

18MES101L – Engineering Graphics and Design

Week 1: ESSENTIALS OF ENGINEERING GRAPHICS

Engineering Drawing

- Language of Engineers
- Communicate ideas and information from one mind to another
- Graphic representation of an object
- Result of creative thought by an Engineer or Technician

Projection

- Drawing or representation of an entity or object on an imaginary plane or planes.
- Depends on four components
 - The actual object
 - The eye of the viewer looking at the object
 - The imaginary projection plane
 - Imaginary lines of sight called Projectors

Application of Engineering Drawing in Industries

- Conceptual stage
- Design stage
- Modification stage
- Prototype development stage
- Process and production planning
- Production
- Inspection
- Marketing
- Servicing and maintenance

Engineering drawing

Contains following information:

- Shape of an object
- Exact Sizes and tolerances of various parts of the object
- The finish of the product
- The details of materials
- The company's name
- Catalogue number of the product
- Date on which the drawing was made
- The person who made the drawing

213-975-000A

IF IN DOUBT ASK

THIRD ANGLE PROJECTION

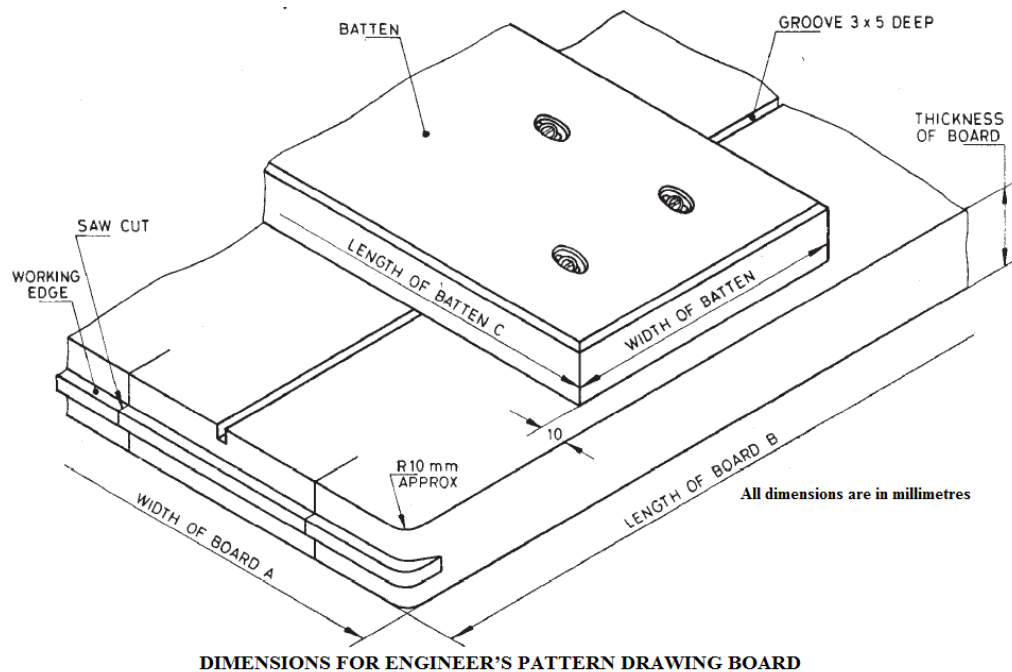
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Drawing Instruments

Drawing Board:

IS 1444 : 1989 – Clauses 3.1 and 6.1

All dimensions are in millimetres



Dimensions of Drawing Boards

IS 1444 : 1989 – Clauses 3.1 and 6.1

All dimensions are in millimetres

Designation	Length x Width B x A	Tolerance on Length/Width	Thickness	Tolerance on Thickness	Tolerance on Straightness of Working Edge	Recommended for Use with Sheet Sizes
D00	1525 x 1220	±5	22	±1	0.25	---
D0	1270 x 920	±5	22	±1	0.25	A0
D1	920 x 650	±5	22	±1	0.25	A1
D2	650 x 470	±5	22	±1	0.1	A2
D3	500 x 350	±5	22	±1	0.1	A3

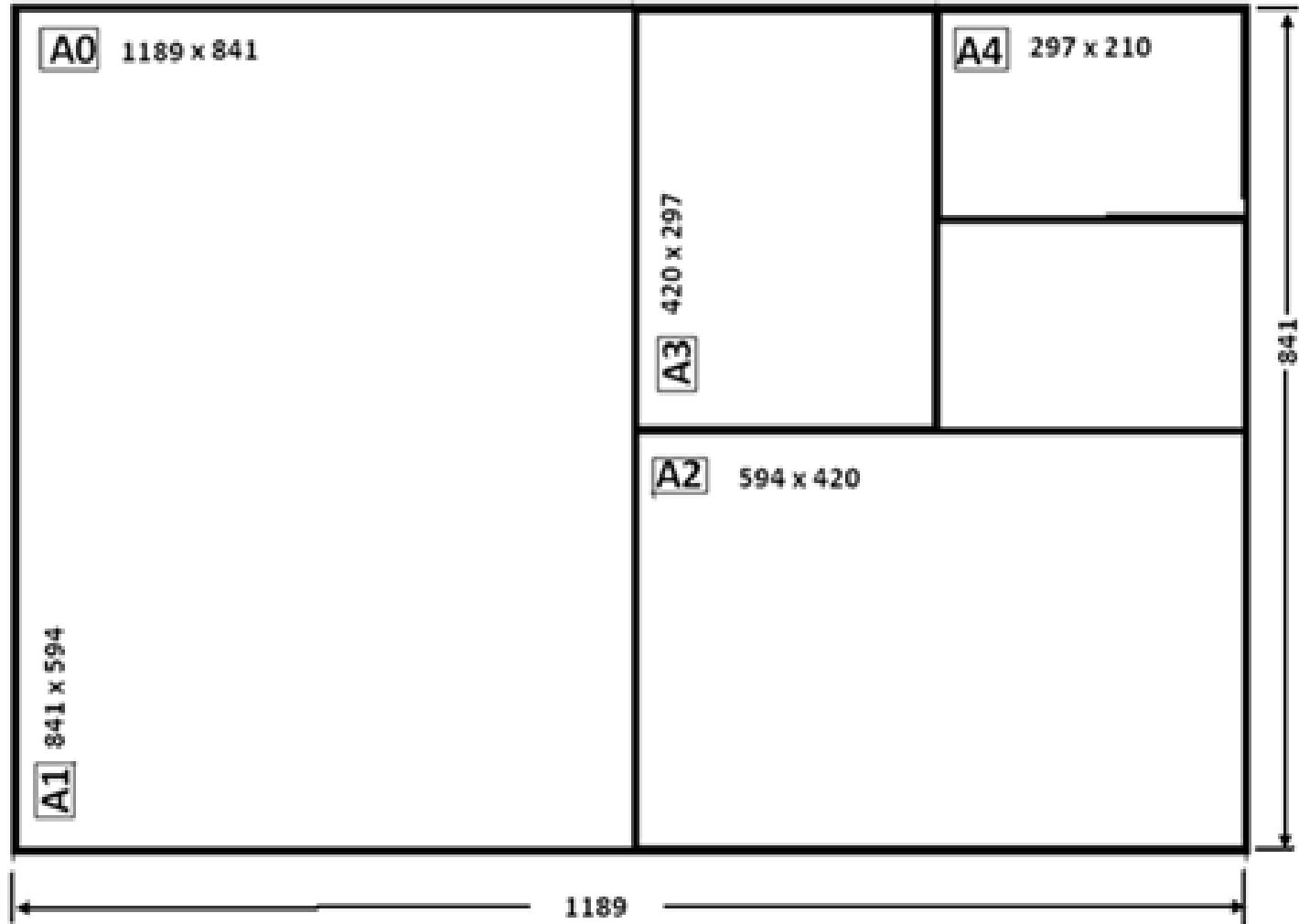
Drawing Sheet

IS 10711 : 2001 and ISO 5457 : 1999

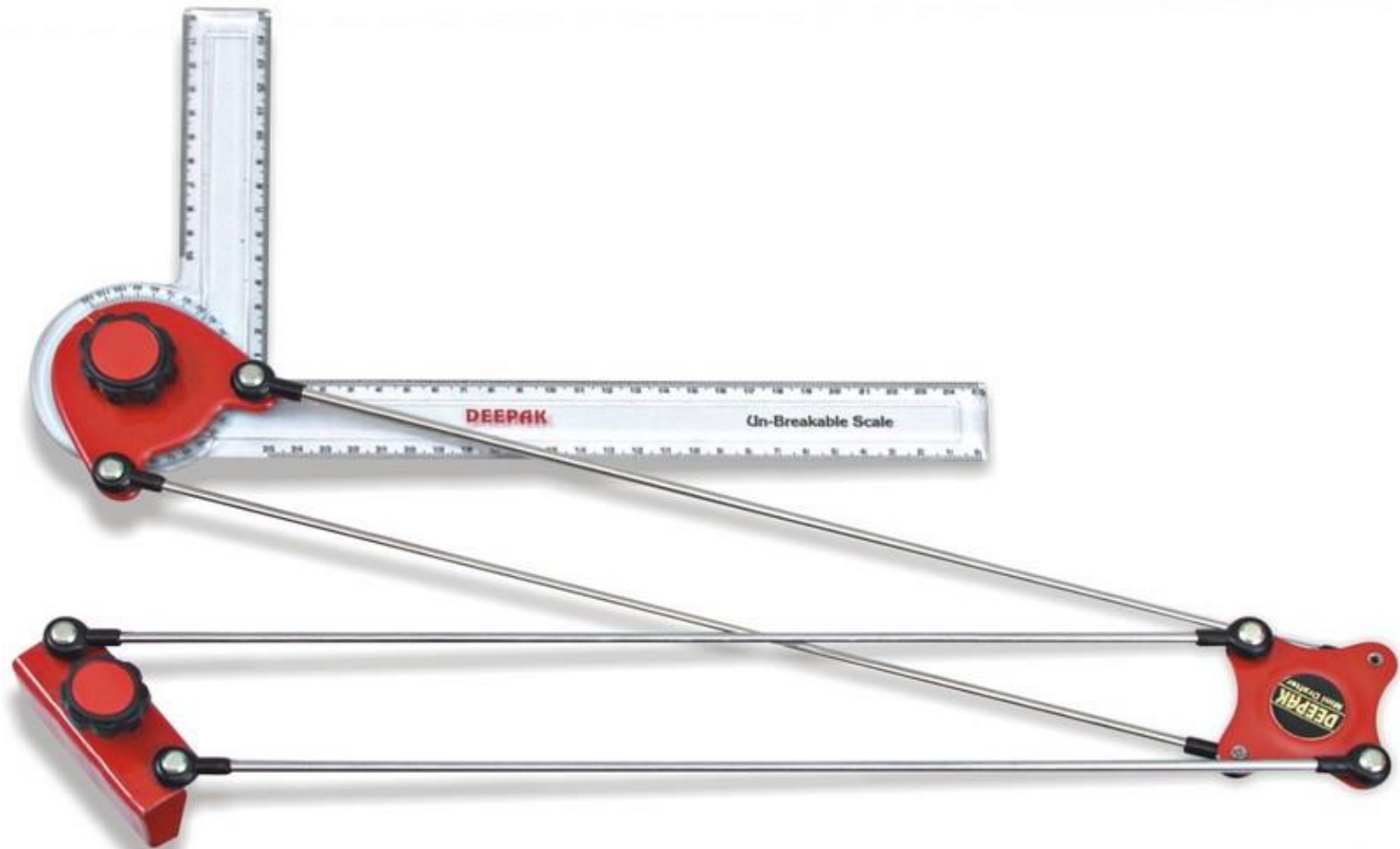
All dimensions are in millimetres

Designation	Size
A0	841 x 1189
A1	594 x 841
A2	420 x 594
A3	297 x 420
A4	210 x 297

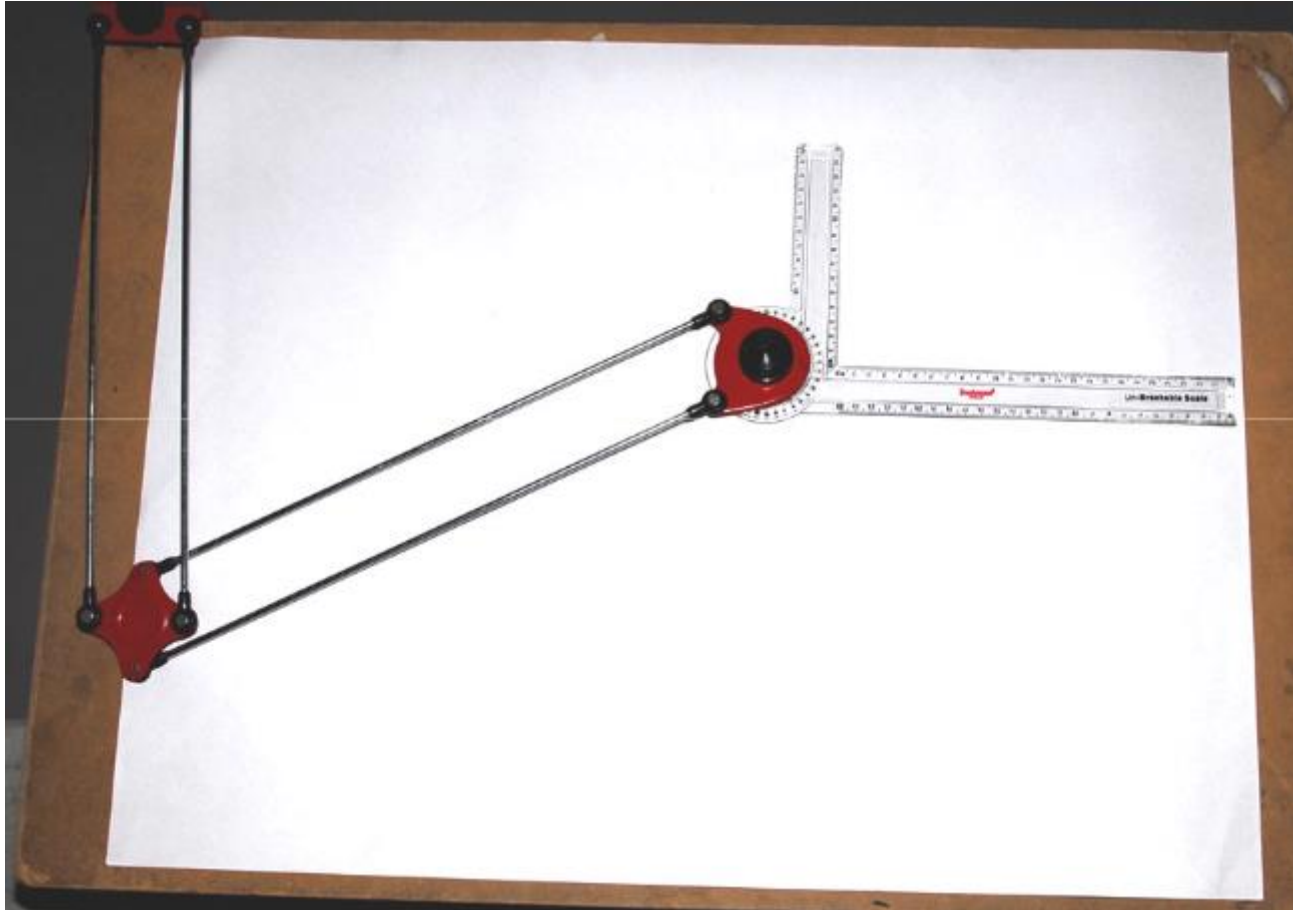
Layout of drawing sheets



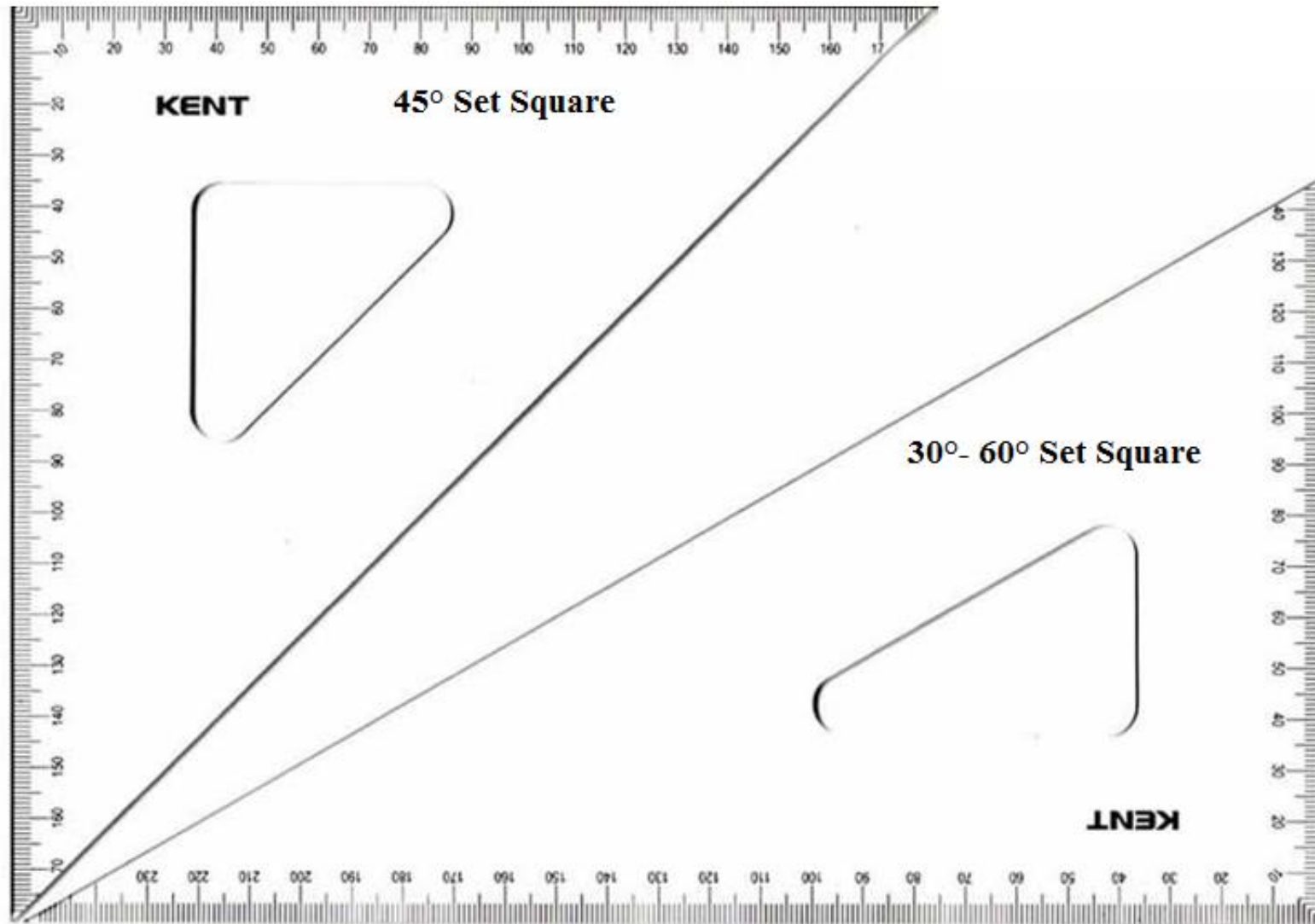
Mini – drafter



How to set a mini – drafter



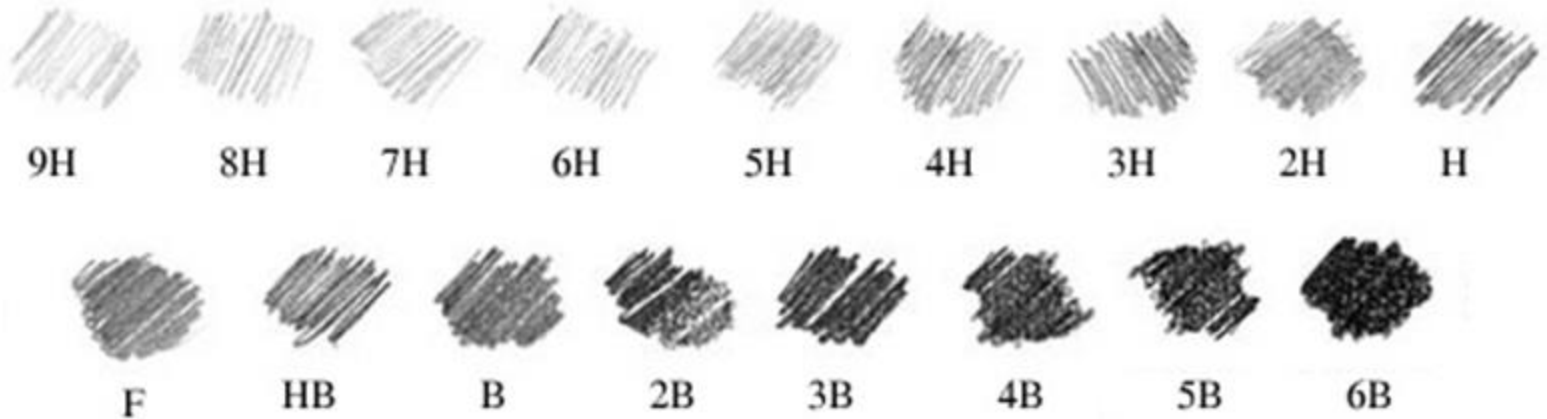
Set squares



Pencils

IS / ISO 9180 : 1988

Hardness of pencil leads:



