Engineering Graphics

Lettering, Lines, Scales and Dimensioning

1.1 Letters and Numerals (Single Stroke Vertical)

Lettering in engineering drawing refers to the standardised writing of letters and numerals used to convey titles, dimensions, notes, and other textual information on a drawing, in a clear, legible, and uniform manner. Since engineering drawings often need to be reproduced, reduced in size, or read quickly under working conditions, the style of lettering used is of great practical importance.

Single stroke vertical lettering is the style most commonly recommended and used in engineering drawing practice. The term "single stroke" does not mean that each letter is drawn in a single pen movement, but rather that the width of every stroke forming a letter is uniform and equal to the thickness of the drawing instrument used (that is, no strokes are deliberately thickened or thinned, as in calligraphic lettering), and "vertical" indicates that the letters are drawn upright, with their vertical strokes perpendicular to the base line, rather than sloped (as in italic or inclined lettering).

Key characteristics and guidelines for single stroke vertical lettering include:

- All strokes forming a letter or numeral should be of uniform width throughout.
- Letters should be drawn vertically upright, with vertical strokes perpendicular to the guide (base) lines.
- The height of capital letters is generally used as the basic unit of proportion; the height of lowercase letters, where used, is typically about five-sevenths (5/7) of the capital letter height.
- Uniform spacing should be maintained between individual letters, words, and lines of lettering, to ensure a neat, legible, and well-balanced appearance.
- Standard letter heights are generally chosen from a recommended series (such as 2.5 mm, 3.5 mm, 5 mm, 7 mm, 10 mm, and so on), depending on the purpose of the lettering (such as titles, sub-titles, dimensions, or general notes).

Legible, well-proportioned lettering, executed according to these standard conventions, ensures that titles, notes, and dimensions on an engineering drawing are read quickly, accurately, and without ambiguity by anyone using the drawing.

1.2 Conventions of Lines and Their Applications

Engineering drawings make use of a standardised set of line types, each with a distinct appearance (thickness and pattern) and a specific conventional meaning, allowing a trained reader to correctly interpret the geometry and features represented in a drawing at a glance. Some of the most important conventional line types, and their applications, are summarised below:

Line Type	**Convention**	**Application**
Visible (Outline) Line	Continuous thick line	Used to represent the visible edges and outlines of an object
Dimension / Extension Line	Continuous thin line	Used to indicate the extent and value of a dimension
Hidden Line	Dashed medium line	Used to represent edges or outlines of an object that are not visible from the viewing direction
Centre Line	Long dash dot thin line	Used to indicate the axis of symmetry of an object, or the centre of circles and arcs
Cutting Plane Line	Long dash dot thick at ends	Used to indicate the plane at which an object is imagined to be cut, for the purpose of a sectional view
Break Line (Short)	Continuous thin freehand (zigzag) line	Used to show that a part of an object has been removed for the purpose of a shortened or broken-out view

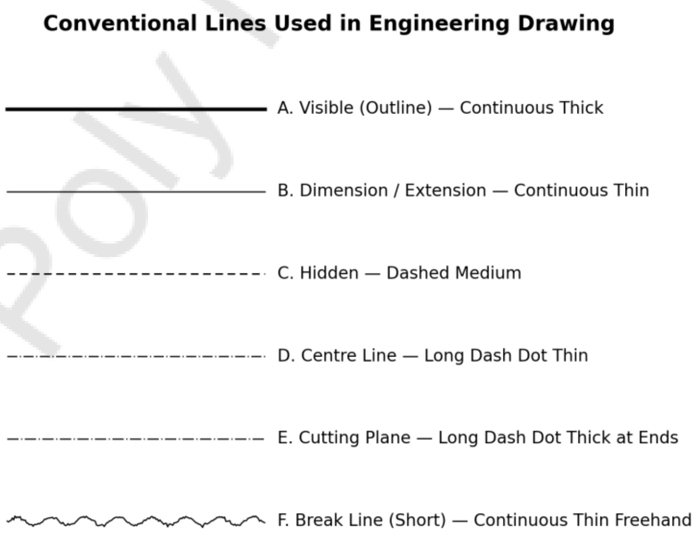

Figure 1: Common conventional line types used in engineering drawing

Correct and consistent use of these line conventions is essential in engineering drawing, since the type of line used conveys specific information about the feature being represented, and incorrect or inconsistent use of line types can lead to misinterpretation of the drawing.

