H14ERP Advanced Engineering Research Preparation

A Practical Introduction to AutoCAD…

Assignment Project Exam Help

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Introduction to AutoCAD

The University of Nottingham
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After this lecture, you should:

- Have a basic familiarity with AutoCAD, including:
  - ➢ Understand, use and personalize the AutoCAD environment
  - ➢ Set up a drawing space (in AutoCAD)
  - ➢ Set up a standard template for engineering drawings

- Be able to use AutoCAD to draw objects
  - ➢ Drawing shapes (lines, rectangles, polygons, circles, arcs, etc.)
  - ➢ Modify objects (copy, erase, move, rotate, trim, extend, scale, mirror, arrays, chamfer, fillet, etc.)
  - ➢ Efficiently manage drawing organisation and properties (layers, grid, snap, etc.)

- Produce an accurate engineering drawing of an object
  - • 3rd angle orthographic projection
  - • Dimensions

⇨ *Emphasis on Interactive Learning*

Watch for slides with: **Interactive Exercise**

Part 1: Getting Started

- Launch AutoCAD

- Opening a drawing (new or existing)

- The AutoCAD environment
  - ➢ Menu Tabs, Panel Buttons, Toolbars and Dialog boxes
  - ➢ Command line
  - ➢ Status bar (coordinates, soft keys)
  - ➢ Drawing area (UCS, properties)
  - ➢ Model and Layout space

- Personalizing AutoCAD

- Setting up your Model Space
  - ➢ Units and precision
  - ➢ Drawing Limits
  - ➢ Layers

- Saving your drawing (and backups)

Launching AutoCAD 2017

Interactive Exercise

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1) To launch AutoCAD click the *AutoCAD 2017 - English* icon on the desktop, or *Start>All Programs>Autodesk>AutoCAD 2017 – English>AutoCAD 2017 – English*

2) In the "**A**" pull-down menu (upper left), click *New* to create a new drawing. In the dialog box, choose the drawing template *acadiso.dwt* and click *Open* Your screen should look like this:

3) Hover the cursor over an object and an explanation appears.
   Explore the AutoCAD window for a few minutes...
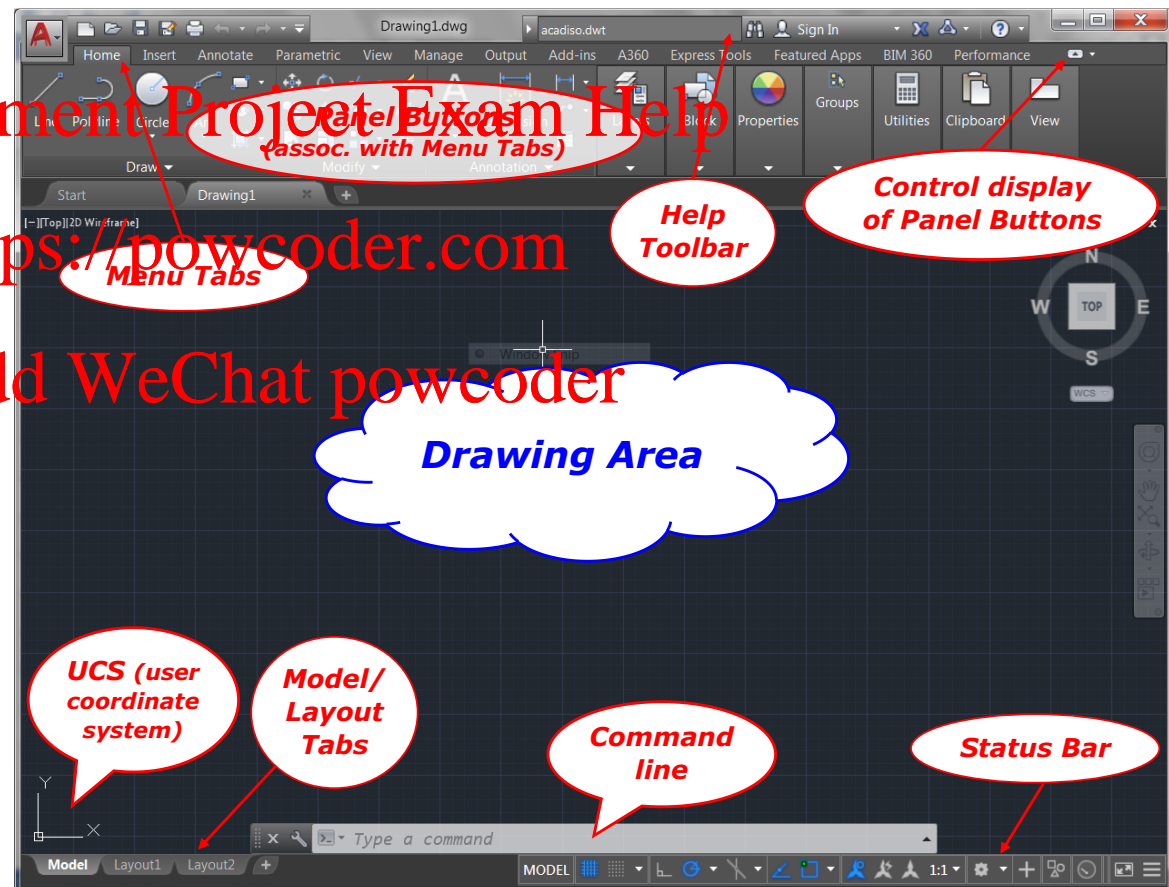
The template acadiso.dwt tells AutoCAD to use metric units and ISO-based dimensioning and colour based plot styles.