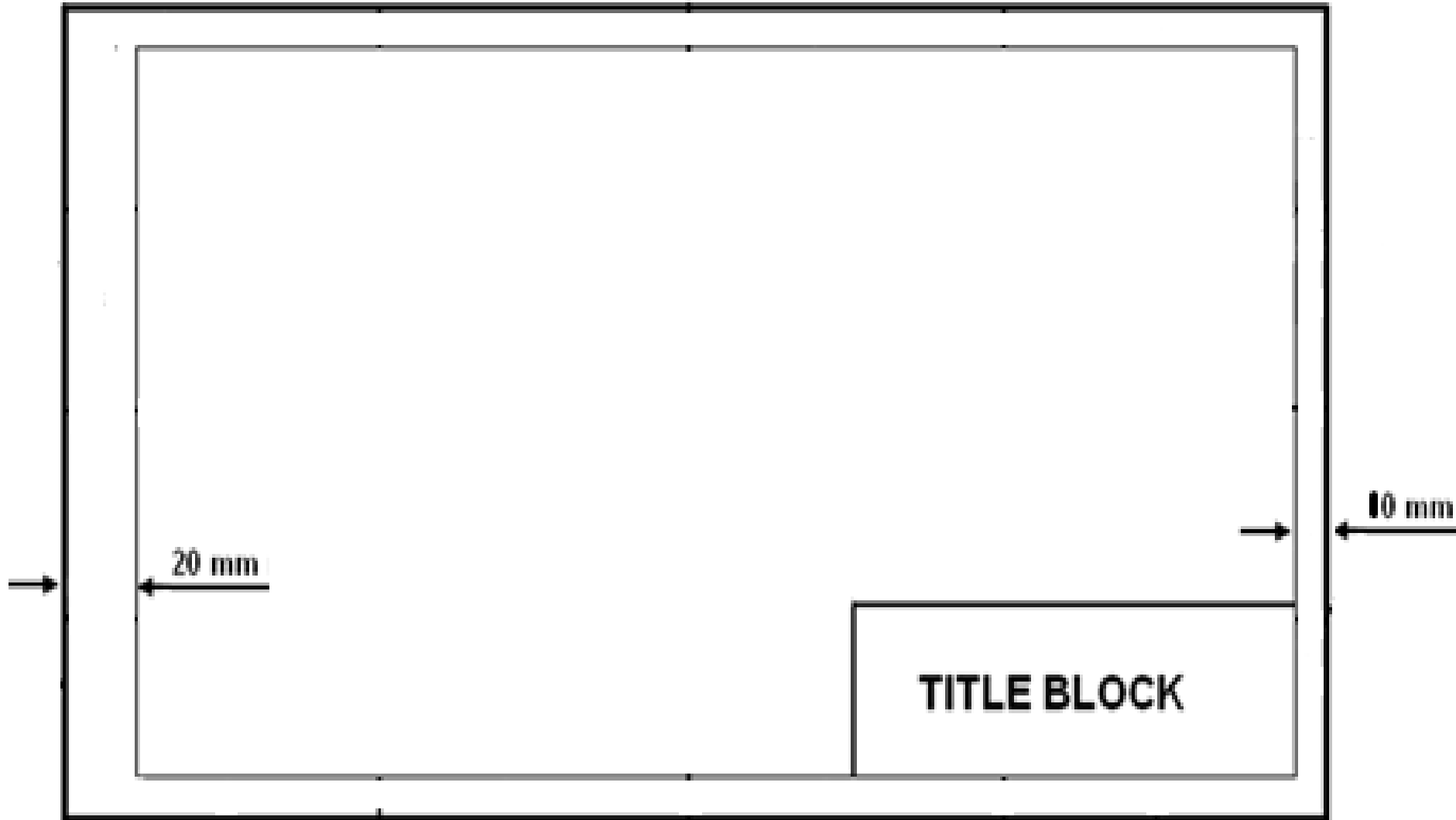
Instrument box



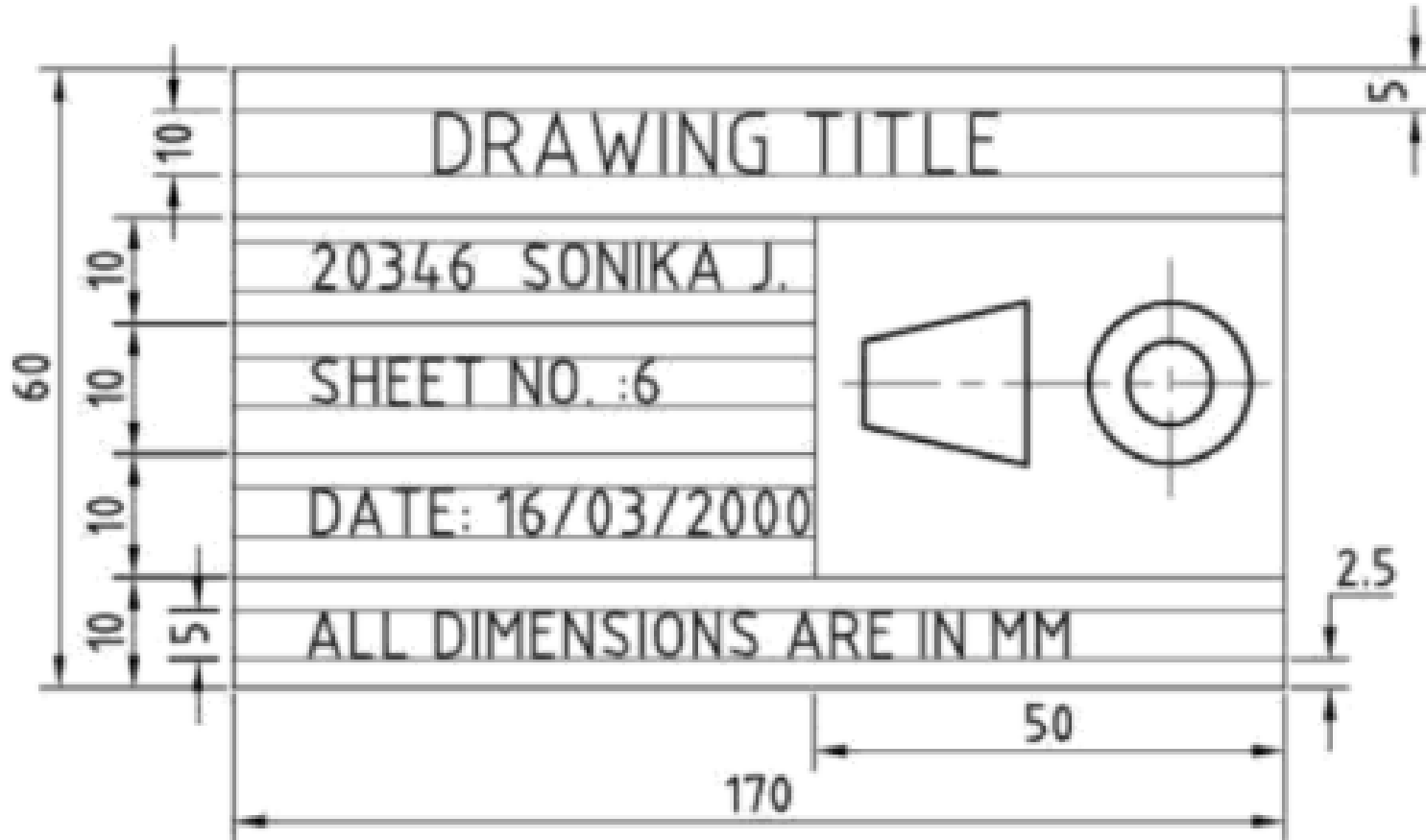
Eraser, sharpener & Clips



Layout of Drawing sheet



Title block



Source: Basics of Engineering Drawing and Graphics, T. Jeyapoovan, Vikas Publishing House Pvt Ltd, New Delhi.

Lettering

SP 46 : 1988

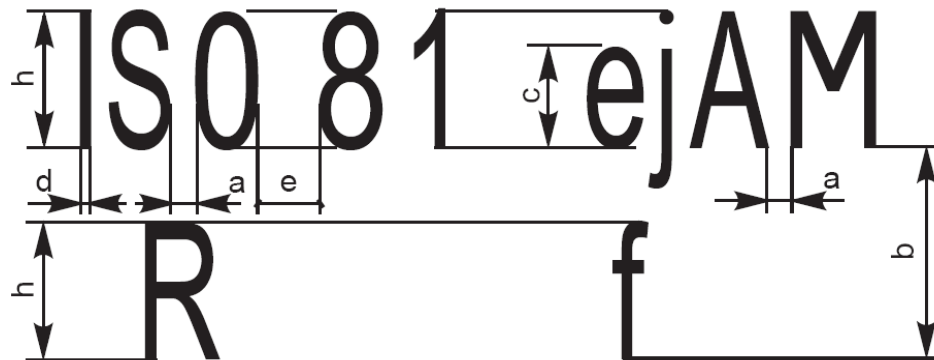
Essential features of lettering on technical drawings are

- Legibility
- Uniformity
- Suitability for microfilming and
- Photographic reproductions.

Dimensions of lettering








Lettering A ($d = h/14$)

Characteristic	Ratio	Dimensions, (mm)							
Lettering height (Height of capitals)	h (14/14) h	2.5	3.5	5	7	10	14	20	
Height of lower-case letters (without stem or tail)	c (10/14) h	—	2.5	3.5	5	7	10	14	
Spacing between characters	a (2/14) h	0.35	0.5	0.7	1	1.4	2	2.8	
Minimum spacing of base lines	b (20/14) h	3.5	5	7	10	14	20	28	
Minimum spacing between words	e (6/14) h	1.05	1.5	2.1	3	4.2	6	8.4	
Thickness of lines	d (1/14) h	0.18	0.25	0.35	0.5	0.7	1	1.4	



Source: Engineering Drawing and Graphics using AutoCAD, T. Jeyapoovan, Vikas Publishing House Pvt Ltd, New Delhi.

Line types

Illustration	Application
Thick 	Outlines, visible edges, surface boundaries of objects, margin lines
Continuous thin 	Dimension lines, extension lines, section lines leader or pointer lines, construction lines, boarder lines
Continuous thin wavy 	Short break lines or irregular boundary lines – drawn freehand
Continuous thin with zig-zag 	Long break lines
Short dashes, gap 1, length 3 mm 	Invisible or interior surfaces
Short dashes 	Center lines, locus lines Alternate long and short dashes in a proportion of 6:1,
Long chain thick at end and thin elsewhere 	Cutting plane lines

Manual Drafting

- Draw the margin and title block with relevant details
- Lettering and Numerals practice
 - A to Z of height 5 and 7 mm
 - 0 to 9 of height 5 and 7 mm
 - Drawing practice

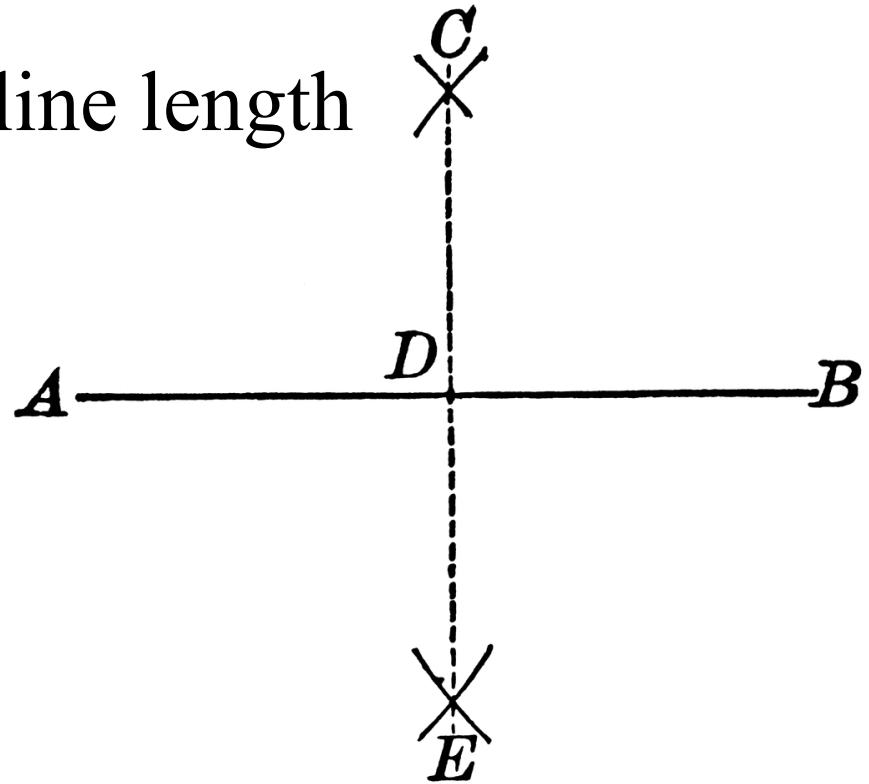
Duration: 1 period

BIS for Drawing

- SP 46:1988 – Engineering Drawing Practice for Schools & Colleges
- SP 46:2003 – Revised
- IS 1444:1989 – DRAWING BOARD SPECIFICATION
- IS 15021:2001 – PROJECTION METHODS
- IS 3221:1966 – DRAWING INSTRUMENTS
- IS 10713:1983 – SCALES
- IS 10714:2001 – LINES
- IS 9609:2001 – LETTERING
- IS 11669:1986 – DIMENSIONING
- IS 10711:2001 – SIZE & LAYOUT OF DRAWING SHEETS

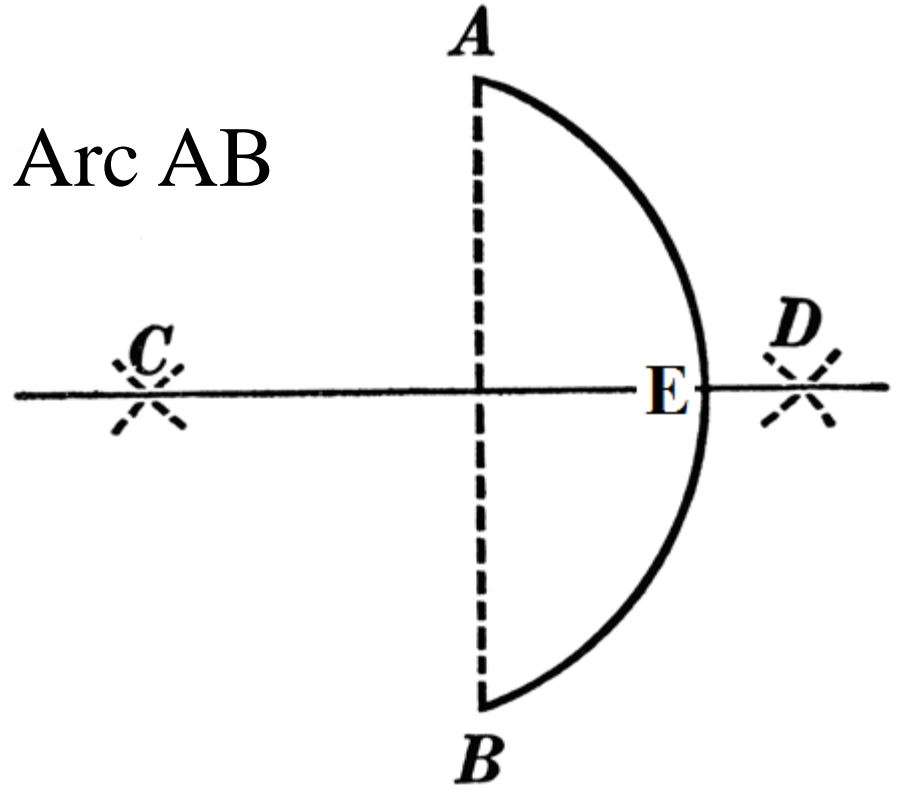
Bisecting a line

- Dividing a line into two equal halves
- Radius of arc $\geq 50\%$ of line length
- $AD = DB = \frac{1}{2} AB$



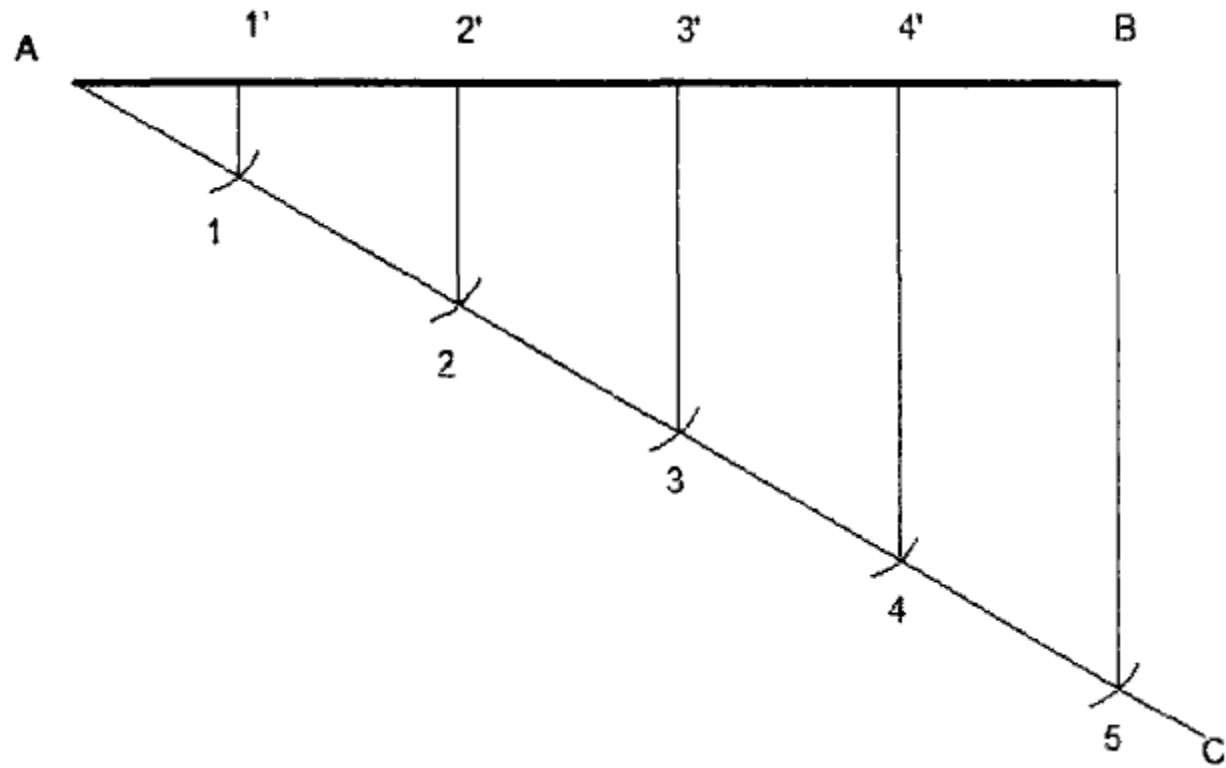
Bisecting an arc

- Dividing an arc into two equal halves
- Radius of arc $\geq 50\%$ of line length AB
- Arc AE = Arc EB = $\frac{1}{2}$ Arc AB

