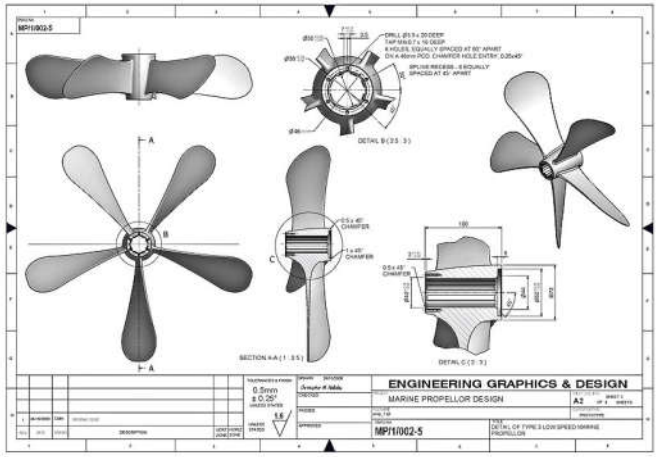
Basics of Drawing, Introduction to AutoCAD

http://www.autodesk.com/education/free-software/autocad

Reference: Chapter # 1-5; N.D. Bhatt

Why Do We Need Engineering Drawing ?

- Designers and manufacturers/fabricators communicate via Engineering Drawing (ED)
  - Enables teamwork
  - Helps preserve design for future
- Good ED skills do not require artistic temperament/skills
  - Procedures are completely based on concepts related to geometry

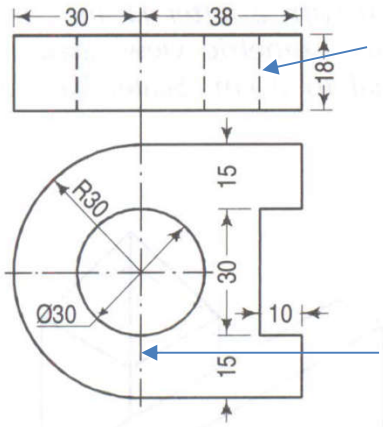


http://www.engd.com.au

Line Types

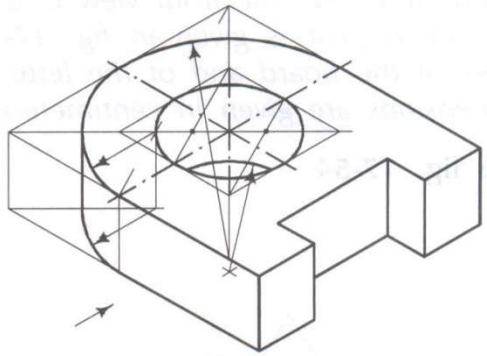
- **Construction lines:** 0.13mm
- **Object lines:** 0.25 mm
- **Borders:** 0.5 mm
- **Hidden lines**: Dashed
- **Centerline**: Dot-Dash
- **Dimensioning**: Double-arrow lines

Line	Description
A	Continuous thick or Continuous wide
F	Dashed thin (narrow)
G	Chain thin Long-dashed dotted (narrow)



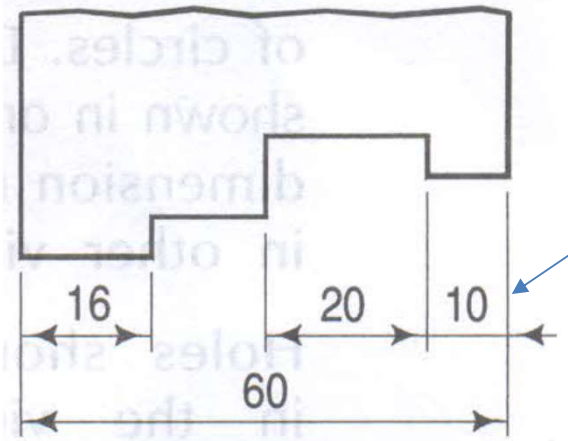
Hidden lines

Center Lines

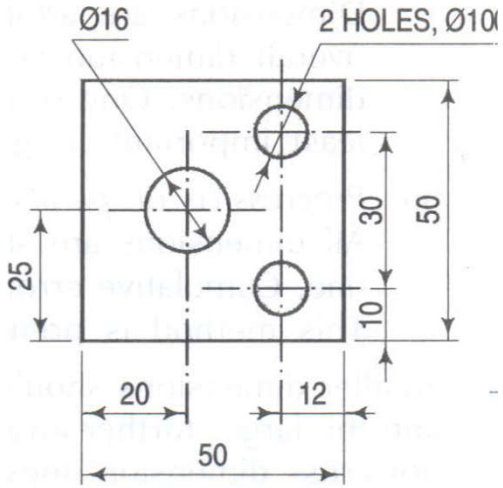


Dimensioning

- Use consistent arrow style for all dimensioning lines
- No dimensioning information should be redundant
- Dimension lines should not intersect object lines
- Diameter of holes are denoted by ϕ
- Units, scale should be mentioned at the bottom of the figure
  - e.g. “All units in mm”, “Scale 1:10”

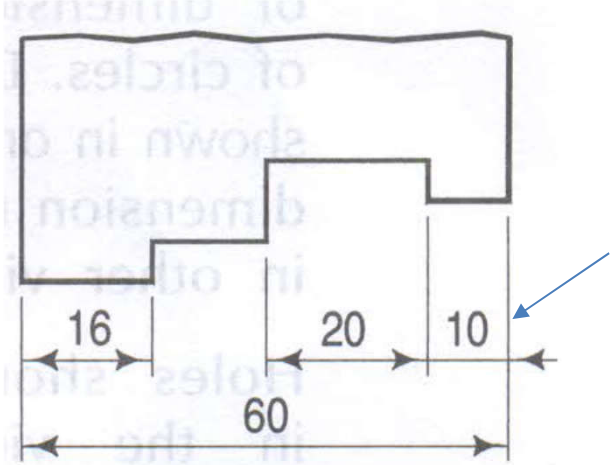


All units in mm
Scale 1:2



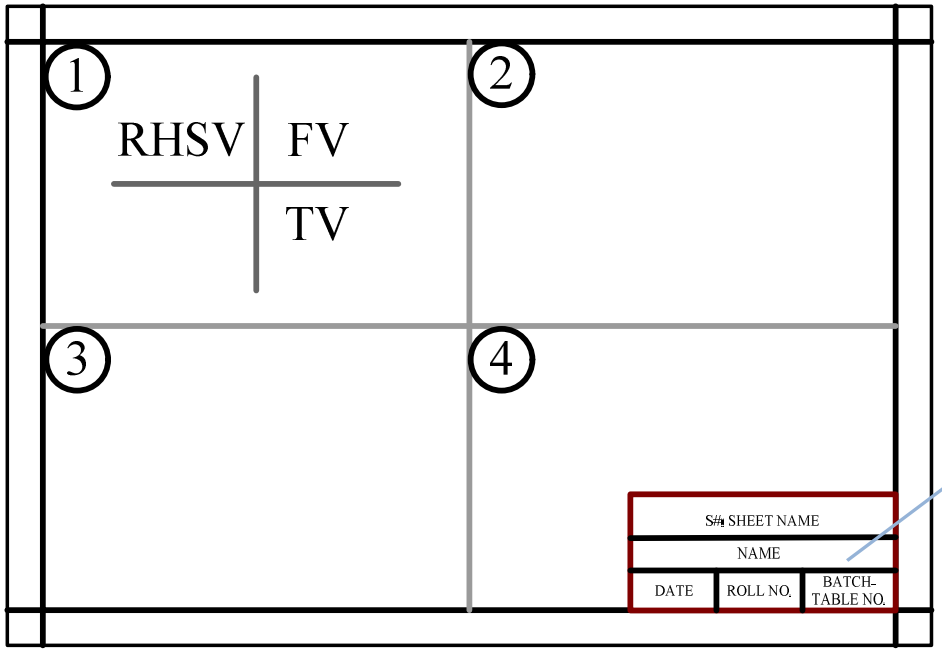
Scales

- May not be always possible to produce full scale drawing i.e. 1:1
- They are therefore drawn smaller or larger
- When drawings are drawn smaller than the actual size of the objects, the scale used is said to be a reducing scale, e.g 1:2
- When drawings are drawn larger than the actual size of the objects, the scale used is said to be a enlarging scale, e.g 2:1
- E.g. If 1 cm on the drawing represents 1 m of the of the object/distance then the scale is mentioned as **SCALE 1:100** under the drawing



