# ENGINEERING DRAWING

## LECTURE 1

INTRODUCTION TO
ENGINEERING DRAWING
&
DRAWING INSTRUMENTS

# TOPICS/SCHEDULE

| |
|---|
| Introduction |
| Introduction to drawing instruments and their proper use |
| Use of scales, line work, lettering |
| Dimensioning |
| Loci: paths of points of simple mechanism |
| Loci: Cam profile, ellipse, hyperbola, parabola, involute, cycloids |
| Orthographic projection in $1^{st}$ and $3^{rd}$ Angle |
| Isometric projection and oblique projection |
| Isometric projections from orthographic projection |

# Engineering and Engineers

- ✓ Engineering is the profession in which knowledge of mathematical and natural sciences, gained by study, experience, and practice is applied with judgment to develop and utilize economically the materials and forces of nature for the benefit of humanity.

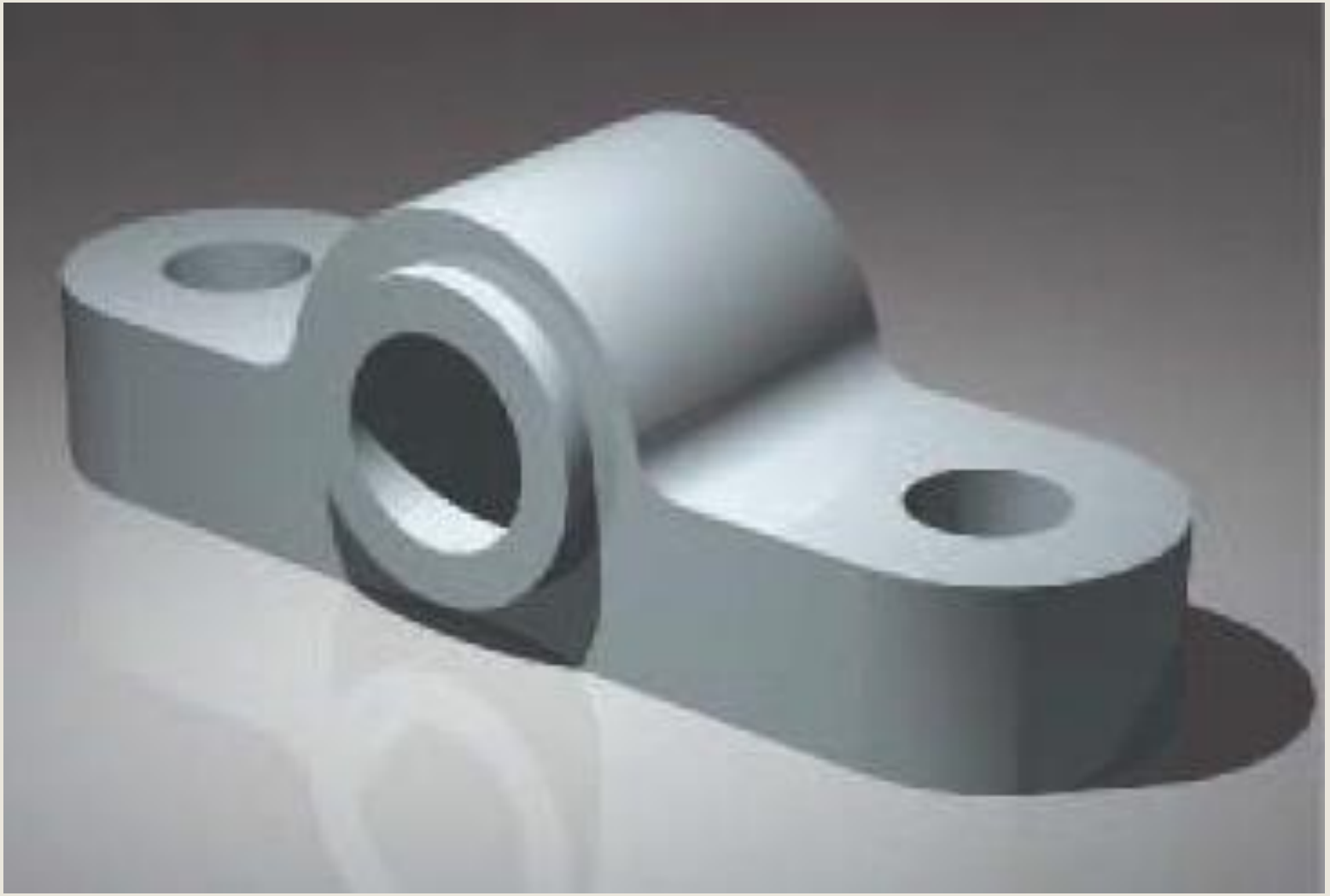
- ✓ The modern and informal definition of engineering is *"the art of making things work."*

- ✓ The term, engineer, comes from the Latin word *"ingenerare"* which means to create.

- ✓ As an engineer it is expected of you to have required knowledge, planning skills and the ability to create.

# Classwork 1

In not more than 200 words, describe the item shown below.



# What is Engineering Drawing?

- Engineering drawing is the language of manufacturing.
- Engineering drawing is a document that communicate a precise description of a part.
- This description is in most cases consists of pictures, words, number and symbols.
- A designer communicates his intention using drawings.
- An engineering drawing contains all necessary information required to get products made, manufactured, modified or assembled.

# Why Engineering Drawing?

Due to the advent of computers and CAD softwares, Engineering Drawing, in most cases, is referred to as Engineering Graphics.

Engineering drawing has played three roles through its history:

- **Communication:** It has been used to convey concepts and ideas quickly and accurately from one person to another without the use of words.

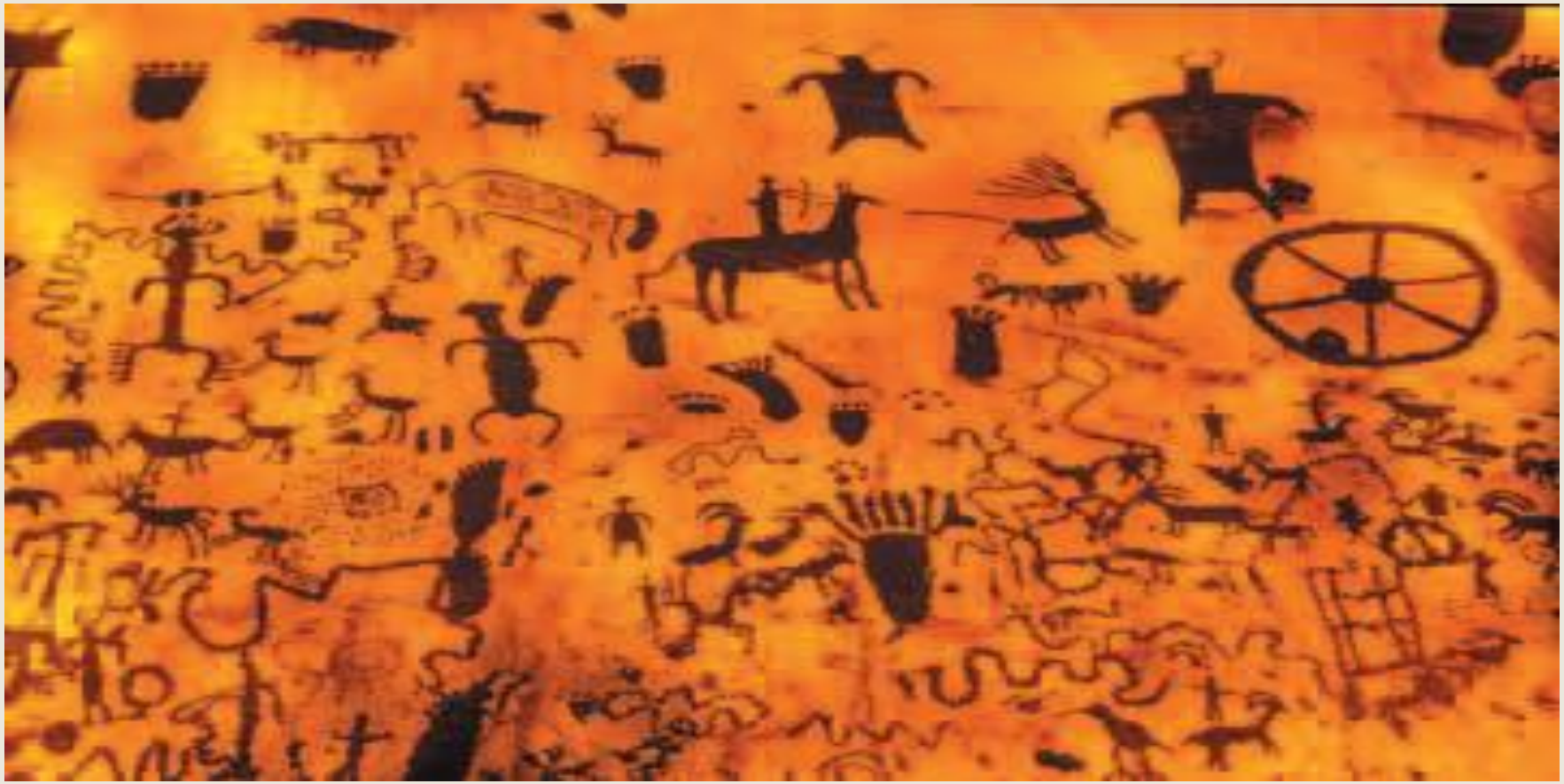
- **Record keeping:** As designs became more complex, it became necessary to record the ideas or features that worked well in a design so they could be repeated in future applications.

- **Analysis:** It has served as a tool for analysis to determine critical shapes and sizes, as well as other variables needed in an engineered system.

It has provided a background to several other courses such as Computer Aided Drawing (CAD).

