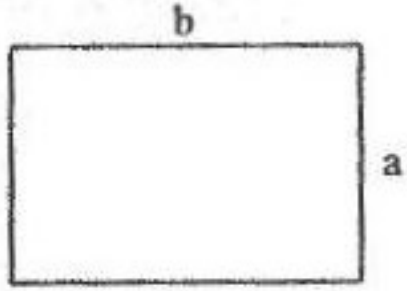
(a) Triangle

$$\frac{1}{2}bh \quad \text{or} \quad \frac{1}{2}a \cdot b \cdot \sin(C)$$



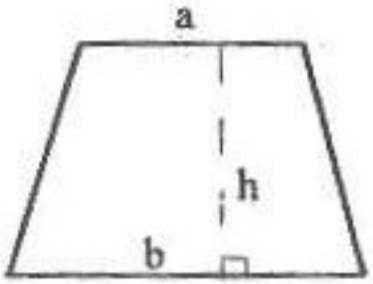
(b) Square

$$a^2$$



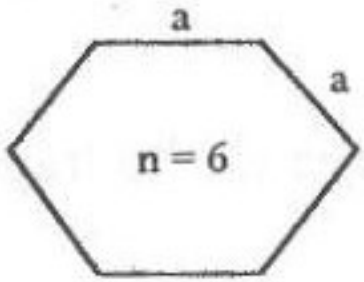
(c) Rectangle

$$a \cdot b$$



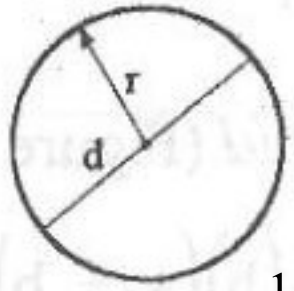
(d) Trapezoid

$$\frac{1}{2}h \cdot (a+b)$$



(e) Regular polygon

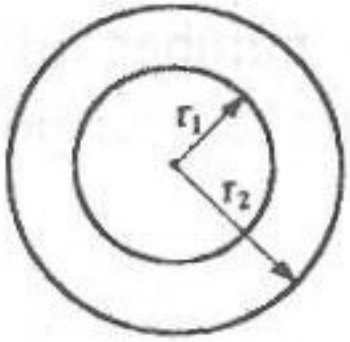
$$\frac{1}{4}n \cdot a^2 \cdot \cot\left(\frac{180°}{n}\right)$$



(f) Circle $\frac{1}{4}\pi \cdot d^2$

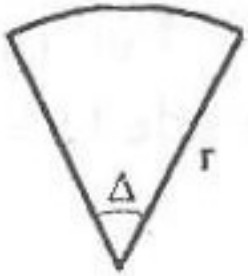
AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

