Computer Aided Machine Drawing
1- Introduction

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Scheme

Credit	**1.5**
Internal Assessment	**45**
End Term Assessment	**30**

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Syllabus

Introduction: Principles of drawing, conventional representation of machine components and materials, lines, types of lines, elements of dimensioning - systems of dimensioning.
Conventional representations: Standard convention using SP-46 (1988)-Materials C.I., M.S., Brass, Bronze, Aluminum, wood. Glass, Concrete and Rubber-Long and short break in pipe, rod and shaft. Various sections- half, removed, standard convention of knurling, splined shafts, and chain wheels, springs with square and flat ends, gears, sprocket wheel-countersunk & counter bore.
Conversion of pictorial views into orthographic views: Introduction to orthographic projection concept of first angle and third angle projection, drawing of simple machine elements in first angle projection, missing view problems covering principles of orthographic projections.

3

Syllabus

Sectional views of mechanical components: Introduction, cutting plane line, type of sectional views-full section, half section, partial or broken section, revolved section, removed section, offset section, sectioning conventions-spokes, web rib, shaft, pipes, different types of holes, conventions of section lines for different metals and materials.
Overview of Computer Graphics: Review of graphic interface of the software-CAD, review of basic sketching commands and navigational commands, starting a new drawing sheet with various sizes, toolbars, dialog boxes and windows, shortcut menus, command line, select and erase objects, isometric views of lines, planes, simple and compound solids, pictorial views into orthographic projections of simple machine parts.
Drawing standards & fits and tolerances: Code of practice for engineering drawing, BIS specifications -welding symbols, riveted joints, keys, fasteners-reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. Limits, Fits, Tolerance of individual dimensions. Specification of fits-preparation of production drawings and reading of part and assembly drawing basic principles of geometric dimensioning & tolerancing.

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Course Outcomes

CO1: Students will be able to understand basic principles of drawing and conventional representation of components and materials.

CO2: Students will be able to draw orthographic projections of simple machine components in first and third angle projection method.

CO3: Students will be able to understand importance of sectioning views and will be able to draw sectional views of simple machine elements.

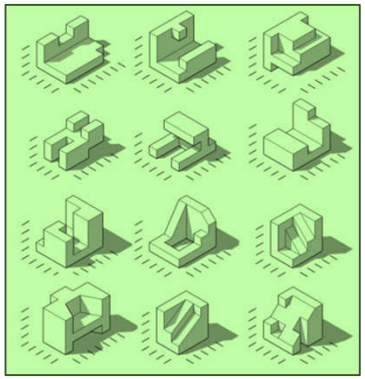
CO4: Students will be able to develop preliminary understanding of fasteners and basic machine elements such as bearings, valves, pulleys etc.

CO5: Students will be able to understand basics of AutoCAD and perform basic functions of AutoCAD software

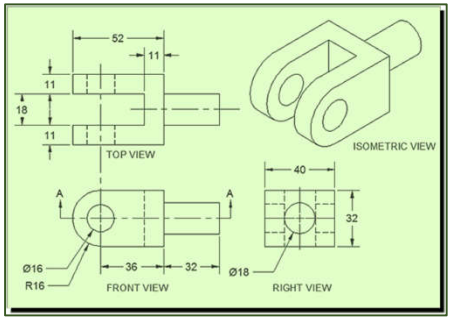
Suggested Books

Title	Author	Publisher
A text book of Machine Drawing	Laxminarayan and Mathur	Jain Brothers
Machine Drawing	Ajeet Singh	Tata McGraw Hill
Machine Drawing	Narayana and Reddy	New Age International

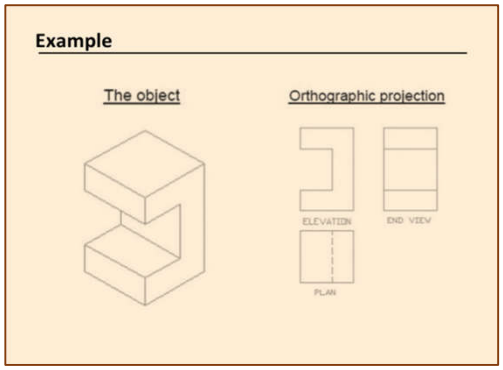
Course Outcomes – Orthographic Projections



