SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution
Coimbatore – 35

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DEPARTMENT OF AGRICULTURAL ENGINEERING
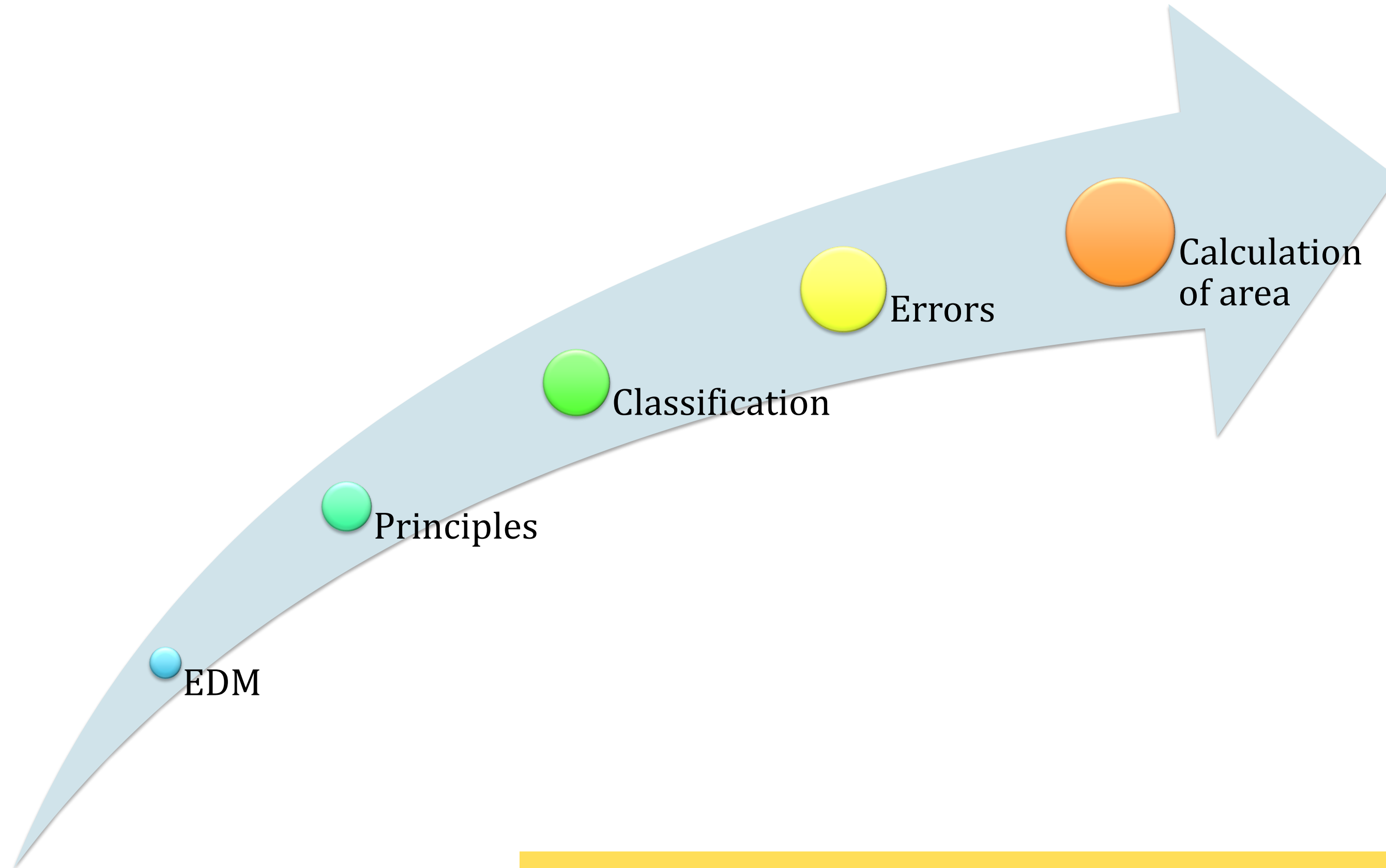
23AGT204 – SURVEYING AND LEVELLING

II – YEAR III SEMESTER

UNIT 3 – LINEAR MEASUREMENT AND COMPUTATION OF AREA, VOLUME

TOPIC 6 – SIMPSON AND TRAPEZOIDAL RULE

Last Class Review

Calculation of area

Errors

Classification

Principles

EDM

Trapezoidal Rule - States!!!