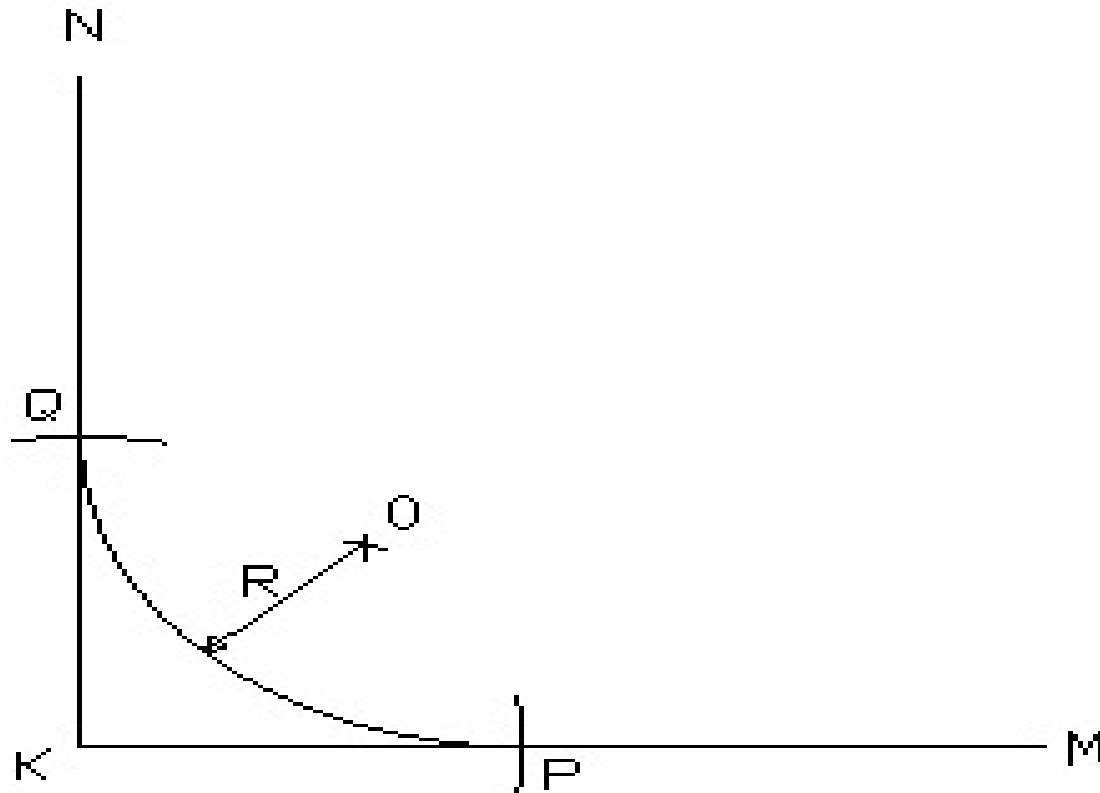


Dividing a line into 'n' equal segments

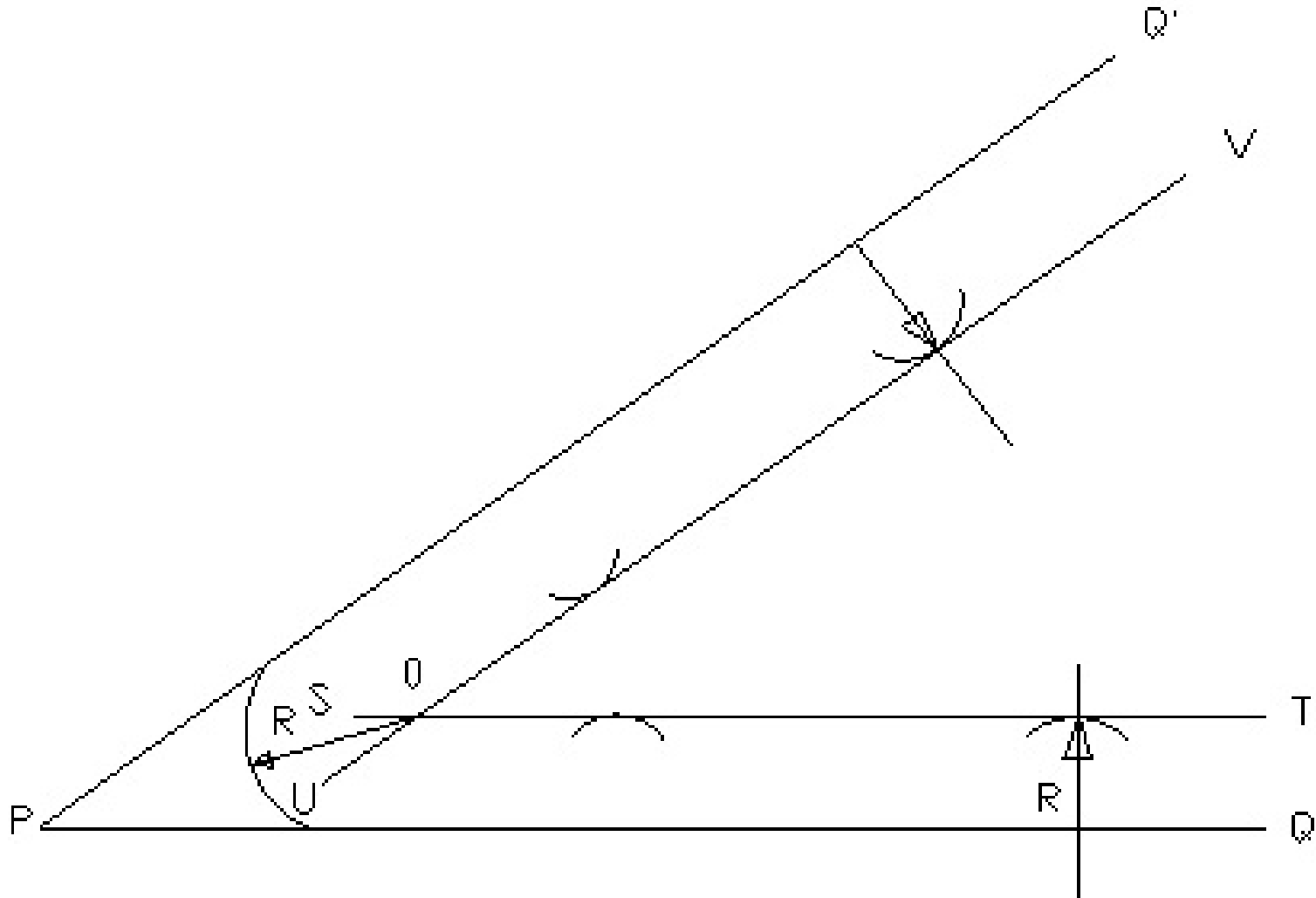
Dividing line AB into 5 equal parts



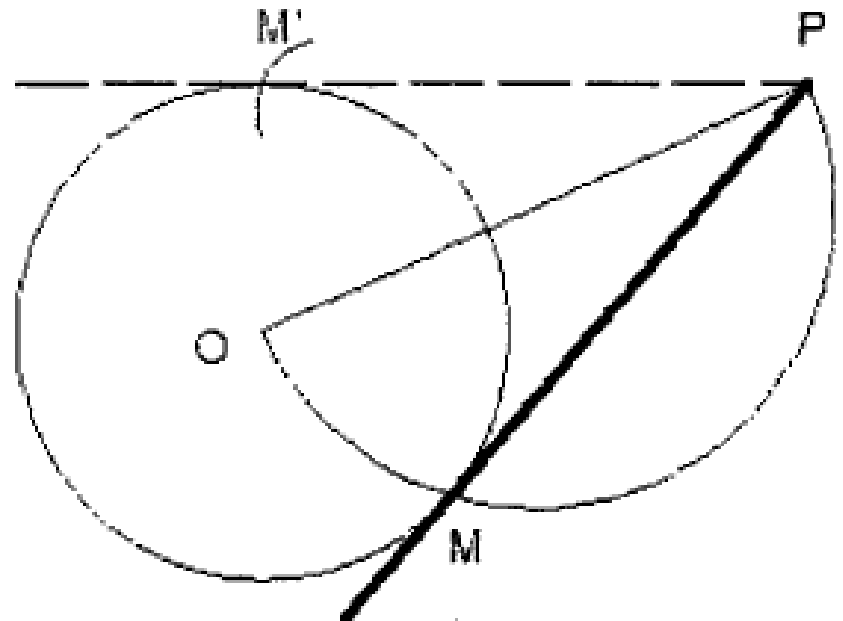
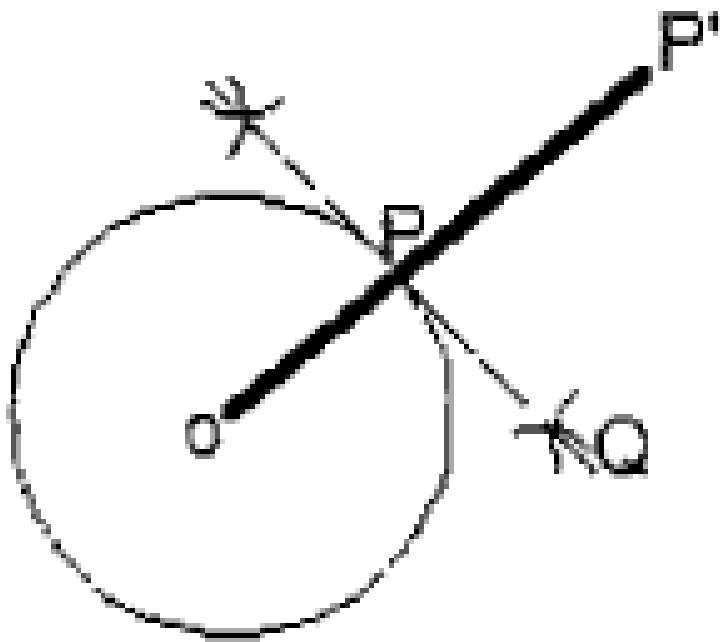
Draw an arc between two perpendicular lines



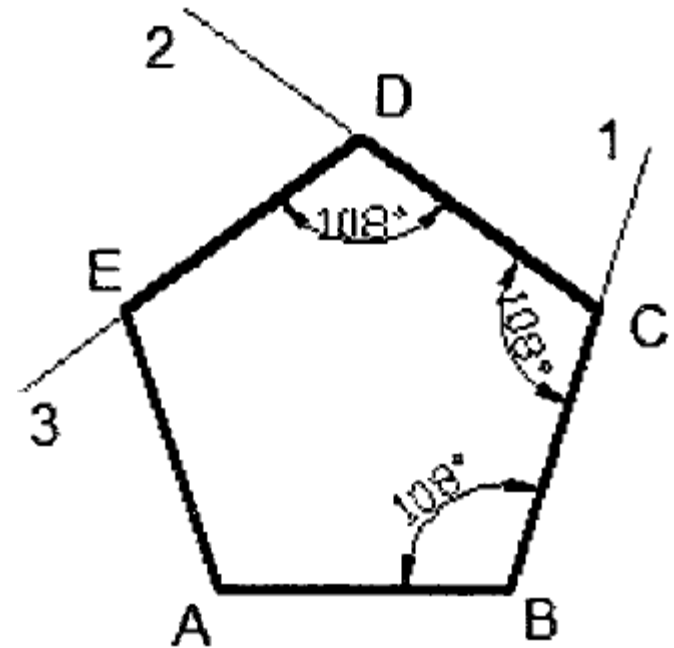
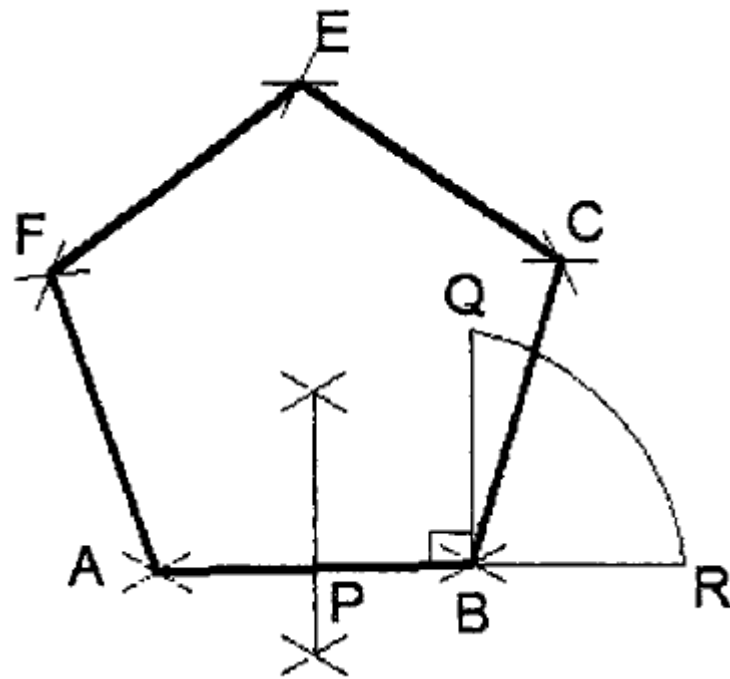
Arc touching two lines making an angle



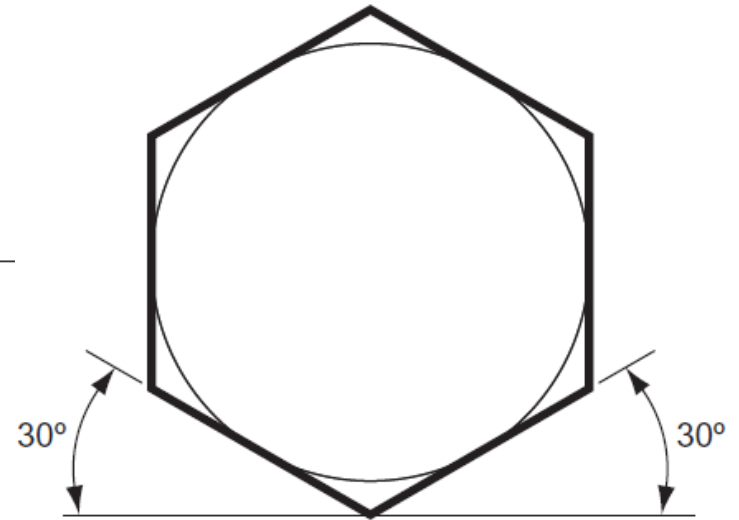
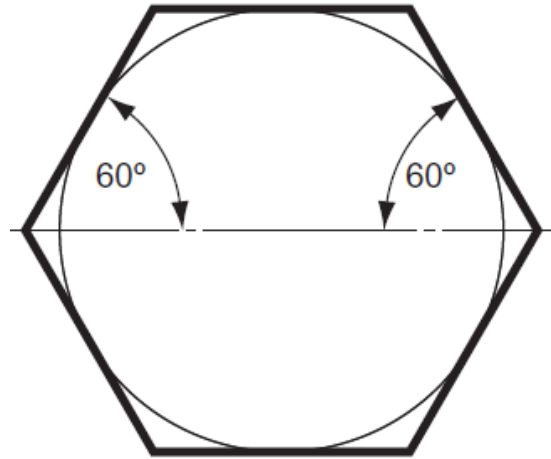
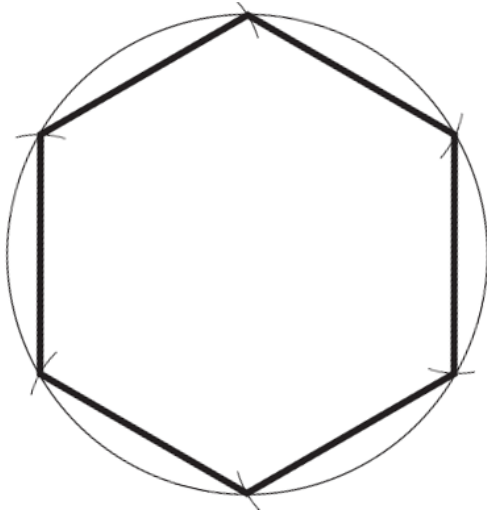
Tangent to a circle



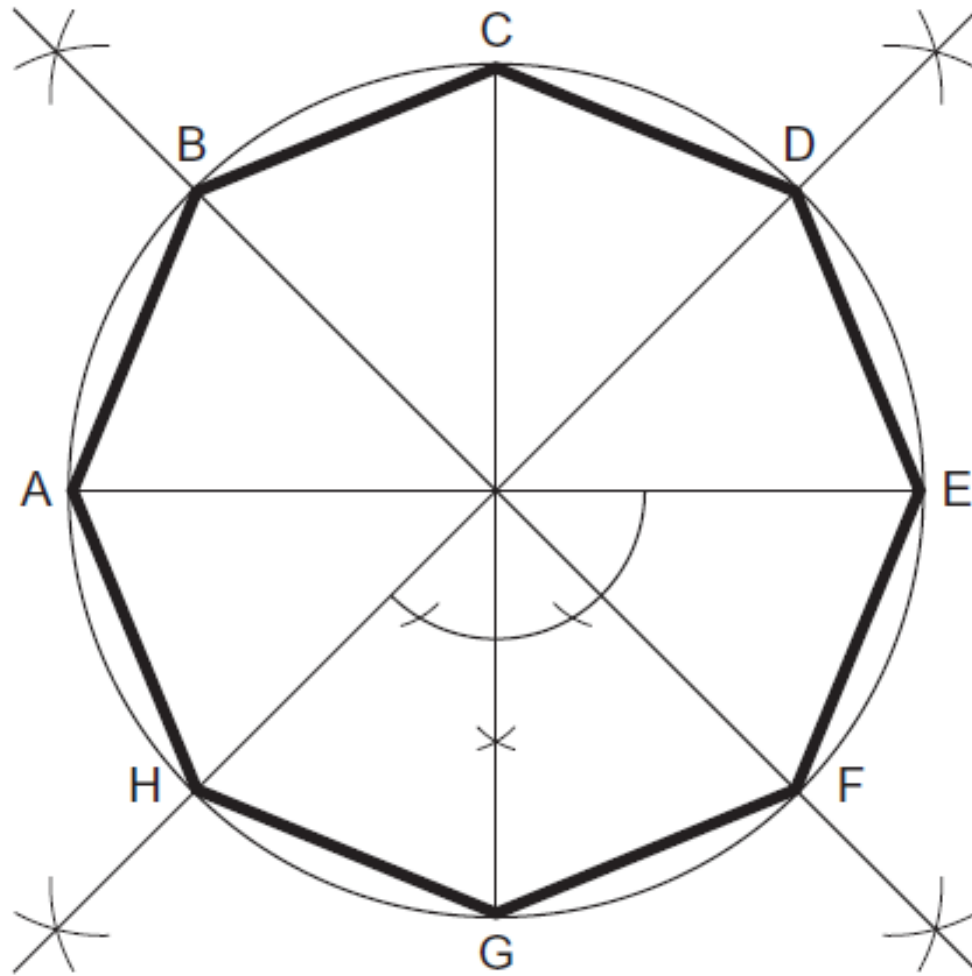
Pentagon



Hexagon



Octagon



Introduction to drafting

Tools available:

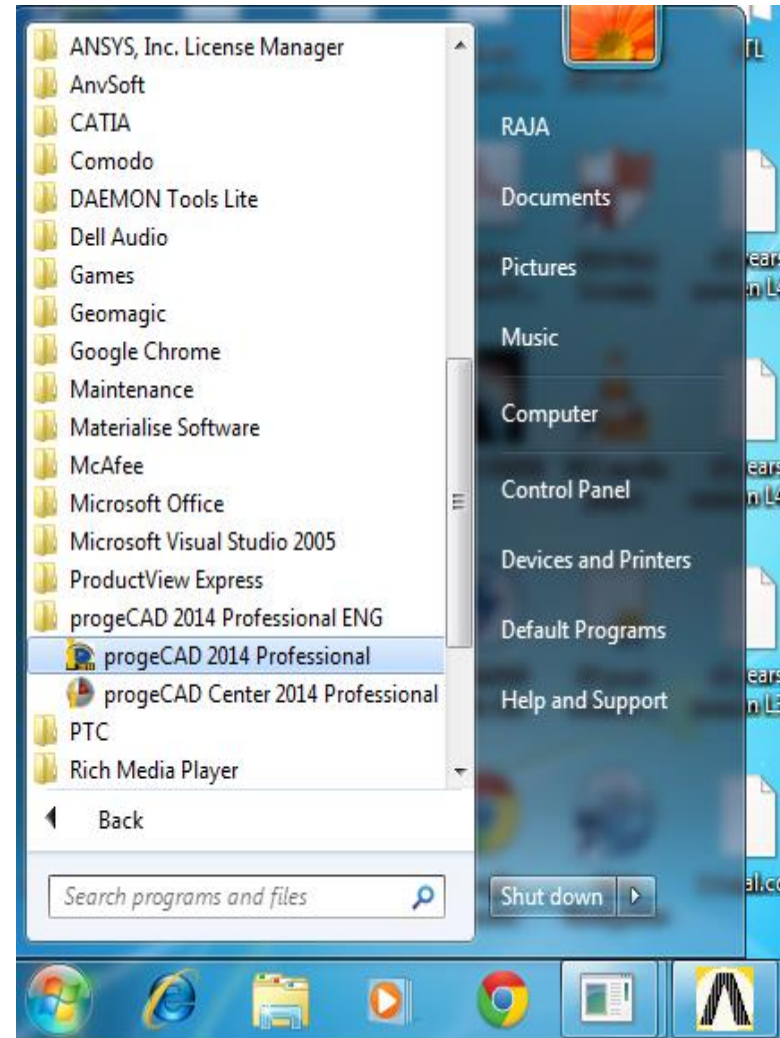
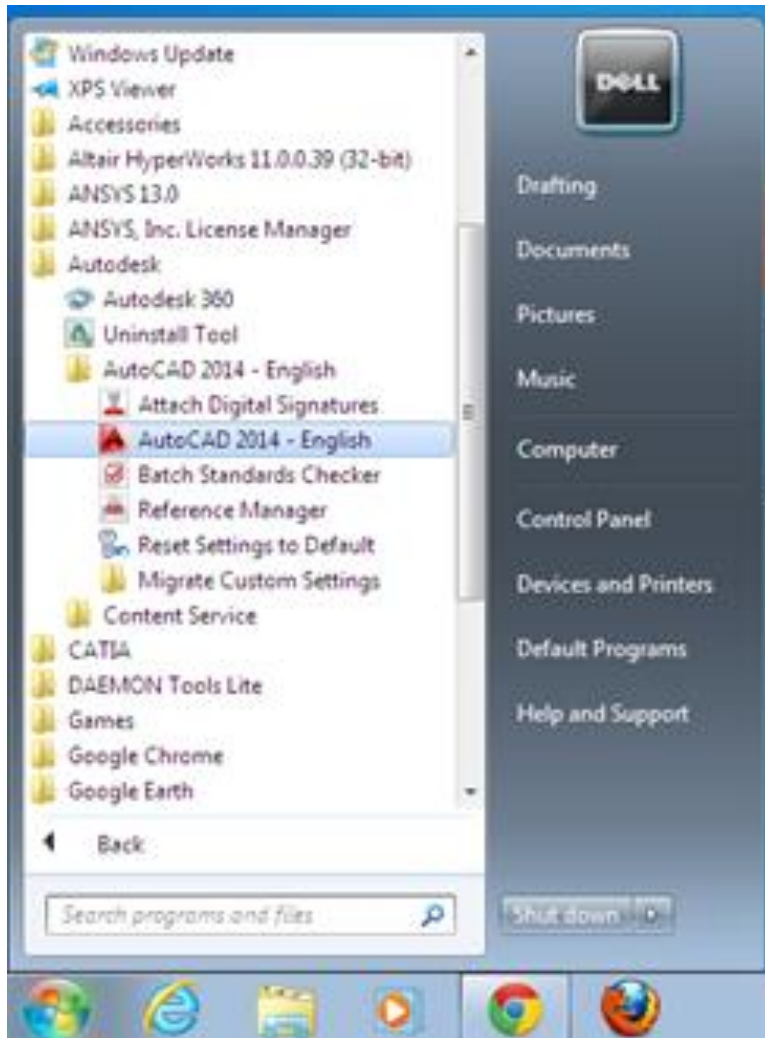
- AutoCAD 2014



- ProgeCAD 2014



Starting AutoCAD / ProgeCAD 2014



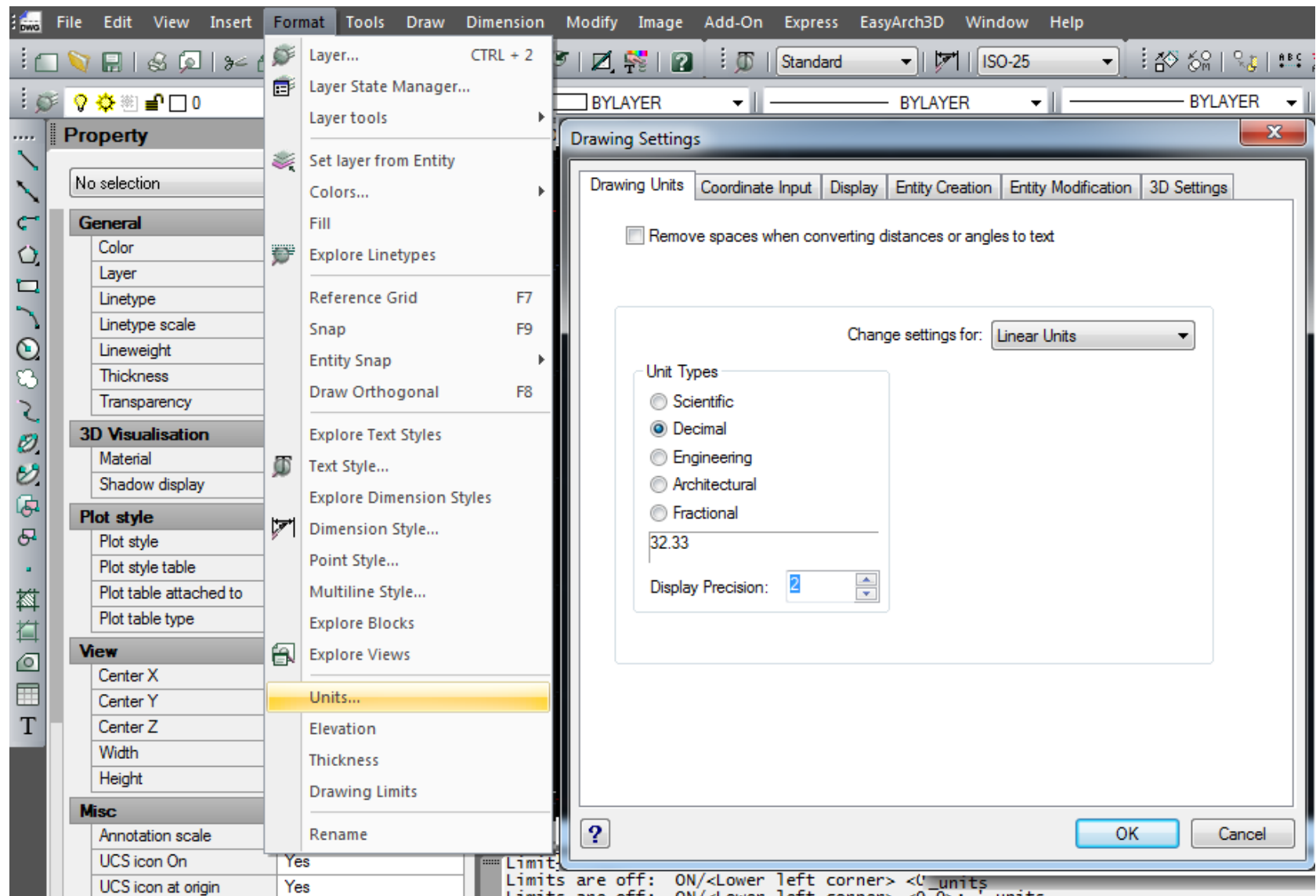
CAD Environment

- Menu bar
- Tool bar
- Command prompt

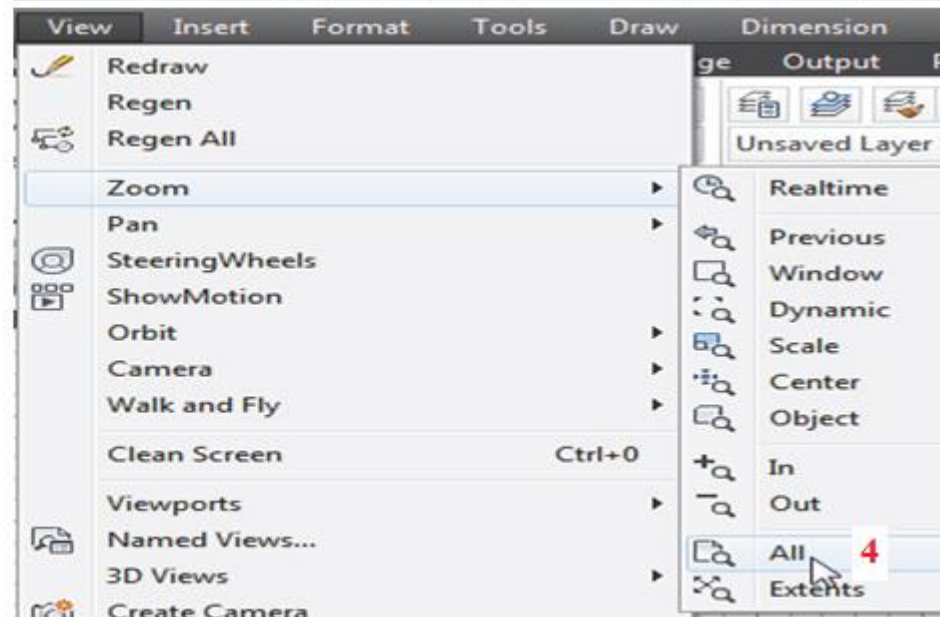
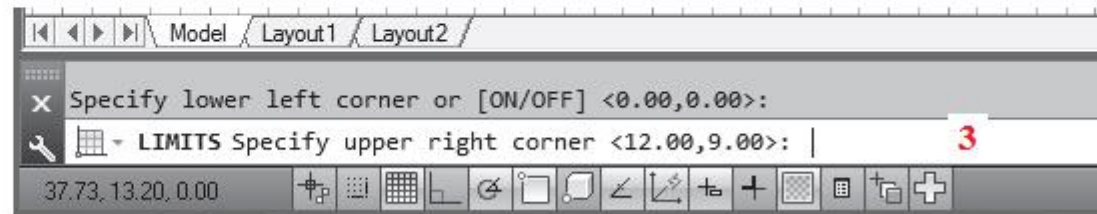
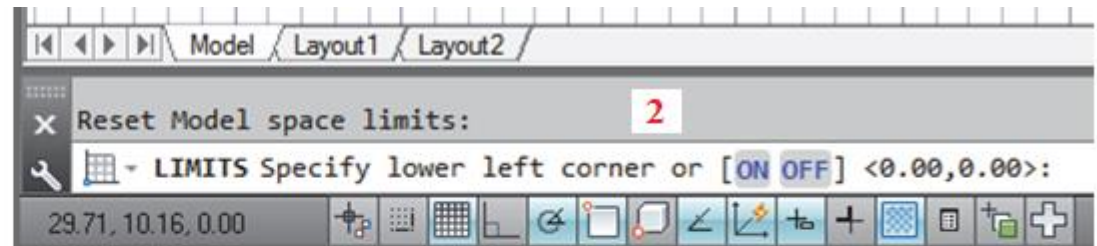
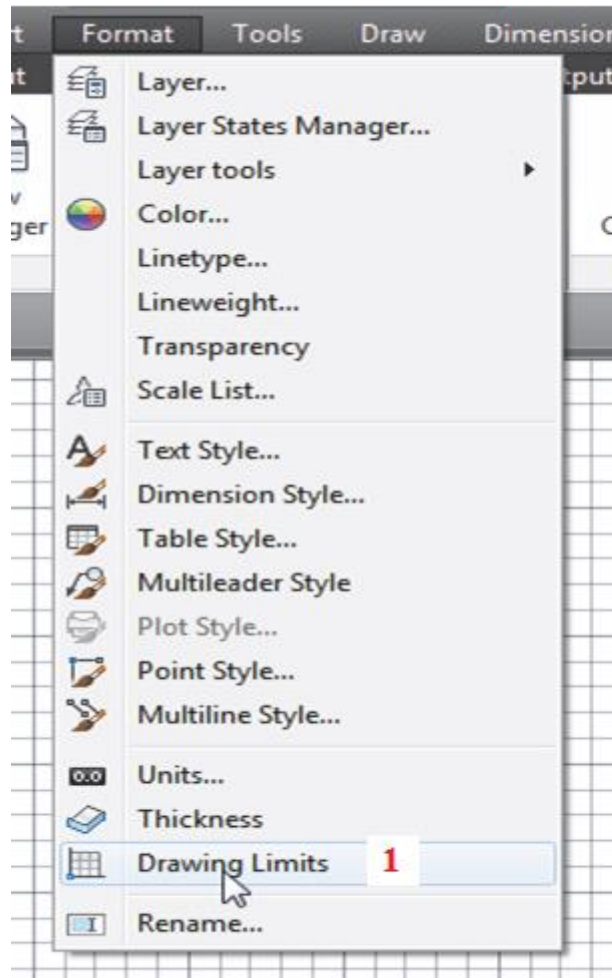
Setting up units

Every object constructed in a CAD system is measured in units, hence the system of units in the CAD system must be set before creating the first geometric entities.

Format – **Units** – **Decimal** – **Precision two digits**

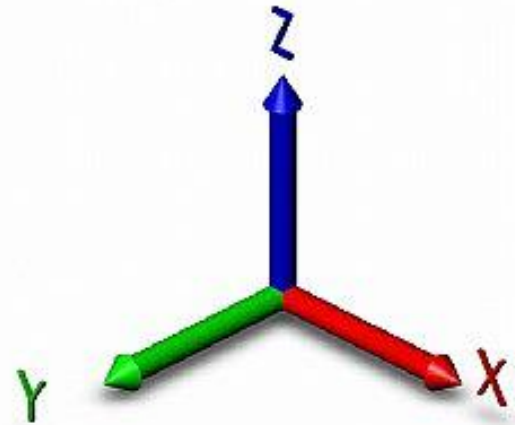


Setting up drawing area



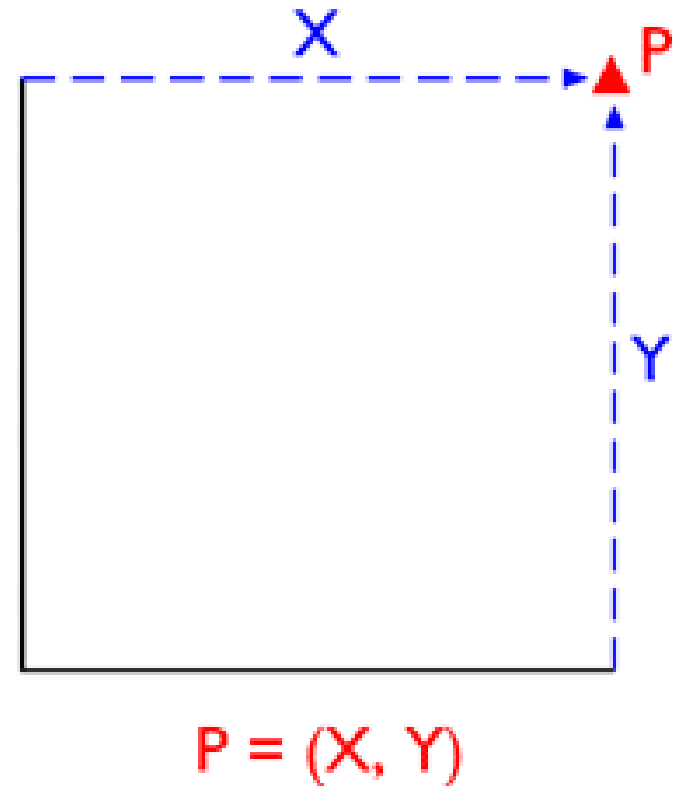
Coordinate systems

- Every point in space can be identified by its X, Y, Z coordinates. This system of coordinates is referred as the *world coordinate system*, or *WCS* in drafting package.
- The intersection of the three coordinate axes forms a point called the **origin**.
- The directions of the arrows shown on the axes identify the positive sides of the coordinates.



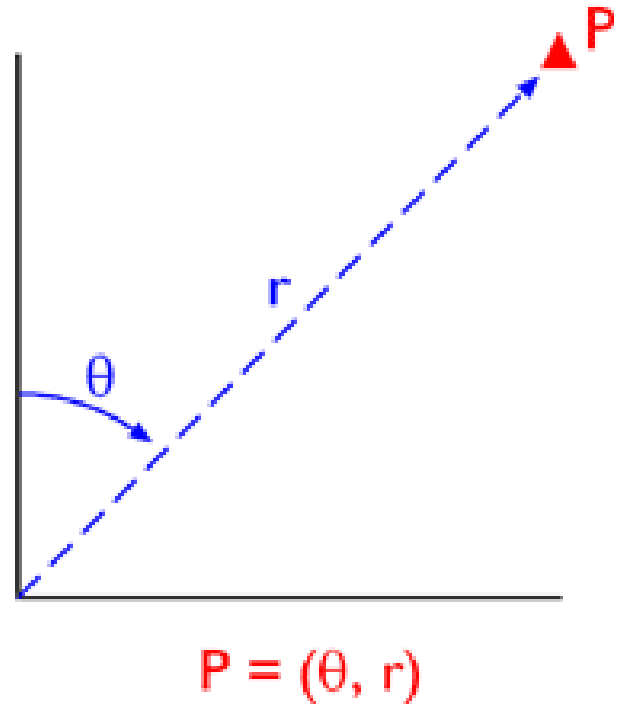
Cartesian Coordinate Systems

In 2 dimensional space, a point can be represented using different coordinate systems. The point can be located, using a Cartesian coordinate system, as X and Y units away from the origin.



Polar Coordinate Systems

In 2 dimensional space, a point can be represented as r and θ units away from the origin.



Defining positions

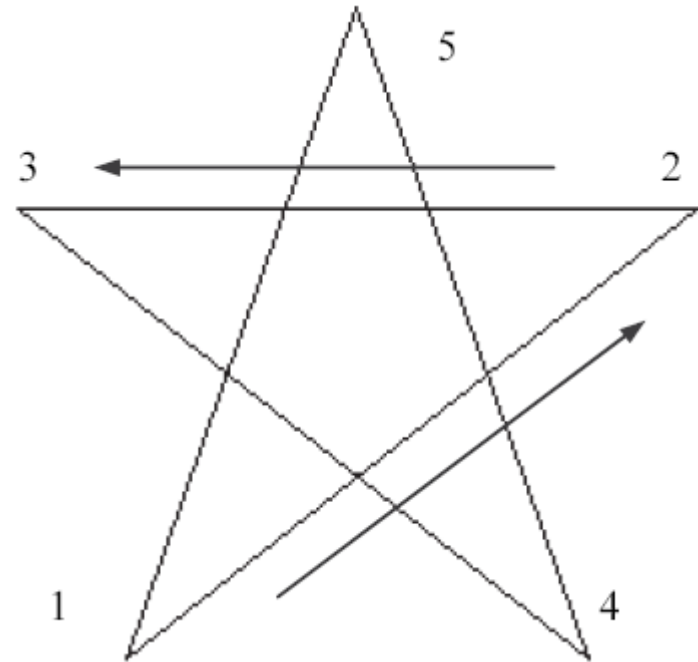
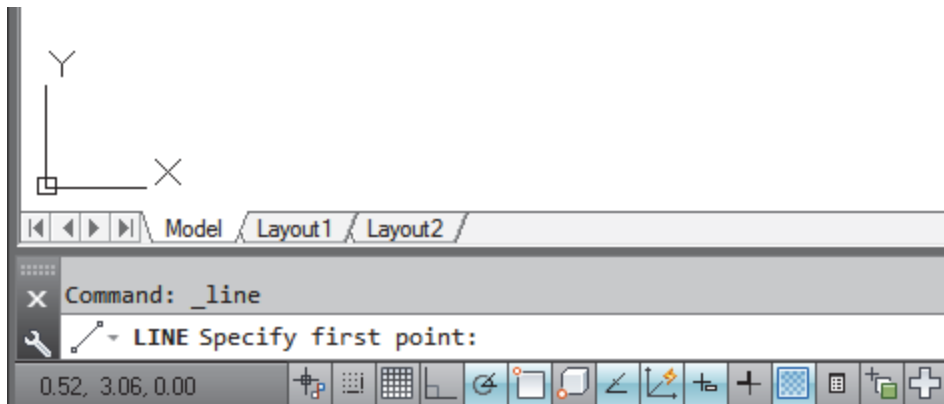
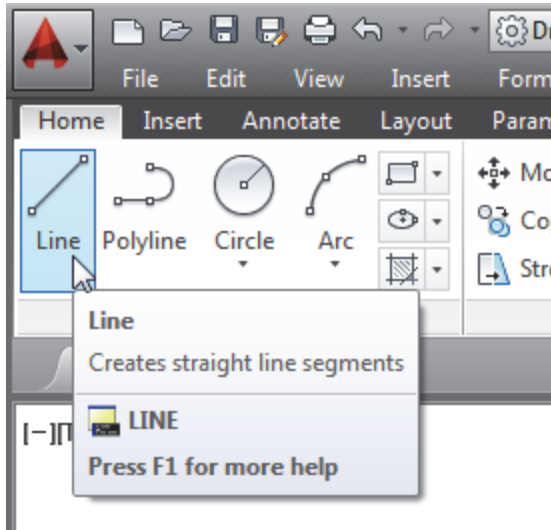
- **Interactive method:** Use the cursor to select on the screen.
- **Absolute coordinates** (Format: X,Y): Type the X and Y coordinates to locate the point on the current coordinate system relative to the origin.
- **Relative rectangular coordinates** (Format: @X,Y): Type the X and Y coordinates relative to the last point.
- **Relative polar coordinates** (Format: @Distance<angle): Type a distance and angle relative to the last point.
- **Direct Distance entry technique:** Specify a second point by first moving the cursor to indicate direction and then entering a distance.