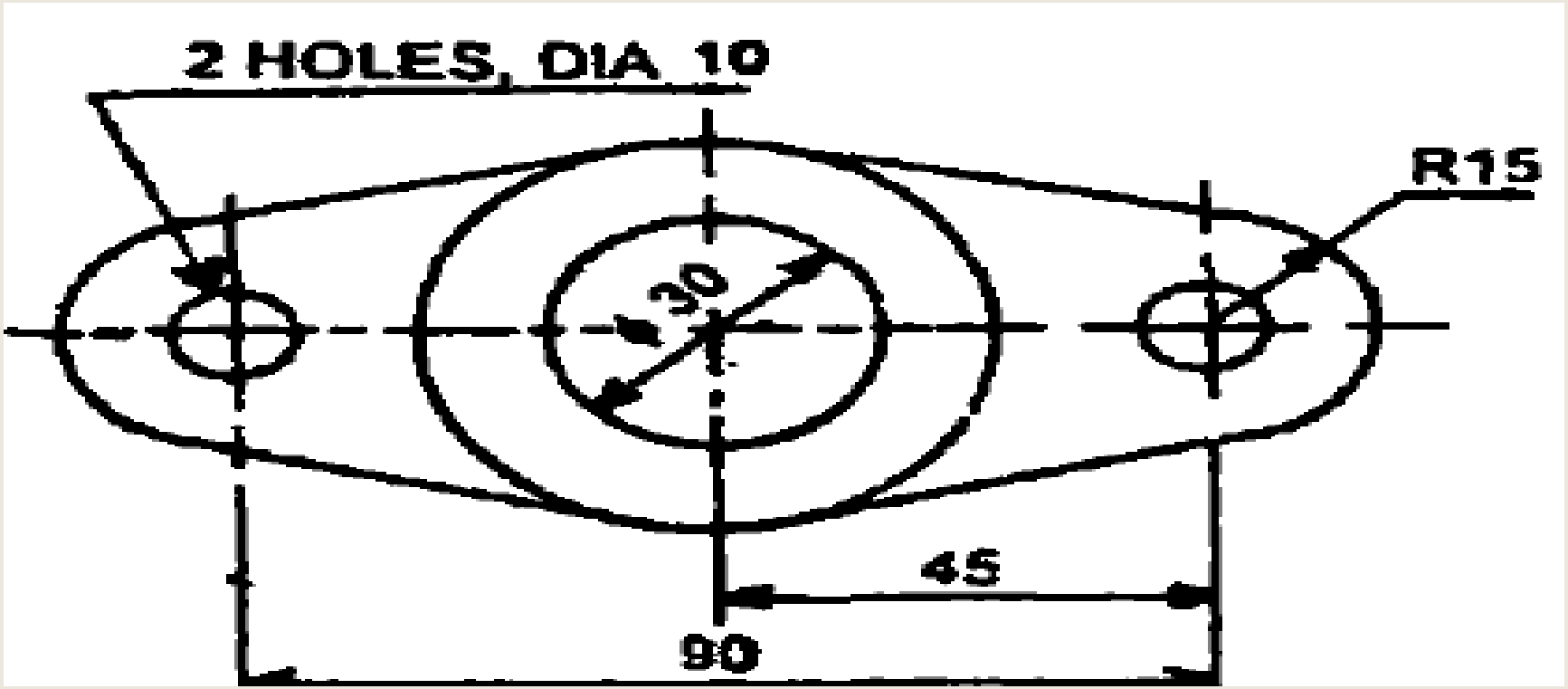
# Types of Drawing

- ✓ **Artistic drawing:** This type of drawing are used to express the feeling, belief, philosophies, or abstract ideas of the artist. This is why a lay person finds its difficult to understand what is being communicated by a work of art.



# Types of Drawing

- ✓ **Engineering Drawing**: This type of drawing is not abstract. It requires an understanding of technical drawing. It is also a means of clearly and concisely communicating all of the information necessary to transform an idea or concept into reality. This type of drawing contains dimension, notes and specification.



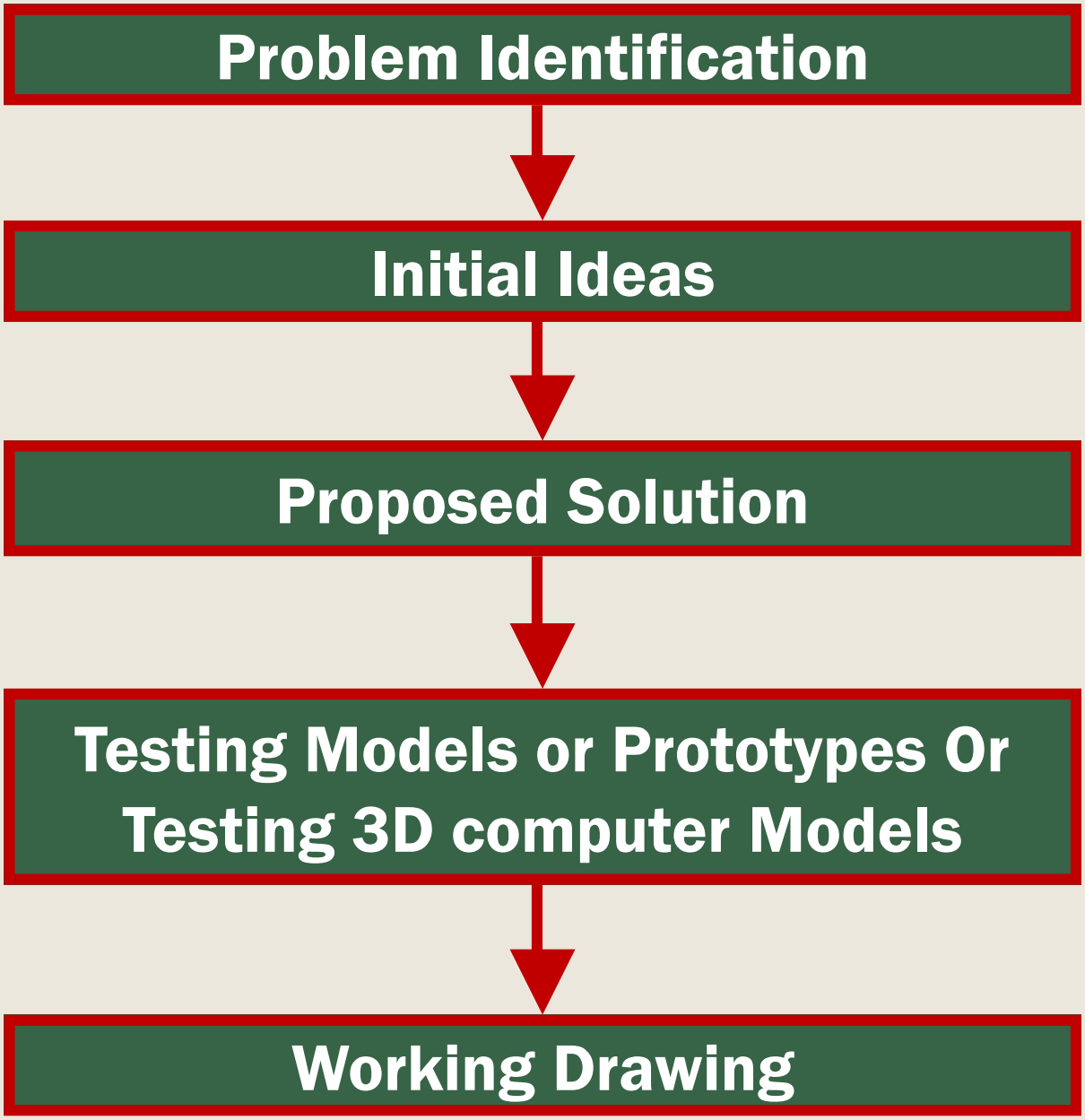
# The Design Process

- ✓ In order to appreciate the need for engineering drawings, one must understand the design process.

- ✓ The design process is an organised, step-by step procedure in which mathematical and scientific principles, coupled with experience, are brought to bear in order to solve a problem or meet a need.

- ✓ **Any product that is to be manufactured, fabricated, assembled, constructed, built, or subjected to any other type of conversion process must first be designed ( e.g. house, car).**

# Design Process



# Application of Engineering Drawings

Engineering drawings are needed in any setting that involves design and subsequent form of conversion process.

It is found in the following fields:

- Manufacturing
- Engineering (Civil/Electrical/Mechanical/etc.)
- Architecture
- Construction

# Regulation of Engineering Drawing

Regulation of engineering drawing ensures that people communicating using the graphic language are speaking the same language.

Standards are sets of rules that govern how technical drawings are represented.

The most widely used standards of practice for engineering drawing and drafting are:

- U.S Department of Defence (DOD)
- U.S military (MIL)
- The American National Standard Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
- Japanese Standard (JIS)
- International Standards Organization (ISO)
- British Standard (BS)

# Engineering drawing and Quality /Competitiveness

Design and Engineering drawing can promote quality competitiveness by ensuring that quality is designed from the outset and ensuring that all drawings accurately communicate the design.

The following examples illustrate this connection:

- An incorrect dimension on a technical drawing can cause the part to be wrong in size.
- An improperly drawn view can cause a part to be manufactured in the wrong configuration.

# Principle of Projection

Engineering drawing is based on fundamental principle of projection.

- A projection is a drawing or representation of an entity on an imaginary plane or planes.

- A projection involves four components which are:
  - ✓ The actual object that the drawing or projection represent
  - ✓ The eye of the viewer looking at the object.
  - ✓ The imaginary projection plane (the viewer's drawing paper)
  - ✓ The imaginary lines of sight called projectors.