Panel Buttons (assoc. with Menu Tabs)

Control display of Panel Buttons

Help Toolbar

Menu Tabs

Drawing Area

UCS (user coordinate system)

Model/ Layout Tabs

Command line

Status Bar

The AutoCAD window...

Menu Tabs: This is a windows=style interface with the commands used to control and use AutoCAD. Instead of pull-down menus (as in earlier AutoCAD versions), the Menu Tabs use **Panel Buttons**.

Command Window: You can enter every AutoCAD command here. AutoCAD also displays messages and prompts here. (Forward/backward compatibility makes the Command Line helpful for working with earlier or later versions of AutoCAD.)

Status Bar: Softkeys for toggling control of your drawing space. Some useful softkeys are:

- Model –vs – Paper view
- Grid On/Off
- Snap (On/Off) and SnapMode (Grid/Polar/Settings)
- Object Snap (On/Off) and OSnap settings [Snaps cursor to defined points on objects.]
- Ortho [Restricts cursor motion to orthogonal directions.]

Drawing Area: This is where your drawing will be made.

UCS: The User Coordinate System is a reference for the origin and axes of your drawing space

WCS: The World Coordinate System. [We won't worry about this now.]

Model/Layout Tabs: There are two distinct working environments in which you can create objects in a drawing - Model space and layout space.

- A **model** composed of geometric objects is created in a 3D space called model space.
- A **layout** of specific views of this model is created in a 2D space called **paper space**. You can use multiple layouts to show details on the components of your model.

Navigating the Drawing area (Layer)

A powerful feature of AutoCAD is its ability to make drawings with multiple Layers.

- Layers are like transparencies that can be laid on top of each other.

- Layers organise the drawing by allowing you to put common features (e.g. dimensions) in a single layer

- Layers can be turned "on" or "off" to make them visible or invisible.

- Many object properties can be specified as "ByLayer." ***This allows all objects on the layer to be modified at the same time!***

  ⇒ Different layer colours helps you identify objects on the wrong layers…

  ⇒ Different layer colours improves drawing clarity

Modifying object properties

Properties we frequently wish to modify:

- Colour, Linetype and Lineweight
- The Layer that the object is on
- Whether the object is displayed or hidden
- Whether the object is printed or not

Object properties can be modified in groups

- **ByLayer** – By assigning all objects of the same type or role to the same layer, their properties can be assigned "ByBlock" and controlled at the Layer level. This is both easy and good practice, since it :
    - Ensures all objects of the same type are treated the same (none are missed)
    - Helps you see when an object is on the wrong layer…
- **ByBlock** – Objects can be grouped as Blocks, with many of their properties being controlled "ByBlock". [We do not cover Blocks in this lecture…]

Personalizing AutoCAD ...

4) It is often useful to know the **coordinates** of the cursor when you are drawing. In the *Status Bar*, locate and click *Customisation*, then click on *Coordinates* in the pop-up menu. *The cursor coordinates should now appear in the Status Bar.*

5) To modify the information displayed in the Menu Tabs, click on the icon on the right side of the Menu Tabs (see *"Control display of Panel Buttons"* in the figure) and cycle through the options. [Leave the Panel Buttons showing for now...]

6) To modify the colour scheme of the Menu Tabs, click the "wrench" icon next to the *Command Line* and click *Options* (or type *"Options"* in the *Command Line*).
   • In the Options dialog box, select the *Display* tab and use the pull down box under "Color Schemes" to change the colour to "Dark" or "Light".

7) (Advanced) To change the model space background colour (e.g. black to white), click the "wrench" icon in the next to the *Command Line* and click *Options*, then:

   • In the Options dialog box, select the *Display* tab and click the *"Color"* softkey.

   • In the Drawing Windows Colors dialog box, select:
      ✓ "2D model space" for the Context;
      ✓ "Uniform background" for the Interface element; and
      ✓ the desired colour.

   • Then click "Apply & Close" and "OK" to close the two dialog boxes

Setting up your model space...
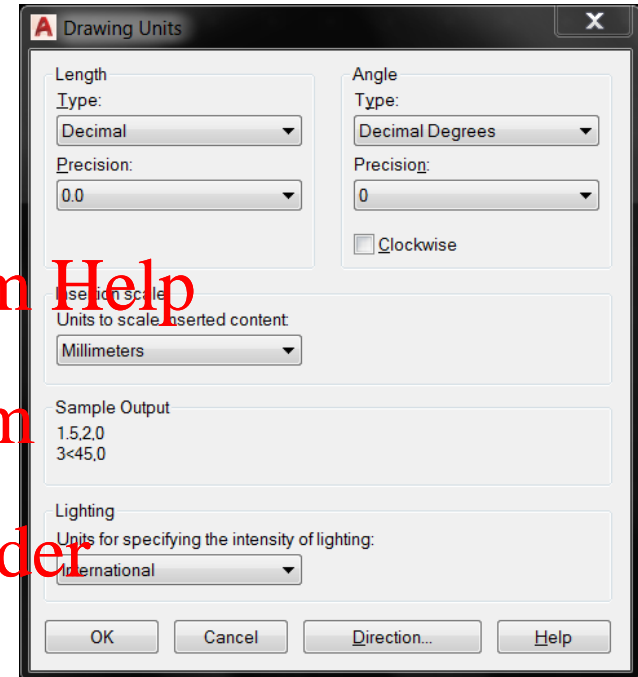
8) To set the drawing limits, type *Limits* in the *Command Line*, then enter :
   - Specify lower left corner: *0,0*
   - Specify upper right corner *420,297*

