ENGINEERING DRAWING

B. TECH (FIRST YEAR)

SCALE
Definition

A scale is defined as the ratio of the linear dimensions of the object as represented in a drawing to the actual dimensions of the same.
Necessity

• Drawings drawn with the same size as the objects are called full sized drawing.

• It is not convenient, always, to draw drawings of the object to its actual size. e.g. Buildings, Heavy machines, Bridges, Watches, Electronic devices etc.

• Hence scales are used to prepare drawing at
  • Full size
  • Reduced size
  • Enlarged size
BIS Recommended Scales

<table>
<thead>
<tr>
<th>Reducing scales</th>
<th>1:2</th>
<th>1:5</th>
<th>1:10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:Y (Y&gt;1)</td>
<td>1:20</td>
<td>1:50</td>
<td>1:100</td>
</tr>
<tr>
<td></td>
<td>1:200</td>
<td>1:500</td>
<td>1:1000</td>
</tr>
<tr>
<td></td>
<td>1:2000</td>
<td>1:5000</td>
<td>1:10000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Enlarging scales</th>
<th>50:1</th>
<th>20:1</th>
<th>10:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>X:1 (X&gt;1)</td>
<td>5:1</td>
<td>2:1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5:1</td>
<td>2:1</td>
<td></td>
</tr>
</tbody>
</table>

| Full size scales |       |       | 1:1   |

Intermediate scales can be used in exceptional cases where recommended scales can not be applied for functional reasons.
Types of Scale

- **Engineers Scale:**
The relation between the dimension on the drawing and the actual dimension of the object is mentioned numerically (like 10 mm = 15 m).

- **Graphical Scale:**
Scale is drawn on the drawing itself. This takes care of the shrinkage of the engineer’s scale when the drawing becomes old.
Types of Graphical Scale

- Plain Scale
- Diagonal Scale
- Vernier Scale
- Comparative scale
Representative fraction (R.F.)

R.F. = \frac{\text{Length of an object on the drawing}}{\text{Actual Length of the object}}

When a 1 cm long line in a drawing represents 1 meter length of the object,

\[ R.F = \frac{1\ cm}{1\ m} = \frac{1\ cm}{1 \times 100\ cm} = \frac{1}{100} \]
Plain scale

- A plain scale consists of a line divided into suitable number of equal units. The first unit is subdivided into smaller parts.

- The zero should be placed at the end of the 1st main unit.

- From the zero mark, the units should be numbered to the right and the sub-divisions to the left.

- The units and the subdivisions should be labeled clearly.

- The R.F. should be mentioned below the scale.
Construct a scale of 1:4, to show centimeters and long enough to measure up to 5 decimeters.

- R.F. = \( \frac{1}{4} \)
- Length of the scale = R.F. × max. length = \( \frac{1}{4} \times 5 \text{ dm} = 12.5 \text{ cm} \).
- Draw a line 12.5 cm long and divide it into 5 equal divisions, each representing 1 dm.
- Mark 0 at the end of the first division and 1, 2, 3 and 4 at the end of each subsequent division to its right.
- Divide the first division into 10 equal sub-divisions, each representing 1 cm.
- Mark cm to the left of 0 as shown.
**Question:** Construct a scale of 1:4, to show centimeters and long enough to measure up to 5 decimeters.

- Draw the scale as a rectangle of small width (about 3 mm) instead of only a line.
- Draw the division lines showing decimeters throughout the width of the scale.
- Draw thick and dark horizontal lines in the middle of all alternate divisions and sub-divisions.
- Below the scale, print DECIMETERS on the right hand side, CENTIMETERS on the left hand side, and R.F. in the middle.
Diagonal Scale

- Through Diagonal scale, measurements can be up to second decimal (e.g. 4.35).
- Diagonal scales are used to measure distances in a unit and its immediate two subdivisions; e.g. dm, cm & mm, or yard, foot & inch.
- Diagonal scale can measure more accurately than the plain scale.
Diagonal scale.....Concept