Basic entities in drafting

- Line
- Arc
- Circle

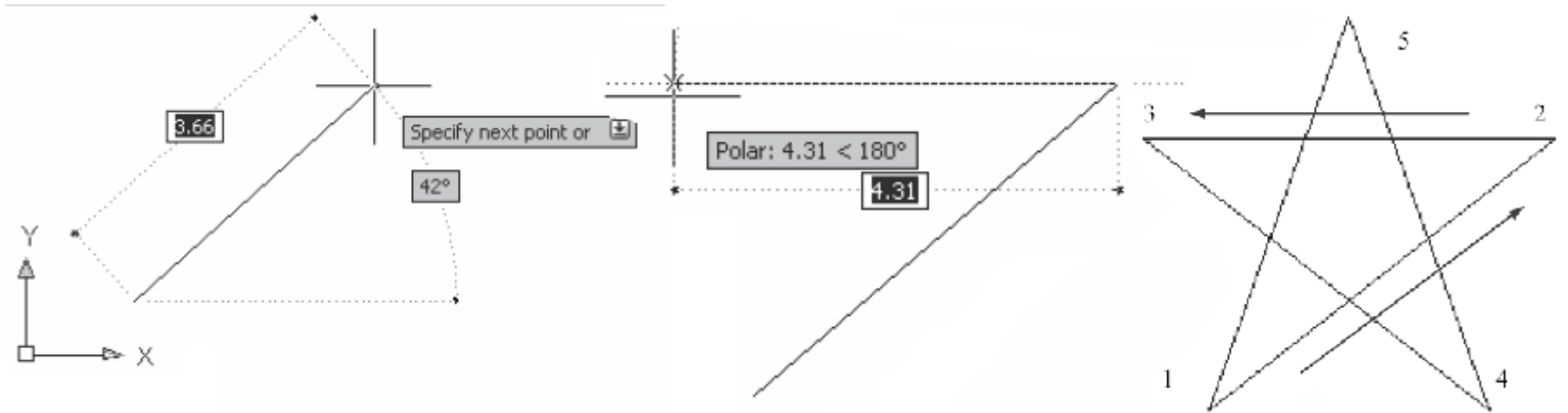
Line

By free hand sketch



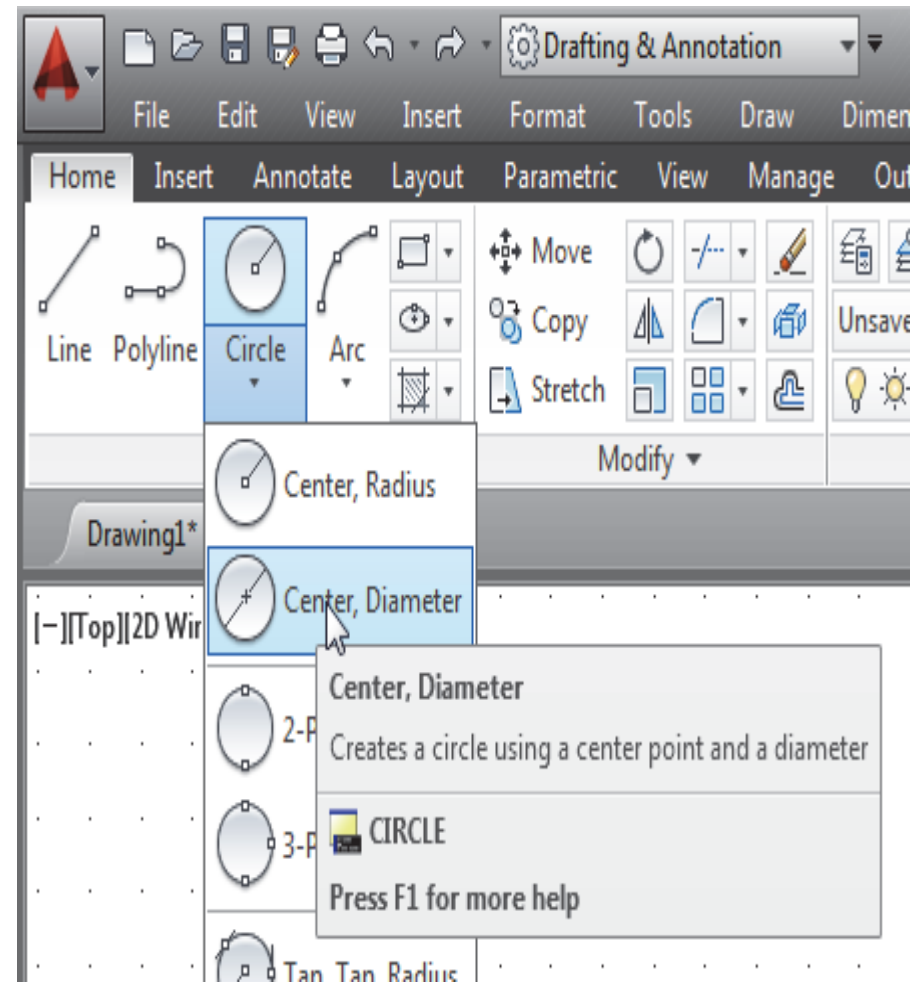
Line

- By polar coordinates

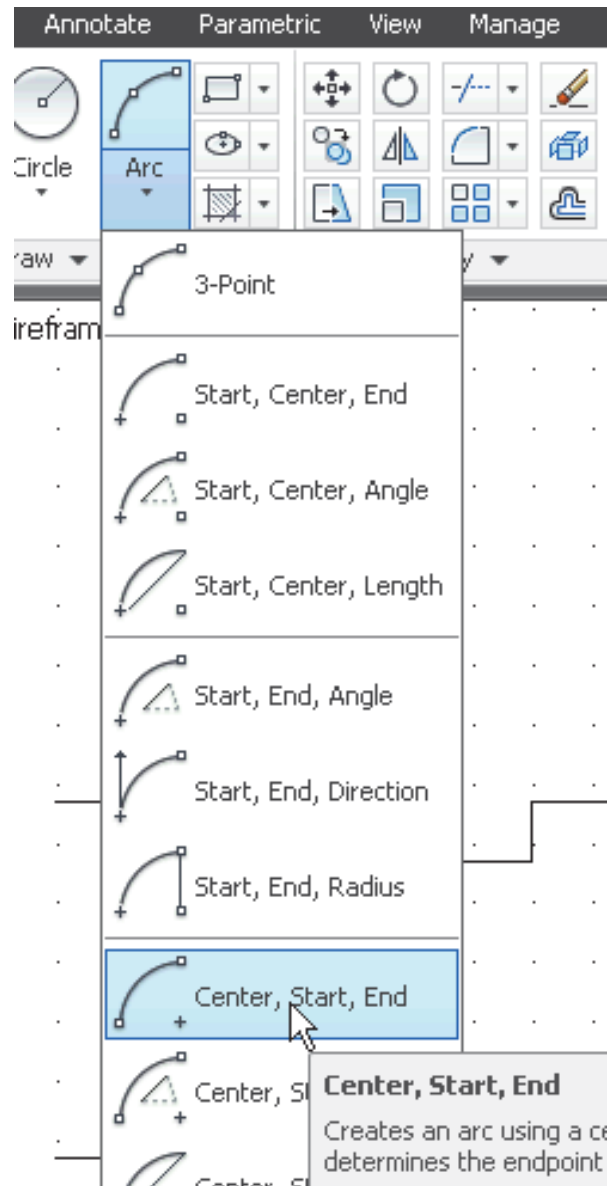


Circle

- **Center, Radius:** Draws a circle based on a center point and a radius.
- **Center, Diameter:** Draws a circle based on a center point and a diameter.
- **2 Points:** Draws a circle based on two endpoints of the diameter.
- **3 Points:** Draws a circle based on three points on the circumference.
- **TTR–Tangent, Tangent, Radius:** Draws a circle with a specified radius tangent to two objects.
- **TTT–Tangent, Tangent, Tangent:** Draws a circle tangent to three objects.



Arc



‘Modify’ Commands in drafting tool

- Fillet
- Chamfer
- Array
- Trim
- Extend
- Mirror
- Scale
- Divide
- Rotate
- Break
- Join
- Explode

Fillet

Command: FILLET  Fillet

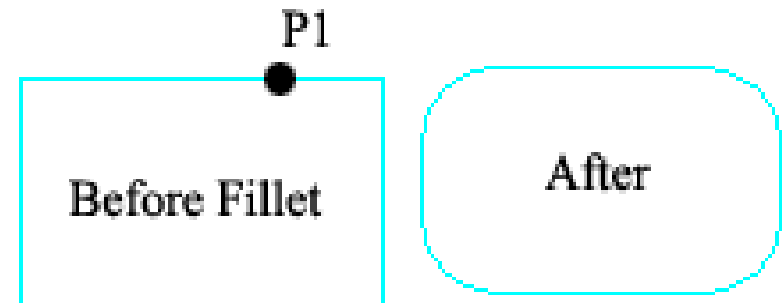
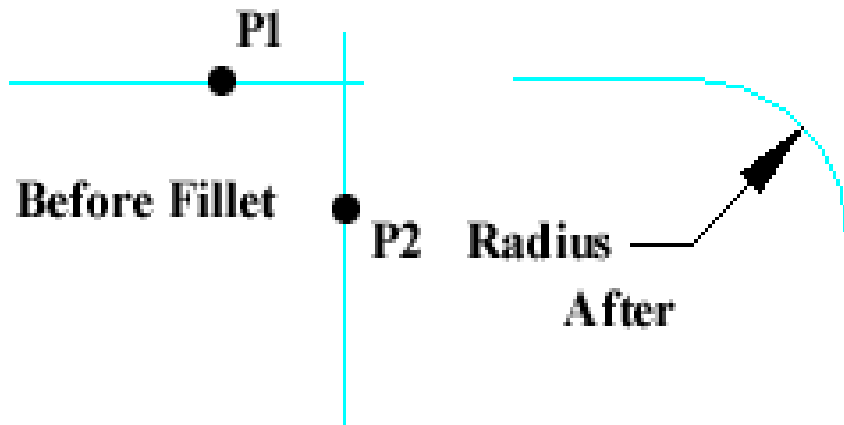
Current settings: Mode = TRIM, Radius = 10.0000

Select first object or [Polyline/Radius/Trim]: R

Specify fillet radius <10.000>: 25

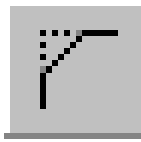
Select first object or [Polyline/Radius/Trim]: (pick P1)

Select second object : (pick P2)



Chamfer

Command: **CHAMFER**



(TRIM mode) Current chamfer Dist1 = 10.0000, Dist2 = 10.0000

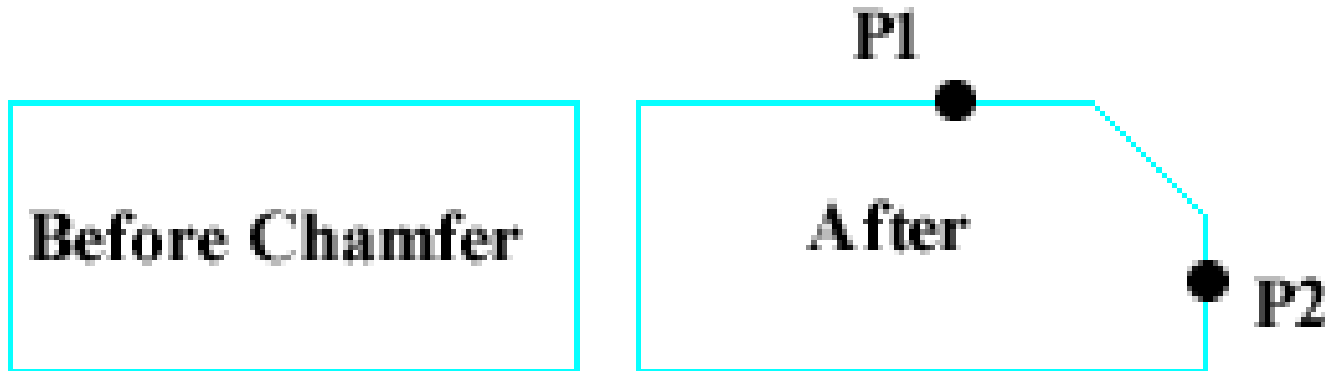
Select first line or [Polyline/Distance/Angle/Trim/Method]: D (to set distances)

Specify first chamfer distance <10.0000>: 20 (enter required distance)

Specify second chamfer distance <20.0000>: (first distance value or enter a different value)

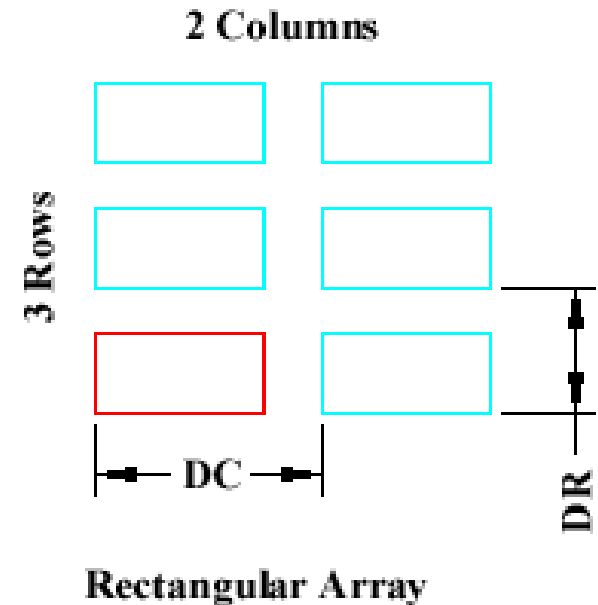
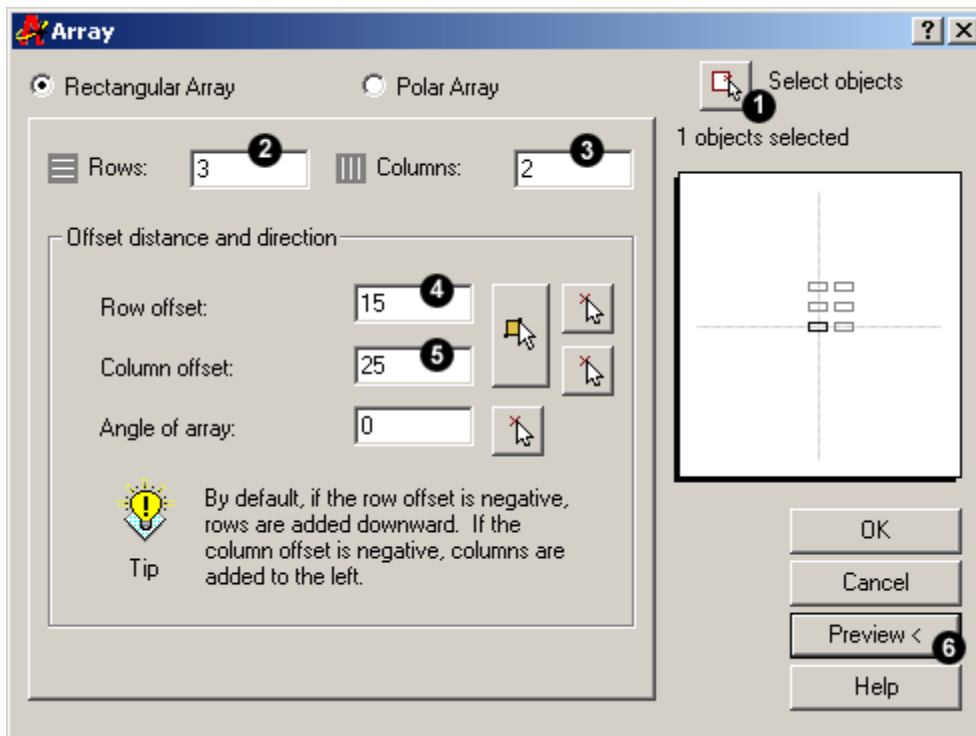
Select first line or [Polyline/Distance/Angle/Trim/Method]: (pick P1)

Select second line: (pick P2)

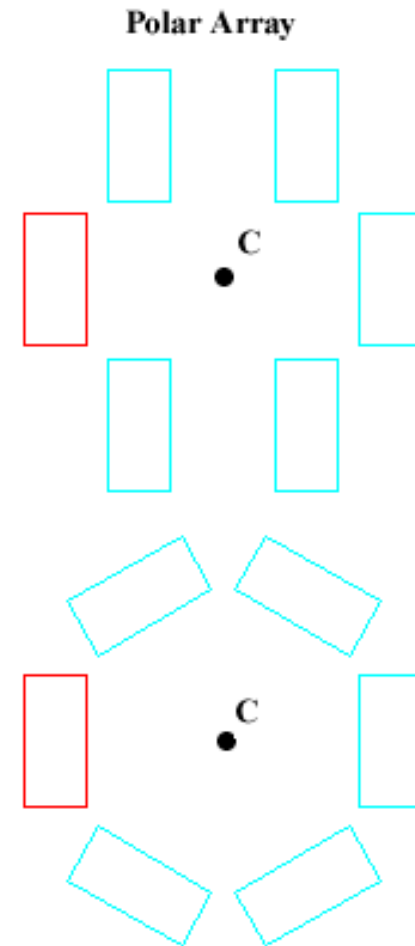
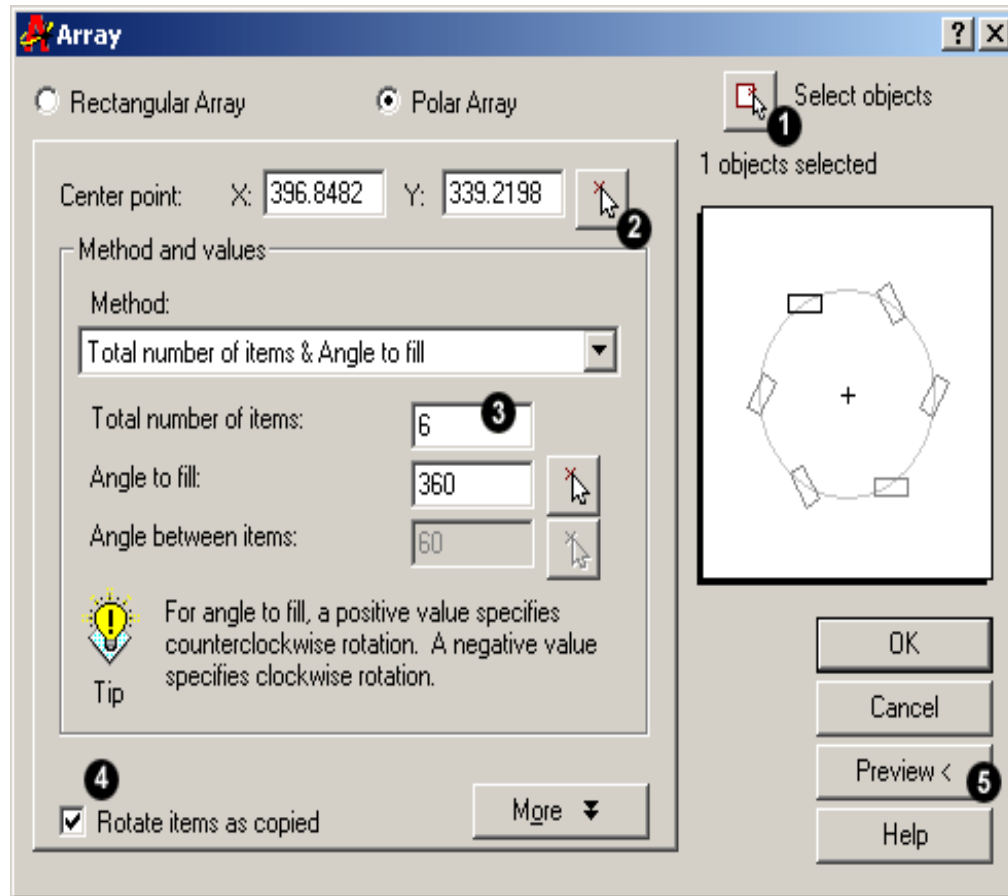


Array

Rectangular array:

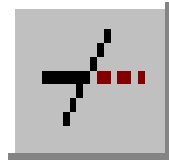


Polar Array



Trim

Command: **TRIM**



Current settings: Projection=UCS Edge=None

Select cutting edges ...