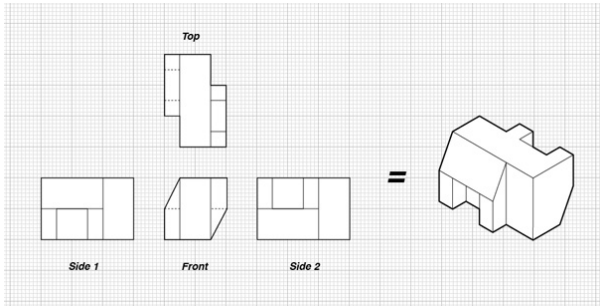
Course Outcomes – Orthographic Projections



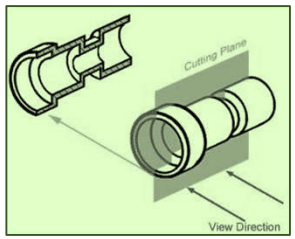
Course Outcomes – Orthographic Projections

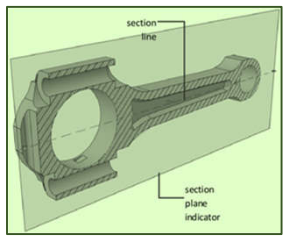


Course Outcomes – Orthographic Projections



Course Outcomes – Sectional Views





Introduction to Engineering Drawing

- It is universal graphic language of Engineers.
- Engineering drawing is a suitable graphic language from which any trained person can visualise the required object.
- As an engineering drawing displays the exact picture of an object, it obviously conveys the same ideas to every trained eye.
- Irrespective of language barriers, the drawings can be effectively used in other countries, in addition to the country where they are prepared.

Thus, the engineering drawing is the universal language of all engineers

Importance of Graphical Language

- The graphic language had its existence when it became necessary to build new structures and create new machines or the like, in addition to representing the existing ones.
- In the absence of graphic language, the ideas on technical matters have to be conveyed by speech or writing, both are unreliable and difficult to understand by the shop floor people for manufacturing.
- This method involves not only lot of time and labour, but also manufacturing errors.
- Without engineering drawing, it would have been impossible to produce objects such as aircrafts, automobiles, locomotives, etc., each requiring thousands of different components.

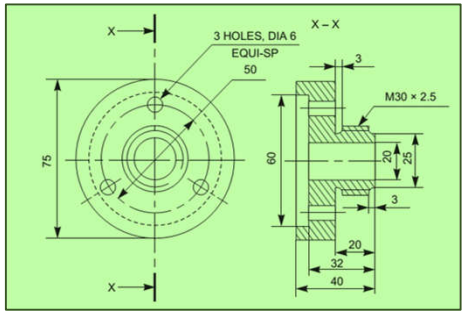
Need for correct drawing

- The drawings prepared by any technical person must be clear, unmistakable in meaning and there should not be any scope for more than one interpretation.
- In a number of dealings with contracts, the drawing is an official document and the success or failure of a structure depends on the clarity of details provided on the drawing.
- Thus, the drawings should not give any scope for mis-interpretation even by accident.
- Hence, an engineer should possess good knowledge, not only in preparing a correct drawing but also to read the drawing correctly.

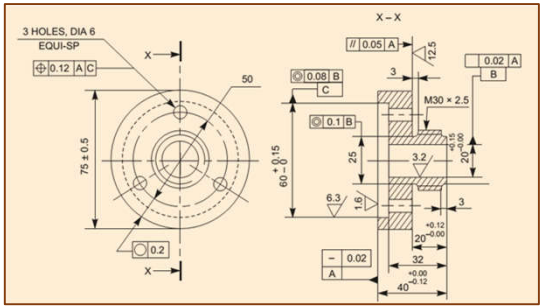
Classification of Drawings

- *Machine Drawing*
- *Production Drawing*
- *Part Drawing*
- *Assembly Drawing*

Machine Drawing



Production Drawings



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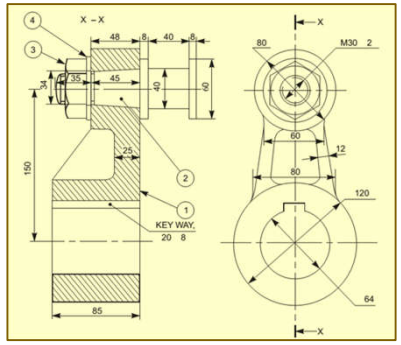
Assembly Drawings