# Types of Projection

The two broad types of projection are:

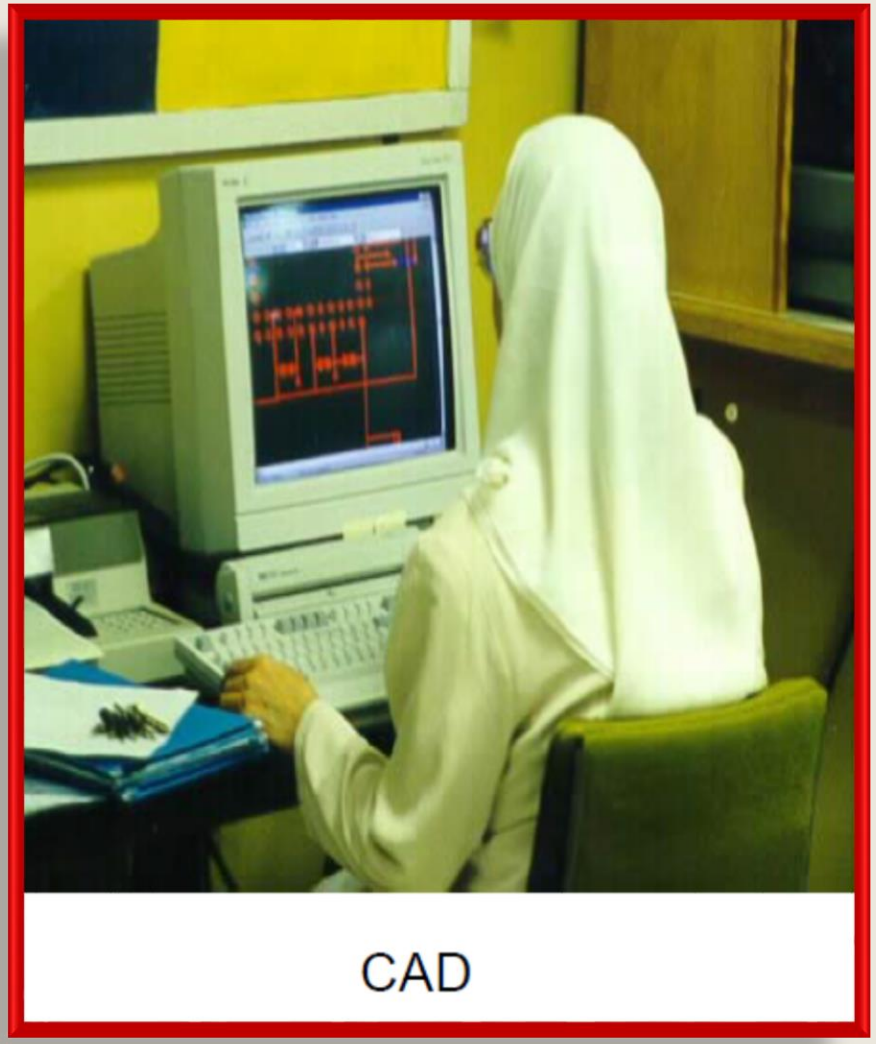
- **Parallel Projection**
  - ✓ Orthographic projection: Are drawn as multi-view drawing that shows flat representations of principal views of the subject.
  - ✓ Oblique projection: Its shows the full size of one view and are of three varieties: cabinet (half - scale), cavalier (Full - scale) and general (between half and full-scale).
  - ✓ Axonometric projections: These are three dimensional drawings and are of different varieties: isometric, diametric and trimetric.

- **Perspective Projection**
  - ✓ These are drawings that attempts to replicate what the human eye actually sees when it views an object. There are three types of perspectives projections: one - point, two - point, and three - point projection.

# Engineering Drawing Instruments

A Design is only as good as instruments used!!!

Conventional



CAD

# A Few Rules

Engineering Drawing is a drawing **guided by rules**. A couple of rules include:

- ✓ No line is made freehand.
  - Each and every line is drawn using some kind of drawing tools.

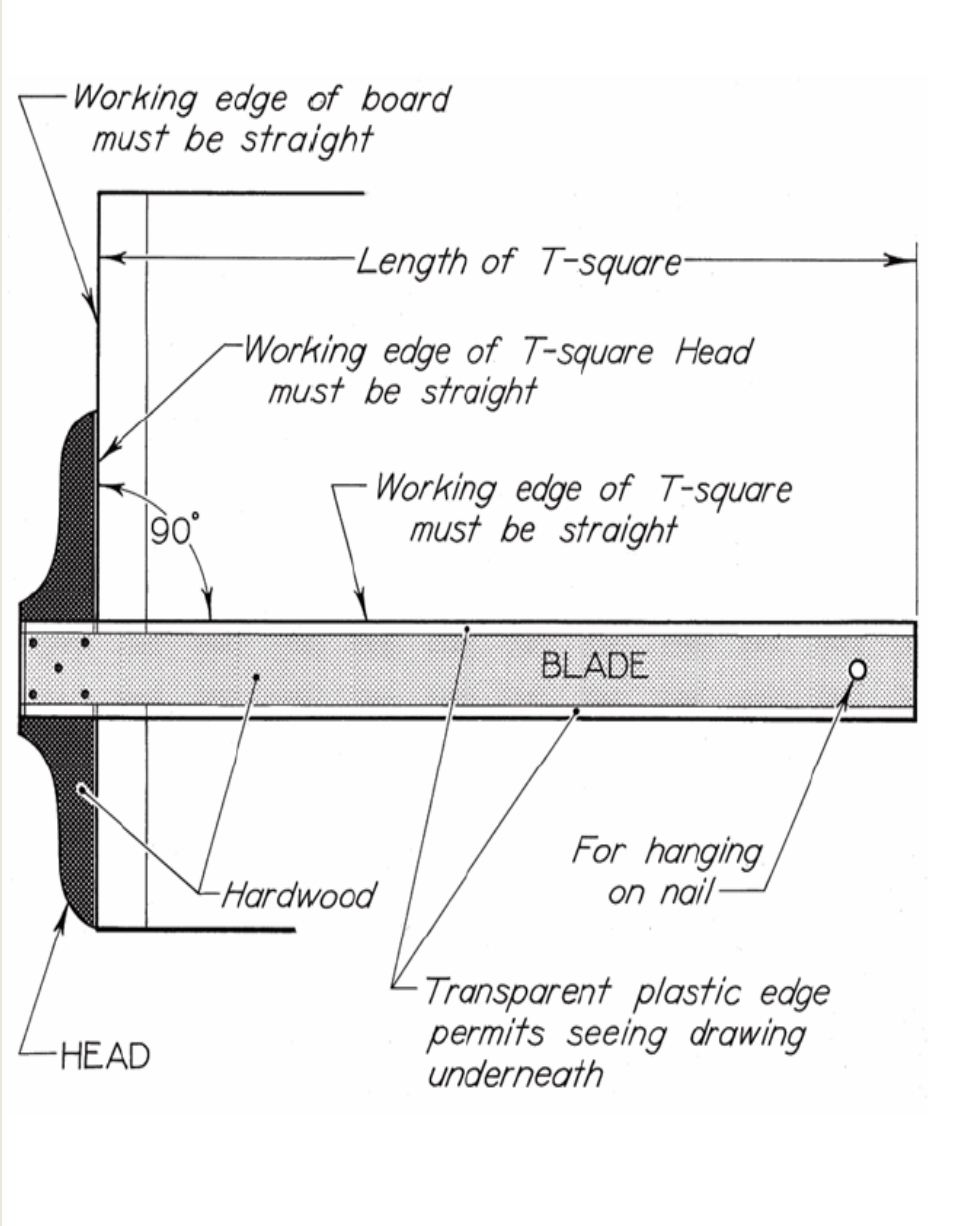
- ✓ Use the correct instruments to draw.
  - Rulers can never perform the function of a Tee-square
  - A table can't perform the function of a drawing board

# Drawing Surface

- ✓ The drawing board is available in a variety of styles and sizes. They may be adjustable and tilt to almost any angle.
- ✓ The drawing surface must be clean, flat, smooth and large enough to accommodate the drawing and some drafting equipment.
- ✓ At least one edge of the board must be absolutely true/straight to accommodate the Tee square.

# Tee Square

- ✓ It provides a parallel straight edge for the beginning drawing drafter.
- ✓ The Tee Square is composed of two parts: The head and the blade.
- ✓ **Rule:**
  - While drawing with the Tee square, the head *must always* lay on the true/straight edge of the drawing board – preferably the left side. This is to guarantee parallel lines.




- ✓ **Rule:**
  - *All* horizontal lines *must* be drawn with the aid of a Tee square.

# Tee Square

- ✓ Used to draw horizontal lines on the drawing sheet.
- ✓ Used to draw vertical and slanted lines with the aid of additional equipment – basically 45° and 60° triangles/set squares.
- ✓ Use only the upper edge of the blade for drawing lines.
- ✓ Rule:
  - Before drawing, the drawing paper must be aligned to the drawing board using the Tee square.