All units in mm
Scale 1:2

Details to be written on the drawing sheet



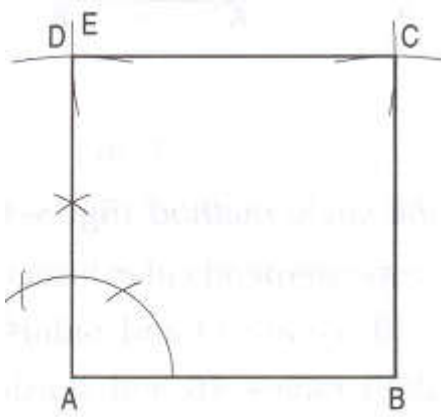
Maximum 2 sheets will be allowed

SHEET#: SHEET NAME		
NAME		
DATE	ROLL NO.	BATCH-TABLE NO.

- Draw a 10 mm margin on all sides of the drawing sheet
- Draw a 150 mm x 45 mm rectangle in the bottom right corner and divide it into three smaller rectangles as shown.
- Write in the following:
  - Sheet number and sheet name
  - Name
  - Date, Roll number and table number

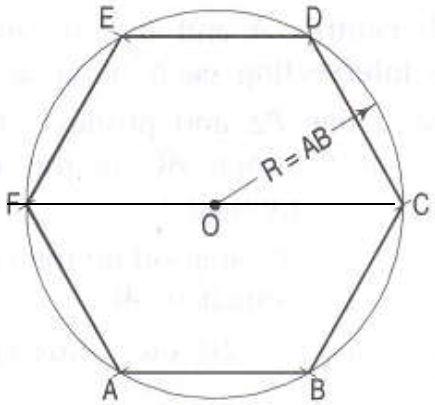
Example of Geometric Constructions

Draw a square given the length of the side



- Draw line AB of required length
- At A, draw a line AE perpendicular to AB
- With A as a center and a radius AB, draw an arc cutting AE at D
- With centers B and D and radius AB draw arcs intersecting at C
- Join B to C and D to C

Draw a hexagon given the length of the side



- Draw a circle with center O and radius equal to the length of the side
- Draw a horizontal line through the center cutting the center at F and C
- With C as the center and radius equal to the length of the side, draw arcs cutting the circle at B and D
- With F as the center and radius equal to the length of the side, draw arcs cutting the circle at A and E.

Based on the fact that the radius of the circumcenter of the hexagon is equal to the length of the side

Ref: Engineering Drawing by N. D. Bhatt et. al

Note labelling of points (A,B,C,D,…)

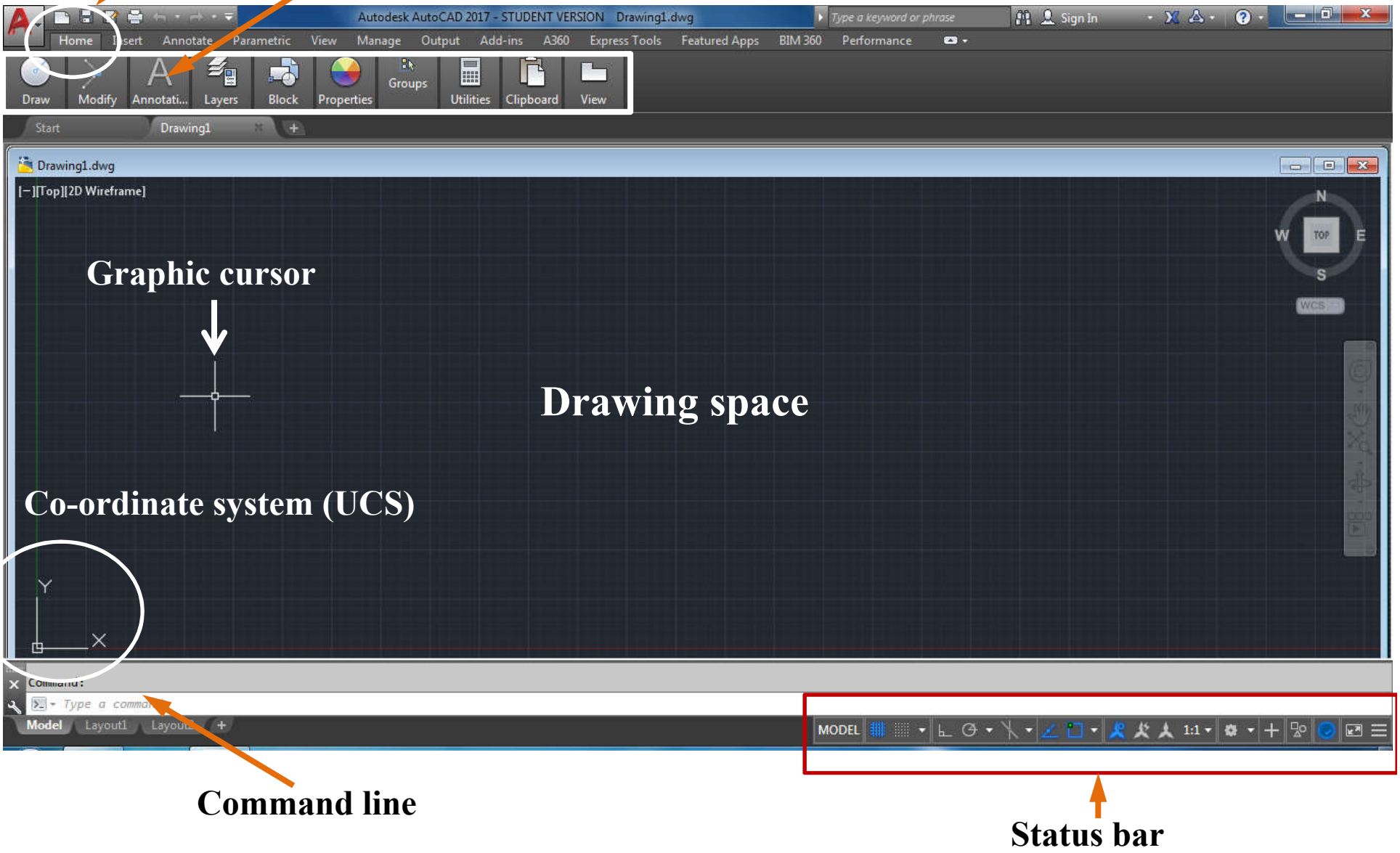
You Will Lose Points If You…

- Solve the problem incorrectly
- Do not make title block properly
- Use incorrect line thickness
- Do not dimension, or if dimension labels/arrows are not visible
- Do not label points in the drawing
- Do not mention scale when necessary