Parts List

Part No.	Name	Material	Qty
1	Crank	Forged Steel	1
2	Crank Pin	45C	1
3	Nut	MS	1
4	Washer	MS	1

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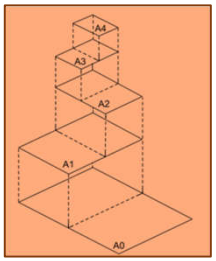
Principles of Drawing

- To provide the correct information about the drawings to all the people concerned, the drawings must be prepared, following certain standard practices, as recommended by Bureau of Indian Standards (BIS).
- **Drawing Sheets:**

Designation	*Dimensions* (mm)
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297



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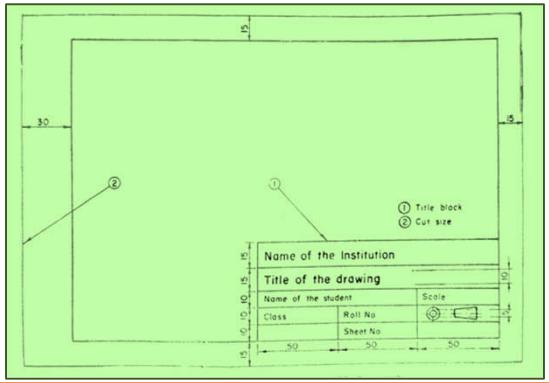
Layout of Drawing Sheet



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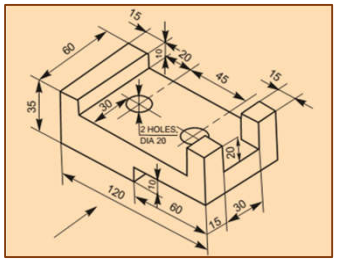
Types of Lines

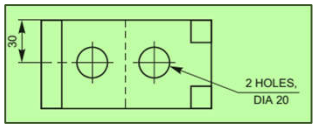
Line	Description	General Applications
A	Continuous thick	A1 Visible outlines
B	Continuous thin (straight or curved)	B1 Imaginary lines of intersection B2 Dimension lines B3 Projection lines B4 Leader lines B5 Hatching lines B6 Outlines of revolved sections in place B7 Short centre lines
C	Continuous thin, free-hand	C1 Limits of partial or interrupted views and sections, if the limit is not a chain thin
D	Continuous thin (straight) with zigzags	D1 Line (see Fig. 2.5)

Types of Lines

E	Dashed thick	E1 Hidden outlines
G	Chain thin	G1 Centre lines G2 Lines of symmetry G3 Trajectories
H	Chain thin, thick at ends and changes of direction	H1 Cutting planes
J	Chain thick	J1 Indication of lines or surfaces to which a special requirement applies
K	Chain thin, double-dashed	K1 Outlines of adjacent parts K2 Alternative and extreme positions of movable parts K3 Centroidal lines

Representation of Lines





Order of Priority of Coinciding Lines

- When two or more lines of different types coincide, the following order of priority should be observed:
  - (i) Visible outlines and edges
  - (ii) Hidden outlines and edges
  - (iii) Cutting planes
  - (iv) Centre lines and lines of symmetry
  - (v) Centroidal lines
  - (vi) Projection lines

Conventional Representation of Materials

Type	Convention	Material
Metals		Steel, Cast Iron, Copper and its Alloys, Aluminium and its Alloys, etc.
		Lead, Zinc, Tin, White-metal, etc.
Glass		Glass
		Porcelain, Stoneware, Marble, Slate, etc.
Packing and Insulating material		Asbestos, Fibre, Felt, Synthetic resin products, Paper, Cork, Linoleum, Rubber, Leather, Wax, Insulating and Filling materials, etc.