- At end B of line AB, draw a perpendicular.
- Step-off ten equal divisions of any length along the perpendicular starting from B and ending at C.
- Number the division points 9, 8, 7, ..., 1.
- Join A with C.
- Through the points 1, 2, 3, etc., draw lines parallel to AB and cutting AC at 1', 2', 3', etc.
- Since the triangles are similar; 1'1 = 0.1 AB, 2'2 = 0.2AB, ..., 9'9 = 0.9AB.
- Gives divisions of a given short line AB in multiples of 1/10 its length, e.g. 0.1AB, 0.2AB, 0.3AB, etc.
Construct a Diagonal scale of RF = 3:200 (i.e. 1:66 2/3) showing meters, decimeters and centimeters. The scale should measure up to 6 meters. Show a distance of 4.56 meters.

- Length of the scale = \( \frac{3}{200} \times 6 \text{ m} = 9 \text{ cm} \)
- Draw a line AB = 9 cm. Divide it into 6 equal parts.
- Divide the first part A0 into 10 equal divisions.
- At A draw a perpendicular and step-off along it 10 equal divisions, ending at D.
• Complete the rectangle ABCD.
• Draw perpendiculars at meter-divisions i.e. 1, 2, 3, and 4.
• Draw horizontal lines through the division points on AD. Join D with the end of the first division along A0 (i.e. 9).
• Through the remaining points i.e. 8, 7, 6, … draw lines // to D9.
• PQ = 4.56 meters
Vernier Scales

• Similar to Diagonal scale, Vernier scale is used for measuring up to second decimal.

• A Vernier scale consists of (i) a primary scale and (ii) a vernier.

• The primary scale is a plain scale fully divided into minor divisions.

• The graduations on the vernier are derived from those on the primary scale.

  Least count (LC) is the minimum distance that can be measured.

  **Forward Vernier Scale** :
  
  MSD > VSD; \[\text{LC} = \text{MSD} - \text{VSD}\]

  **Backward Vernier scale** :
  
  VSD > MSD; \[\text{LC} = \text{VSD} - \text{MSD}\]
Vernier scale.... Concept

- Length $A^0$ represents 10 cm and is divided into 10 equal parts each representing 1 cm.

- $B^0 = 11$ (i.e. 10+1) such equal parts = 11 cm.

- Divide $B^0$ into 10 equal divisions. Each division of $B^0$ will be equal to $11/10 = 1.1$ cm or 11 mm.

- Difference between 1 part of $A^0$ and one part of $B^0 = 1.1$ cm - 1.0 cm = 0.1 cm or 1 mm.
**Question:** Draw a Vernier scale of R.F. = 1/25 to read up to 4 meters. On it show lengths 2.39 m and 0.91 m

- Length of Scale = \(\frac{1}{25} \times (4 \times 100) = 16\) cm
- Draw a 16 cm long line and divide it into 4 equal parts. Each part is 1 meter. Divide each of these parts into 10 equal parts to show decimeter (10 cm).
- Take 11 parts of dm length and divide it into 10 equal parts. Each of these parts will show a length of 1.1 dm or 11 cm.
- To measure 2.39 m, place one leg of the divider at A on 99 cm mark and other leg at B on 1.4 mark. \((0.99 + 1.4 = 2.39)\).
- To measure 0.91 m, place the divider at C and D \((0.8 + 0.11 = 0.91)\).
**Question:** Draw a Vernier scale of R.F. = 1/25 to read up to 4 meters. On it show lengths 2.39 m and 0.91 m

- Length of Scale = \((1/25) \times (4 \times 100) = 16\) cm
- Draw a 16 cm long line and divide it into 4 equal parts. Each part is 1 meter. Divide each of these parts into 10 equal parts to show decimeter (10 cm).
- Take 11 parts of dm length and divide it into 10 equal parts. Each of these parts will show a length of 1.1 dm or 11 cm.
- To measure 2.39 m, place one leg of the divider at A on 99 cm mark and other leg at B on 1.4 mark. \((0.99 + 1.4 = 2.39)\).
- To measure 0.91 m, place the divider at C and D \((0.8 + 0.11 = 0.91)\).