❖ To the sum of the first and last ordinate, twice the sum of intermediate ordinates is added. This total sum is multiplied by the common distance. Half of this product is the required area

Solution

2.50 3.50 5.00 4.60 3.20

0   0

├── 10m ──┤

Fig. P.7.1
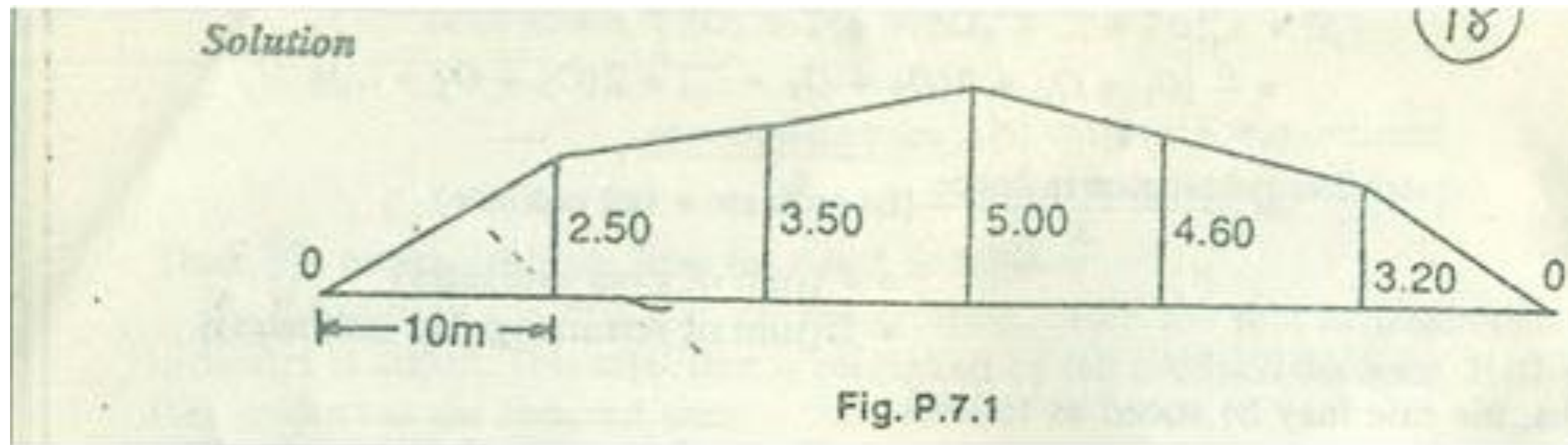
Trapezoidal Rule

1st area = $\dfrac{O_1+O_2}{2} *d$

2nd area = $\dfrac{O_2+O_3}{2} *d$

3rd area = = $\dfrac{O_2+O_3}{2} *d$

Last area = $\dfrac{O_{n-1}+O_n}{2} *d$

❖ While applying the trapezoidal rule, boundaries between the ends of ordinates are assumed to be straight. Thus the areas enclosed between the base line and the irregular boundary line are considered as trapezoids.