Conventional Representation of Materials

Liquids		Water, Oil, Petrol, Kerosene, etc.
Wood		Wood, Plywood, etc.
Concrete		A mixture of Cement, Sand and Gravel

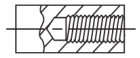
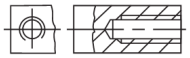
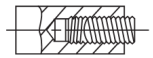
Conventional Representation of Machine Components

Title	Subject	Convention
Straight knurling		
Diamond knurling		
Square on shaft		

Conventional Representation of Machine Components

Title	Subject	Convention
Holes on circular pitch		
Bearings		
External screw threads (Detail)		

Conventional Representation of Machine Components

Title	Subject	Convention
Internal screw threads (Detail)		
Screw threads (Assembly)		

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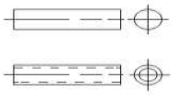
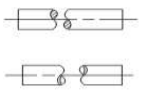
Conventional Representation of Machine Components

Title	Subject	Convention
Splined shafts		
Interrupted views		
Semi-elliptic leaf spring		

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Conventional Representation of Machine Components

	Subject	Convention	Diagrammatic Representation
Cylindrical compression spring			
Cylindrical tension spring			

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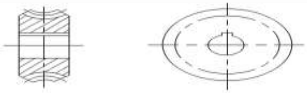
Conventional Representation of Machine Components

Title	Convention
Spur gear	
Bevel gear	
Worm wheel	
Worm	

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Dimensioning

- A drawing of a component, in addition to providing complete shape description, must also furnish information regarding the size description. These are provided through the distances between the surfaces, location of holes, nature of surface finish, type of material, etc.
- The expression of these features on a drawing, using lines, symbols, figures and notes is called dimensioning.
- Dimension is a numerical value expressed in appropriate units of measurement and indicated on drawings, using lines, symbols, notes, etc., so that all features are completely defined.

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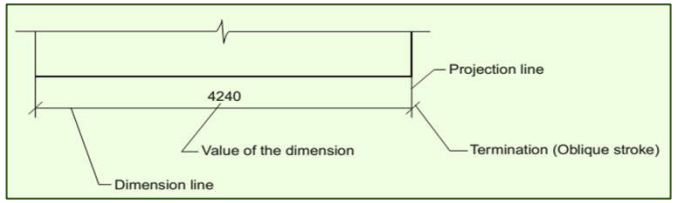
Elements of Dimensioning



- Projection and dimension lines should be drawn as thin continuous lines.
- Projection lines should extend slightly beyond the respective dimension lines.

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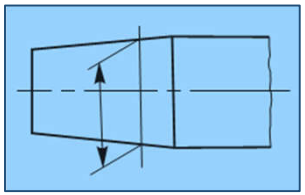
Dimensioning –Methods of Execution

- Projection lines should be drawn perpendicular to the feature being dimensioned. Where necessary, they may be drawn obliquely, but parallel to each other. However, they must be in contact with the feature.



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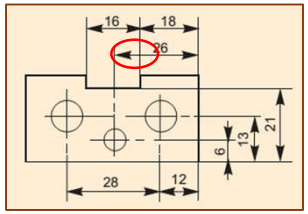
Dimensioning –Methods of Execution

- Projection lines and dimension lines should not cross each other, unless it is unavoidable



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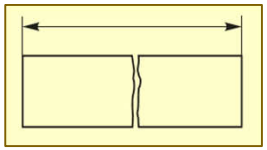
Dimensioning –Methods of Execution

- A dimension line should be shown unbroken, even where the feature to which it refers, is shown broken.



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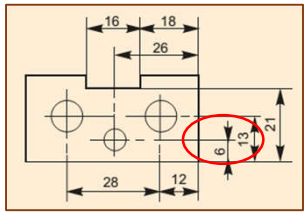
Dimensioning –Methods of Execution

- A centre line or the outline of a part should not be used as a dimension line, but may be used in place of projection line



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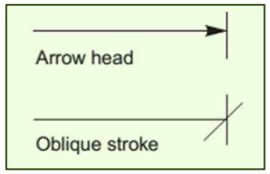
Dimensioning –Indication of termination

- Dimension lines should show distinct termination, in the form of arrow heads or oblique strokes.
- The arrow head is drawn as short lines, having an included angle of 15°, which is closed and filled-in.
- The oblique stroke is drawn as a short line, inclined at 45°.