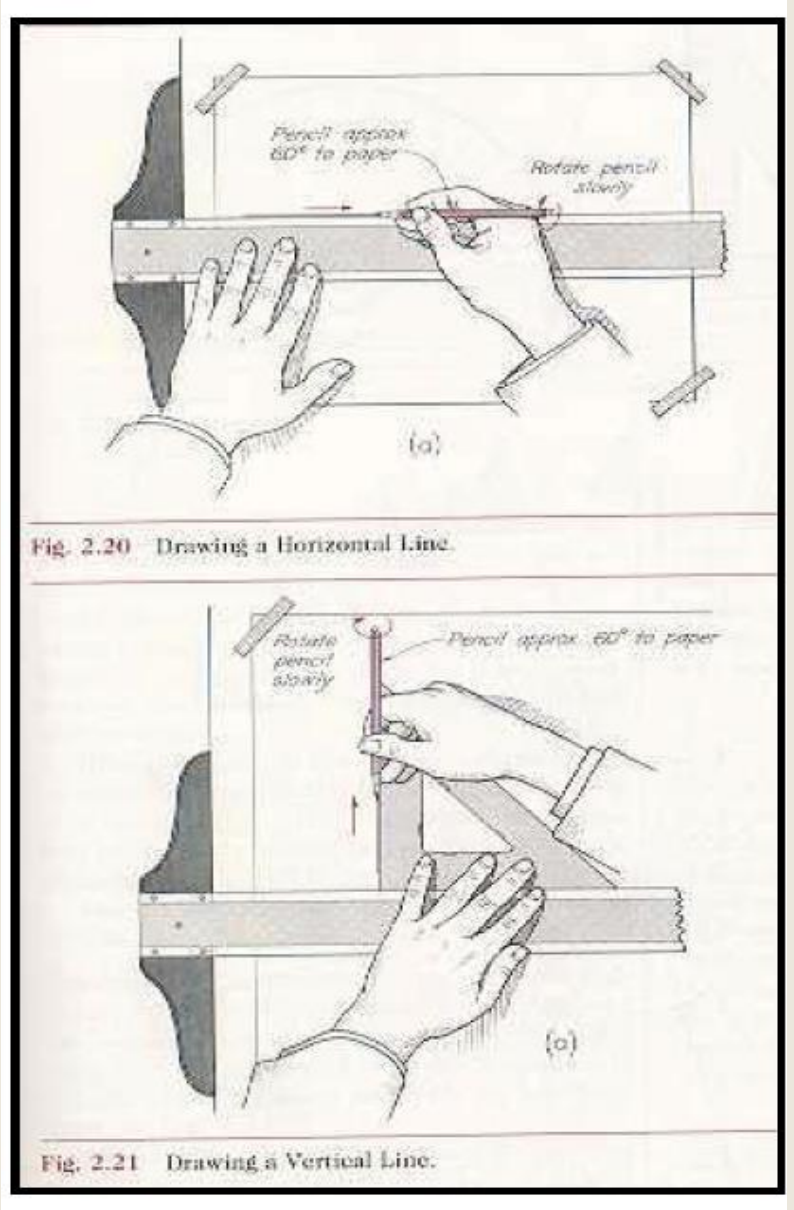



Fig. 2.20 Drawing a Horizontal Line.

Fig. 2.21 Drawing a Vertical Line.

# Compass

There are two main types of compasses: the friction-joint type and the spring-bow type.

- ✓ The friction-joint type is used for lightly laying out pencil drawing that will be inked. The disadvantage of this type of compass is that the setting may slip when strong pressure is applied to the lead.

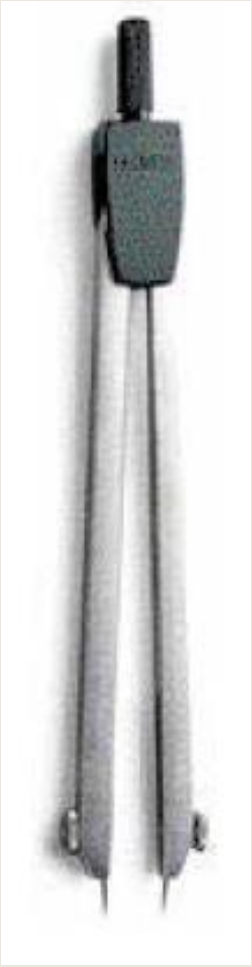
- ✓ The spring bow type of compass is best for pencil drawing and tracing because it retains its setting even when strong pressure is applied to obtain dark lines.

- ✓ The compass is an instrument used to make:
  - circles and
  - arcs.

- ✓ Extension bars are utilized with large bow compasses to draw large diameter circles.

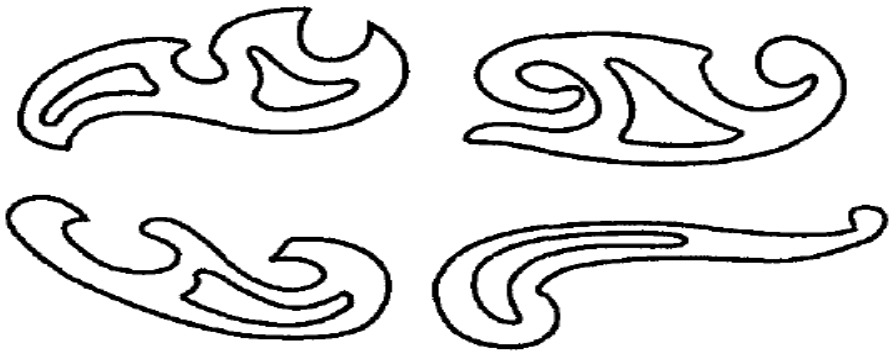

# Divider

- ✓ A divider is similar to a compass except that it has a metal point on each leg.
- ✓ Pivot-joint divider are used for measurement of approximately 20mm or more while for measurement less than 20mm, the bow divider is used.
- ✓ One type of divider is the proportional divider which is used to enlarge or reduce an object in scale.
- ✓ The tool has a sliding, adjustable pivot that varies the scale.
- ✓ **Usually used to lay off distances and to transfer measurement.**



# French Curves

- ✓ French curves are thin, plastic tools that comes in assortment of curved surfaces.
- ✓ **French curves and flexible curves are used to produce irregular curved lines that cannot be made with a compass.**
- ✓ French curves are actually segments of such geometric curves as ellipse, parabolas, hyperbolas, and the like.



(a) French curves

(b) Flexible curve

# Protractor

- ✓ **A protractor is used to measure and lay out angles.** It can be used in place of drafting machine or an adjustable triangle.

- ✓ To use the protractor, place the center point on the corner point of the angle . Align the base of the protractor along one side of the angle. The degree are read along the semi circular edge.

# Triangles/Set Squares

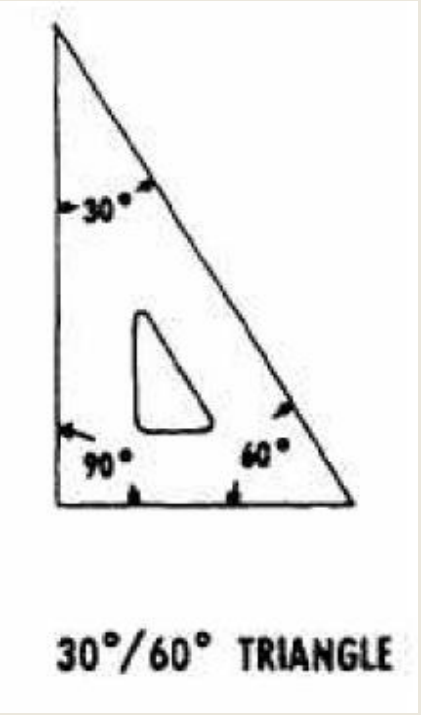
- ✓ There are two standard triangles used in drawing, they are:

  - 30-60 degree triangle and
  - 45 degree triangle.

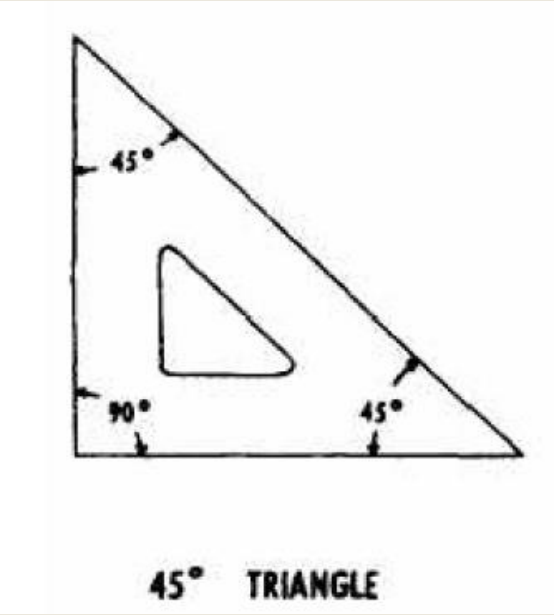
- ✓ Triangles are made of plastics and come in a variety of sizes.

- ✓ It is an instrument used to make common lines at common angles.

- ✓ The adjustable triangle may be used in the stead of either the 30-60 degree or 45 degree triangle.



30°/60° TRIANGLE

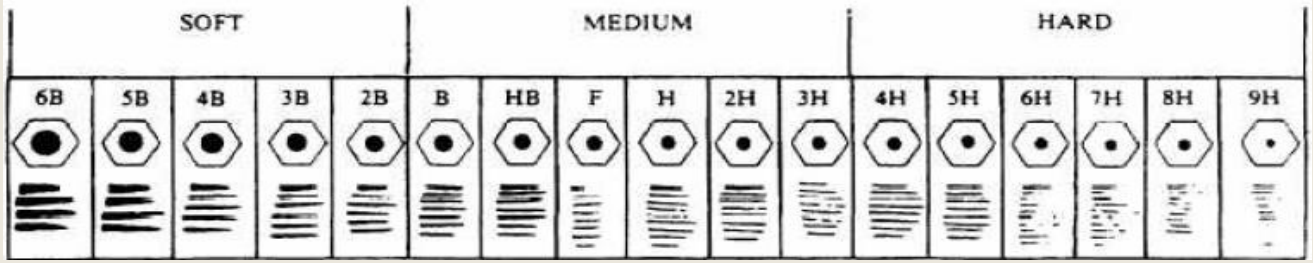


45° TRIANGLE

# Pencils

- ✓ This is an engineering instrument used to draw directly on the desired sized vellum sheet.