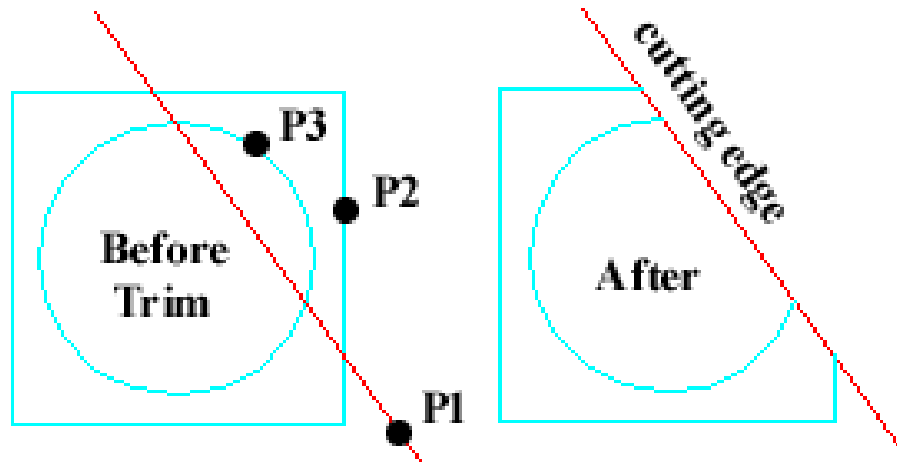
Select objects: (select the cutting edge, P1)

Select objects: (to end cutting edge selection)

Select object to trim or shift-select to extend or [Project/Edge/Undo]: (pick the part of the square which you want to trim, P2)

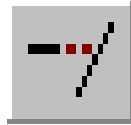
Select object to trim or shift-select to extend or [Project/Edge/Undo]: (pick the circle, P3)

Select object to trim or shift-select to extend or [Project/Edge/Undo]: ↵ (to end)



Extend

Command: **EXTEND**



Current settings: Projection=UCS Edge=None

Select boundary edges ...

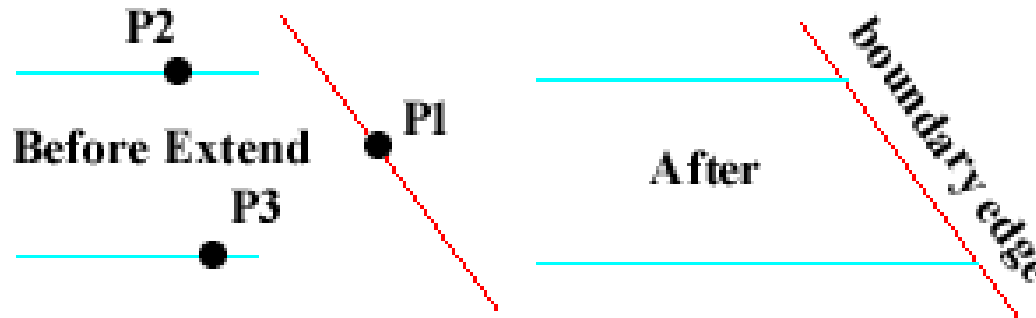
Select objects: (select the boundary edge, P1)

Select objects: (to end boundary edge selection)

Select object to extend or shift-select to trim or [Project/Edge/Undo]: (pick the object which you want to be extended, P2)

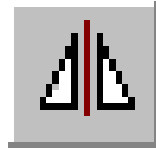
Select object to extend or shift-select to trim or [Project/Edge/Undo]: (pick another object which you want to be extended, P3)

Select object to extend or shift-select to trim or [Project/Edge/Undo]: (to end)



Mirror

Command: **MIRROR**




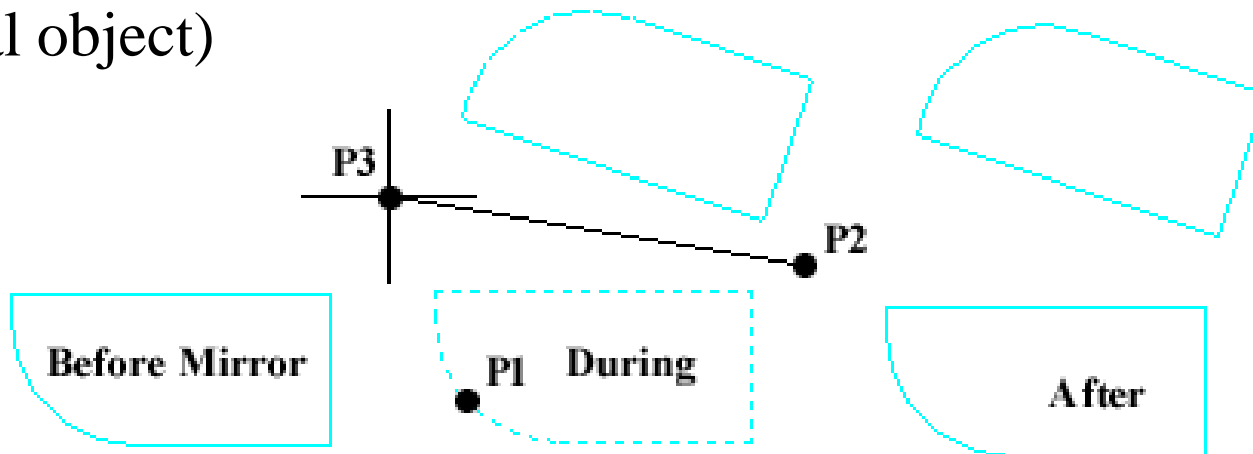
Select objects: (pick object to mirror, P1)

Select objects:  (to end selection)

Specify first point of mirror line: (pick P2)

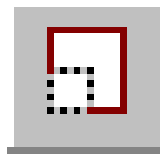
Specify second point of mirror line: (pick P3)

Delete source objects? [Yes/No] <N>:  (for No to keep the original object)



Scale

Command: SCALE

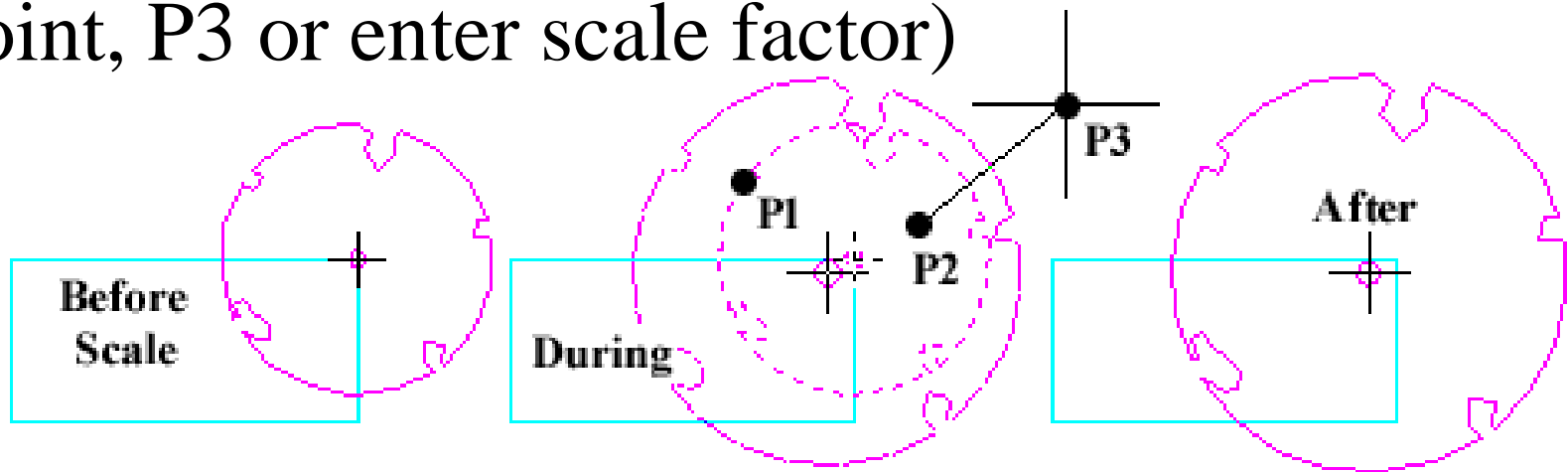


Select objects: (pick objects to be scaled, P1)

Select objects: ↵ (to end selection)

Specify base point: (pick base point, P2)

Specify scale factor or [Reference]: (pick second point, P3 or enter scale factor)



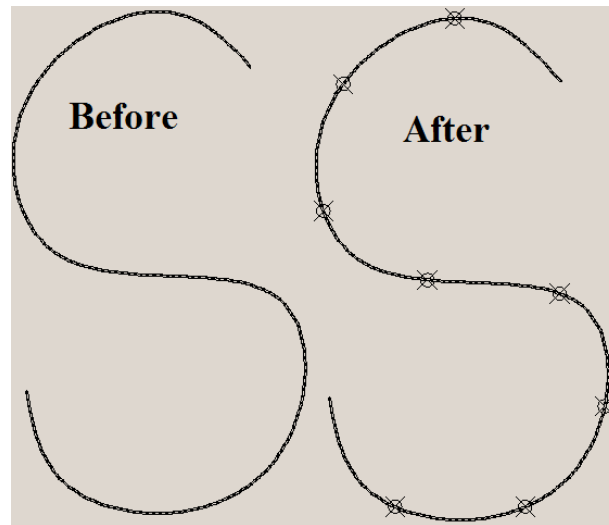
Divide

Command: DIVIDE



Select Object to Divide: Select objects

Number of Segments: 9



Rotate

Command: **ROTATE** 

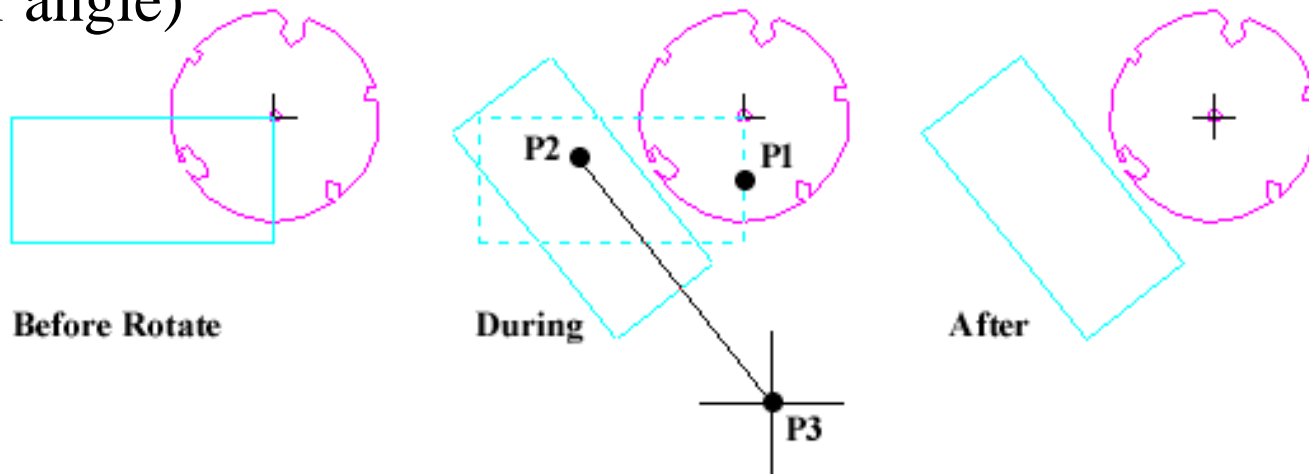
Current positive angle in UCS: ANGDIR=counterclockwise
ANGBASE=0

Select objects: (pick object to rotate, P1)

Select objects: (to end selection)

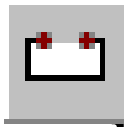
Specify base point: (pick base point, P2)

Specify rotation angle or [Reference]: (pick second point, P3 or enter angle)



Break

Command: **BREAK**



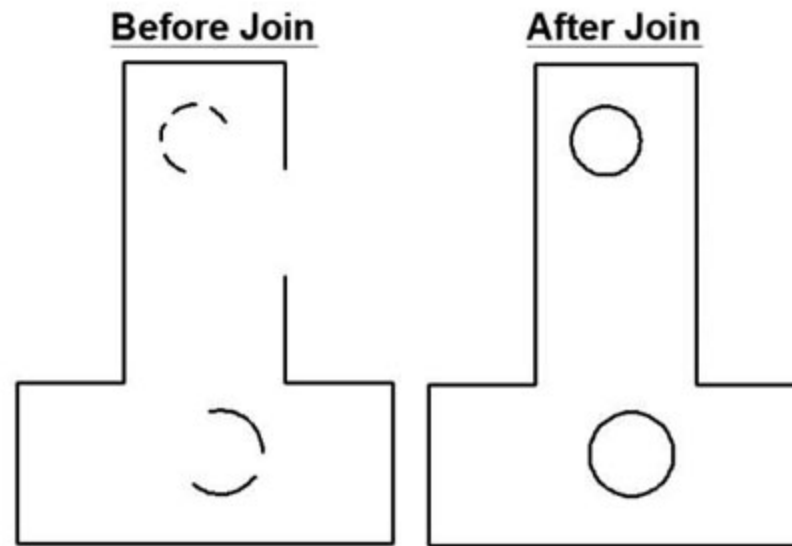
Select objects: (select the object using the first break point, P1)

Specify second break point or [First point]: (pick the second break point, P2)



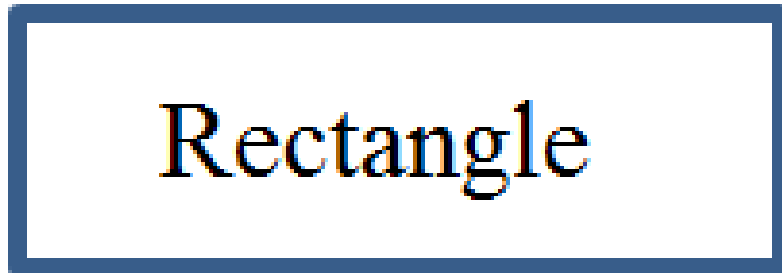
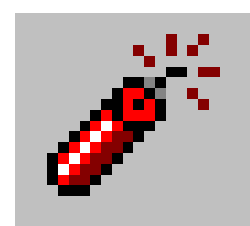
Join

- Joins two disconnected entities

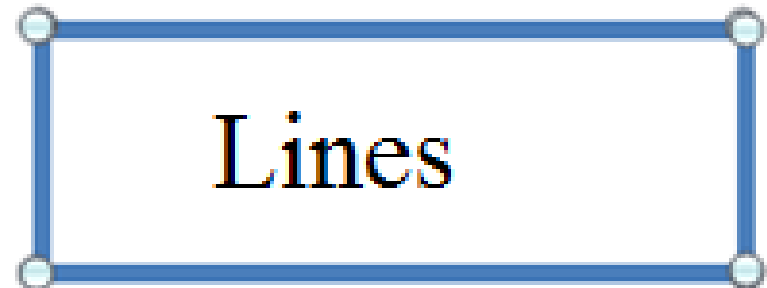


Explode

Changes a grouped item into its individual elements so it can be edited



Before



After

MOVE

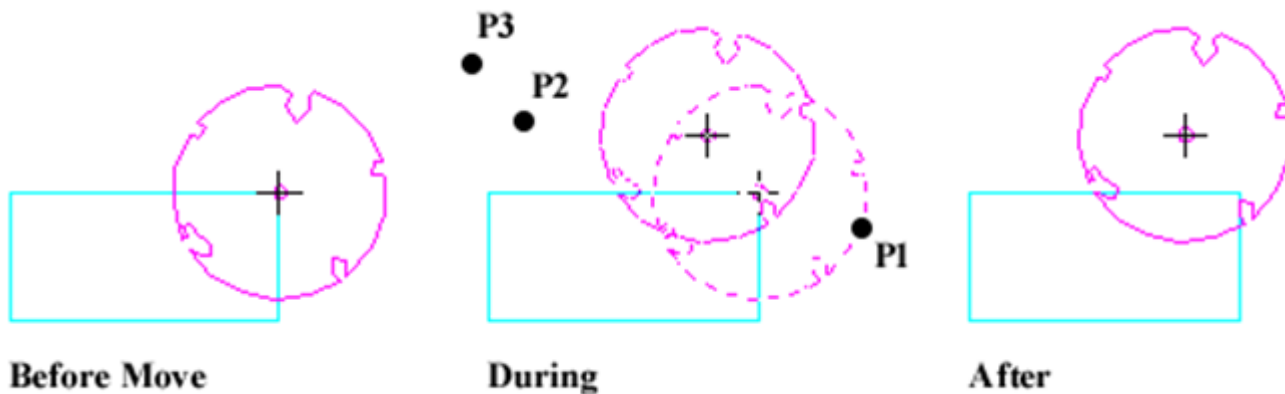
Command: MOVE

Select objects: (pick object to move, P1)

Select objects: (to end selection)

Specify base point or displacement: (pick P2)

Specify second point of displacement or <use first point as displacement>: (pick P3)



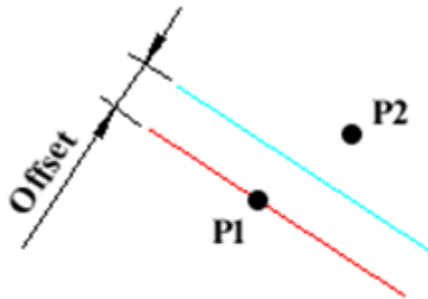
OFFSET

Specify offset distance or [Through] <1.0000>: 10
(specify distance)

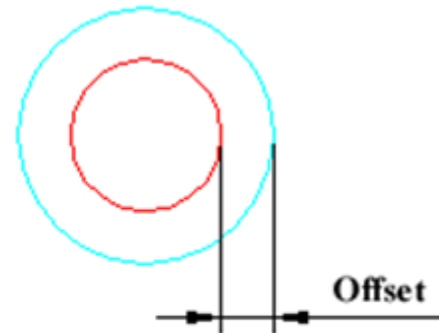
Select object to offset or <exit>: (select object, P1)

Specify point on side to offset: (pick direction, P2)

Select object to offset or <exit>: ↵ (to end or select another object to offset)



Offsetting a Line



Offsetting a Circle

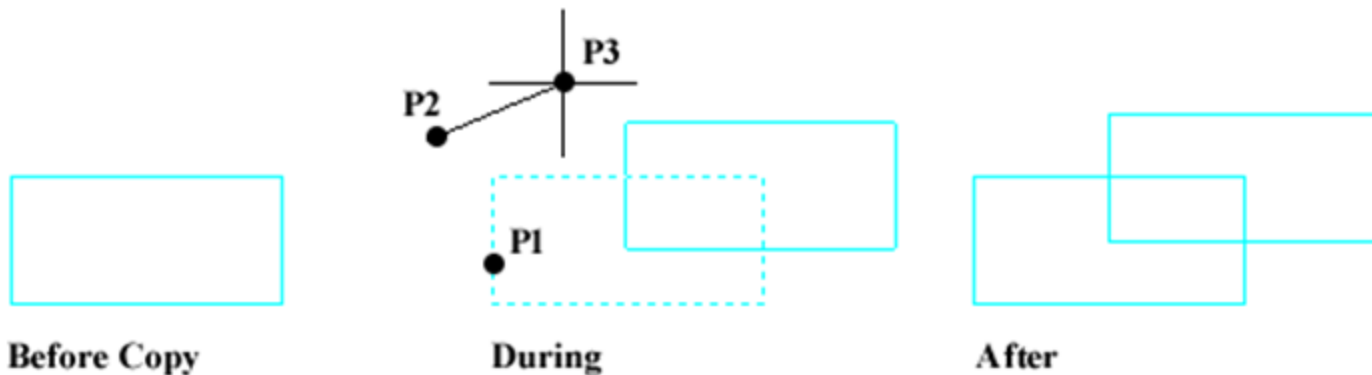
Copy

Select objects: (pick object to copy, P1)

Select objects: (to end selection)

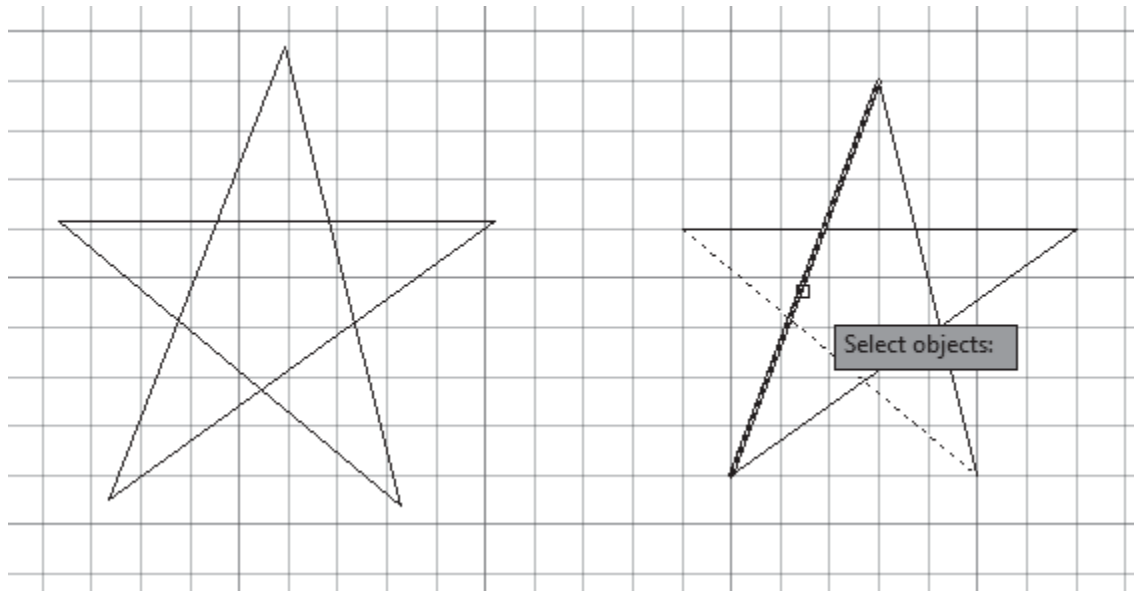
Specify base point or displacement, or [Multiple]: (pick P2 or M for multiple copies)