9) To set the drawing units & precision, type *Units* in the *Command Line*, then
   - under "Length", select Type as *Decimal* and Precision as *0.0*
   - under "Angle", select Type as *Decimal Degrees* and Precision as *0*

10) To set the format for entering points, type *Coords* in the *Command Line* and enter the value *1. T*he options include:

   0 – Absolute coordinates are displayed, but updated only when a point is specified

   1 – Absolute coordinates are displayed and updated in realtime.

   2 – Relative polar coordinates are displayed and updated in realtime when a command is active and while a point, distance, or an angle is specified. (When no command is active, absolute coordinate values are displayed.)

   3 – Geographic (latitude & longitude) coordinates are displayed & updated in realtime.

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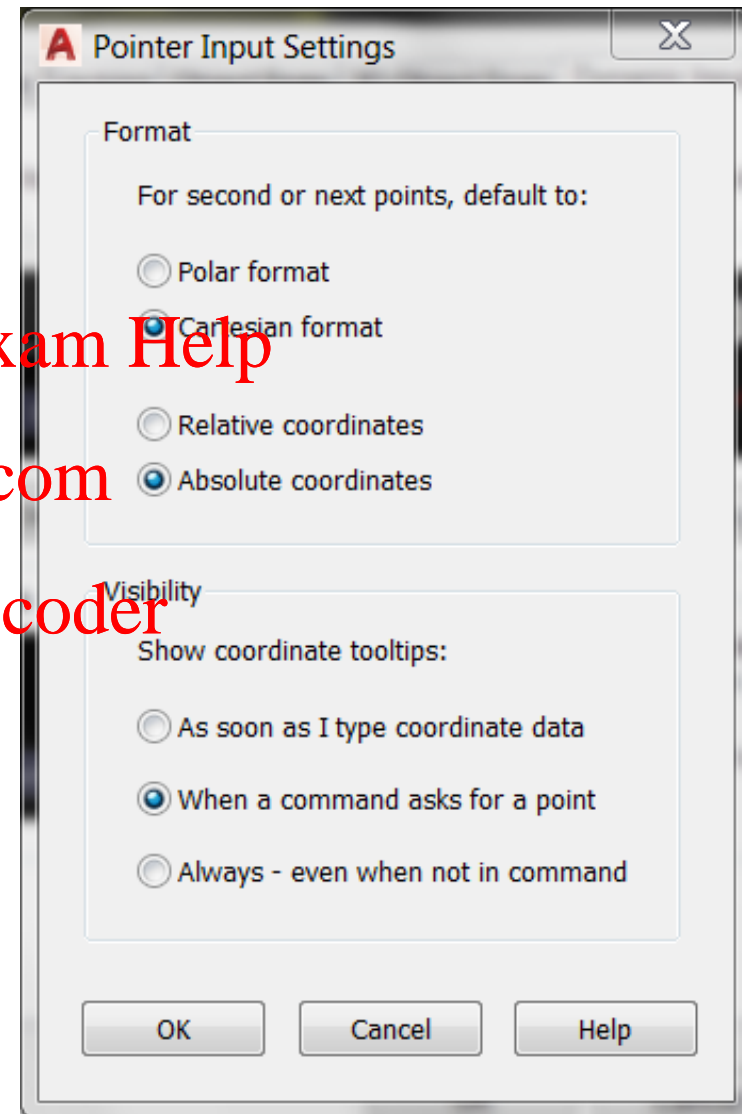# Setting up your model space…

11) Pointer Input settings:

Click *Snap Settings* in the *Snap* pull-down menu in the *Status Bar* [The arrow next to the *Snapmode* softkey…]

Choose the *Dynamic Input* tab and click *Settings* under *Pointer Input*, then:

✓ select *Cartesian Format* and *Absolute Coordinates* [*Polar format* and *Relative coordinates* can lead to problems and confusion (e.g. when drawing lines)…]

Pointer Input Settings

Format

For second or next points, default to:

○ Polar format
● Cartesian format
○ Relative coordinates
● Absolute coordinates

Visibility

Show coordinate tooltips:

○ As soon as I type coordinate data
● When a command asks for a point
○ Always - even when not in command

OK   Cancel   Help

Setting up your model space…

12) Dynamic Input : Click *Snap Settings* in the *Snap pull-down menu* in the *Status Bar* [This step stops the display of coordinates next to the cursor when entering points, which can be confusing and annoying…]

Choose the *Dynamic Input* tab and:

✓ Uncheck the box next to *Enable Pointer Input*

✓ Uncheck the box next to *Enable Dimension Input where possible*

Drafting Settings dialog box with tabs: Snap and Grid | Polar Tracking | Object Snap | 3D Object Snap | Dynamic Input | Quick Propert. Shows Pointer Input (15.1643, 22.0669), Dimension Input (3.7721), Dynamic Prompts (Specify first point:), with checkboxes for "Show command prompting and command input near the crosshairs" and "Show additional tips with command prompting". Buttons: Options…, OK, Cancel, Help, Settings…, Drafting Tooltip Appearance…

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Setting up your model space…

13) Grid and Snap settings: Click *Snap Settings* in the *Snap pull-down menu* in the *Status Bar* [The arrow next to the *Snapmode* softkey…]
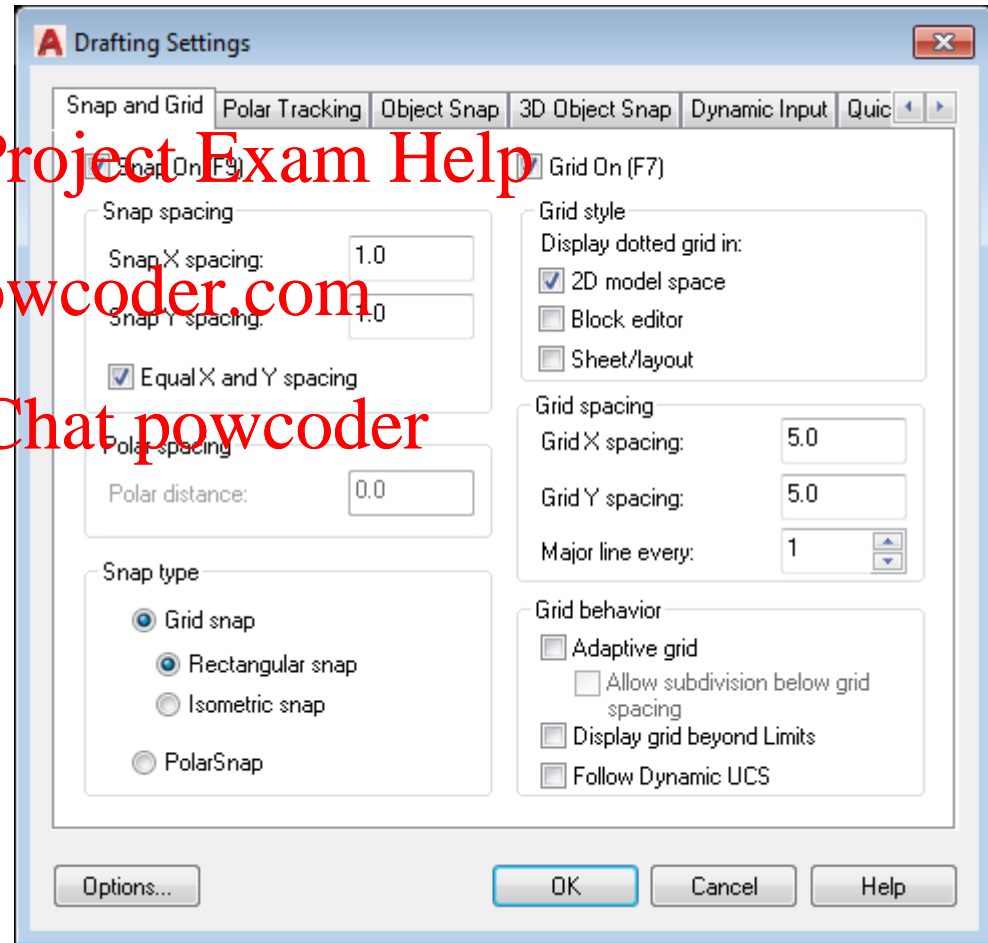
Choose the *Snap and Grid* tab, then

- ✓ select *Snap On* and *Grid On*
- ✓ under "*Snap spacing*" select *Equal X and Y spacing* and set the Snap X & Snap Y to "*1*"
- ✓ under "*Grid Style*" select *2D model space*.
- ✓ Under "*Grid spacing*" set the Grid X and Grid Y spacing to *5*
- ✓ Under "Grid behaviour" uncheck the *Display grid beyond limits*

Notes:

If the cursor doesn't "snap" to grid points, type *snapgridlegacy* in the *Command Line* and set it to "*1*".

If you rely on a constant grid spacing, turn *Adaptive grid* off!

Drafting Settings

Tabs: Snap and Grid | Polar Tracking | Object Snap | 3D Object Snap | Dynamic Input | Quic...

☐ Snap On (F9)   ☑ Grid On (F7)

Snap spacing
- Snap X spacing: 1.0
- Snap Y spacing: 1.0
- ☑ Equal X and Y spacing

Polar spacing
- Polar distance: 0.0

Snap type
- ◉ Grid snap
  - ◉ Rectangular snap
  - ◯ Isometric snap
- ◯ PolarSnap

Grid style
Display dotted grid in:
- ☑ 2D model space
- ☐ Block editor
- ☐ Sheet/layout

Grid spacing
- Grid X spacing: 5.0
- Grid Y spacing: 5.0
- Major line every: 1

Grid behavior
- ☐ Adaptive grid
  - ☐ Allow subdivision below grid spacing
- ☐ Display grid beyond Limits
- ☐ Follow Dynamic UCS

Options... | OK | Cancel | Help

Setting up your model space...