❖ Let O1, O2, …..On=ordinate at equal intervals,
❖ d= common distance between two ordinates
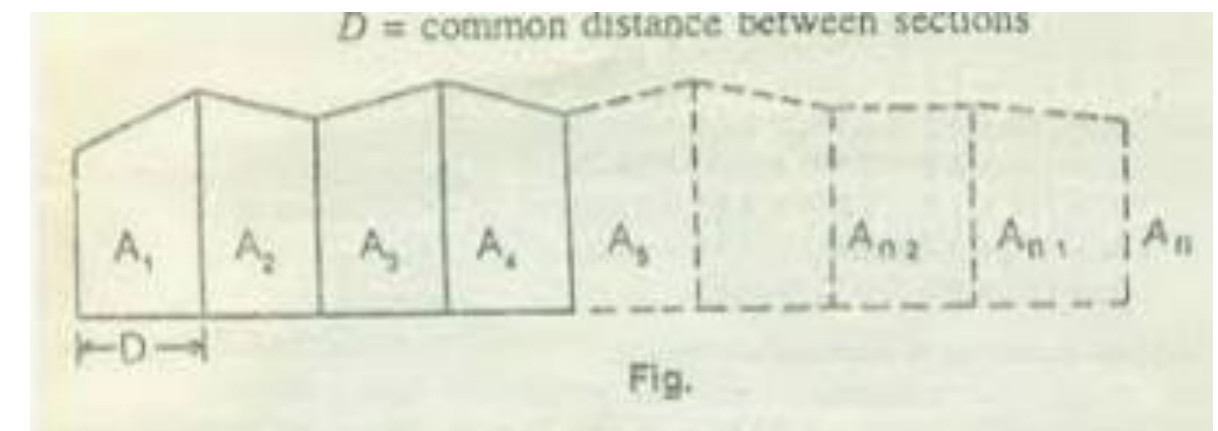
Total area=d/2{ $O_1+2O_2+2O_3+.......+2O_n-1+O_n$}

AREA = $\dfrac{\text{common distance }((1^{st}\text{ ordinate }+\text{last ordinate}) +2(\text{sum of other ordinates})}{2}$

Fig.

Problem

The following offsets were taken from a chain line to an irregular boundary line at an interval of 10 m:
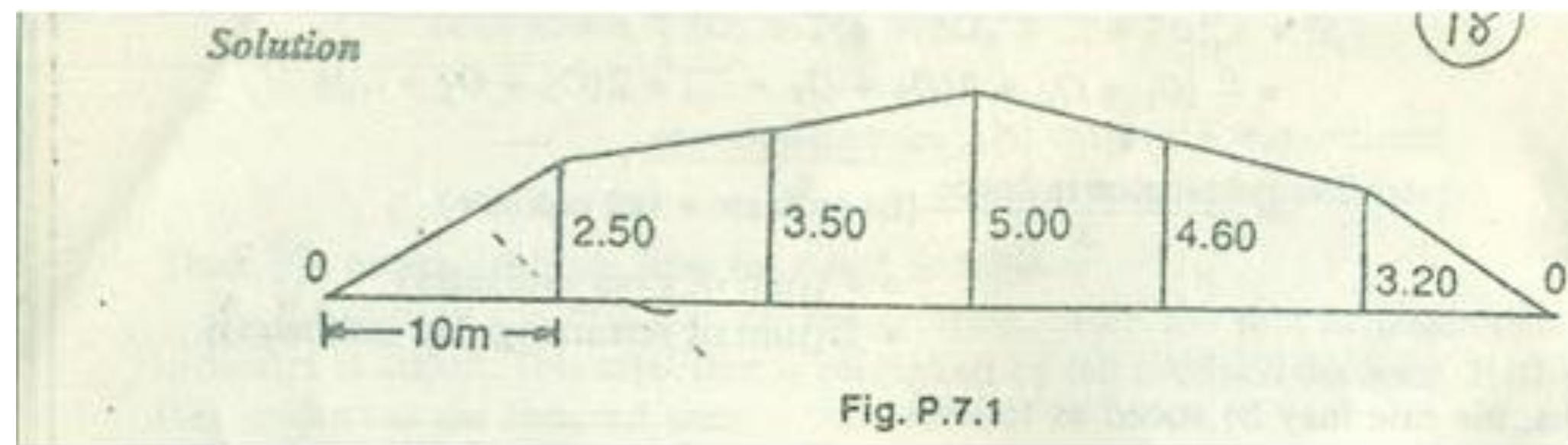
0, 2.50, 3.50, 5.00, 4.60, 3.20, 0 m

Compute the area between the chain line, the irregular boundary line and the end of offsets by:

a. Trapezoidal rule

Problem

Fig. P.7.1

Here d=10m

Required area

=10/2{0+0+2(2.50+3.50+5.00+4.60+3.20+)}

= 5*37.60=188 m^2

Assessment

- **State Average ordinate rule**

Simpson Rule - States!!!