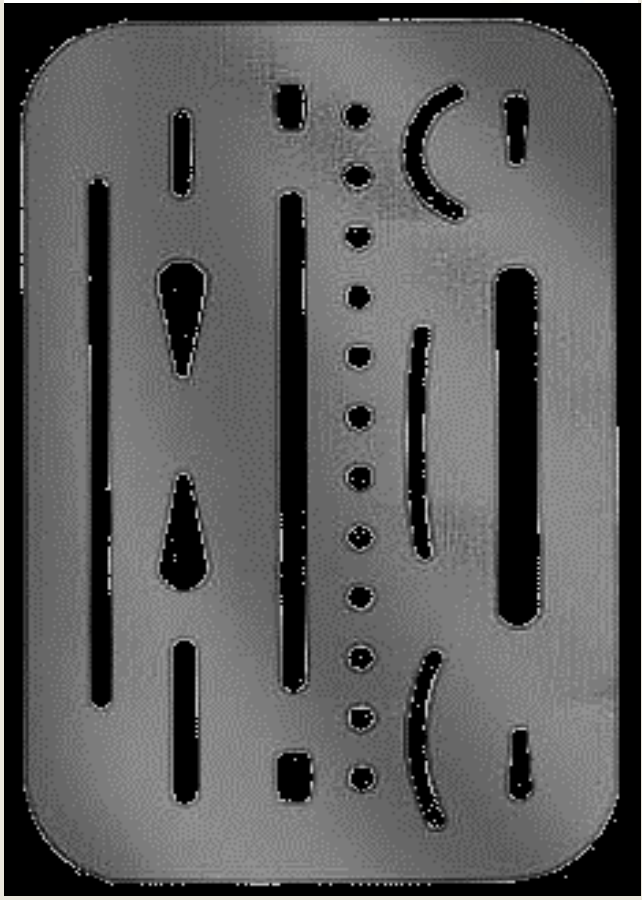
- ✓ For drafting purposes, the scale of hardness is as follows;
  - 3H or 4H is recommended for layout work, and
  - 2H, H for most line work and
  - HB for outline.

# Eraser and Erasing Shield

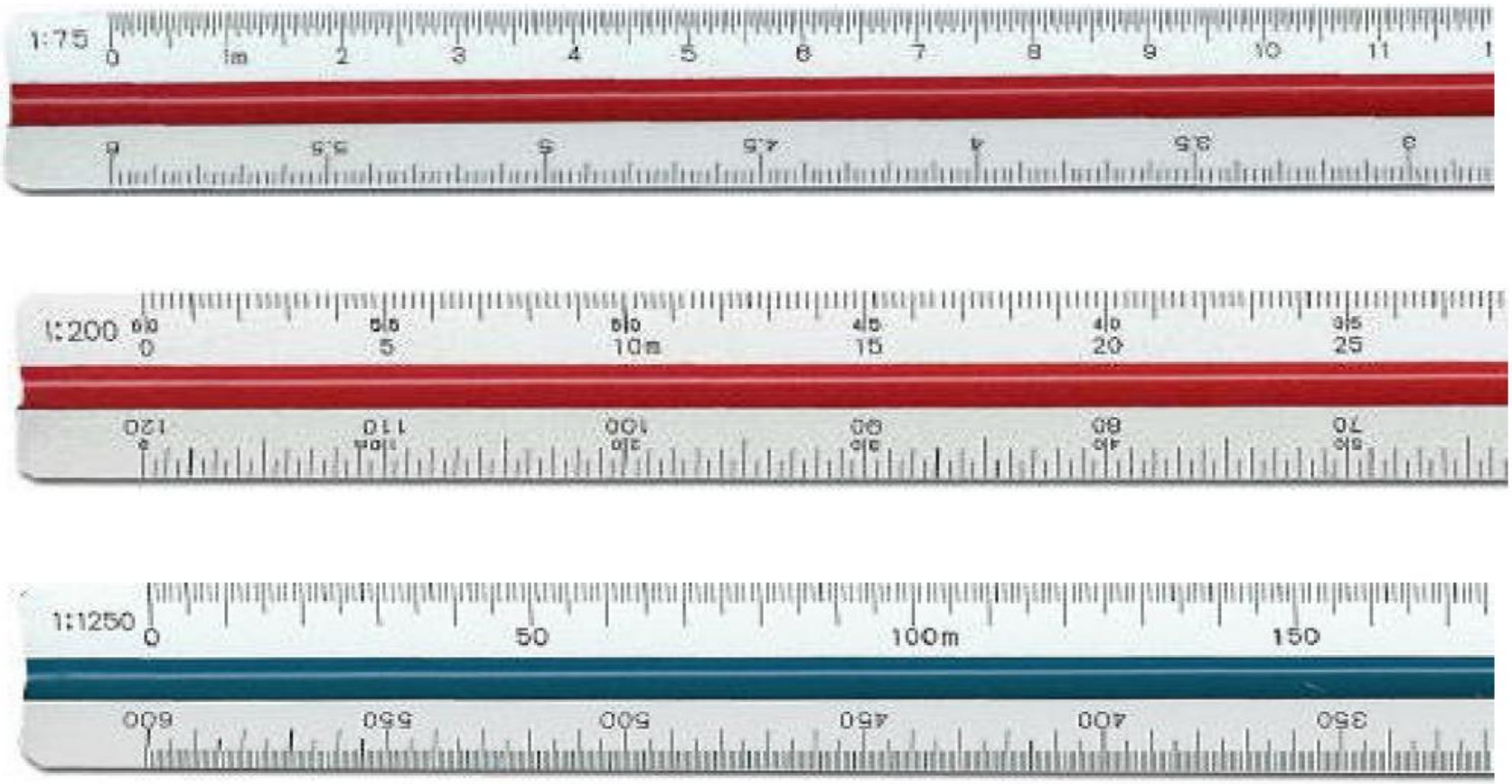
- ✓ Various kinds of eraser are available to a drafter. One of the most commonly used is a soft, white block-type eraser.

- ✓ An erasing shield restricts the erasing area so that the correctly drawn lines will not be disturbed during the erasing procedure. It is made from a thin, flat piece of metal with variously sized cut-outs. The shield is used by placing it over the line to be erased and erasing through the cut-out.

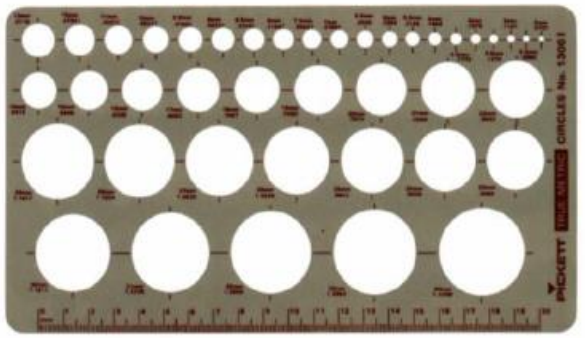
# Ruler

- ✓ The ruler is the easiest of all measuring tools to use.
- ✓ It is used in measuring the distance between two points.
- ✓ The metric system uses the meter (m) as its basic dimension.

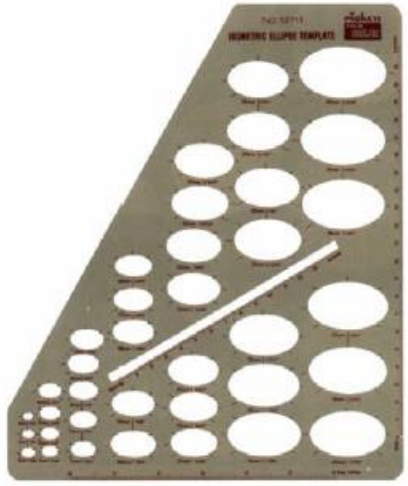


# Templates

- ✓ Templates are thin, flat pieces of plastic containing various cut-out shapes.
- ✓ They are designed to speed the work of the drafter and to make the finished drawing more accurate.
- ✓ Used for drawing circles, ellipse, plumbing fixtures, blots and nuts, screw threads, electronic symbols, springs, gears and structural metals.
- ✓ Templates come in many sizes to fit the scale being used on the drawing.
- ✓ It is used wherever possible to increase accuracy and speed.



Circle Template



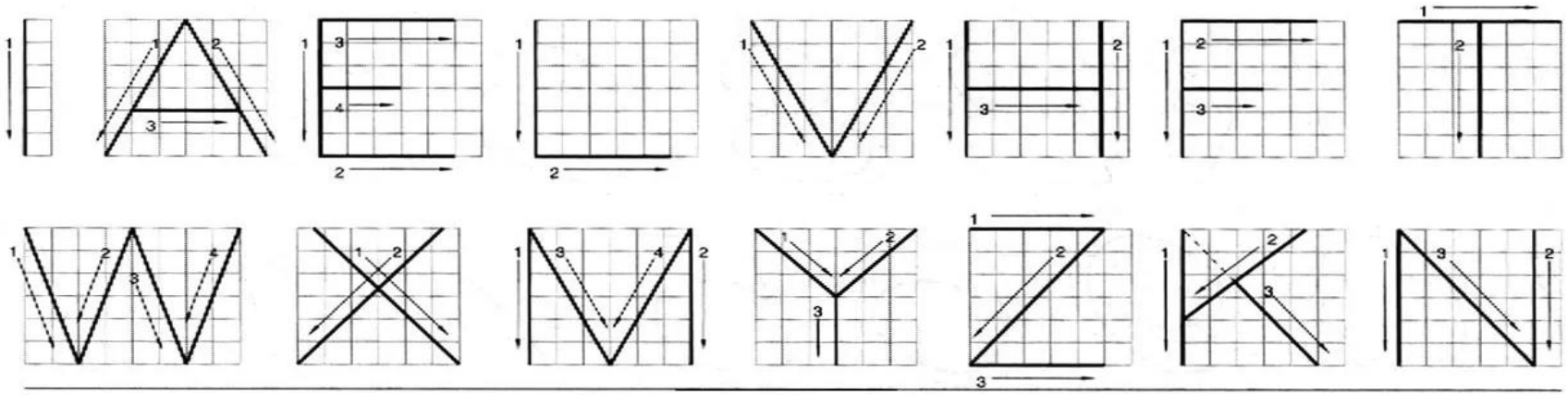
Ellipse Template

# Mechanical Lettering Sets

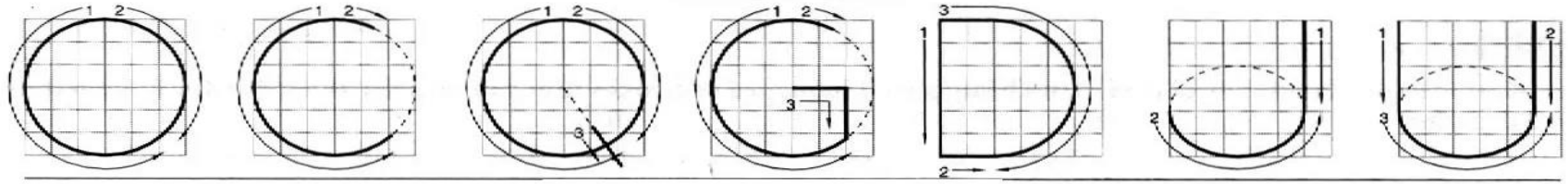
Lettering sets are in various sizes and templates. All sets contains a scriber, various pen sizes and templates. Some of the available templates are:

- ✓ Scriber Templates: consists of laminated strips with engraved grooves that are used to form letters.
- ✓ Scribers may be adjusted to form vertical or slanted letters of several sizes from a single guide by simply unlocking the screw underneath the scriber and extending the arms.
- ✓ Standard Templates: Learning to form mechanical letters requires a great deal of practice. This template have three sets of uppercase and lowercase letters.

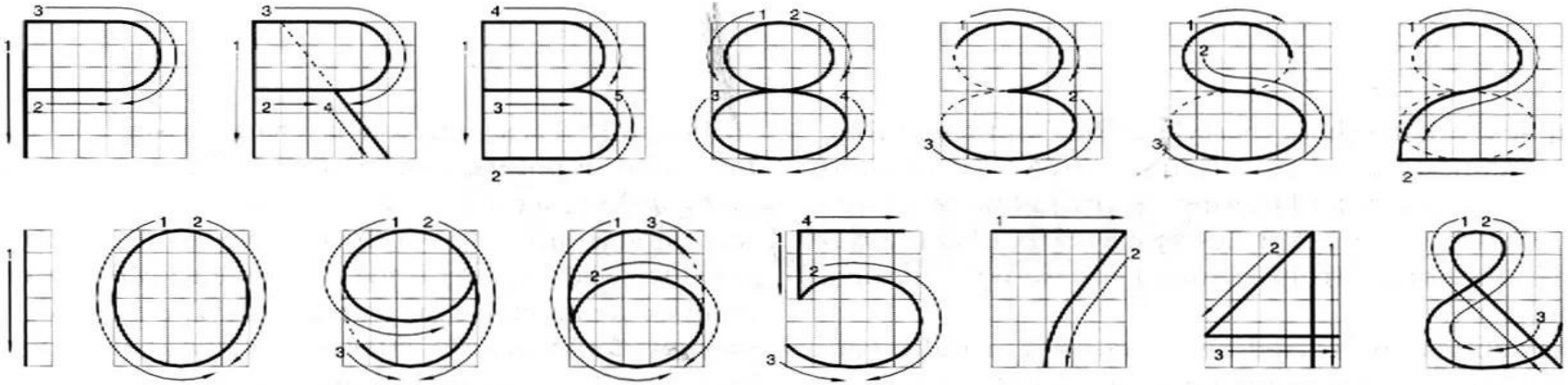
## Straight - line letters



## Curved - line letters



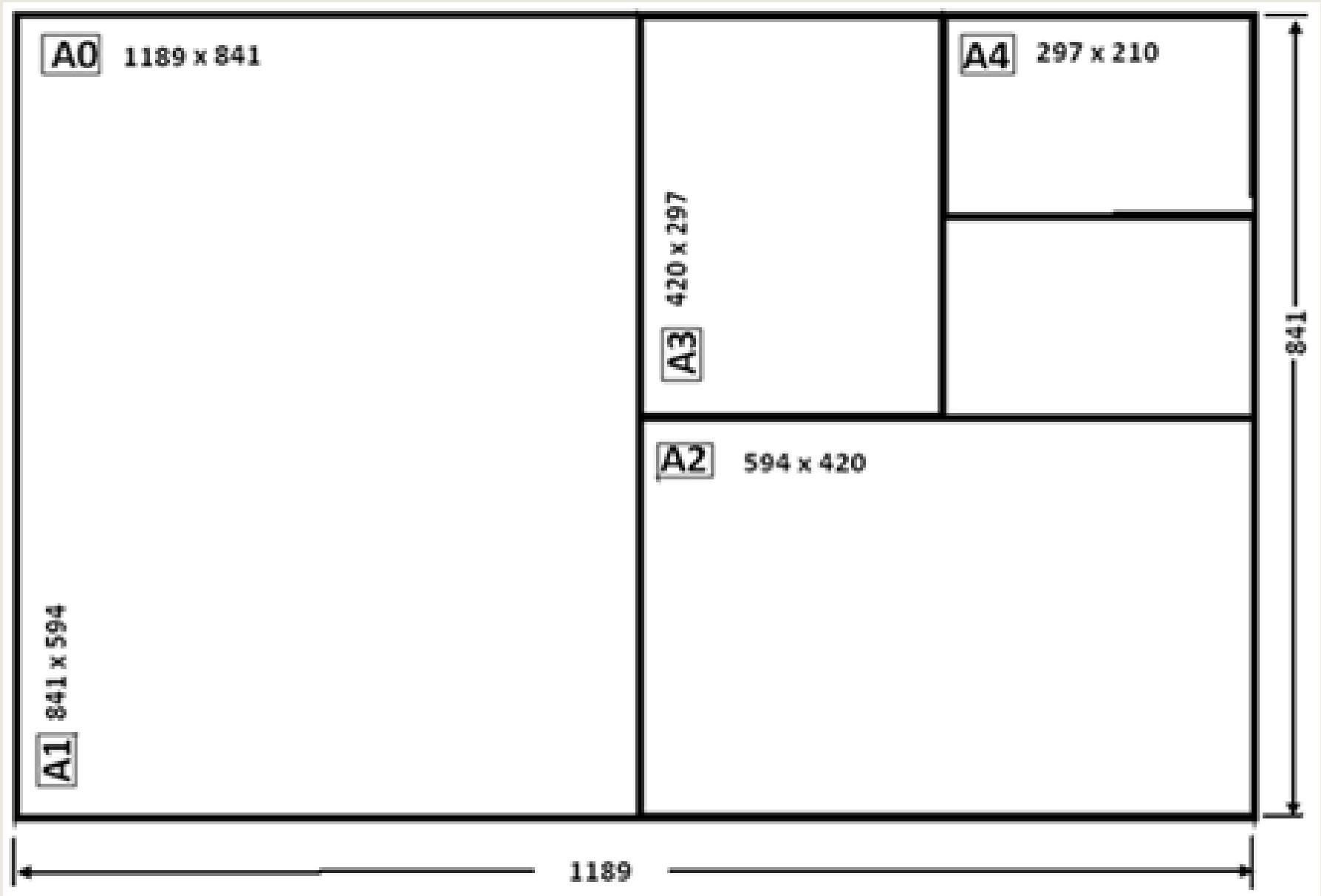
## Curved line letters & Numerals

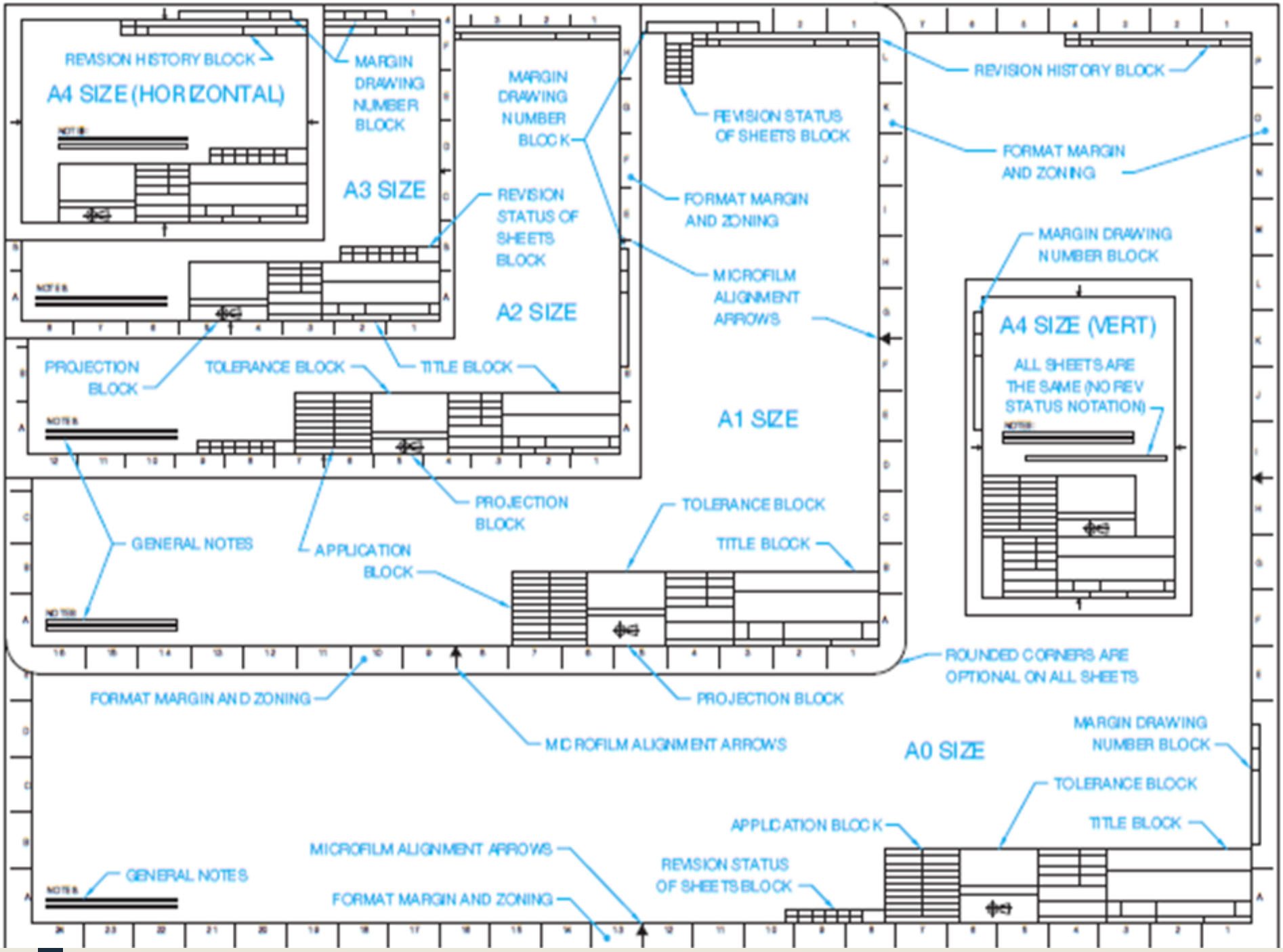


# Drawing Media

- ✓ Drawings may be made on paper, vellum, or polyester film.
- ✓ When selecting drawing sheets, consider the size of objects drawn, drawing scale, amount of additional content (border, title block, items list, notes, etc.) and drafting standards.
- ✓ Sizes of drawing sheets are

| Size designation | Vertical (mm) | Horizontal (mm) |
|---|---|---|
| A0 | 841 | 1189 |
| A1 | 594 | 841 |
| A2 | 420 | 594 |
| A3 | 297 | 420 |
| A4 | 210 | 297 |


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


REVISION HISTORY BLOCK
A4 SIZE (HORIZONTAL)
MARGIN DRAWING NUMBER BLOCK
A3 SIZE
REVISION STATUS OF SHEETS BLOCK
A2 SIZE
PROJECTION BLOCK
TOLERANCE BLOCK
TITLE BLOCK
GENERAL NOTES
APPLICATION BLOCK
FORMAT MARGIN AND ZONING
MICROFILM ALIGNMENT ARROWS
A1 SIZE
ROUNDED CORNERS ARE OPTIONAL ON ALL SHEETS
A4 SIZE (VERT)
ALL SHEETS ARE THE SAME (NO REV STATUS NOTATION)
A0 SIZE

# Linework

- ✓ Line work is the generic term given to all the various techniques used in creating the graphics data on technical drawing.

- ✓ **For pencil drawing, the thick lines should be approximately twice as wide as thin lines.**