14) Object Snap settings: Click *Snap Settings* in the *Snap pull-down menu* in the *Status Bar*
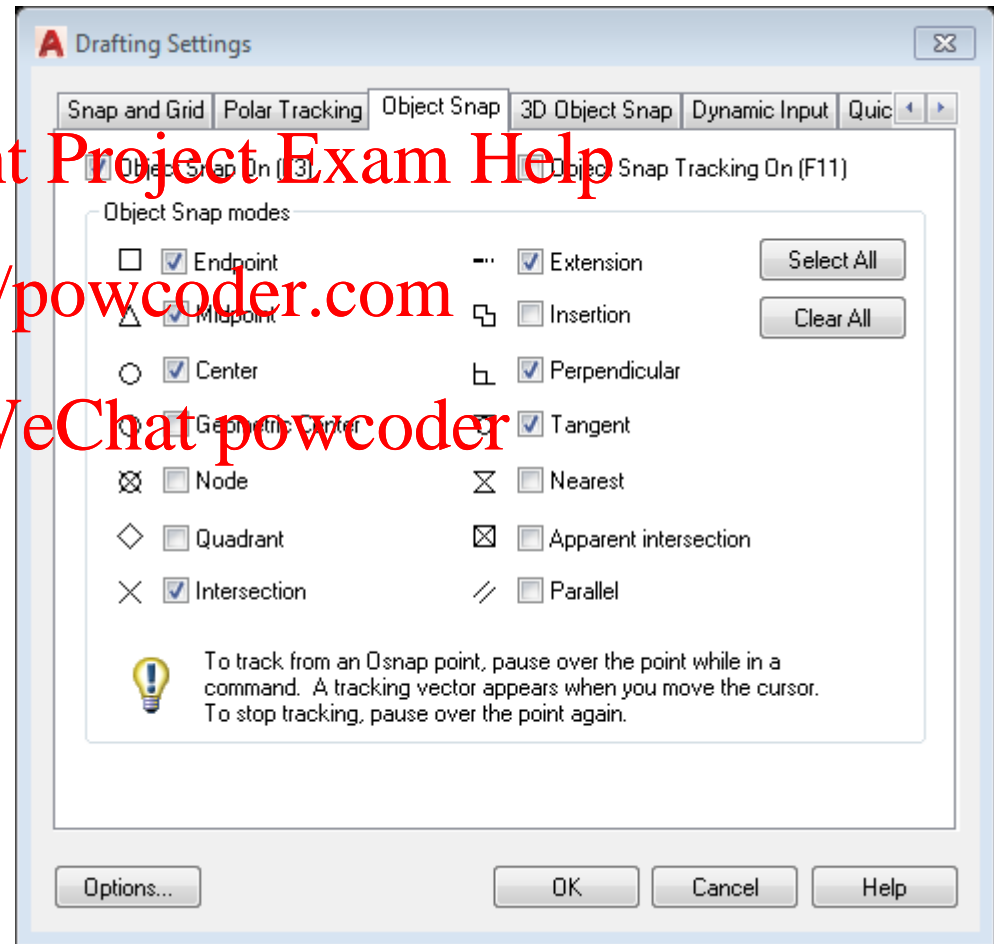
Choose the *Object Snap* tab, then select the following:

- ✓ *Endpoint*
- ✓ *Midpoint*
- ✓ *Center*
- ✓ *Intersection*
- ✓ *Extension*
- ✓ *Perpendicular*
- ✓ *Tangent*

Note: The power of Osnap and the purpose of these options will become clear later, when we try to align or modify objects...

Setting up your model space…

Interactive Exercise

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AutoCAD uses Layers to organise and control a drawing. We can show/hide layers and modify their properties (colour, linetype, lineweight).

15) Select the Menu Tab *Home*, then

- go to the Panel Button *Layers* and click the icon *Layer Properties*
- In the dialog box, click on the icon *New Layer*
- Double-click on the new layer's name and type in "Border", assign it a colour and turn it "on"
- Make the new layer "current", by…
  - ✓ clicking on the "Status" icon; or
  - ✓ Selecting the new layer and click on the "Set Current" button
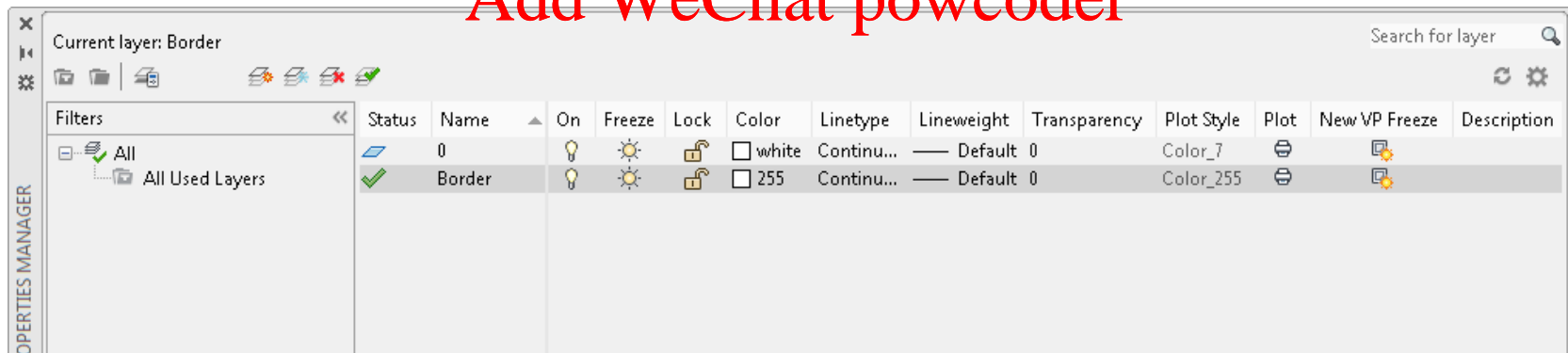
16) In the "**A**" pull-down menu, click *Save As …* [Complete as normal…]
   Avoid losing work - Save your drawing frequently!