❖ Sum of first and last ordinates has to be done. Add twice the sum of remaining odd ordinates and four times the sum of remaining even ordinates. Multiply to this total sum by 1/3rd of the common distance between the ordinates which gives the required area

❖ In this rule, the boundaries between the ends of ordinates are assumed to form an arc of parabola. Hence simpson's rule is some times called as parabolic rule
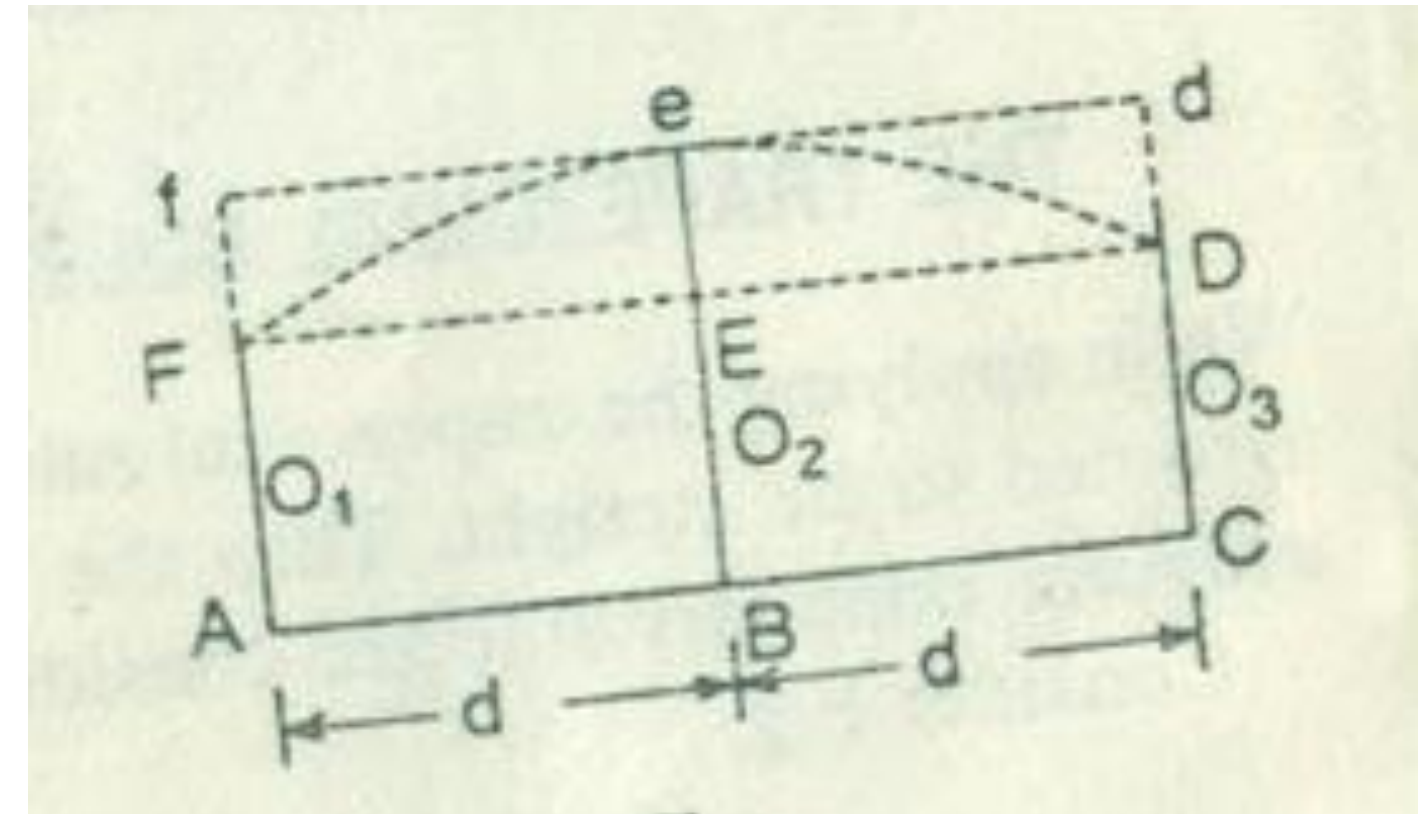
Simpson Rule