- ✓ Standard line thicknesses are;
  - 0.6 mm minimum for thick lines
  - 0.3 mm minimum for thin lines.

- ✓ **Rule:** All lines of the same type should have uniform thickness throughout the drawing.

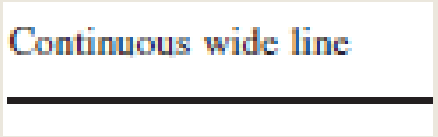
# Line Types

- ✓ **Construction Line**

  *Very light and used for setting out the main shape of the object.*

- ✓ **Thick Continuous Line**

  *Used for visible outlines and edges.*




- ✓ **Thin Continuous Line**

  *Used for:*

  *dimension,*

  *extension and projection lines;*

  *hatching lines for cross sections;*

  *leader and reference lines;*

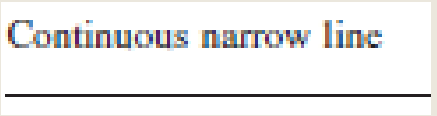
  *outlines of revolved sections;*

  *imaginary lines of intersection;*

  *short centre lines;*

  *diagonals indicating flat surfaces;*

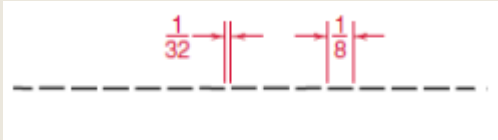
  *bending lines; repetitive features.*



# Line Types

- ✓ **Thin Short Dashed Line**

  *Used for hidden outlines and edges.*




- ✓ **Thin Continuous Irregular Line**

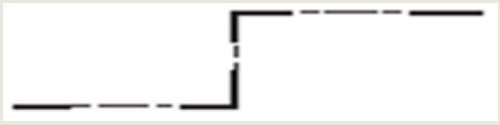
  *Used for limits of partial views or sections provided the line is not an axis.*

- ✓ **Thin Chain Line (Long and Short Dashed Line)**

  *Used for centre lines; lines of symmetry; pitch circle for gears; pitch circle for holes.*


- ✓ **Thin Chain Line, with Thick Ends and Change in Direction**

  *Used for cutting planes*



# Line Types

- ✓ **Thick Chain Line**

  *Used for surfaces which have to meet special requirements.*

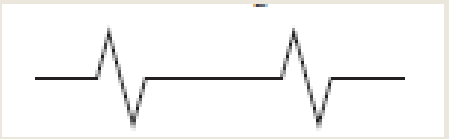
- ✓ **Thin Phanthom Line (Long and double short dashed Line)**

  *Used for alternate or extreme positions of moving parts;*
  *preformed outlines;*
  *adjacent parts;*
  *initial outlines prior to forming;*
  *projected tolerance zones.*

