

ESE-2025 Prelims Paper-I

General Principles of Design, Drawing & Safety



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PREFACE

Giving life to an engineer's dream for the betterment of society involves **Design, Drawing and Safety**. With the increasing complexities of economy, as well as the ensuing disruption in IT, besides the stringent safety rules, this inter-disciplinary subject has become quite challenging to comprehend from exam point of view.

Looking at the nature of Engineering Services Examination (ESE), and the level of questions being asked, the conventional approach of preparing through theory and examples is not enough to serve the purpose. The revised and updated edition of **General Principles of Design, Drawing and Safety** attempts to provide logical reasoning through mathematical analysis, gives a clear insight into the concepts, and paints a complete picture in front of you. In line with this, the book has been written in a simple and clear manner.

The book is divided into three major parts **(i) Engineering Drawing (ii) Engineering Design and (iii) Engineering Safety**. The first part discusses the basic principle of drawing associated with drafting of various points, object, sketches etc. Next, an overview of basic principles of design, types of design, associated governing tools and product development. Finally, basic knowledge need for engineering safety is presented. In addition to the above, UPSC/ESE sample papers and questions asked in **ESE 2017-2024** are discussed after the completion of relevant topics. For students to determine their level of preparation, self-practice questions have been provided at the end of this book. Students may generally not require any additional study, and may be reasonably confident that all the probable questions and topics are covered in this book.

In their endeavour to give students the best, IES Master has brought about this book in an easy-to-grasp language that gives in a complete clarity of thought. As a result, what students get is their collective wisdom that breaks free the constraints of engineering students in appreciating the basics of Design, Drawing and Safety.

As you flip over the pages of this book, you would come across a slew of diagrams, flow charts, mind maps and tables. This book is a delight for every ESE aspirant as it communicates, connects, and builds upon the exam preparedness right up to the standards of the UPSC.

All care has been taken to make the understanding of this subject more clear and interesting. The credit goes to the entire IES Master team for their continuous support in bringing out this book. All comments and suggestions for further improvement of the book are welcome and will be appreciated.

Bipin Thakur
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CHAPTER

1

Introduction to Engineering Drawing

1.1 INTRODUCTION

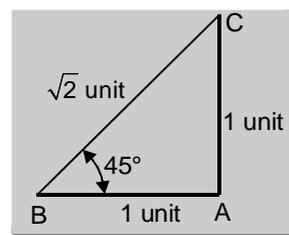
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- 1.11 Drawing Pencil
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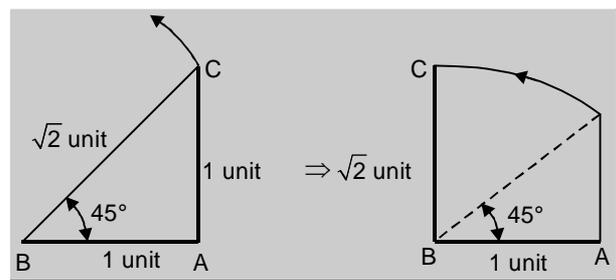
Engineering drawing is a technique of creating graphical representation that contains all necessary information such as dimensions, specifications and notes using which an abstract concept can be transformed into real world object. To realize such concept, basic tools of construction of drawing has to be clearly understood as to what standard has to be followed. There is an international standard on code of practice for drawing which is followed and adopted by Bureau of Indian Standard (BIS). In this chapter, we shall be dealing with drawing instruments and accessories (i.e. drafting tools) which is necessary for engineering drawing.

1.2 DRAWING SHEETS : [IS 10711 : 2001]

Consider an isosceles triangle ABC of unit length as shown below.



Now rotate BC anticlockwise so that BC becomes perpendicular to AB as shown below.



Now taking AB as one side and BC as another side complete a rectangle ABCD as shown below.

- Ebony strip fitted to the left side of drawing board provides the guide for the T-square.

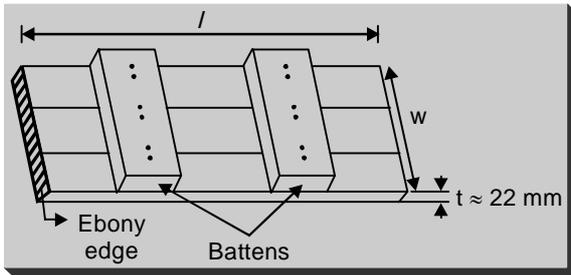


Table 1.2 : Recommended sizes of drawing boards.

Drawing Board (IS 1444 : 1989)		
Designation	Size (mm) Length x Width	Recommended for use with sheet sizes
D0/B0	1270 x 920	A0
D1/B1	920 x 650	A1
D2/B2	650 x 470	A2
D3/B3	500 x 350	A3

Note: D2 size drawing board is normally used for class work.