❖ Let O1, O2, O3= three consecutive ordinates

❖ d= common distance between the ordinates

❖ area AFeDC= area of trapezium AFDC+ area of segment FeDEF

$$\text{Area of trapezium} = \frac{O_1+O_3}{2} *2d$$

Area of segment= 2/3* area of parallelogram FfdD

= 2/3* eE*2d

= 2/3 *{ O_2- O_1+O_3 /2 }*2d

Simpson's Rule

So, the area between the first two divisions,

$$\Delta_1 = \frac{O_1 + O_3}{2} * 2d + 2/3 * \{ O_2 - O_1 + O_3 /2 \} * 2d$$

$$= d/3(O_1 + 4O_2 + O_3)$$

Similarly, the area of next two divisions

Total area $= d/3[O_1 + O_n + 4(O_2 + O_{4+......}) + 2(O_3 + O_5)]$

$= \dfrac{\text{Common distance} \{1\text{st ordinate} + \text{last ordinate}) +}{3}$

$4(\text{sum of even ordinates})$

$+2(\text{sum of remaining odd ordinate})\}$

Problem

The following offsets were taken from a chain line to an irregular boundary line at an interval of 10 m:
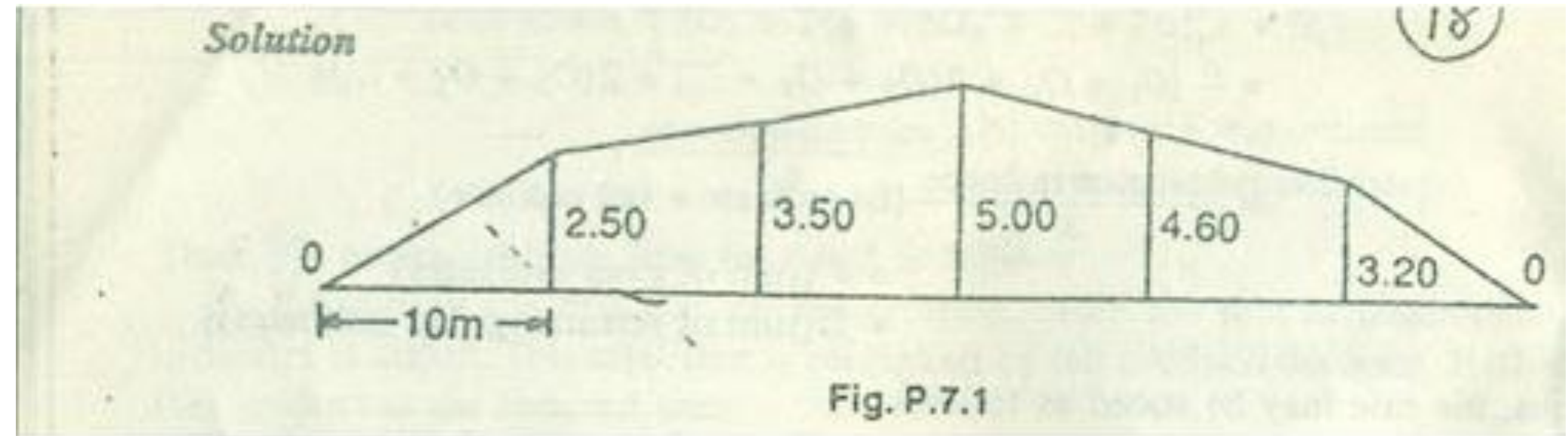
0, 2.50, 3.50, 5.00, 4.60, 3.20, 0 m

Compute the area between the chain line, the irregular boundary line and the end of offsets by:

a) Simpson rule

Problem

Fig. P.7.1

d=10m

Required area

$=10/3\{0+0+4(2.50+5.00+3.20)+2(3.50+4.60)\}$

$= 10/3\{ 42.80+16.20\}=10/3*59.00$

$= 196.66m^2$

Limitation

Trapezoidal rule

- The boundary between the ordinates is considered to be straight

- There is no limitation. It can be applied for any number of ordinates

- It gives an approximate result

Simpson's rule

- The boundary between the ordinates is considered to be an arc of a parabola

- To apply this rule, the number of ordinates must be odd

- It gives a more accurate result.