Specify second point of displacement or <use first point as displacement>: (pick P3)

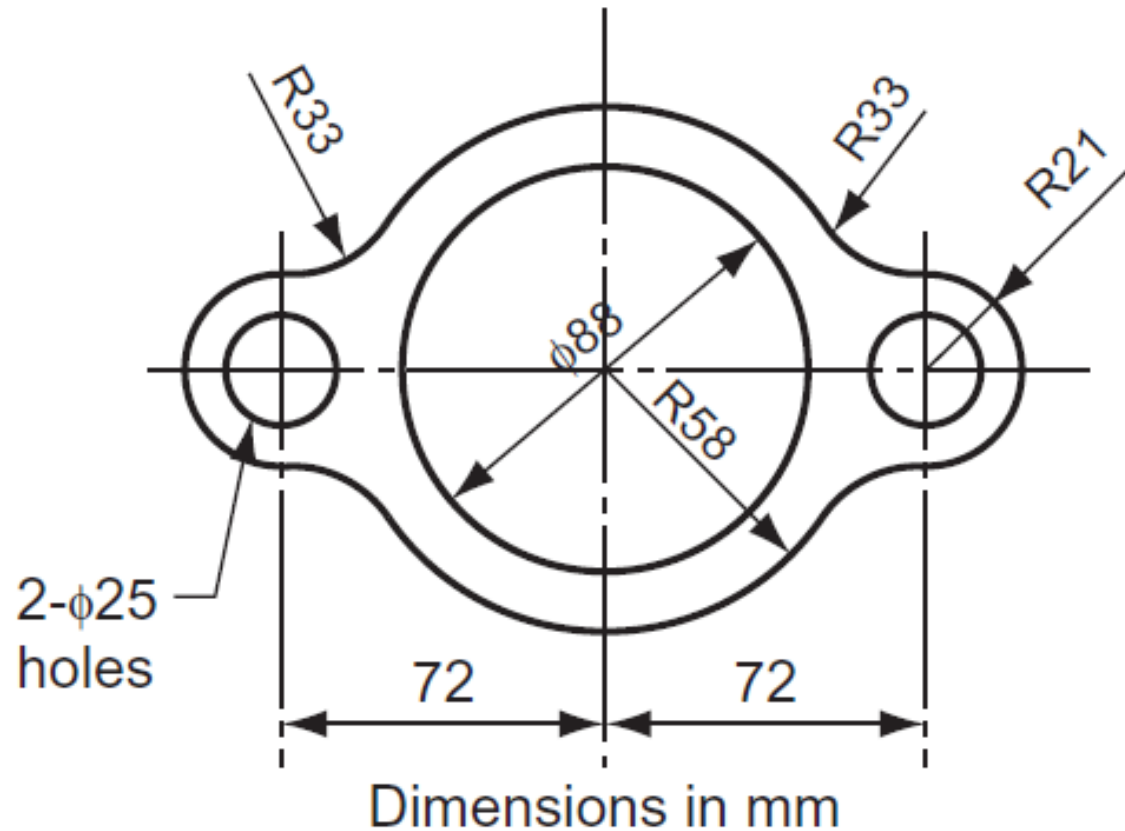


Erase

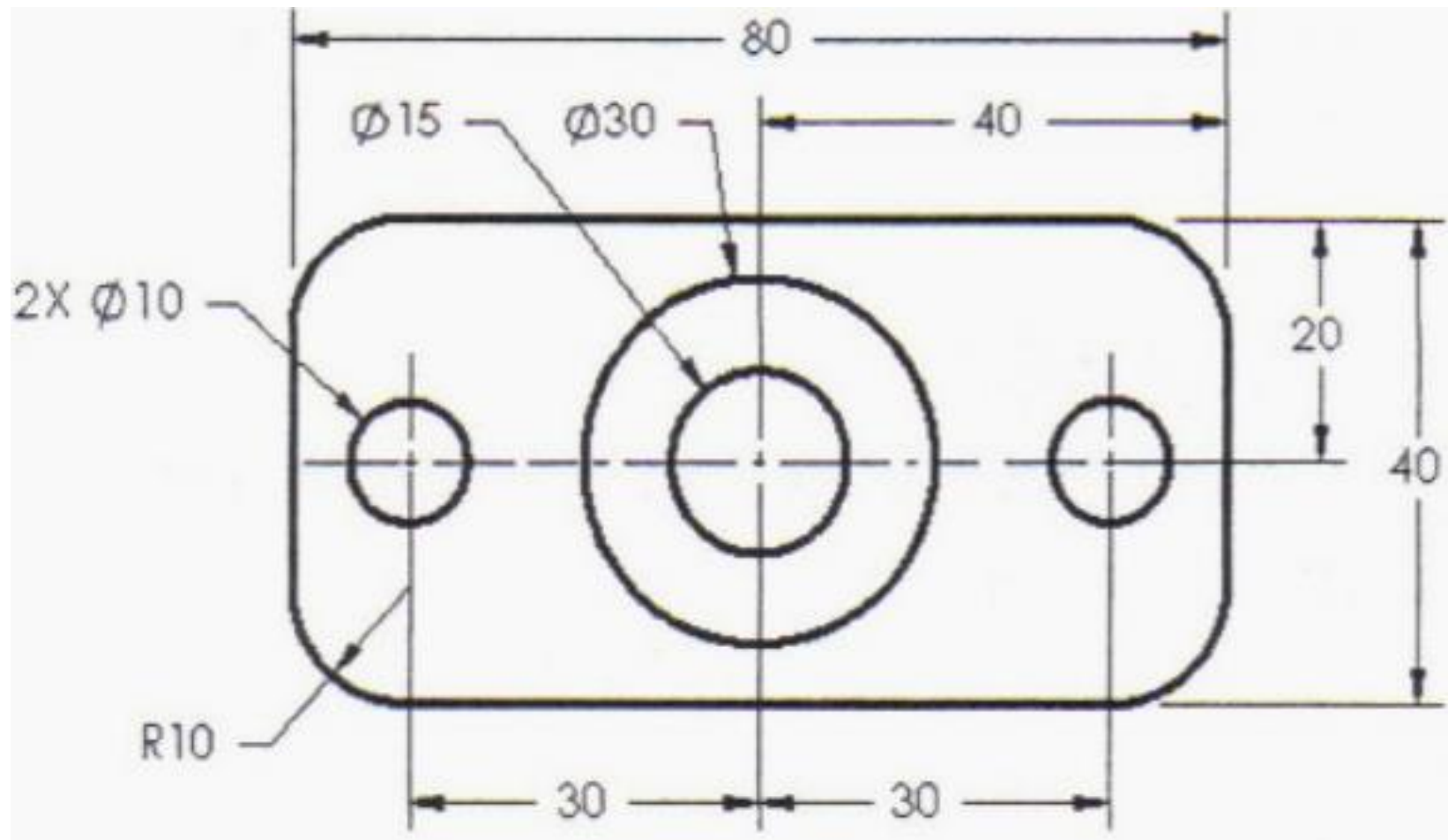
- Select objects: (pick an object to erase)