Computer Aided Drawing (CAD)

- **We will NOT be carrying out any paper and pen drawing in this course**
  - **DO NOT buy drafters, drawing instruments etc. for the lab**
- ***Computer aided drafting (CAD)*** is a process of constructing drawing on a computer screen with the help of specially developed software's and hardware's.
- Advantages: Accurate, time saving, standardization. Easily integrated
- Widely used commercial softwares:
  - *AutoCAD*
  - *Pro/Engineer*
  - *Catia*
  - *SolidWorks*
  - *NX Unigraphics*
- We will use AutoCAD (10 lab sessions+2 tests) and SolidWorks (1 lab session)
  - Both are available for free at IITB – you can install them in your laptops
  - AutoCAD compatible with Windows/Mac
  - Solidworks is compatible with only Windows

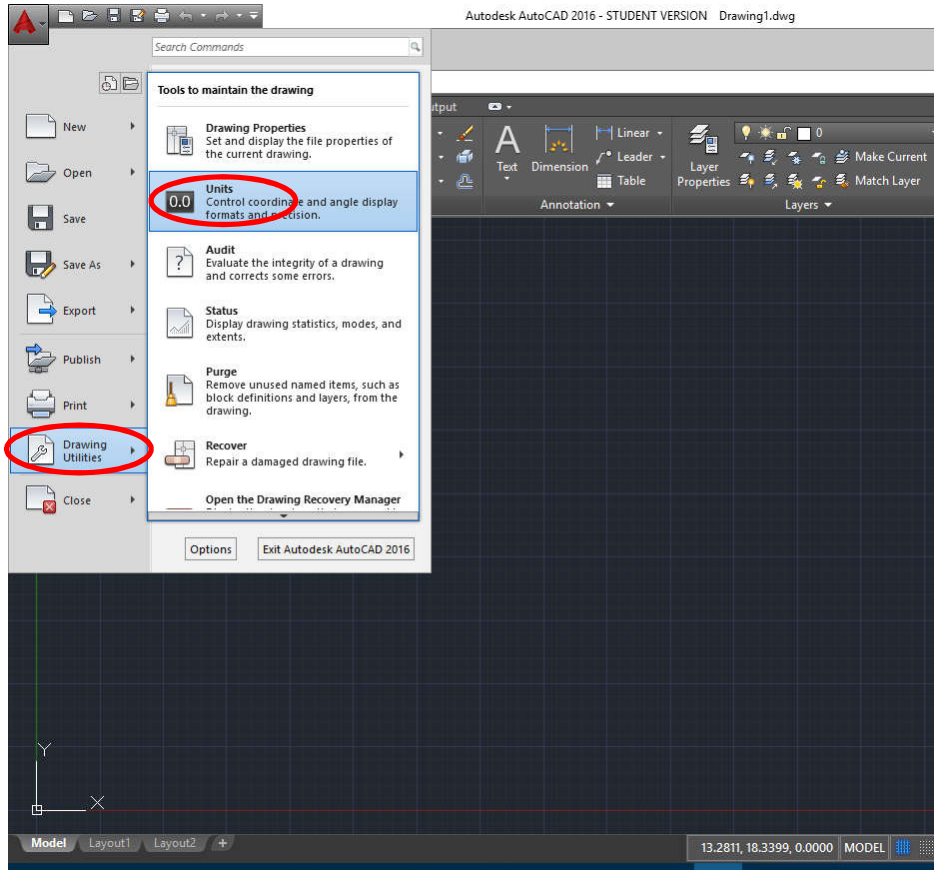
Snapshot of the AutoCAD screen



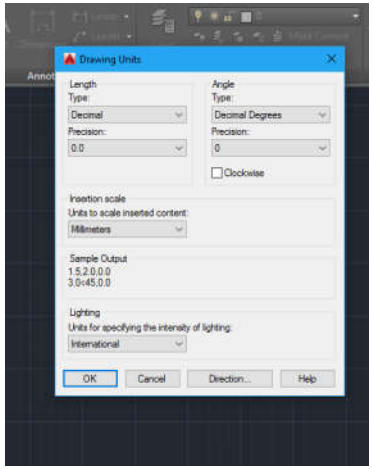
Setting Units

- In this course, the units for drawing objects will usually be in mm
  - If nothing is mentioned then units are in mm
- AutoCAD does not use mm by default
  - This may cause issues while printing/saving as pdf
  - Becomes difficult to define other properties like line thickness, etc
- We will first ensure that the units are in mm
  - Also a good idea to set the precision to single decimal place