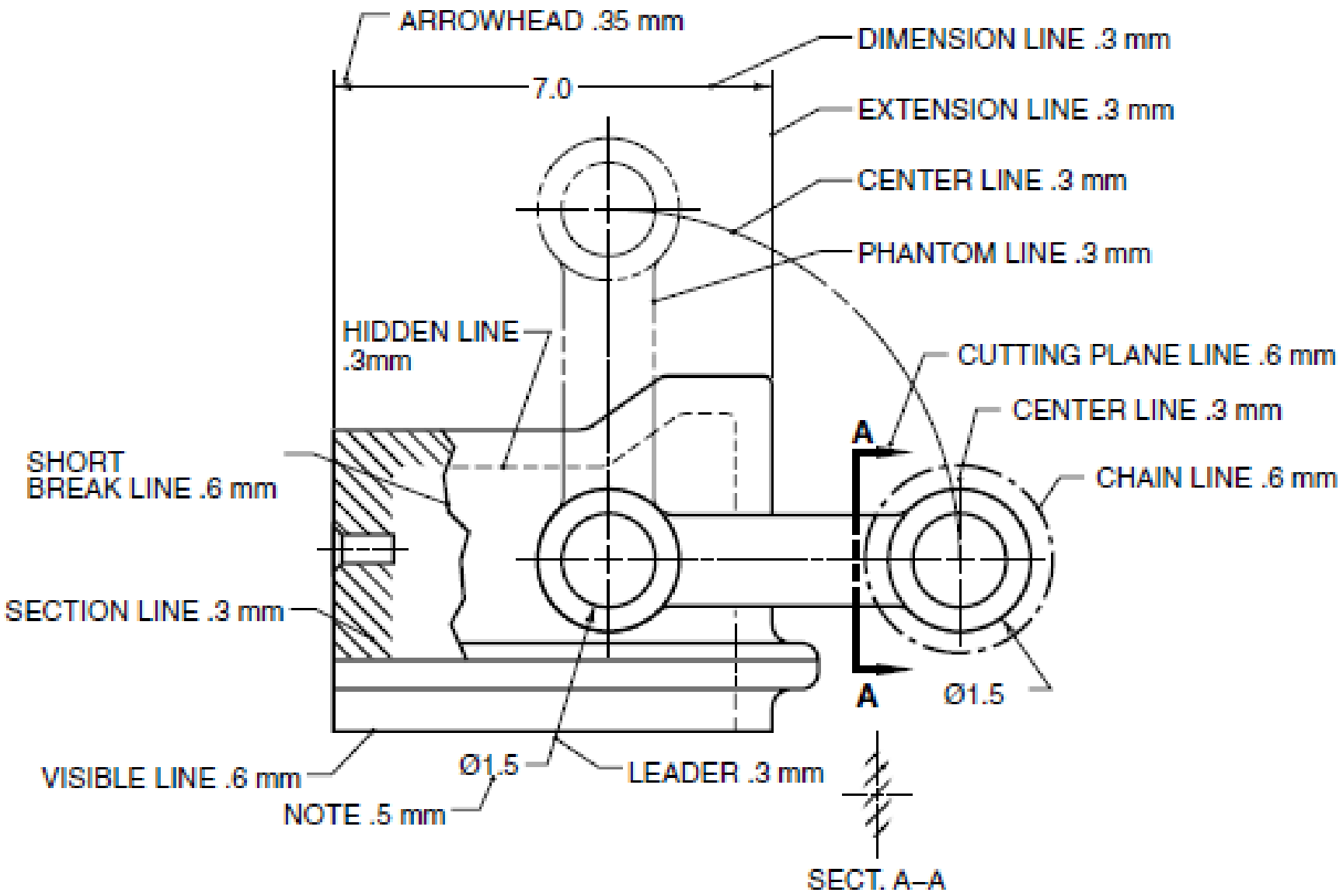


- ✓ **Thin Continuous Straight Line with Zig Zags**

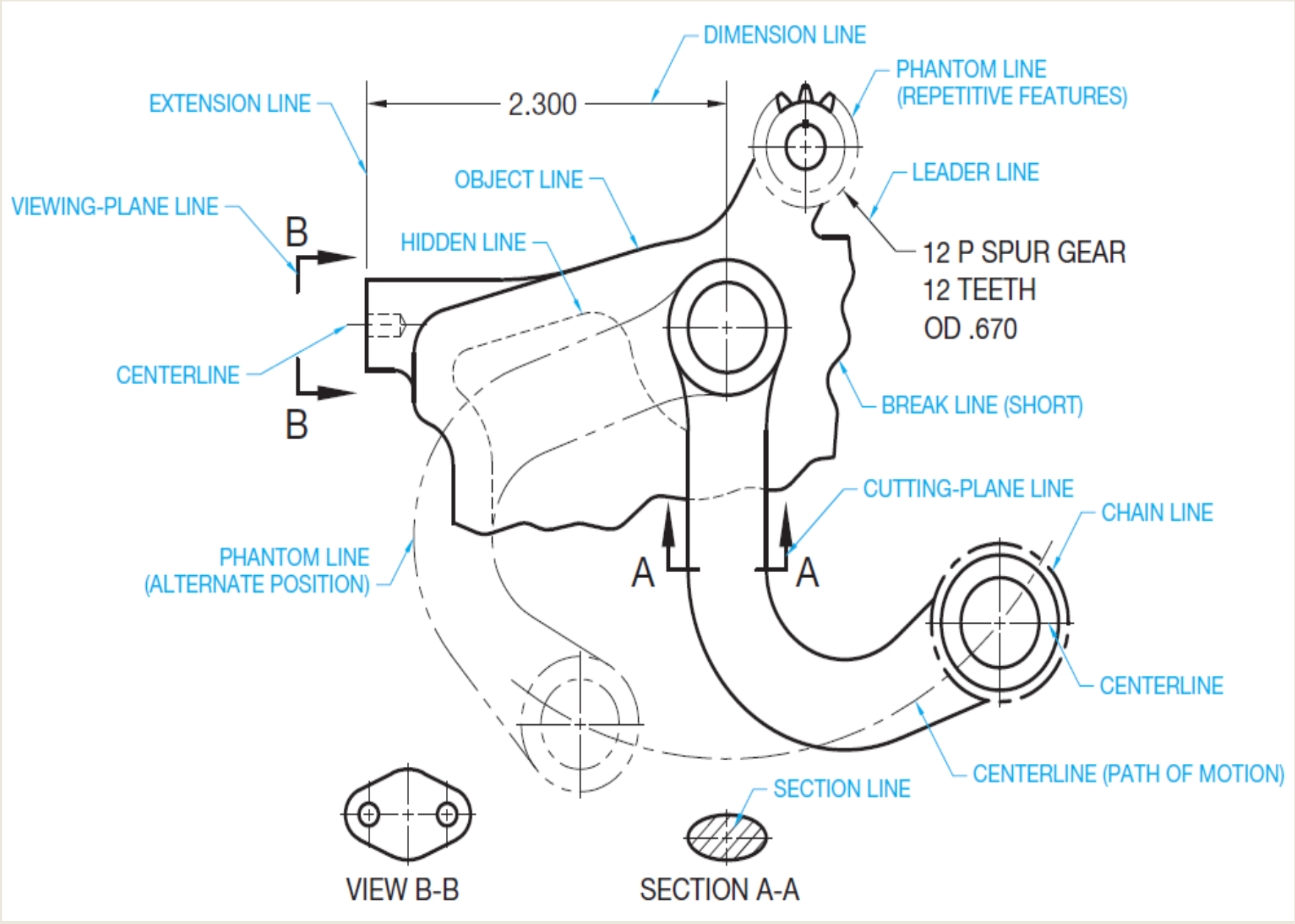
  *Used for limits of partial or interrupted views.*



# Line Types


ARROWHEAD .35 mm
DIMENSION LINE .3 mm
7.0
EXTENSION LINE .3 mm
CENTER LINE .3 mm
PHANTOM LINE .3 mm
HIDDEN LINE .3mm
CUTTING PLANE LINE .6 mm
CENTER LINE .3 mm
A
SHORT BREAK LINE .6 mm
CHAIN LINE .6 mm
SECTION LINE .3 mm
A
Ø1.5
VISIBLE LINE .6 mm
Ø1.5
LEADER .3 mm
NOTE .5 mm
SECT. A–A

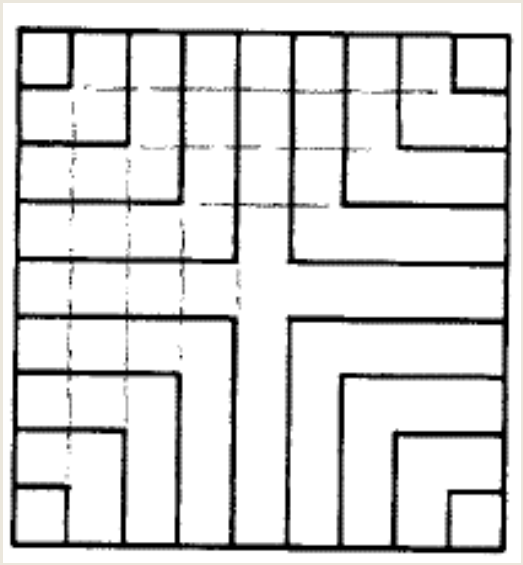
# Line Types

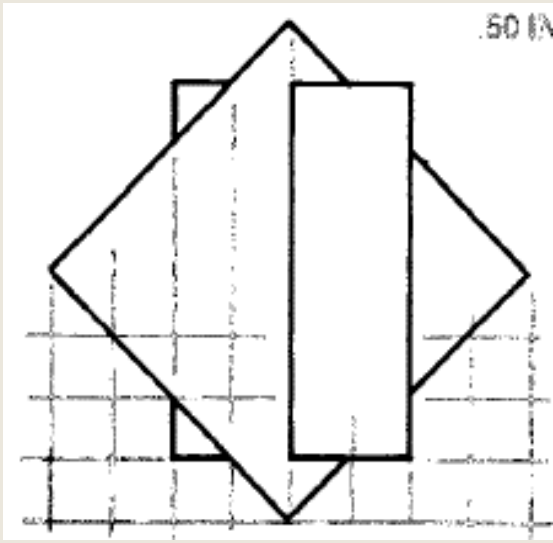

DIMENSION LINE
PHANTOM LINE
(REPETITIVE FEATURES)
EXTENSION LINE
2.300
LEADER LINE
OBJECT LINE
VIEWING-PLANE LINE
B
HIDDEN LINE
12 P SPUR GEAR
12 TEETH
OD .670
CENTERLINE
B
BREAK LINE (SHORT)
CUTTING-PLANE LINE
CHAIN LINE
PHANTOM LINE
(ALTERNATE POSITION)
A
A
CENTERLINE
CENTERLINE (PATH OF MOTION)
SECTION LINE
VIEW B-B
SECTION A-A

# Assignment

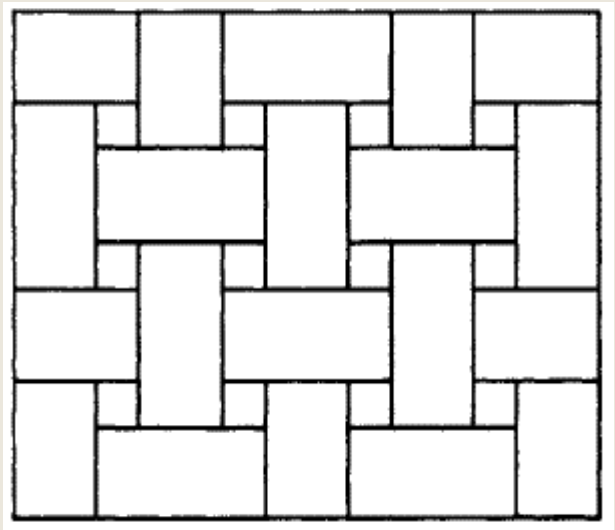
Reproduce the shapes shown.

The square grids have area of $100\ mm^2$.

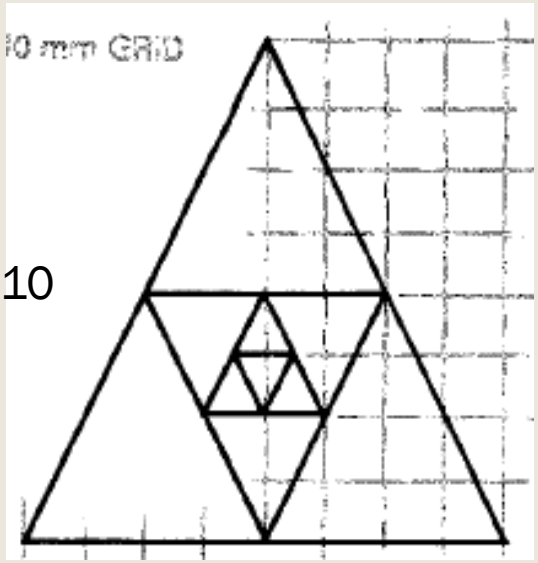


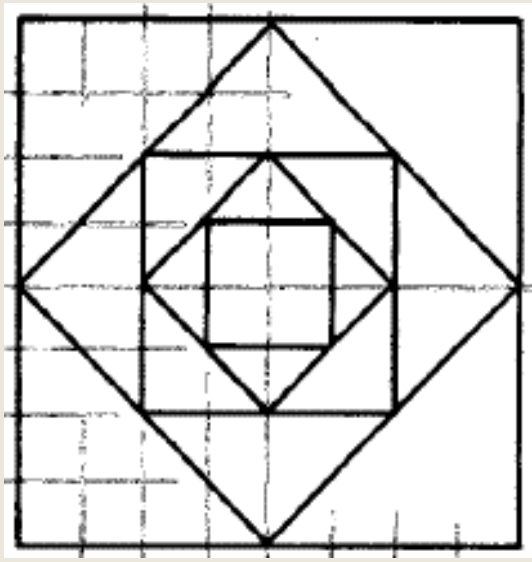


140



110



# END OF LECTURE 1