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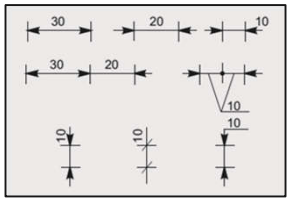
Dimensioning –Methods of Execution

- The size of the terminations should be proportionate to the size of the drawing on which they are used.
- Where space is limited, arrow head termination may be shown outside the intended limits of the dimension line that is extended for that purpose.
- In certain other cases, an oblique stroke or a dot may be substituted



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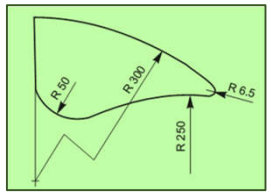
Dimensioning –Methods of Execution

- Where a radius is dimensioned, only one arrow head termination, with its point on the arc end of the dimension line, should be used.
- However, the arrow head termination may be either on the inside or outside of the feature outline, depending upon the size of feature.



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Methods of Indicating Dimensions

- Dimensions should be shown on drawings in characters of sufficient size, to ensure complete legibility.
- They should be placed in such a way that they are not crossed or separated by any other line on the drawing.
- There are two methods of dimensioning – Aligned and Unidirectional.
- Either of the two systems should be used in a drawing

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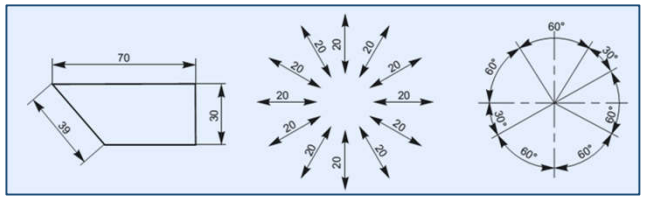
Aligned System of Dimensioning

- Dimensions should be placed parallel to their dimension lines and preferably near the middle, above and clear-off the dimension line.
- Dimensions may be written so that they can be read from the bottom or from the right side of the drawing.



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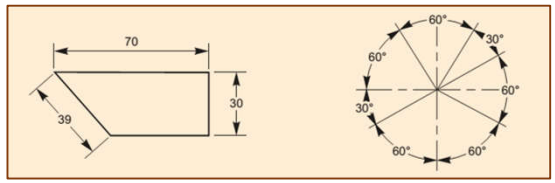
Unidirectional System of Dimensioning

- Dimensions should be indicated so that they can be read from the bottom of the drawing only. Non-horizontal dimension lines are interrupted, preferably near the middle, for insertion of the dimensions.



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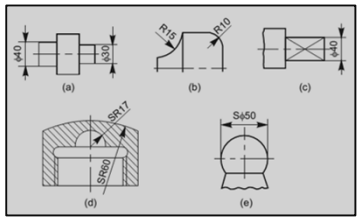
Dimensioning –Methods of Execution

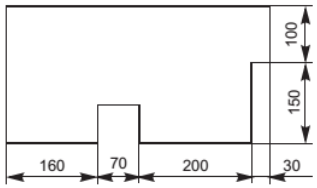
- The following indications (symbols) are used with dimensions to reveal the shape identification and to improve drawing interpretation. The symbol should precede the dimensions.