Setting Units

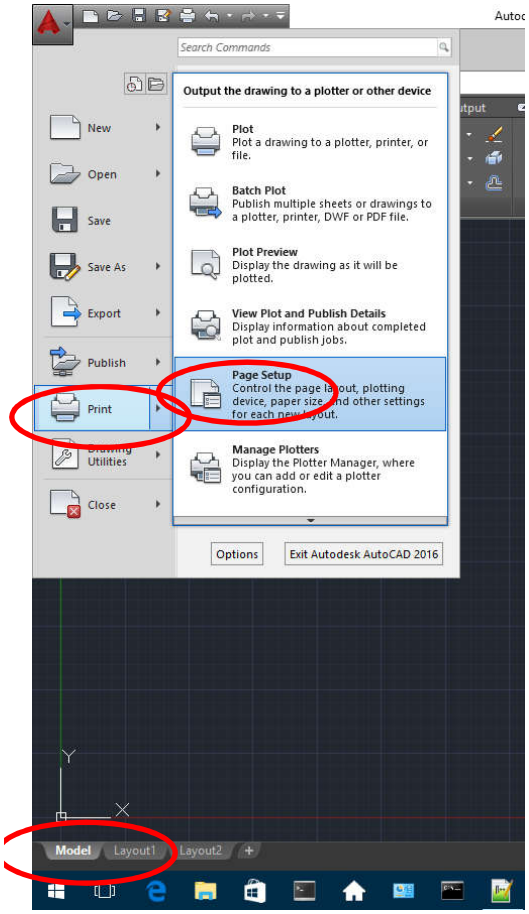


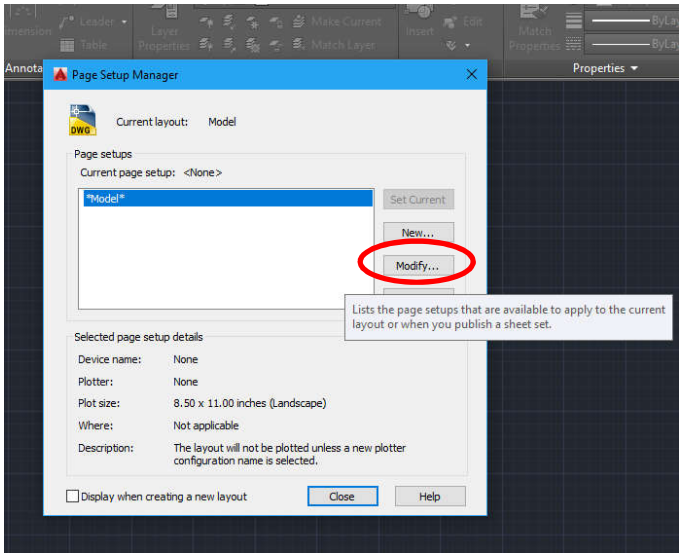
A

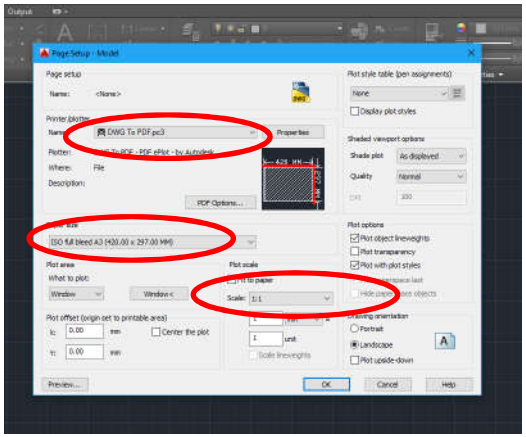


B

Page Setup : Model





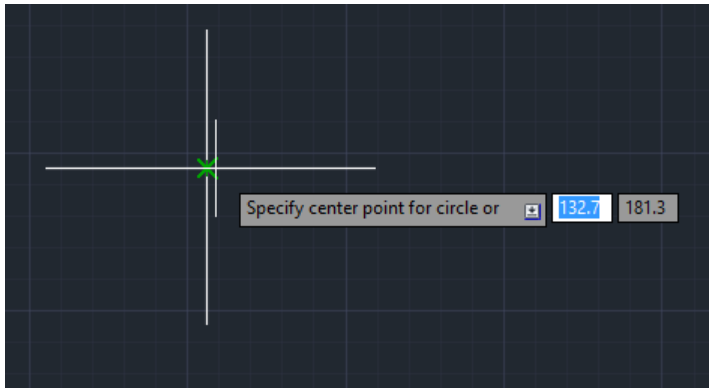


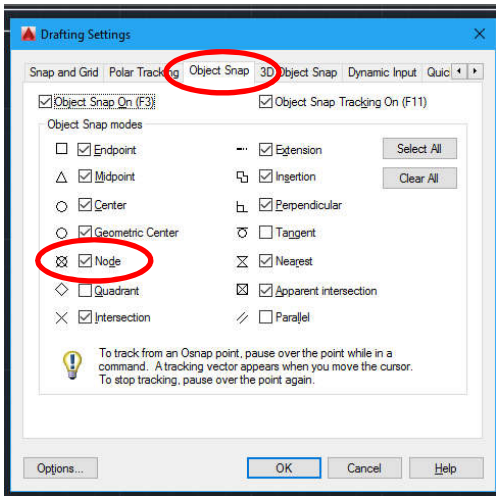
Printer name: DWG to PDF
Paper size: ISO full bleed A3 (420x297 mm)
Scale: 1:1

- This ensures that the drawing is being made on an A3 sized paper
- We won't really worry about the page setup for "Layout" tabs

Object Snap (OSNAP Command)

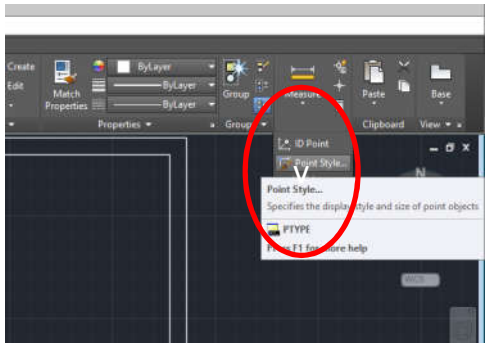
- While hovering cursor, AutoCAD will automatically select intersections, midpoints etc.
- OSNAP command can be used to set which points should be chosen



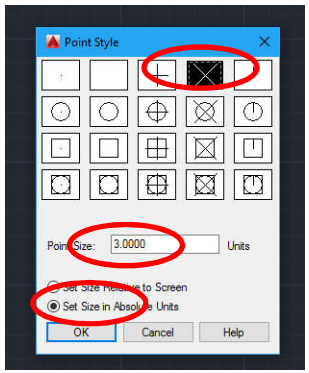


Make Nodes/Points Visible

- Sometimes we mark intersections/divisions using nodes/points
- We have to make these intersections visible using markers

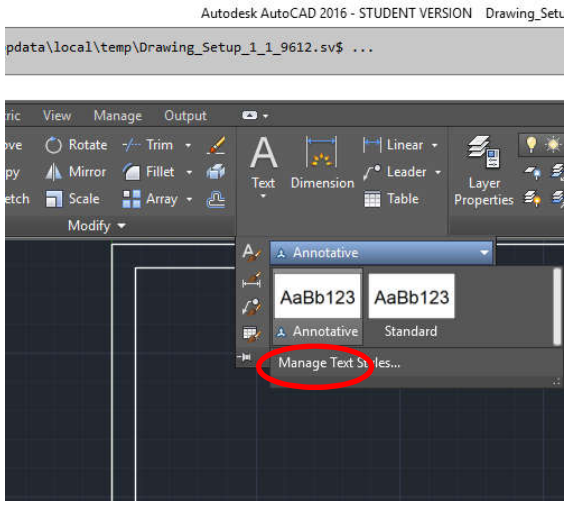


Utilities -> Point Style

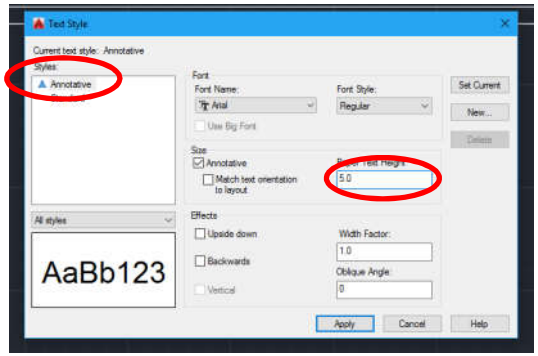


Setting Up Text Style

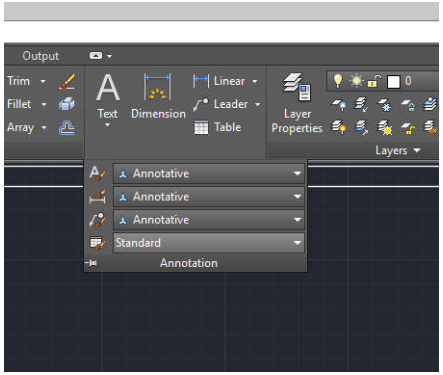
- Text size should not be too large/small compared to figures
  - Always test your settings