Part 2: Mastering the AutoCAD Basics

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- Drawing the Border [Can be re-used for future drawings!]
  - ➤ Drawing simple shapes
    - ✓ Lines
    - ✓ Rectangles
    - ✓ Circles
    - ✓ Arrays
    - ✓ Text
  - ➤ Entering and executing Commands
    - ✓ Using the Command line
    - ✓ Using the Menu Tabs and Panel Keys
    - ✓ Using the Grid and Snap Grid
  - ➤ Controlling AutoCAD
    - ✓ Use of Pan (to move around the Drawing Area)
    - ✓ Creating a new Layer
    - ✓ Changing the properties of a Layer
    - ✓ Locking a Layer

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Drawing the Border (1)…

Now let's begin to draw the border or frame for our drawing…

17) Type *Rectangle* in the *Command Line*, then:
- Specify first corner point: *10,10*
- Specify other corner point: *410,280*

18) In the *Home* menu tab, select *Line* panel button, then:
- Move the cursor to the first point *10,50* and *<right click>*
- Move the cursor to the first point *410,50* and *<right click>* [See note below…]
- press the *<Enter>* key [This ends the line command…]

> ***Note:*** If the coordinates displayed in the *Status Bar* have the have the polar format "mm>nn", press the *<Esc>* key to exit *Line* command.
> Next, type *Coords* in the *Command Line* and enter the value: *1*

19) Type *Line* in the *Command Line*, then:
- Specify first point: 2*10,20*
- Specify other corner point: *20,410* [A mistake so we can illustrate "undo"…]
- Type: *Undo*
- Specify other corner point: *410,20*
- Press the *<Enter>* key

Drawing the Border (2)…

20) Type *Pan* in the *Command Line*, then:
   - Move the cursor into the *Drawing Area*, then *right click and drag* the drawing upwards until the bottom of the border rectangle is accessible…
   - Press the *<Enter>* key [This ends the pan command…]

21) In the *Home* menu tab, select the *Modify>Rectangular Array* panel button, select the horizontal line just drawn and press *<Enter>*. Then enter the following in the dialog box:
   - Under "*Columns*":
     - ✓ Columns: *1*
     - ✓ Between: *10* [With only 1 column, this doesn't matter…]
   - Under "*Rows*":
     - ✓ Rows: *3*
     - ✓ Between: *10*
   - Under "*Levels*", enter values of *1* [We are making a 2D drawing…]
   - Click the "*Close Array*" softkey [This ends the line command…]

Drawing the Border (3)…

22) Next, draw a vertical line from *(110, 10)* to *(110,50)*

23) Draw vertical lines from *(210,10)* to *(210,50)* and *(310,10)* to *(310, 50)*:

- Type *copy* in the *Command Line*, then:
    - ✓ Use the cursor to select the vertical line you just drew and press *<Enter>*
    - ✓ Specify base point: *0,0* [Doesn't need to be the object – (0,0) is simple!]
    - ✓ Enter second point: *100,0* [Correct 2D displacement from the base point]
    - ✓ Enter second point: *200,0*
    - ✓ Press the *<Enter>* key

24)) Type *Text* in the *Command Line*, then:
- Specify start point of text: *115,42.5*
- Specify height: *3.5*
- Specify rotation angle of text: *0*
- Type in text: *DESCRIPTION* [Use uppercase letters…]
- Press *<Enter><Enter>* [Need to press <Enter> twice to end text…]

Drawing the Border (4)...

25) In the *Home* menu tab, select the *Annotation>Text* panel button, choose "single line text", then:
- Specify start point of text: *215,42.5*
- Specify height: *3.5*
- Specify rotation angle of text: *0*
- Type in text: *DRAWN BY: "Your Name"*
- Press *<Enter><Enter>*

26) Now enter the following text:
- At *(215,32.5),* enter *DATE:*
- At *(215,22.5),* enter *UNITS:*
- At *(215,12.5),* enter *SCALE:*
- At *(315,42.5),* enter *DRAWING NO.*
- At *(315,32.5),* enter *VERSION NO.*
- At *(315,22.5),* enter *SHEET NO.*
- At *(365,22.5),* enter *OF*
- At *(385,22.5),* enter *SHEETS*
- At *(315,12.5),* enter *TO STANDARDS:*

Draw the projection symbol…

27) Type *Circle* in the *Command Line*, then:
- Specify center point for circle: *180,260*
- Specify radius of circle: *3.5*

28) To create a concentric circle, type *Offset* in the *Command Line*, then:
- Specify offset distance: *4.0*
- Select object to offset <Place cursor over circle and left click>
- Specify point on side to offset <Click cursor outside of circle>
- Click *<Escape>*