1.3 Concept of Representative Fraction, Reduced/Enlarged/Full Scale, and Engineering Scales

Since most objects represented in engineering drawings cannot conveniently be drawn at their actual size (either because they are too large or too small to fit on a standard drawing sheet while remaining legible), drawings are generally prepared to a suitable scale, which defines the fixed proportional relationship between the size of the drawing and the actual size of the object represented.

Term	Definition
Representative Fraction (R.F.)	The ratio of the length of a line on the drawing to the corresponding actual length of the same line on the object, expressed as a fraction: R.F. = Drawing length / Actual length (both measured in the same unit).
Reduced Scale	A scale in which the drawing is made smaller than the actual size of the object, used when the object is too large to be conveniently drawn at full size; here R.F. is less than 1 (e.g. 1:50, 1:100).
Enlarged Scale	A scale in which the drawing is made larger than the actual size of the object, used when the object is too small to be conveniently and clearly drawn at full size; here R.F. is greater than 1 (e.g. 10:1, 50:1).
Full Scale	A scale in which the drawing is made exactly the same size as the actual object, so that R.F. = 1 (i.e. 1:1).

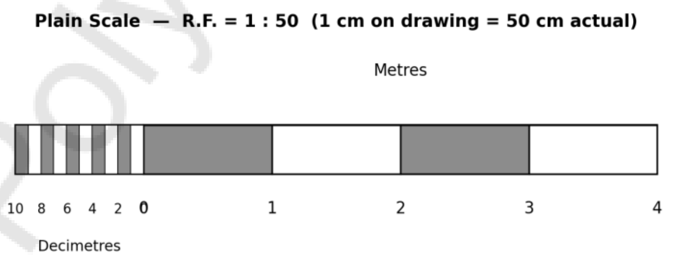

Figure 2: Example of a plain scale (R.F. = 1:50), reading metres and decimetres

Two important types of engineering scales, used for accurately constructing and reading scaled drawings, are described below:

Engineering Scale	Description
Plain Scale	A scale used to represent two consecutive units of measurement (such as metres and decimetres, or kilometres and hectometres), consisting of a main scale divided into major units, with one extra major division sub-

	divided to represent the smaller unit; readings can be taken directly for two units only.
Diagonal Scale	A scale used to represent three consecutive units of measurement (such as metres, decimetres, and centimetres), constructed using a geometric principle of similar triangles, in which diagonal lines are drawn across a subdivided rectangular grid, allowing very fine (up to 1/100th of the main unit) readings to be taken directly from the scale.

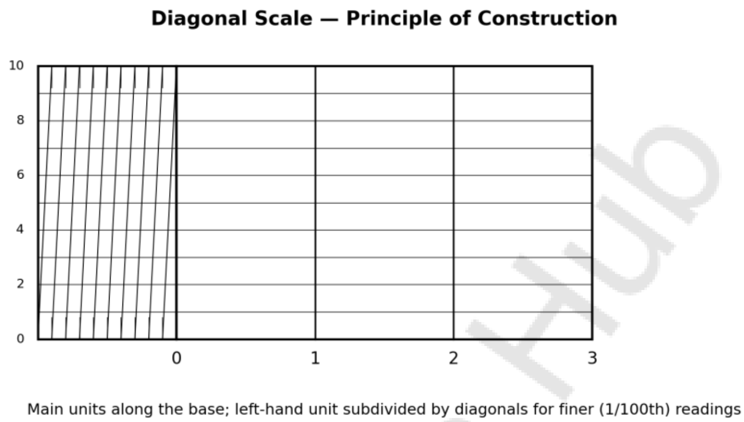

Figure 3: Principle of construction of a diagonal scale

The choice between a plain scale and a diagonal scale depends on the degree of precision required in reading the drawing: a plain scale is sufficient when readings are needed only to two units of measurement, while a diagonal scale is used when a finer, third-unit level of precision is required, such as when very small measurements need to be read accurately from a reduced-scale drawing.