Annotation –> Text Style -> Manage text styles

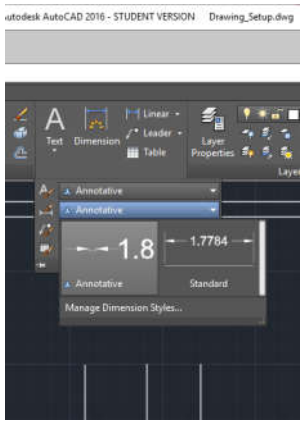


Select annotative



Annotation – Select Annotative for text, dimensions and multi-leader style

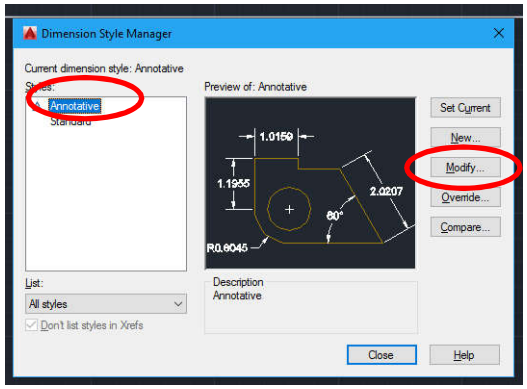
Dimensioning Style

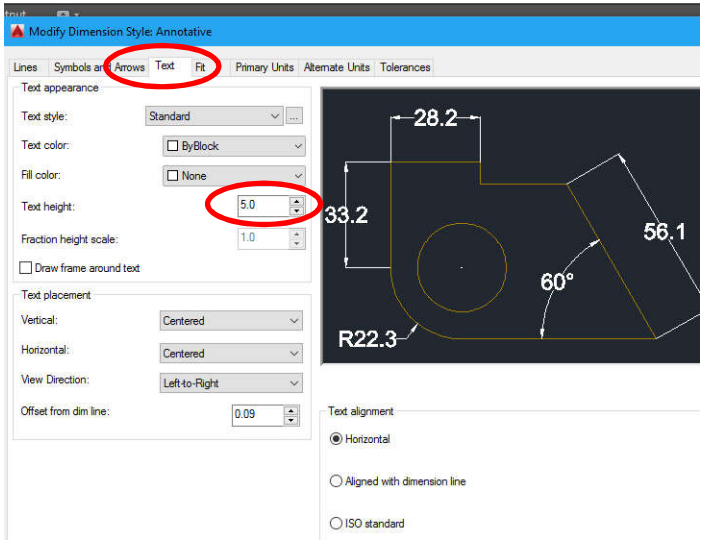


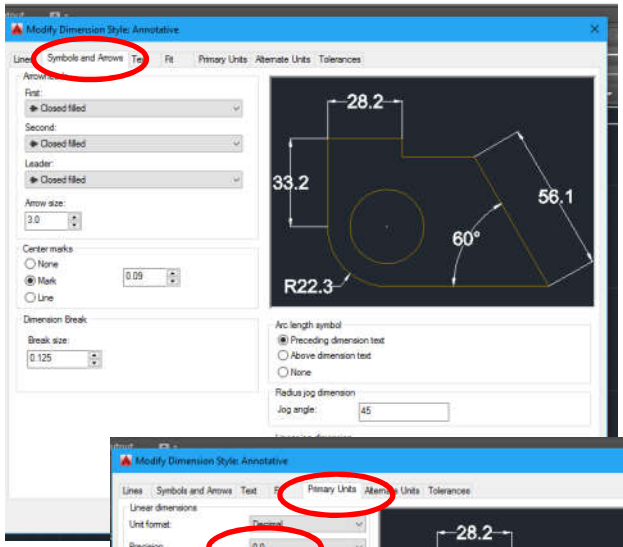
Annotation –>
Dimension Style ->
Manage text styles

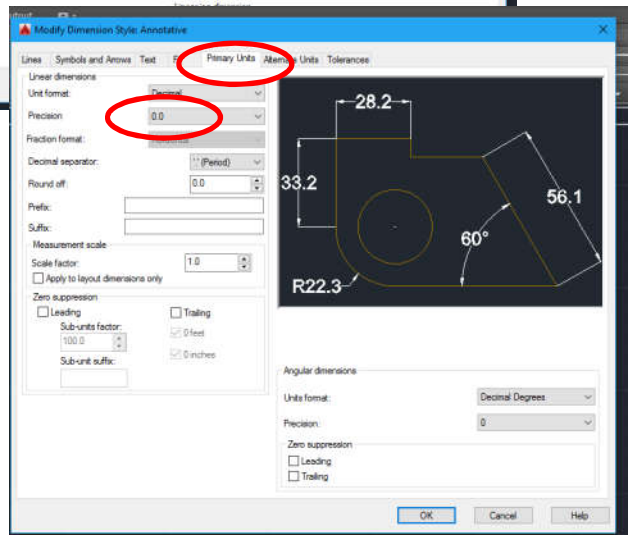
OR

Command: DIMSTY





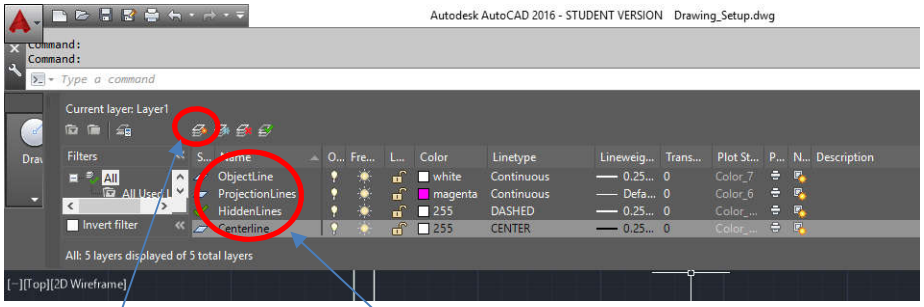




Make sure that size of text and arrows are not too large/small
Again – test your settings

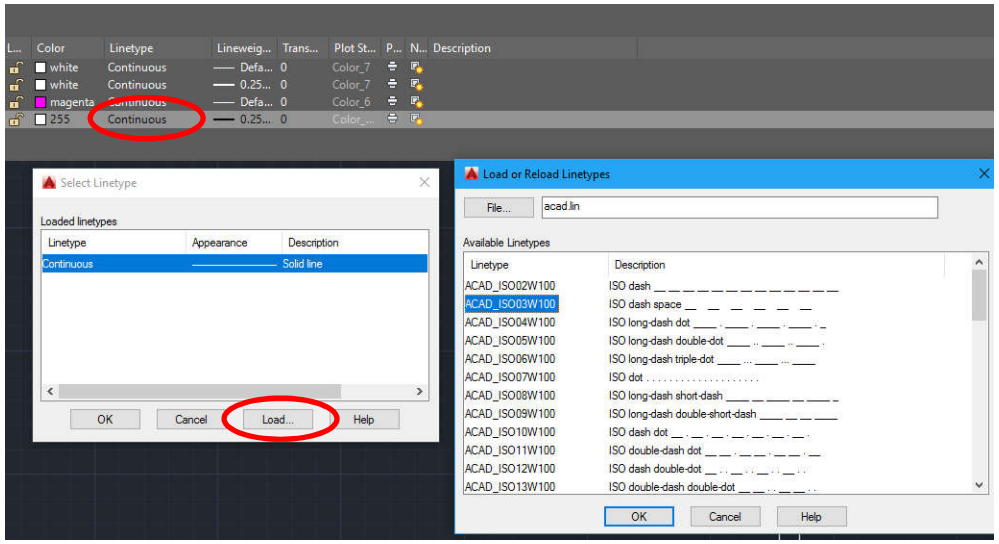
LAYER Command

Layer manager

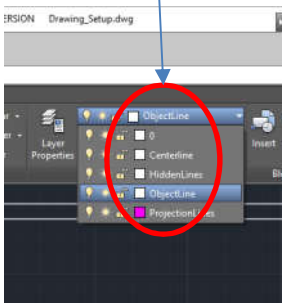


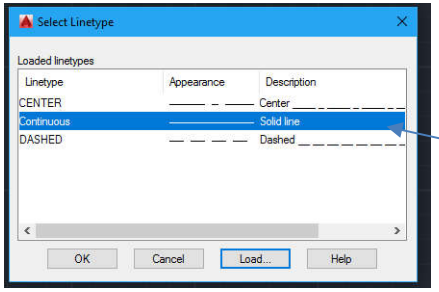
Add new layer

New layers created using the layer manager



To activate a layer in the drawing





Now select the loaded line type.

To change the line type of a layer, click on the current line type, then load, then select appropriate line type to load.