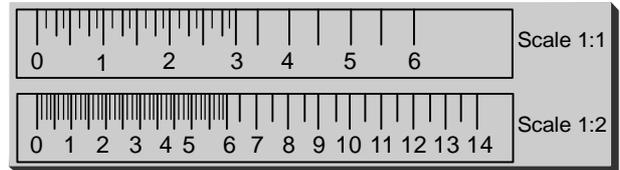
1.4 SCALES

The word 'scale' is usually employed for an instrument used for drawing or measuring the length of a straight line. It is also used to represent the proportion in which the drawing is made with respect to the object. It is used to make full size, reduced size or enlarged size drawing conveniently depending upon the size of the object and that of the drawing sheet. As recommended by Bureau of Indian Standards (BIS) there are eight set of scales. These are designated from M1 to M8 as shown in Table 1.3.

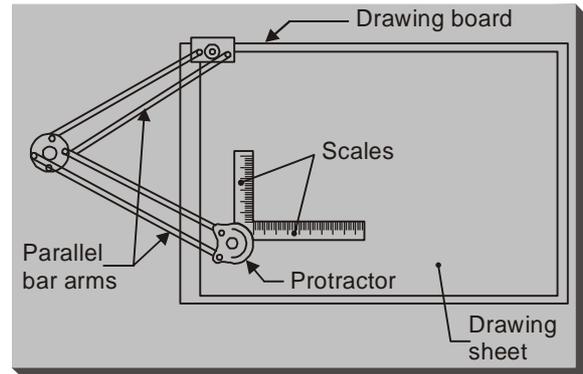
Table 1.3 : Designation and description of Engineer's scale

Designation	Description	Scale
M1	Full size	1 : 1
	50 cm to a metre	1 : 2
M2	40 cm to a metre	1 : 2.5
	20 cm to a metre	1 : 5
M3	10 cm to a metre	1 : 10
	5 cm to a metre	1 : 20
M4	2 cm to a metre	1 : 50
	1 cm to a metre	1 : 100
M5	5 mm to a metre	1 : 200
	2 mm to a metre	1 : 500
M6	3.3 mm to a metre	1 : 300
	1.66 mm to a metre	1 : 600
M7	2.5 mm to a metre	1 : 400
	1.25 mm to a metre	1 : 800
M8	1 mm to a metre	1 : 1000
	0.5 mm to a metre	1 : 2000

For example, a length designated as 2 cm on a 1 : 2 scale is equal to the length designated as 1 cm on a 1 : 1 scale.

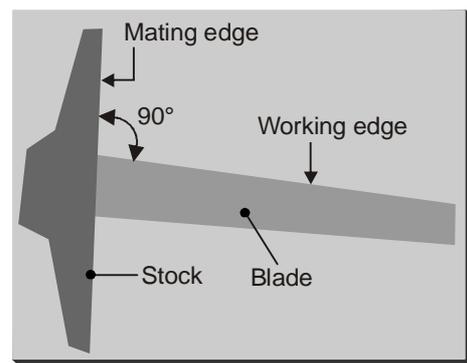


1.5 MINI DRAFTER



- It combines the function of a T-square, set square, scales and protractor.
- It is used for drawing horizontal, vertical, inclined, parallel, perpendicular lines along with its measurement.
- It is also used to trace angle.

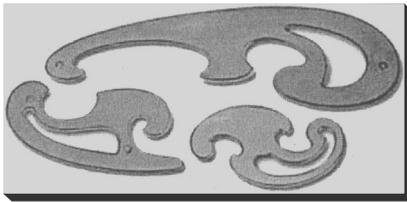
1.6 T-SQUARE



It is a T-shape drawing tool whose mating edge slide along width of drawing board with the help of stock. It is useful in drawing primarily horizontal lines and also used for guiding the set squares while drawing vertical or inclined lines.

1.7 SET SQUARE

A pair of right angled triangle is called set squares. A set square has either 45°-45° angle or 30°-60° angle. The 45° set square shown below in fig. (a) is a right-angled triangle having acute angles of 45°. The 30°-



It is used in drawing curve (like ellipse, parabola, involute etc.) for which a series of points are plotted along the desired path then the most suitable curve is made along the edge of curve.

Example :

Drawing an Irregular Curve

You need to perform the following steps to draw an irregular curve:

1. Locate the curve through a series of points.
2. Sketch a curve through the points for best results.
3. Align the French curve with only two or three points and then draw the curve only through these points. The curve segment drawn through the last of these points should be aimed in the general direction of the next point.
4. Adjust the French curve to go through the next two or three points.
5. Repeat these steps to complete the curve.

The pictorial representation of these steps is given in Figure below.