Computation of Volume

❖ The computation of volumes of various quantities from the measurements done in the field is required in the design and planning on many engineering works.

❖ The volume of earth work is required for suitable alignment of road works, canal and sewer lines, soil and water conservation works, farm pond and percolation pond consent.

Computation of Volume

❖ For estimation of volume of earth work cross sections are taken at right angles to a fixed line, which runs continuously through the earth work.

❖ The spacing of the cross sections will depend upon the accuracy required.

❖ The volume of earth work is computed once the various cross-sections are known, adopting Prismoidal rule and trapezoidal rule.
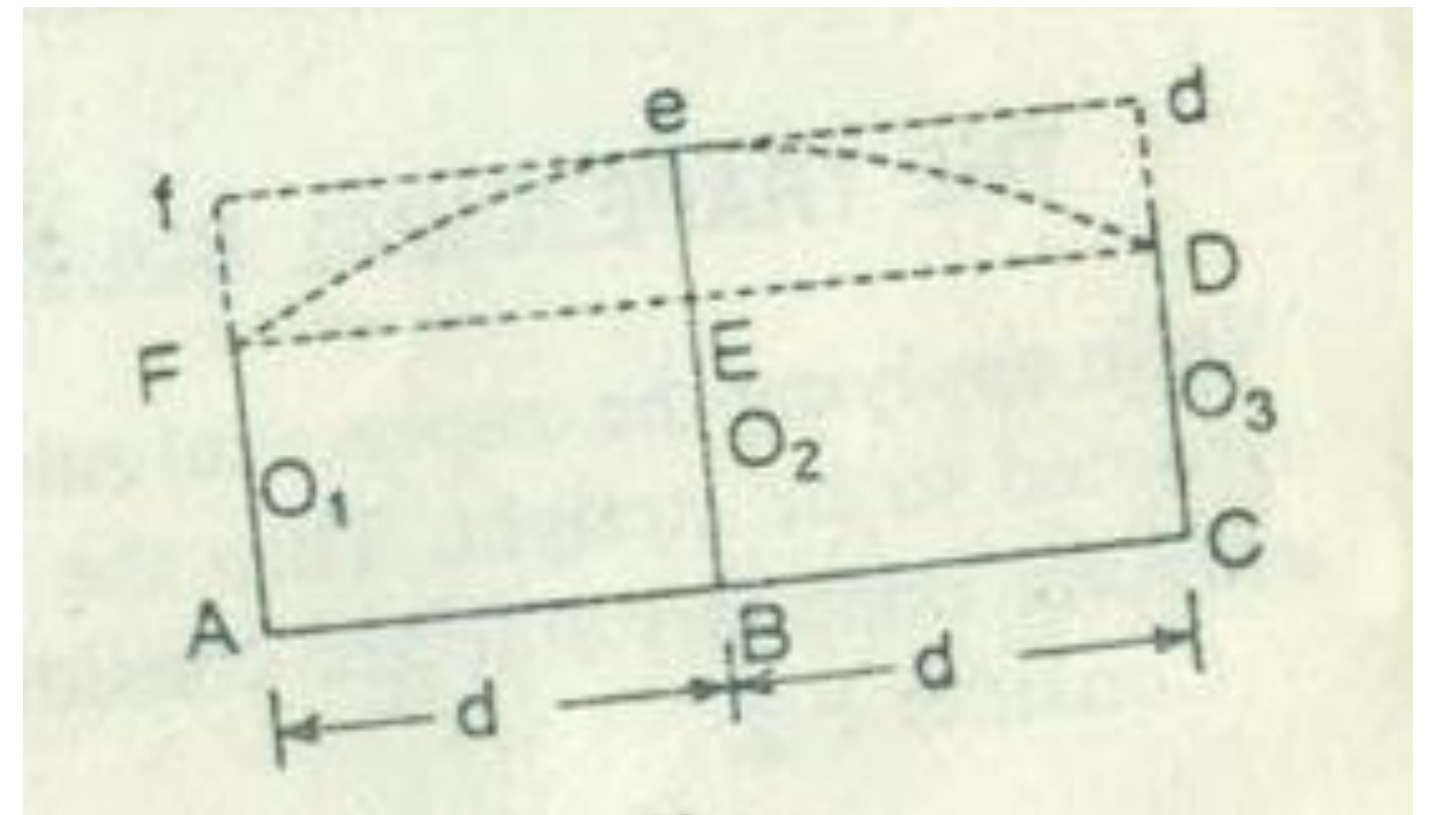
Trapezoidal Rule