1.4 Dimensional Techniques — Unidirectional and Aligned Systems

Dimensioning refers to the process of indicating the sizes (dimensions) of various features of an object on an engineering drawing, using dimension lines, extension lines, and dimension figures (numerical values), so that the object can be manufactured or constructed accurately without ambiguity. Two standard systems are used for orienting the dimension figures on a drawing:

System	Description
Unidirectional System	All dimension figures (numerical values) are written horizontally, so that they can be read from the bottom of the drawing sheet only, regardless of the orientation of the dimension line; this system is widely preferred in modern engineering drawing practice, particularly for large drawings, since it allows all dimensions to be read without turning or rotating the drawing sheet.

Aligned System	Dimension figures are written so that they align with (are oriented parallel to) their respective dimension lines, meaning horizontal dimensions are read from the bottom of the sheet, while vertical dimensions are read from the right-hand side of the sheet by rotating the drawing (or one's head) accordingly; this system was more traditionally used, particularly in earlier drawing practice.

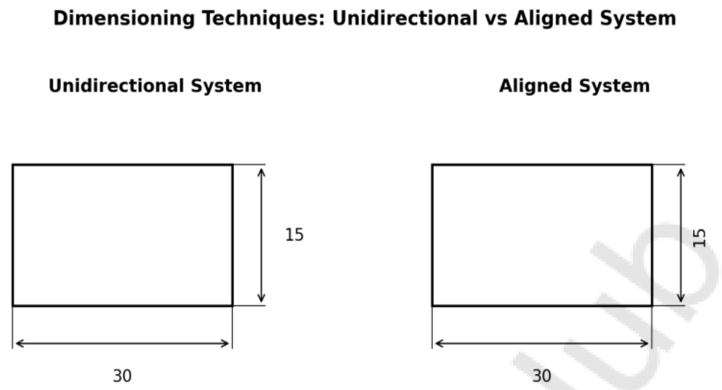

Figure 4: Comparison of the unidirectional and aligned systems of dimensioning

Of the two systems, the unidirectional system is now more widely adopted in modern engineering drawing practice and standards, since it allows every dimension on a drawing, regardless of the orientation of its dimension line, to be read directly from the normal (bottom) reading position of the drawing sheet, without the reader needing to rotate the drawing or tilt their head, which is particularly advantageous when working with large or complex drawings viewed by multiple people.

2. Multiple Choice Questions (MCQs)

Answer the following questions by selecting the most appropriate option.

1. Single stroke vertical lettering is characterised mainly by:

A) Letters formed with a single continuous stroke of uniform thickness, drawn upright (vertical)
B) Letters that are always drawn in italics
C) Letters with widely varying stroke thickness
D) Only lowercase letters

2. The primary purpose of using single stroke lettering in engineering drawings is to ensure:

A) Decorative appearance
B) Legibility, uniformity, and ease of rapid execution
C) Maximum stroke thickness variation
D) That letters cannot be read easily

3. A continuous thick line in engineering drawing is conventionally used to represent:

A) Hidden edges
B) Visible outlines and edges of an object
C) Centre lines only
D) Cutting planes only

4. A dashed medium line in engineering drawing conventionally represents:
A) Visible outlines
B) Hidden edges not visible from the current viewing direction
C) Dimension lines
D) Centre lines

5. A long dash dot thin line in engineering drawing conventionally represents:
A) A visible outline
B) A centre line
C) A break line
D) A hidden line