Using the layer manager you can add/delete layers, change linetypes, colour and freeze and thaw layers

You may use different colors for layers. Set all layers to white color before exporting to pdf.

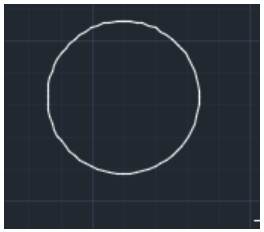
NEVER use the “defpoints” layer

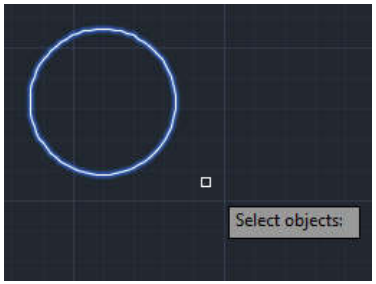
Summary of Settings

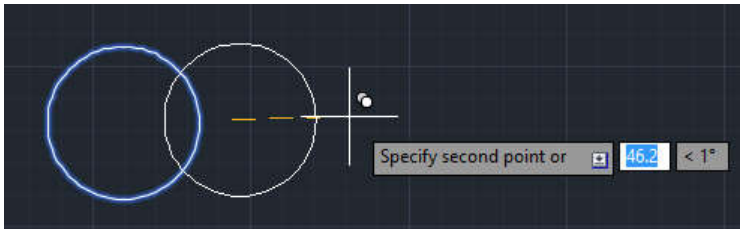
- Units (to mm)
- Page setup (420x297 mm)
- Object snap settings (OSNAP)
- Make nodes visible
- Set text size
- Set dimensioning style
- Set Layer properties

COPY/MOVE

- Make a circle (CIRCLE command)

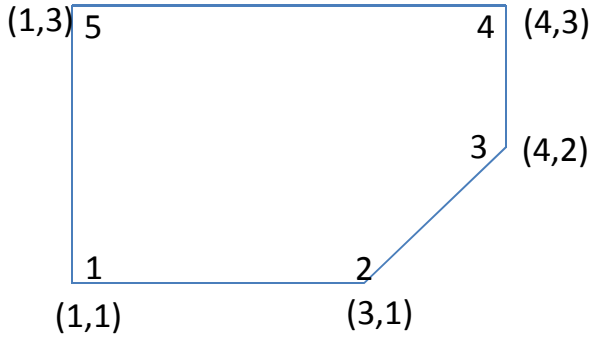






- Enter COPY command->select object (left-click)->right click (select base point)->drag object->right click (repeat if needed)
- Press Esc once you are finished copying
- MOVE command is very similar

PLINE: Different ways of creating polygons



Absolute Cartesian coordinates
Command: PLINE
1st point: 1,1
2nd point: 3,1
3rd point: 4,2
4th point: 4,3
5th point: 1,3
6th point: c

Relative Cartesian coordinates
Command: PLINE
1st point: 1,1
2nd point: @2,0
3rd point: @1,1
4th point: @0,1
5th point: @-2,0
6th point: c

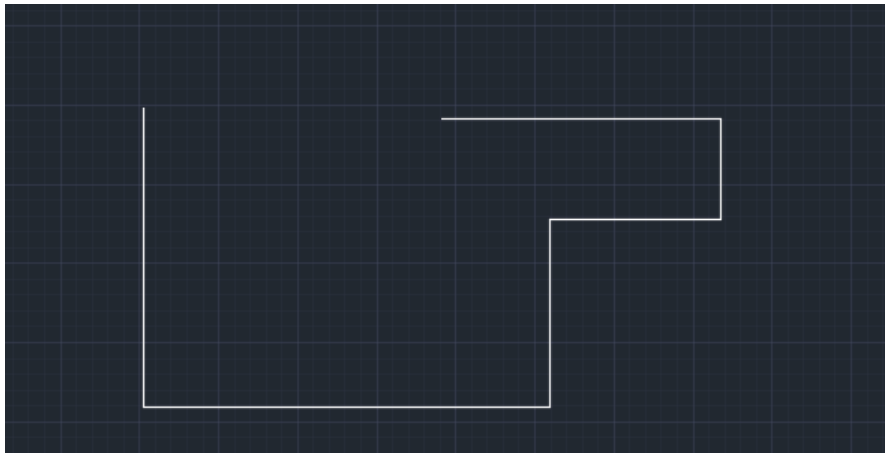
Relative Polar coordinates
Command: PLINE
1st point: 1,1
2nd point: @2<0
3rd point: @1.414<45
4th point: @1<90
5th point: @3<180
6th point: c

If you are making polyline using mouse clicks, press Esc to exit polyline

Other important shapes: CIRCLE, SPLINE

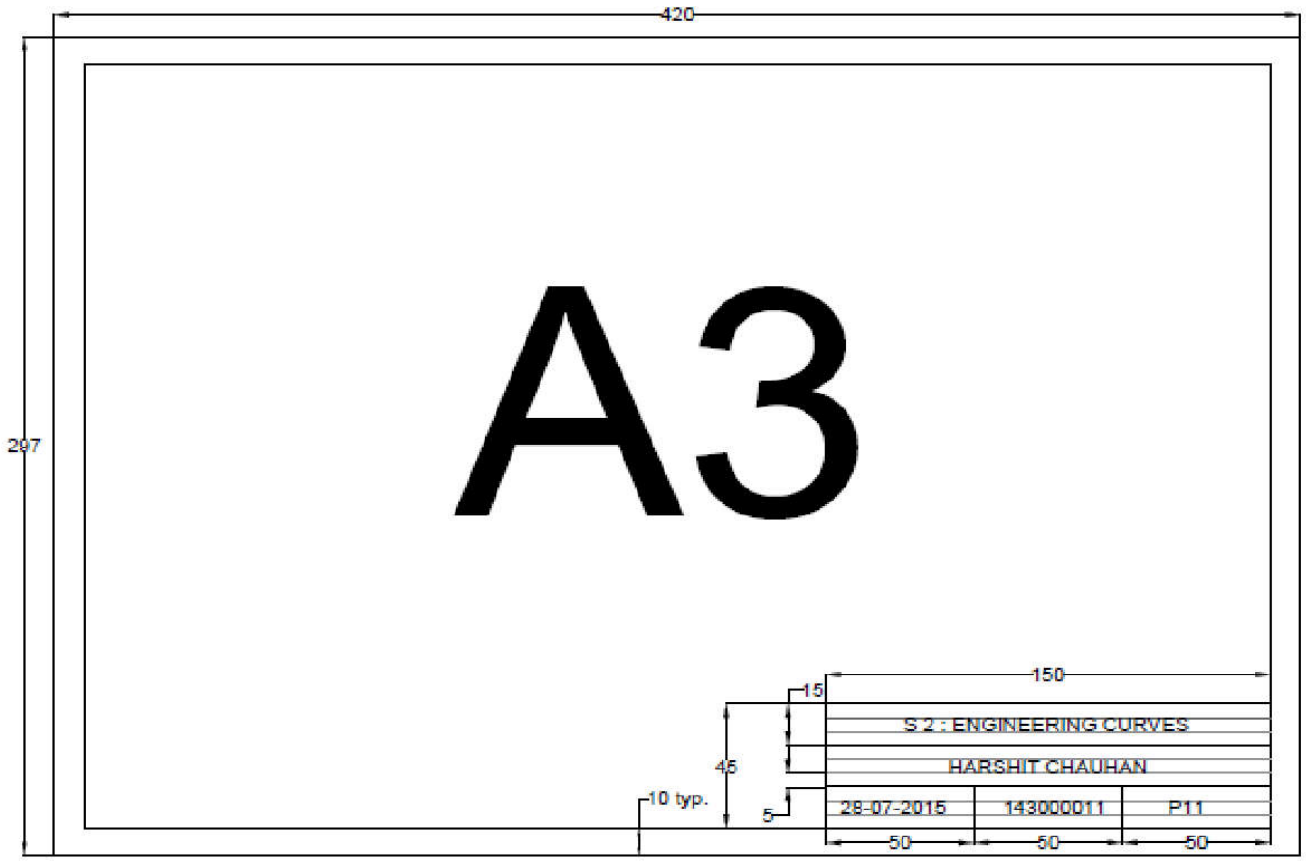
ORTHO Mode

- ORTHO mode ON helps us draw lines that are exactly parallel to axes
- Turn ORTHO OFF if line needs to be drawn at an angle