❖ Volume(cutting or filling),
V=D/2(A1+An+2(A2+A3+….+An-1))

i.e. volume = $\dfrac{\text{common distance}}{2}$ {area of first section+ area of last section

+2(sum of area of other sections)}

Prismoidal Rule

❖ Volume(cutting or filling),
$V = D/3\{A_1 + A_n + 4(A_2 + A_4 + A_{n-1}) + 2(A_3 + A_5 + ... + An_{n-1})\}$

❖ V=common distance/3 {area of 1st section+ area of last section+ 4(sum of areas of even sections) +2(sum of areas of odd sections)

Problem

The following offsets were taken at 15 m intervals from a survey line to an irregular boundary line

3.50, 4.30, 6.75, 5.25, 7.50, 8.80, 7.90, 6.40, 4.40, 3.25 m

Calculate the area enclosed between the survey line, the irregular boundary line, and the offsets, by:
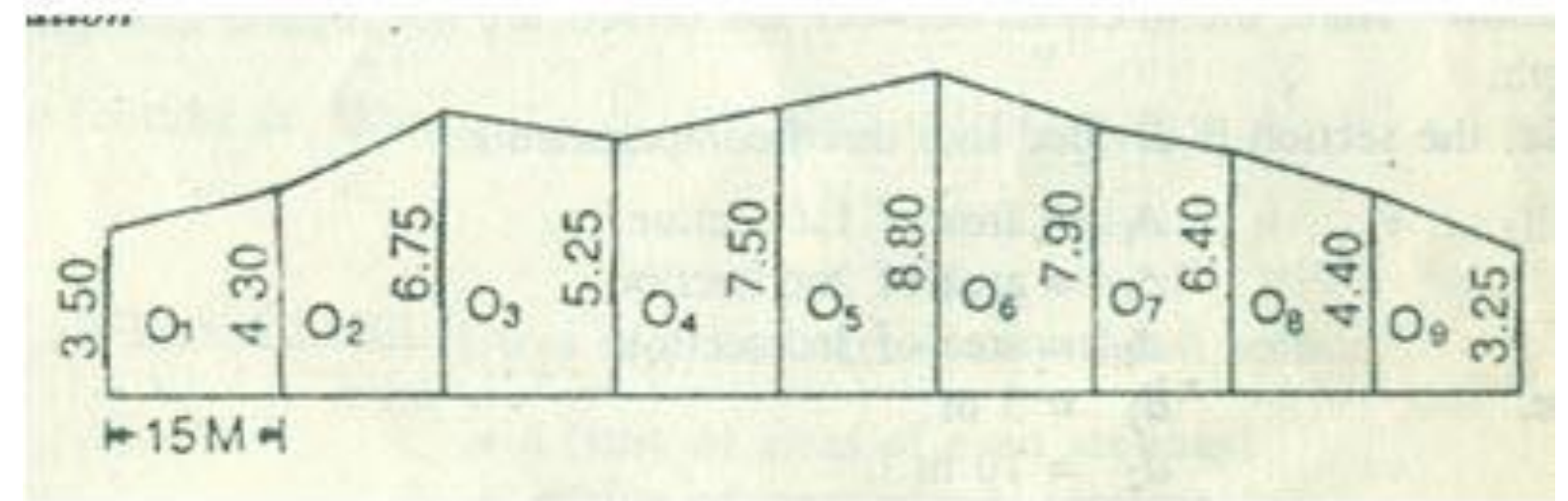
a) the trapezoidal rule

b) simpson's rule

Problem

a) the trapezoidal rule

required area
=15/2{3.50+3.25+2(4.30+6.75+5.25+7.50+8.80+7.90+
6.40+4.40)}
= 15/2{6.75+102.60} = 820.125 m^2

Problem

b) simpson's rule
if this rule is to be applied, the number of ordinates must be odd. But here the number of ordinates must be odd. But here the number of ordinate is even(ten).
So, simpson's rule is applied from O1 to O9 and the area between O9 and O10 is found out by the trapezoidal rule.