6. The Representative Fraction (R.F.) of a scale is defined as:
A) Actual length divided by drawing length
B) Drawing length divided by actual length (in the same units)
C) The sum of drawing length and actual length
D) A fixed value that never changes

7. A scale with R.F. less than 1 is called a:
A) Full scale
B) Enlarged scale
C) Reduced scale
D) Diagonal scale

8. A scale with R.F. greater than 1 is called a:
A) Reduced scale
B) Enlarged scale
C) Full scale
D) Plain scale

9. A scale with R.F. exactly equal to 1 is called a:
A) Reduced scale
B) Enlarged scale
C) Full scale
D) Diagonal scale

10. A plain scale is generally used to represent readings in:
A) One unit only
B) Two consecutive units of measurement
C) Three consecutive units of measurement

D) An unlimited number of units simultaneously

11. A diagonal scale is generally used to represent readings in:

A) One unit only
B) Two consecutive units of measurement
C) Three consecutive units of measurement
D) No units at all

12. The construction of a diagonal scale is based on the geometric principle of:

A) Congruent circles
B) Similar triangles
C) Parallel lines only, without triangles
D) Random line placement

13. In the unidirectional system of dimensioning, all dimension figures are written:

A) Aligned with their respective dimension lines
B) Horizontally, readable from the bottom of the drawing sheet only
C) Vertically only, regardless of the dimension line
D) In a random orientation

14. In the aligned system of dimensioning, dimension figures are written:

A) Always horizontally, regardless of the dimension line direction
B) Aligned with (parallel to) their respective dimension lines
C) Only in capital letters
D) Only for vertical dimensions

15. Compared to the aligned system, the unidirectional system of dimensioning is generally preferred in modern practice mainly because it:

A) Requires rotating the drawing sheet to read every dimension
B) Allows all dimensions to be read from the bottom of the sheet without rotating it
C) Cannot be used on large drawings
D) Uses only vertical dimension figures

Answer Key

1. A) Letters formed with a single continuous stroke of uniform thickness, drawn upright (vertical) | 2. B) Legibility, uniformity, and ease of rapid execution | 3. B) Visible outlines and edges of an object | 4. B) Hidden edges not visible from the current viewing direction | 5. B) A centre line | 6. B) Drawing length divided by actual length (in the same units) | 7. C) Reduced scale | 8. B) Enlarged scale | 9. C) Full scale | 10. B) Two consecutive units of measurement | 11. C) Three consecutive units of measurement | 12. B) Similar triangles | 13. B) Horizontally, readable from the bottom of the drawing sheet only | 14. B) Aligned with (parallel to) their respective dimension lines | 15. B) Allows all dimensions to be read from the bottom of the sheet without rotating it

3. Broad / Long Answer and Practical Questions

1. Explain the significance of single stroke vertical lettering in engineering drawing, and state the general proportions used for the height and stroke width of such letters.

2. Explain the various types of conventional lines used in engineering drawing, giving the application of each type.

3. Distinguish between a visible outline, a hidden line, and a centre line, referring to their conventional representation.

4. Define Representative Fraction (R.F.), and explain reduced scale, enlarged scale, and full scale, giving an example R.F. value for each.

5. Explain the construction and use of a plain scale, illustrating your answer with reference to a scale of R.F. = 1:50 representing metres and decimetres.

6. Explain the construction and use of a diagonal scale, and state why it is capable of representing finer subdivisions than a plain scale.

7. Distinguish between the unidirectional system and the aligned system of dimensioning, explaining how dimension figures are oriented in each case.

8. Explain why the unidirectional system of dimensioning is generally preferred over the aligned system in modern engineering drawing practice.

9. Construct a plain scale of R.F. = 1:100 to read metres and decimetres, and mark on it a distance of 3.6 metres. (Show your construction with appropriate labelling.)

10. Construct a diagonal scale of R.F. = 1:50 to read metres, decimetres, and centimetres, and mark on it a distance of 2.34 metres. (Show your construction with appropriate labelling.)