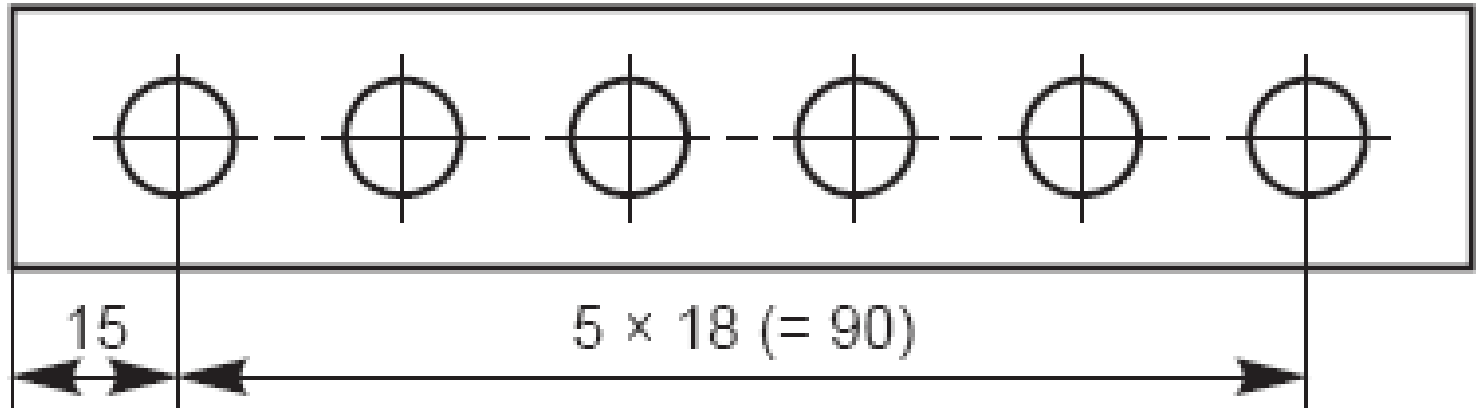
Practice problem – 1



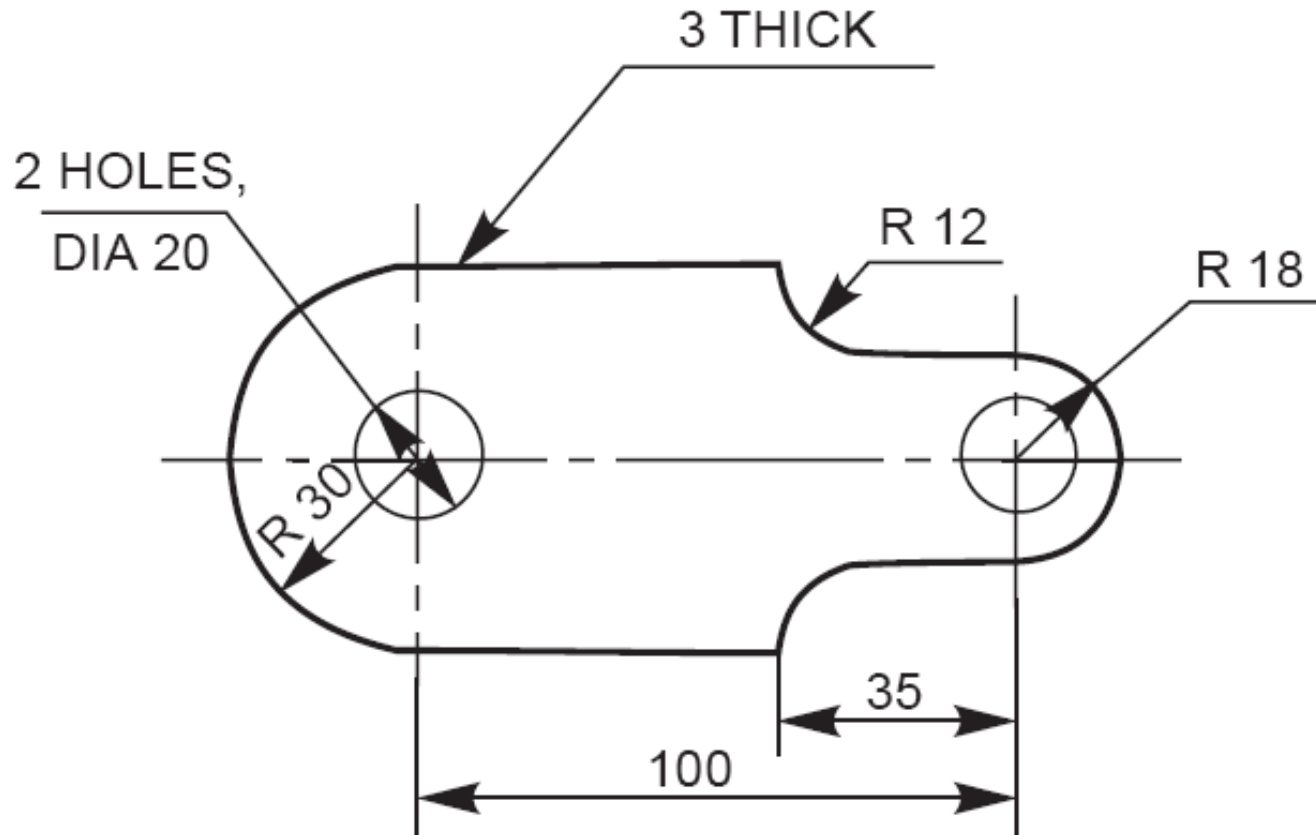
Practice problem – 2



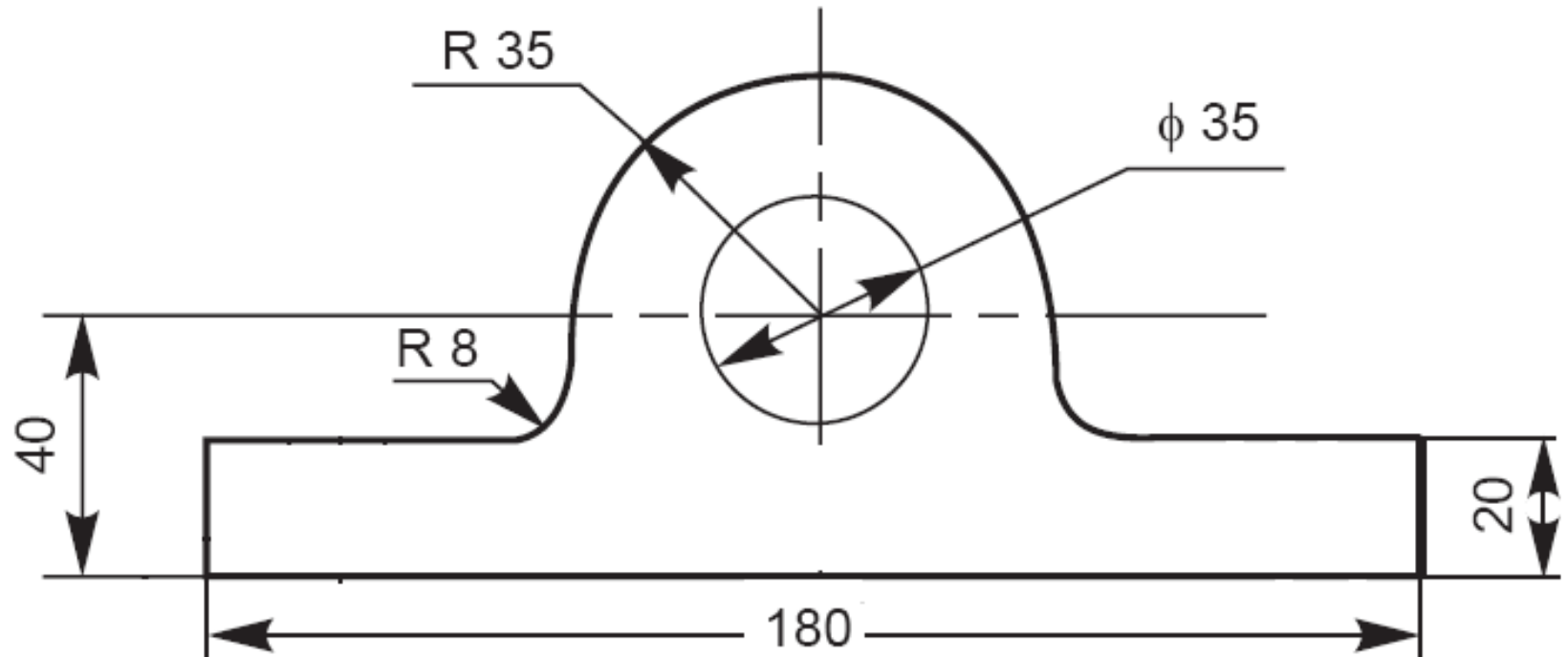
Practice problem – 3



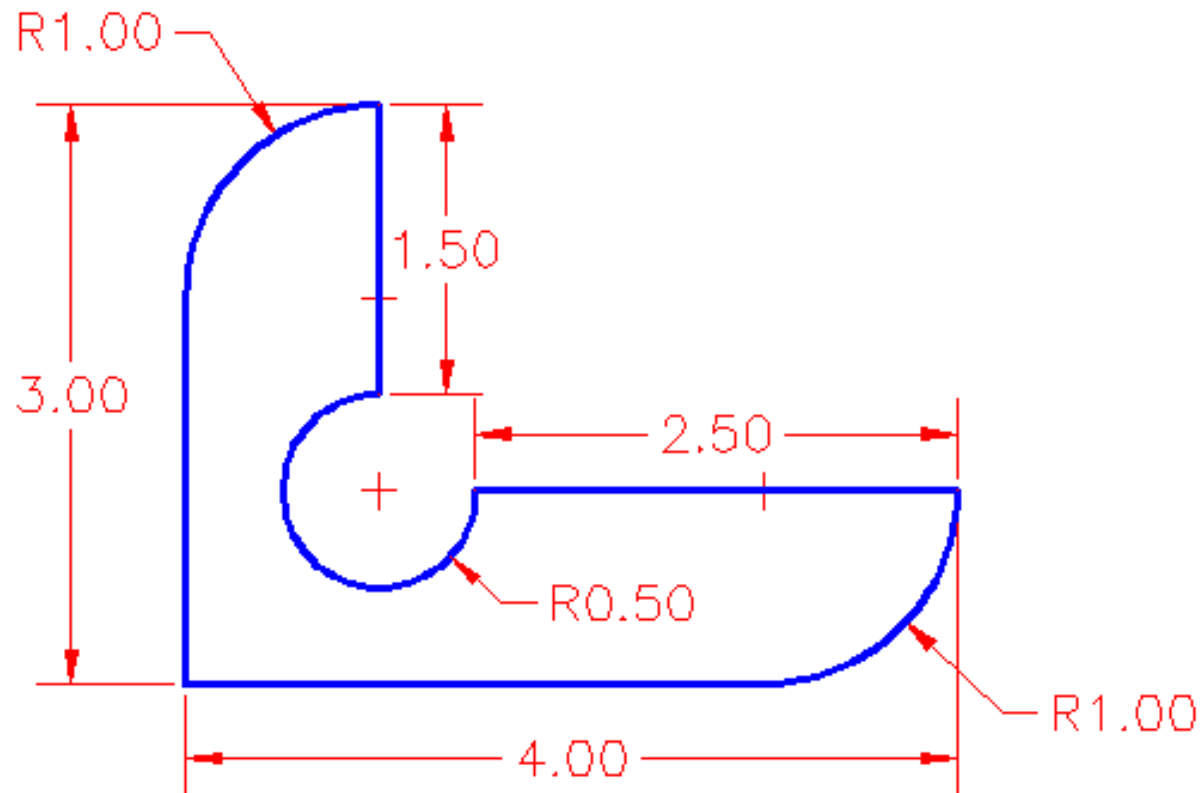
Practice problem – 4



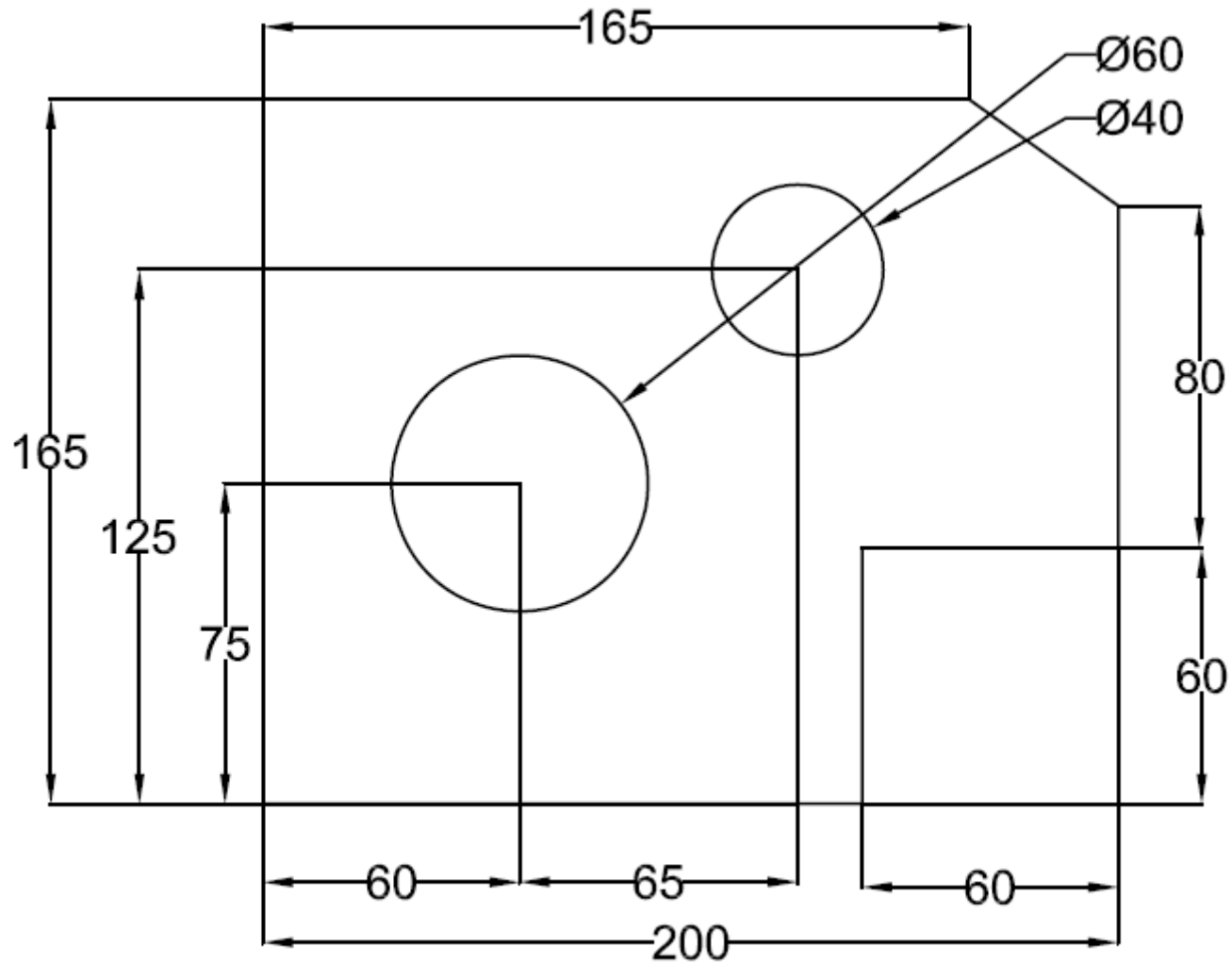
Practice problem – 5



Practice problem – 6

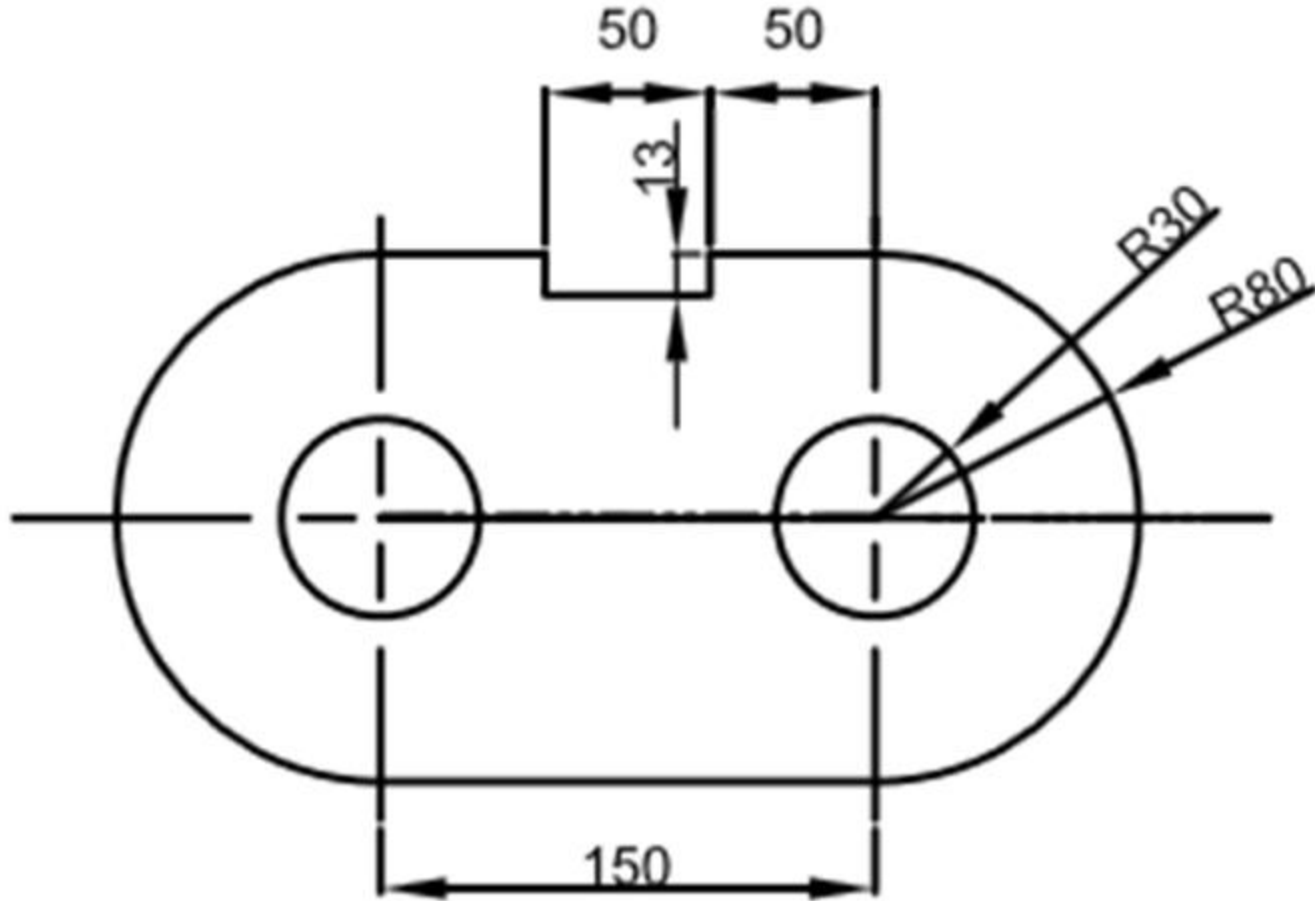


Practice problem – 1



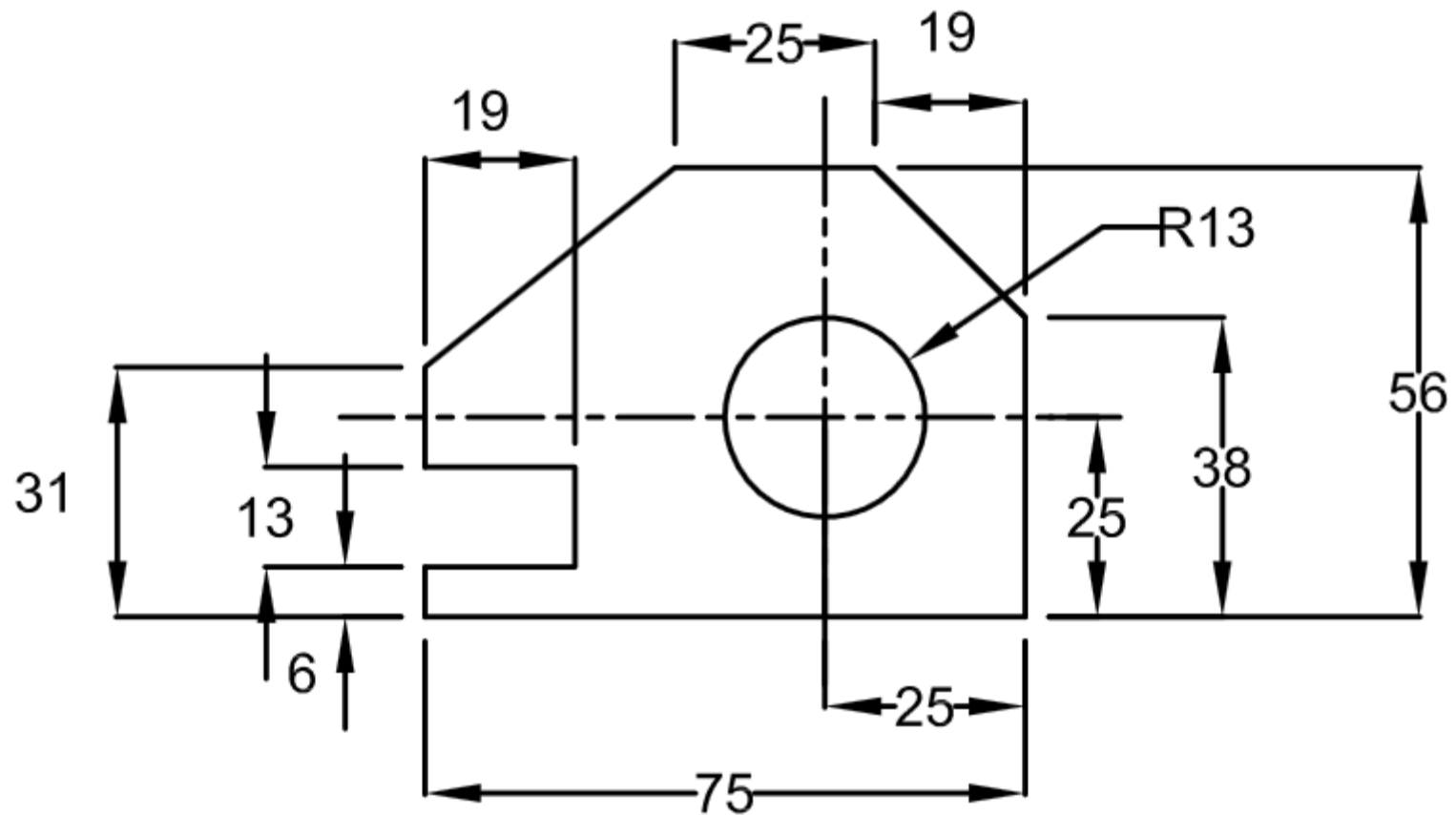
All dimensions are in 'mm'

Practice problem – 2



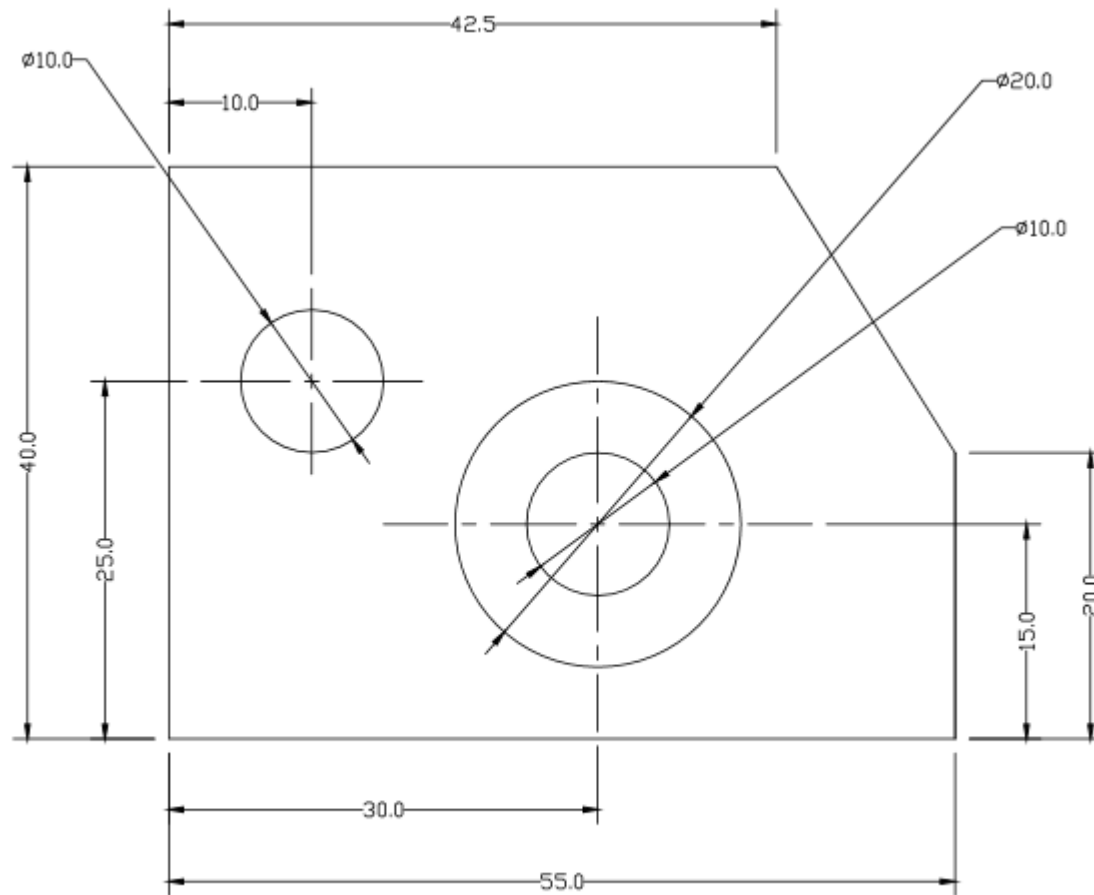
All dimensions are in 'mm'

Practice problem – 3



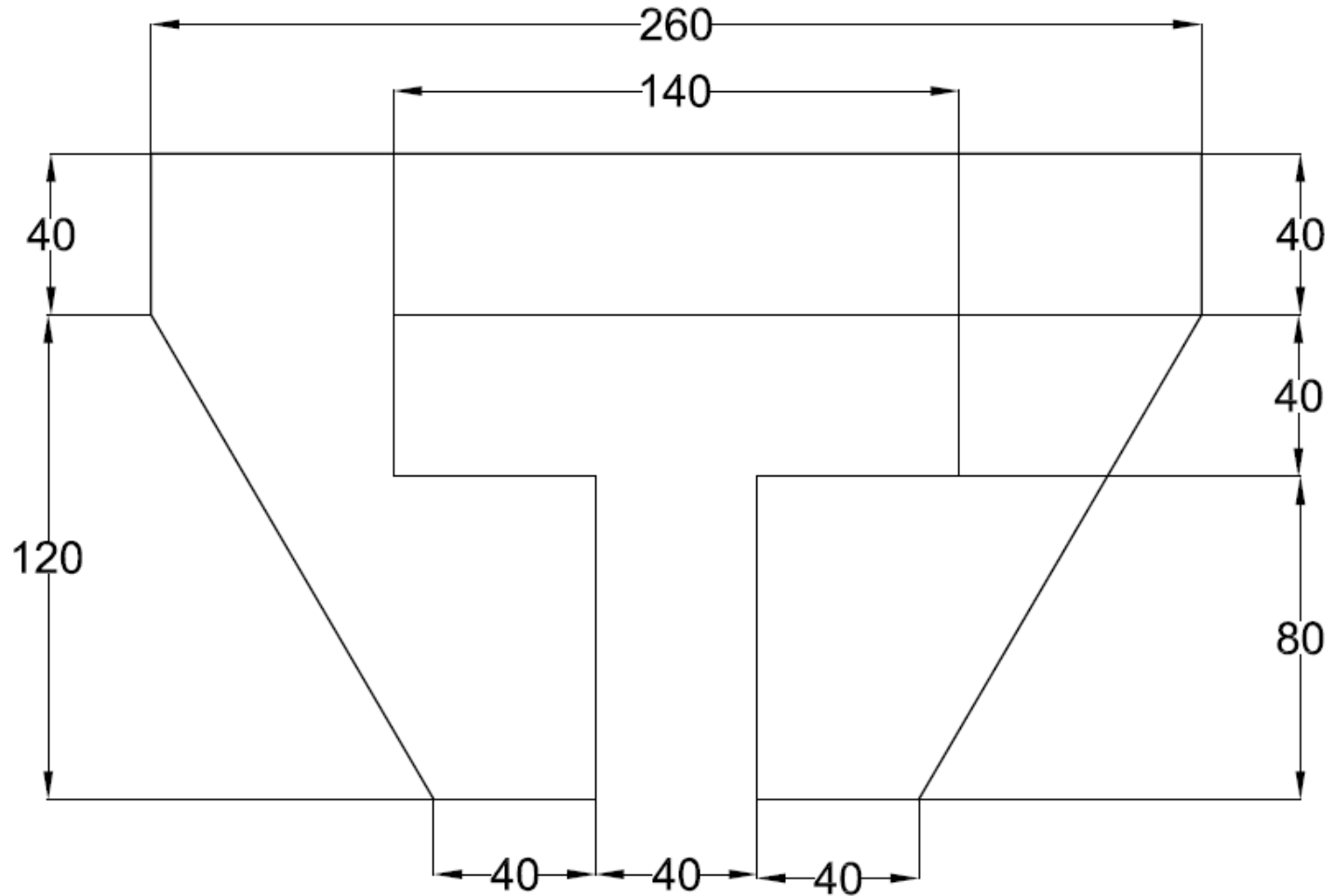
All dimensions are in 'mm'

Practice problem – 4



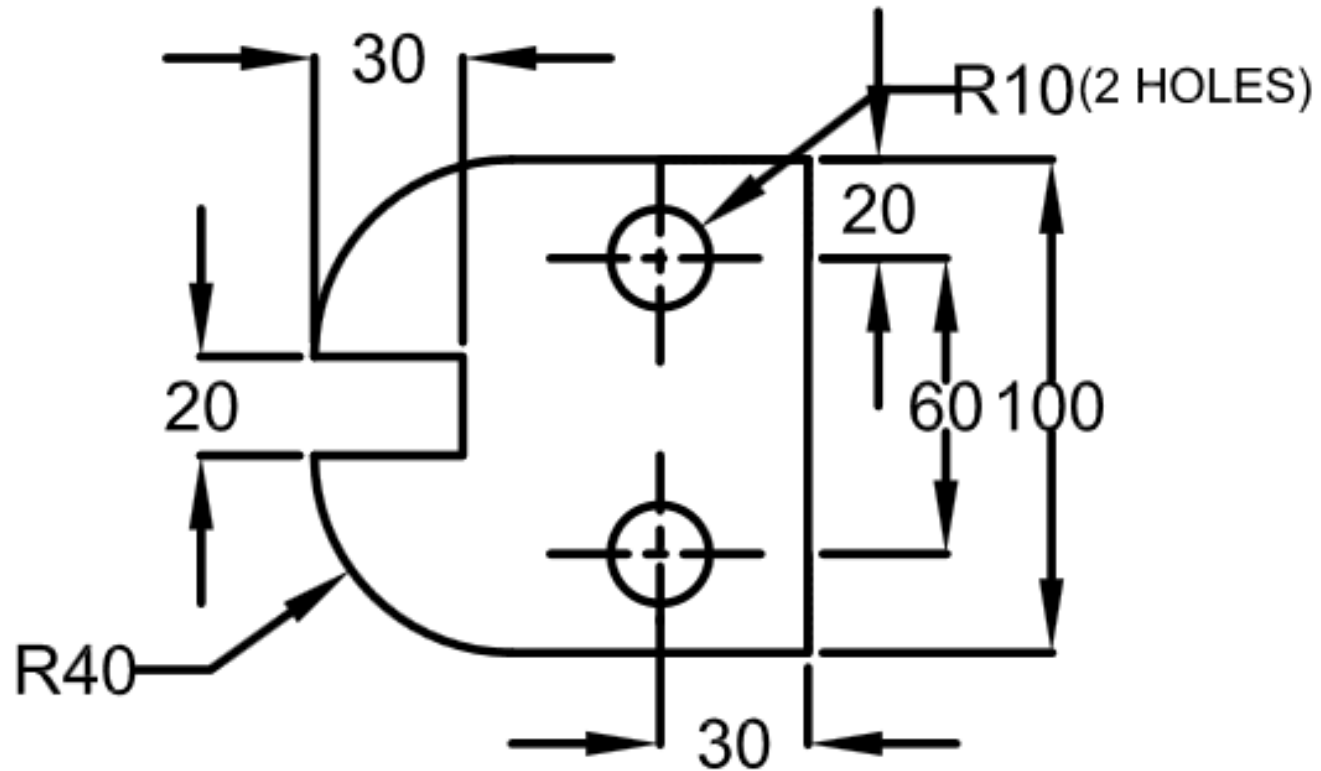
All dimension are in 'mm'

Practice problem – 5



All dimensions are in 'mm'

Practice problem – 6



All dimensions are in 'mm'