Template to be used for all the AutoCAD sheets

- **Paper, margins and name plate**:
  - *Size of sheet is* A3 (Width = 420 mm, Height = 297 mm)
  - 10 mm *margin on all sides*
  - *Name plate* (Size: 150 mm x 45 mm) *should appear in the right bottom corner as follows*



Steps to generate the template

(1) Use "*rectangle*" command with corner co-ordinates (0,0) and (420,297) to generate "**A3**" size drawing area.

(2) Use "*rectangle*" command with corner co-ordinates (10,10) and (410,287) to generate border with a gap of 10 mm. Other option is "*offset*" command or *relative co-ordinates @.*

(3) For name-plate, again "*rectangle*" command can be used with appropriate co-ordinates.

(4) Other option is move the "*ucs*" to the right bottom corner of the inner rectangle. Use "*rectangle*" command with corner co-ordinates (0,0) and (-150,45). Move the "*ucs*" back to the left corner of the outer rectangle.

(5) For Name plate, the innermost smaller rectangle in the right corner is to be divided into three equal parts. Switch on the ORTHO mode (F8). See the right corner of the computer screen.

(6) Draw line to coincide with the horizontal edge of the smallest rectangle.

(7) "*Move*" the line along *–y* direction by 15 units w.r.t original location.

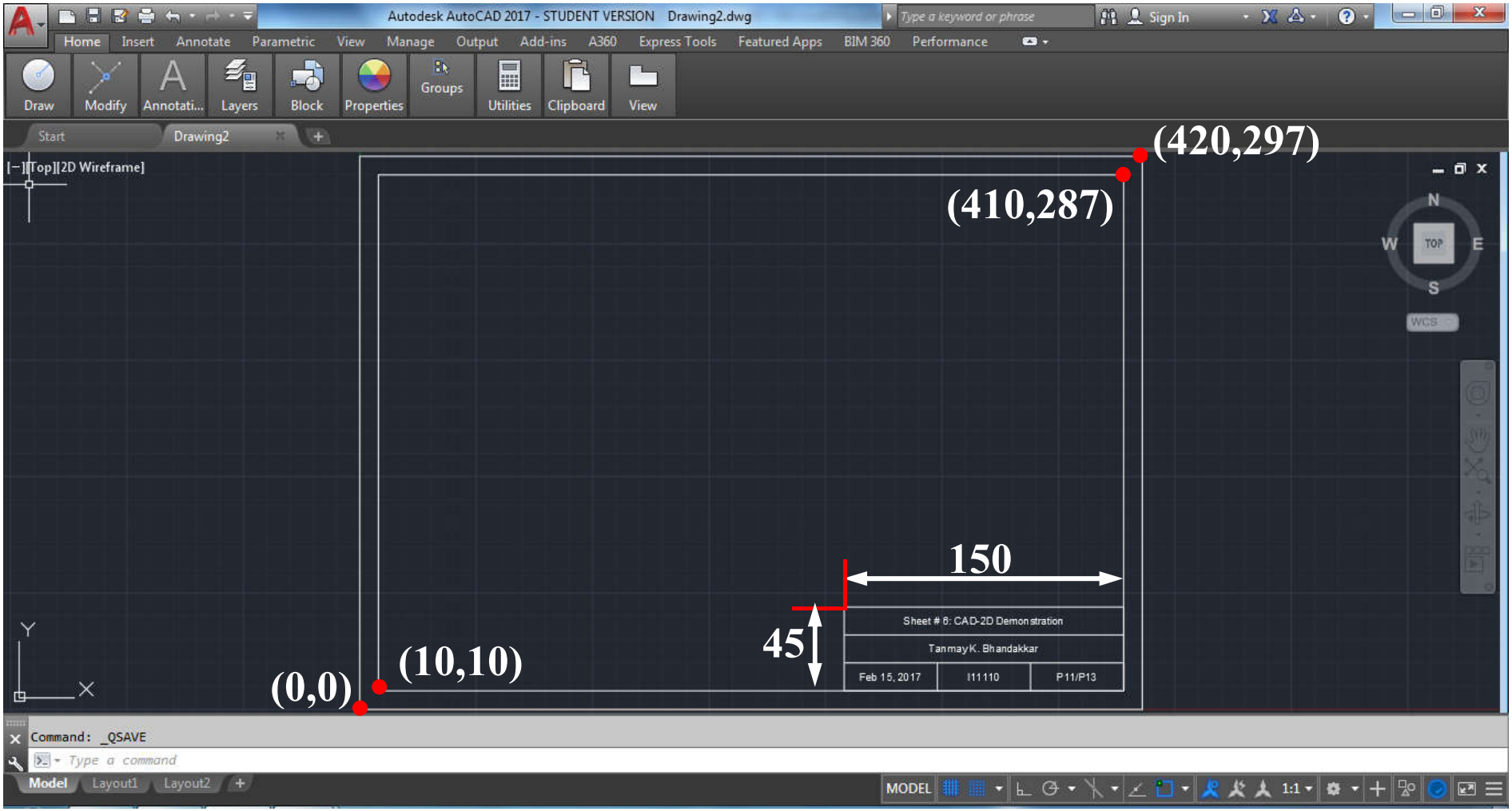
(8) "*Copy*" this line and move the new line relative to the 2nd line further by 15 units in the *–y* direction.

(9) In the bottommost rectangle of the name plate, use “Move" and "*Copy*" to further divide the rectangle into three move parts. Keep both the ORTHOMODE and SNAPON mode active.

Steps to generate the template

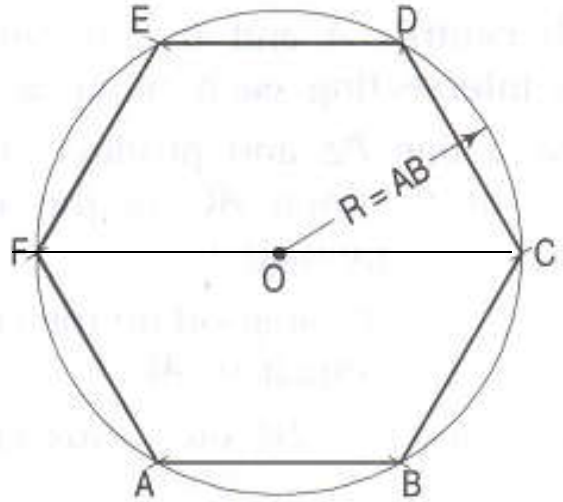
10) Add text using "*text*" command. The text should appear at the centre of the rectangular boxes of the rectangles of the name plate. It's a good idea to turn off "Object Snap" (OSNAP), since the text placement can get constrained.
11) With TEXT command, you can always enter multiple text lines. Press CTRL-ENTER to stop entering the text.