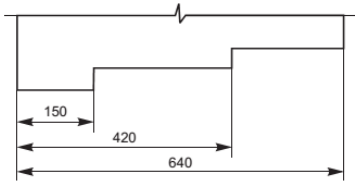
ϕ : Diameter Sϕ : Spherical diameter R : Radius SR : Spherical radius □ : Square



Arrangement of Dimensions

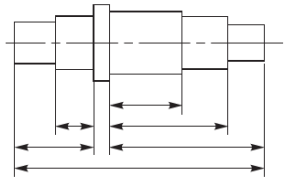
1. Chain Dimensioning
2. Parallel Dimensioning

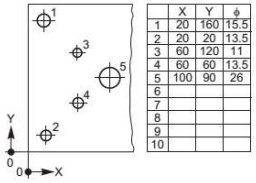




Arrangement of Dimensions

3. Combined Dimensioning
4. Coordinate Dimensioning

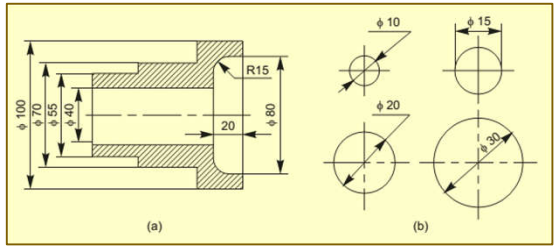




	X	Y	ϕ
1	20	160	15.5
2	20	20	13.5
3	60	120	11
4	60	60	13.5
5	100	90	26
6			
7			
8			
9			
10			

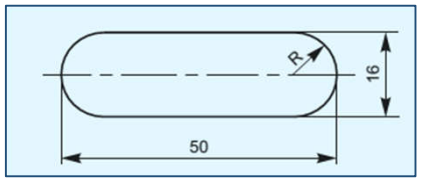
Dimensioning –Methods of Execution

(a) Diameters: Diameters should be dimensioned on the most appropriate view to ensure clarity. The dimension value should be preceded by φ.



Dimensioning –Methods of Execution

(b) Radius: Where the size of the radius can be derived from other dimensions, it may be indicated by a radius arrow and the symbol R, without an indication of the value



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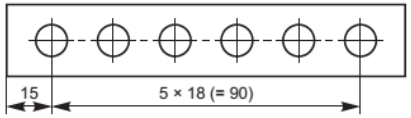
Dimensioning –Methods of Execution

(c) Equidistant features: Linear spacings with equi-distant features may be dimensioned as shown in Figure.



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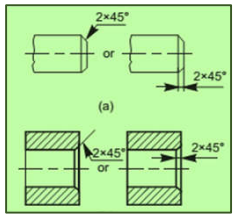
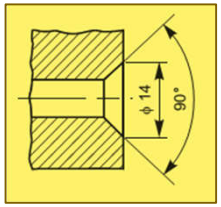
Dimensioning –Methods of Execution

(d) Chamfers and Countersunk:





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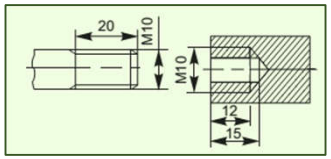
Dimensioning –Methods of Execution

(e) Screw Threads:

- Screw threads are always specified with proper designation.
- The nominal diameter is preceded by the letter M.
- The useful length of the threaded portion only should be dimensioned.
- While dimensioning the internal threads, the length of the drilled hole should also be dimensioned.



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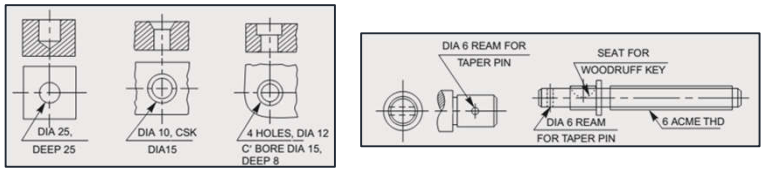
Notes for Dimensioning

- Notes should always be written horizontally in capital letters and begin above the leader line and may end below also. Further, notes should be brief and clear and the wording should be standard in form.



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Dimensioning – General Principles

- As far as possible, dimensions should be placed outside the view.
- Dimensions should be taken from visible outlines rather than from hidden lines.
- Dimensioning to a centre line should be avoided except when the centre line passes through the centre of a hole.
- Each feature should be dimensioned once only on a drawing.
- Dimensions should be placed on the view or section that relates most clearly to the corresponding features.
- Each drawing should use the same unit for all dimensions, but without showing the unit symbol.
- No more dimensions than are necessary to define a part should be shown on a drawing.

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Thanks for your kind attention

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