29) To enlarge the area around the circles, type *Zoom* in the *Command Line*:
- Type *Window*
- Use the cursor to define a window [Leave about 30mm on both sides…]

30) Draw two vertical lines:
- From *(213.75,252.5)* to *(213.75,267.5)*
- From *(198.75,256.5)* to *(198.75,263.5)*

31) Click the *Object Snap* in the *Status Bar* (or type *OSnap*) to turn it *ON*

32) Draw two lines to complete the trapezoid using *Object Snap*

Draw the projection symbol…

The completed border should look like:
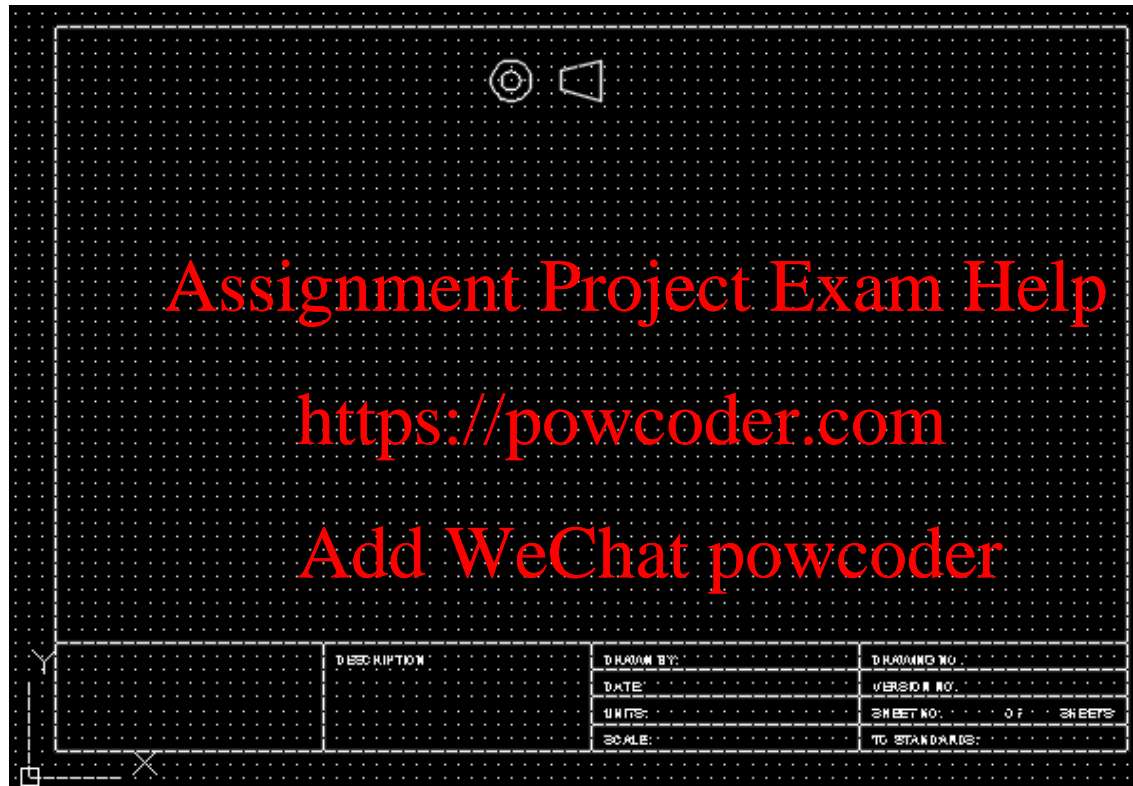
33) When you are happy with your border, click the *Layer Properties* softkey and click on the *Lock* symbol to lock the layer (and prevent changes) [The brightness of the objects in this layer will dim, indicating that it is locked.]

34) Don't forget to **SAVE** it!

Part 3: Drawing Skills

- ## More useful drawing skills

  ➤ Selecting and Manipulating Objects (Select, Move, Rotate)

  ➤ Creating Copies of Objects (Copy, Arraypolar, Arrayrect, Mirror, Offset)

  ➤ Correcting Mistakes (<Esc>, Undo, Erase, Oops)

  ➤ Aligning with Object Snap (Osnap)

  ➤ Modifying Objects (Trim, Extend, Scale, etc.)

  ➤ Navigating the Drawing Area (Zoom, Pan)

Selecting and manipulating objects

- **Select** -
- **Move** – Moves one or more selected items away from the original item by a user specified dispacement.
  - ➤ Select the objects to be moved
  - ➤ Choose a base point for the displacement [If using the cursor to displace relative to an object in the drawing, use Snap Grid and Osnap. If *calculating* the displacement, it is easiest to use (0,0).]
  - ➤ Choose the point or points to calculate the displacement (by subtracting the base point)

- **Rotate** – Moves one or more selected items away from the original item by a user specified dispacement.
  - ➤ Select the objects to be rotated
  - ➤ Choose a base point for the rotation
  - ➤ Specify the rotation angle (counterclockwise by default)

Creating copies of objects…

There are several commands which copy objects:

- **Copy** – Creates one or more copies of selected items, which are displaced from the original item by user specified distances:
  - ➢ Select the objects to be copied
  - ➢ Choose a base point for the displacement. [Also see **Move**…]
  - ➢ Choose the point or points to calculate the displacement (by subtracting the base point).