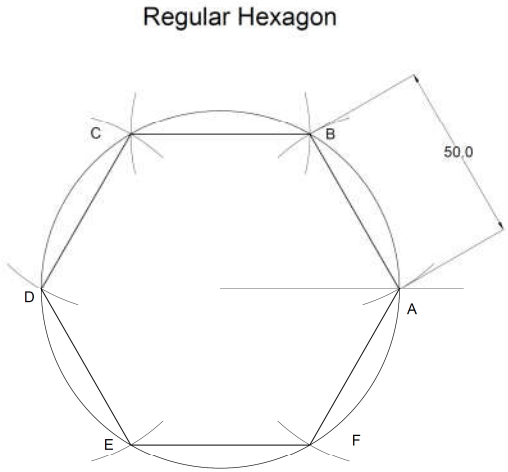
Snapshot of the template to be used for all the AutoCAD sheets



Example: Drawing a Hexagon

- Draw a hexagon with side 50 mm

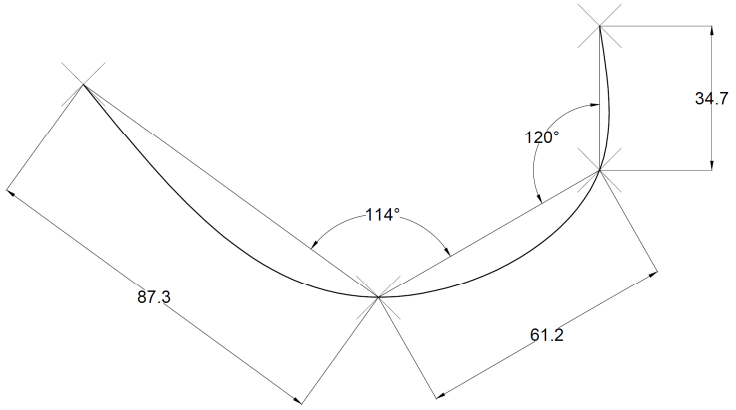




Commands used: CIRCLE, LAYER, TRIM, TEXT, DIMALI

Example: Drawing a Spline

- Draw a polyline, connect the vertices with a curve

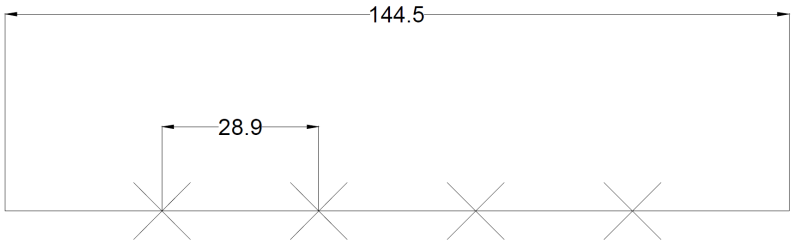


Spline
All Dimensions In mm

Commands used: PLINE, POINT, LAYER, DIMALI, DIMANG

Example: Divide a Line

- Divide a line into 5 equal parts



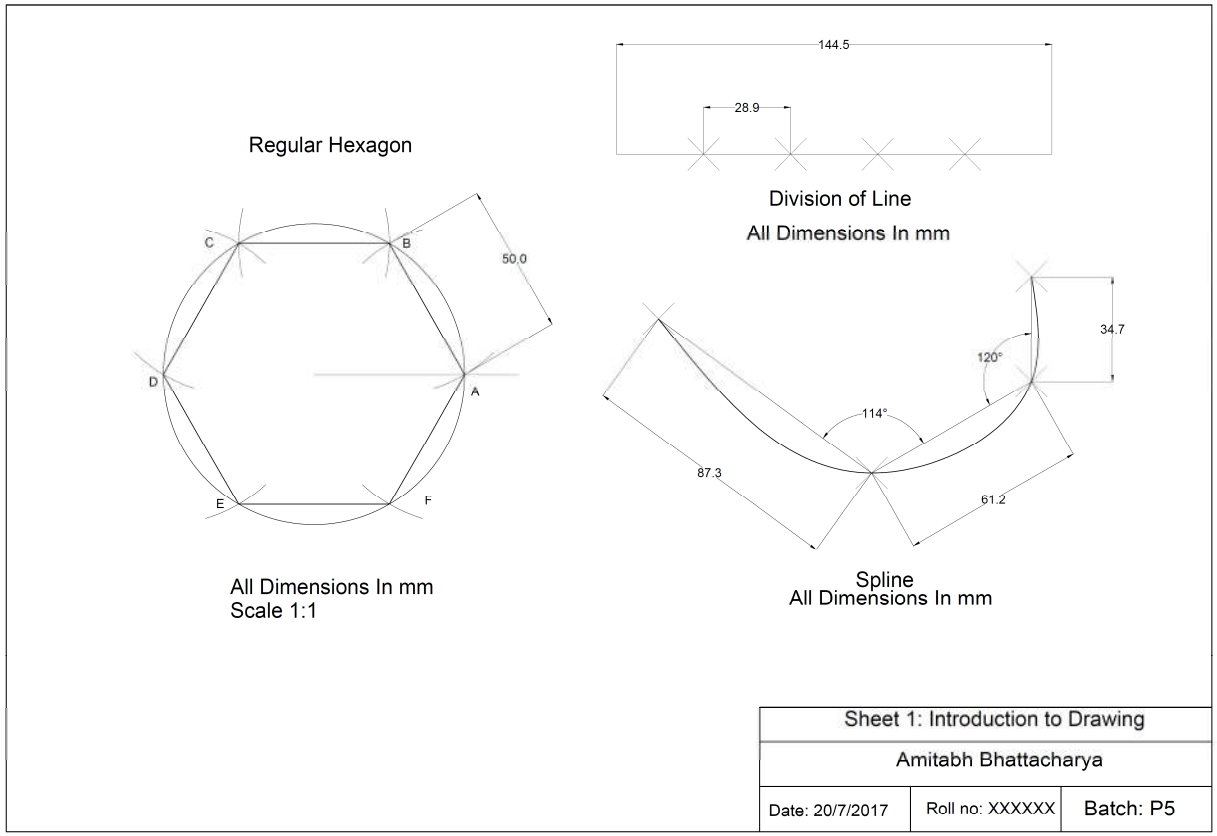
Division of Line

All Dimensions In mm

Commands used: PLINE, DIVIDE, POINT, DIMALI,

Example: Final Sheet

- Use export->pdf to print
- Always check print->plot preview



List of important AutoCAD commands

ARC
AREA
ARRAY
BLOCK
CIRCLE
COPY
CYLINDER
DIM
DIMALINGNED
DIMANGULAR
DIMCENTER
DIMDIAMETER
DIMSTYLE
DIVIDE
ELLIPSE
ERASE
EXTEND
LAYER
LINE
MOVE
OFFSET
PLINE
POLYGON
RECTANG
REDRAW
ROTATE
SAVE
SCALE
TRIM
U
UCS
ZOOM

AutoCAD Resources on the Web

https://www.andrew.cmu.edu/course/48-568/

https://openlab.citytech.cuny.edu/fall-2015-visual-studies-i/files/2015/09/AutoCAD-Tutorial-002.pdf

http://www.arch.virginia.edu/computing/training/online/pdf/CAD%20Tutorial-Fangfang-110227.pdf

http://core.coe.drexel.edu/ay1314/engr100/sites/core.coe.drexel.edu.engr101/files/downloads/files/AutoCAD_Command_Shortcuts.pdf