Mathematical Formulae



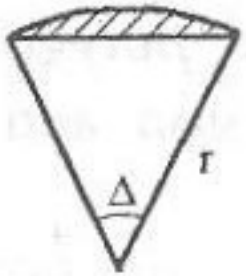
(g) Circular ring

$$\pi\left(r_2^2 - r_1^2\right)$$



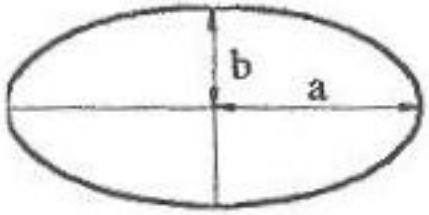
(h) Circular sector

$$\frac{1}{360}\pi \cdot \Delta \cdot r^2$$



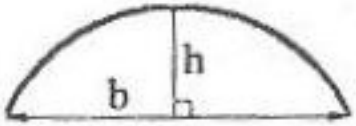
(i) Circular segment

$$\frac{1}{2}r^2\left(\frac{\pi\Delta}{180} - \sin\Delta\right)$$



(j) Ellipse

$$\pi(a \cdot b)$$

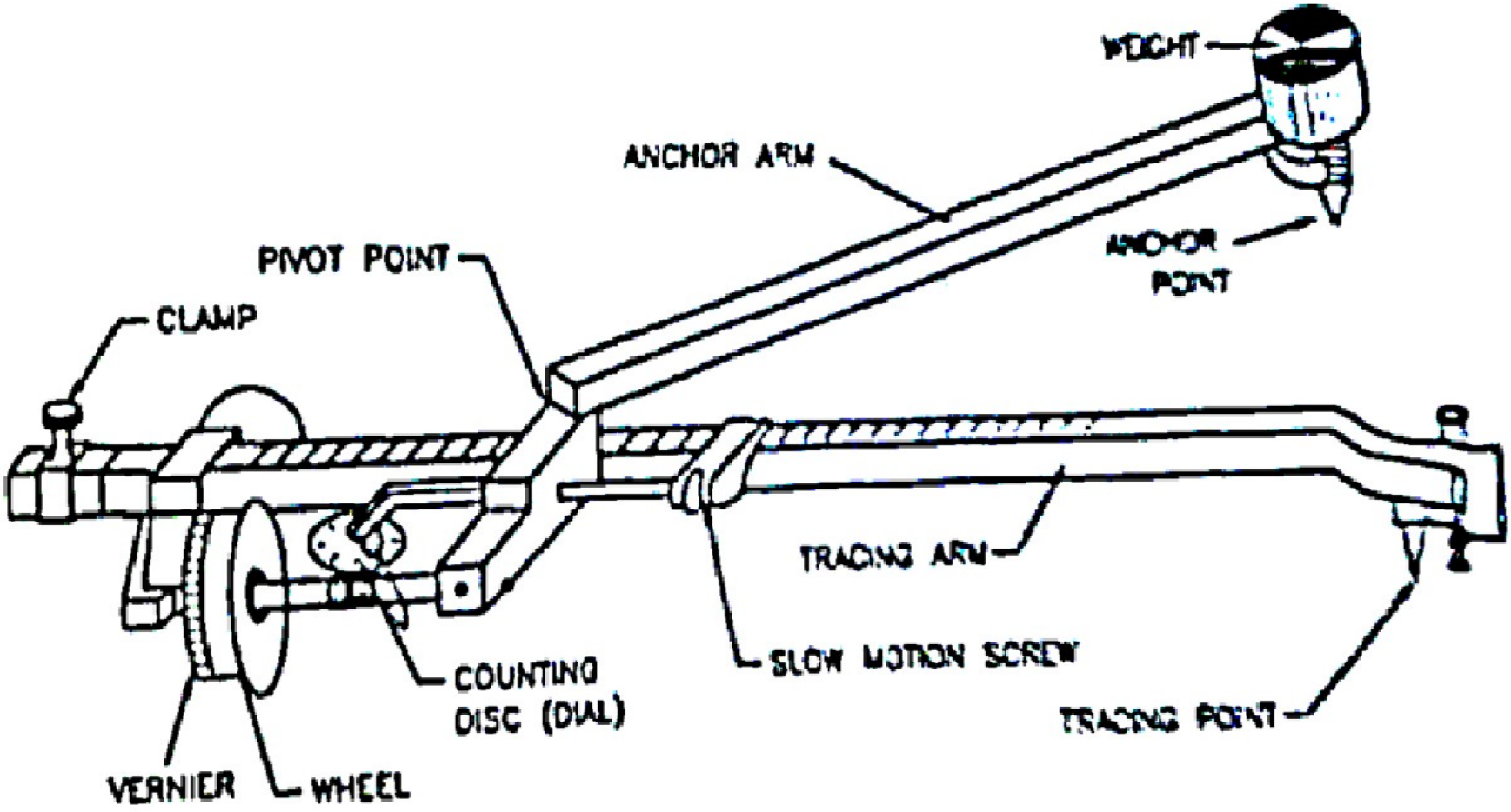


(k) Parabola

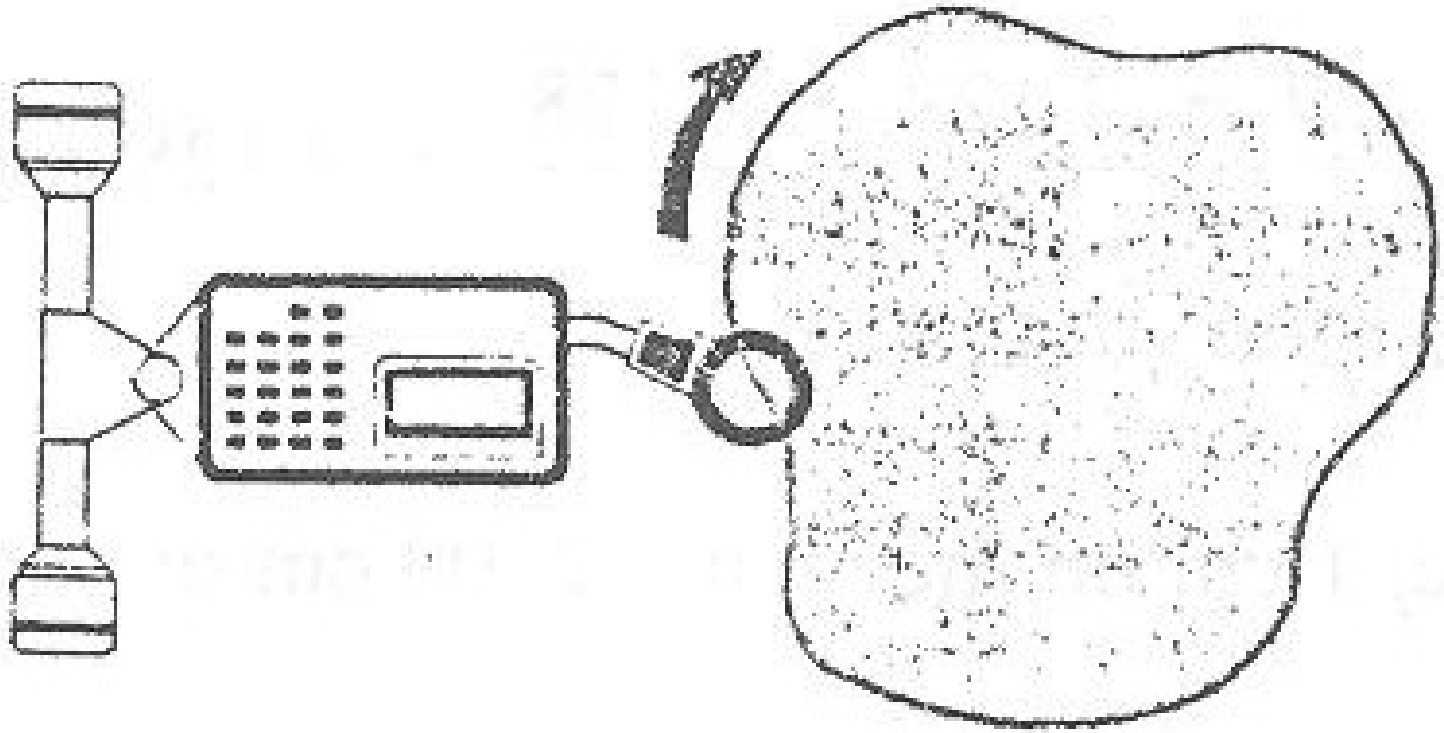
$$\frac{2}{3}bh$$

AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

The various component part of a polar planimeter is as follow



AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY



Construction

- Two arm
- One is anchor arm
- Second is tracing arm
- Anchor arm is fixed in length
- Tracing arm length is varied by means of fixed screw.
- Two point
- One is anchor point attached at the end of the anchor arm.
- Second is tracing point attached at the end of the tracing arm.

- The wheel carries a concentric drum which is divided in to 100 division.
- A smaller vernier near the drum reads 1/10 of the drum division .
- Each reading in the form of the four digits.

Procedure

- Fix the anchor point (outside or inside the area).
- Mark the tracing point on the boundary of the plan.
- Initial reading is taken.
- Tracing point is moved in clock wise direction along the boundary till it come to the original point.
- Final reading is noted.

- The area of the figure is then calculated from the following equation.

- Area (Δ) = M (F – I ± 10 N + C)
- Where F = Final reading

I = Initial reading

M = A multiplying constant, it is equal to the area per revolution of the roller.

N = The no. of times the zero mark of the dial passed the fixed index mark.

C = Instrument constant