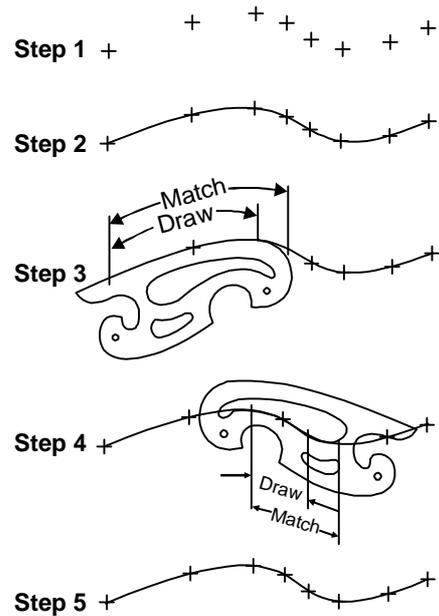


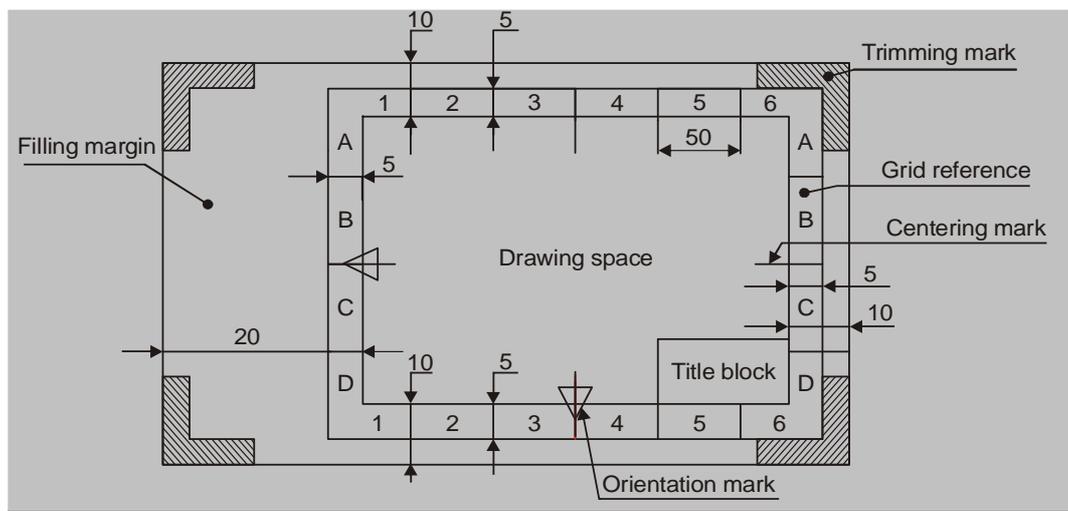
Fig. Steps to draw an irregular curve.

1.12.1 Flexible Cord

A flexible cord shown in figure below is also used in place of French curves for drawing smooth curves with relatively great ease. It consists of a lead bar embedded in rubber covering. The flexibility of the material allows it to bend to any contour.



1.13 LAYOUT OF A DRAWING SHEET (IS 10711 : 2001)



(a) Title Block of Drawing [IS 10711 : 2001]

- It lies within the drawing space of bottom right hand corner of sheet.

Questions

Choose the most appropriate answer out of the given alternatives :

1. A drafter helps in drawing
 - (a) parallel and perpendicular lines
 - (b) concentric circles
 - (c) smooth curves
 - (d) all the above
2. In the engineering system of paper sizes, which of the following is "A2" size?
 - (a) 841 mm × 1189 mm
 - (b) 594 mm × 841 mm
 - (c) 420 mm × 594 mm
 - (d) 210 mm × 297 mm
3. Which of the following pencil leads is hardest?

(a) HB	(b) H
(c) B	(d) F
4. Which of the following purposes is **not** served by dividers?
 - (a) Divide lines or curves into a number of equal parts
 - (b) Transfer measurement from one part of the drawing to another part
 - (c) Make full size, reduced size or enlarged size drawing
 - (d) Step-off a series of equal distances on the drawing
5. To draw smooth curves of any nature, the draughting instrument used is

(a) mini-drafter	(b) French curve
(c) templates	(d) eraser shield
6. Parallel lines can be drawn with the help of

(a) mini-drafter	(b) T-square
(c) pair of set squares	(d) all of these
7. A typical layout of a drawing sheet **does not** contain

(a) centering mark	(b) orientation mark
(c) trimming marks	(d) identification mark
8. Grid references on a drawing sheet provide the following information:
 - (a) Location of details, additions, modifications, revisions, etc. of drawing
 - (b) To facilitate the positioning of the drawing when reproduced
 - (c) To facilitate brief record and initials of the person responsible
 - (d) To facilitate trimming
9. "A" series of paper has length-to-width ratio of approximately

(a) 3:2	(b) $\sqrt{3} : 1$
(c) $\sqrt{2} : 1$	(d) 5:3
10. The number of orientation marks generally contained by a drawing sheet is

(a) one	(b) two
(c) three	(d) four
11. Extension arms are used with engineering compasses to
 - (a) draw circles of larger diameter
 - (b) increase the gripping arm
 - (c) adjust distance between the legs
 - (d) increase accuracy
12. Which of the following statements are correct?
 - I. The length of A2 size drawing sheet is equal to the width of A1 size drawing sheet.
 - II. For technical drawing, harder grades of pencils are preferred.

(a) only I	(b) Only II
(c) Both	(d) None
13. Which of the following statements are correct?
 - I. A D2 size drawing board has dimensions of 920 mm × 650 mm.
 - II. A title block is placed at bottom right corner of the drawing frame.

(a) only I	(b) Only II
(c) Both	(d) None
14. To draw a circle of diameter 20 mm, the most