$A_1 = 15/3\{ 3.50+4.40+ 4(4.30+5.25+8.80+6.40)\}+2(6.75+7.50+7.90)$

$= 15/3(7.90+99.00+44.30)= 756.00 \text{ m}^2$
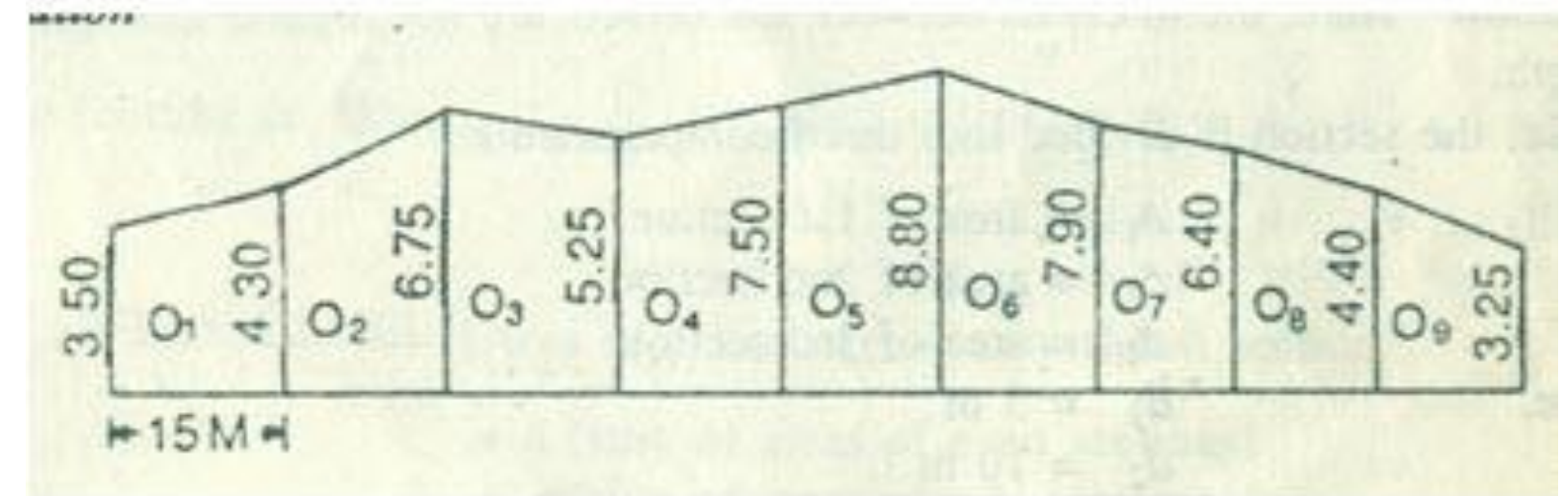
$A_2 = 15/2(4.40+3.25)= 57.38 \text{ m}^2$
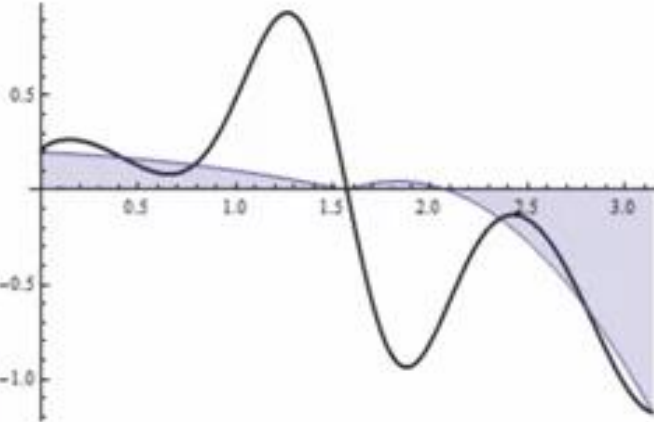
Total area= A1+ A2 =756.00+57.38 = 813.38 m^2

Reference Videos

See You at Next Class!!!!