- **Arraypolar** – creates a polar array of selected objects:
  - ➢ Select the objects to be copied
  - ➢ Choose a center point for the array.
  - ➢ Set the number of items in the array.

- **Mirror** – Creates a mirror image object across a user-defined line:
  - ➢ Select the objects to be copied
  - ➢ Choose the 2 ends of the line to mirror the objects across.

- **Offset** – Duplicates the object, scaled with a fixed offset distance to the original:
  - ➢ Select the objects to be copied
  - ➢ Specify the offset distance
  - ➢ Click in the direction that the copy is to be offset from the original

Correcting mistakes…

- **<Esc>** – Gets you out of the command you are in without completing it.

- **Undo** – Undoes the last command [Sometimes doesn't work. **<ctrl>+z** seems more reliable.]

- **Erase** – You can erase selected objects from the drawing. This does not move objects to the Clipboard, where they can then be pasted to another location. **Erase L** erases the last object drawn, **Erase p** erases the previous selection set, while **Erase ALL** erases all objects.

- **Oops** – Restores erased objects

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Manipulate and copy objects...

35) Open the Layer Properties dialog box to create a new Layer named "*Doodle*", colour it *bright blue*, turn it *On*, make it the *Current Layer*

36) Draw some objects to "play" with:
- A horizontal line across the drawing area, using the *Ortho* softkey in the Status Bar [Otho(gonal) forces the line to be either vertical or horizontal. Don't forget to turn Ortho off again!]
- A rectangle with dimensions of *10* and *20*
- A circle with a diameter of *20*
- A right triangle with sides of *30*, *40* and *50* [Use the Line command…]

37) Try manipulating the objects (suggestions below):
- Try using Move to move an object
- Try using Rotate to rotate the triangle
- Try using Erase to remove and object and Oops to restore it

38) Try <u>duplicating</u> the objects (suggestions below):
- Use Copy to duplicate the rectangle
- Use Arraypolar to make a 6 element polar array of circles
- Use Mirror to make a mirror image copy of the triangle
- Use Offset to create a second rectangle which outside of and separated from the original rectangle by *2.5*

Aligning objects (with each other)

Object Snap – When you use the cursor to define a point during drawing and Osnap is turned "on", the cursor "snaps" to a point on the object. (Like Snap to grid causes the cursor to snap to a grid point.) The following Osnap settings do the following:

➢ **Endpoint** – snaps to the Endpoint of a line or edge of a polygon

➢ **Midpoint** – snaps to the Midpoint of a line or edge of a polygon

➢ **Intersection** – snaps to the intersection of two lines or objects

➢ **Center** – snaps to the center of an object (e.g. circles)

➢ **Quadrant** – snaps to top, bottom, left side or right side of a circle

➢ **Perpendicular** – snaps to the point that creates a perpendicular intersection.

➢ **Tangent** – snaps to the point that creates a tangential intersection

[**Hint:** If your cursor doesn't behave (e.g. snaps to objects), try turning **Osnap** "off"…]

Modifying objects

The following commands can be very powerful when drawing:

- **Trim** – Trims an object where it intersects with one or more selected objects.
  - ✓ Select the object(s) to be used as the cutting edges
  - ✓ Select the object(s) to be trimmed [Select the parts of the objects to be removed and not the parts you want to keep!]

- **Extend** – Extends a line to reach an object
  - ✓ Select the object(s) to be used as extension boundary
  - ✓ Select the object(s) to be extended

- **Scale** – Enlarges or reduces selected objects, keeping the proportions of the object the same.
  - ✓ Select the objects to be scaled
  - ✓ Choose a base point for the scaling [Caution – if the base point is external to the object, the position of the object relative to the base point also scales…]

Navigating the Drawing Area

- **Zoom** (increase/decrease the size of the drawing on screen)
  - ➢ All — Displays entire drawing area
  - ➢ Extents — Displays all objects in the drawing area
  - ➢ Previous – Returns to previous zoom setting
  - ➢ Window – Displays a window defined by 2 diagonal points
  - ➢ dynamic - Pans and **zooms** using a rectangular view box.
  - ➢ Scale - Zooms to scale at nX, where the user specifies "n"

- **Pan** (move around when entire drawing can't be displayed)

Part 4: Engineering Drawings

- Engineering Drawing

  - Orthographic Projections

    - ✓ 1st angle projection
    - ✓ 3rd angle projection

  - Dimensioning

  - Practice drawing a real object

Engineering Drawings

In general, an engineering drawing must:

- Be accurately scaled

- Clearly show all features and their relationships to each other

- Show all dimensions and tolerances

- Include information about the kind of drawing (e.g. 1st or 3rd angle projection, etc.)

- Include relevant practical information about the drawing itself (title, version, units, drawing standard, draftsman's name)

Note: Drafting Standards are __not__ covered in this lecture!

Orthographic projections

Engineering drawings frequently use an **orthographic projection** in order to represent a 3 dimensional object in 2 dimensions. In this lecture, we will introduce the 3rd angle projection.

3rd angle projection

- Comprises multiple (usually 3) drawings of the object from different perspectives

- The drawings are images of the object "projected" onto the sides of an imaginary rectangular box with parallel lines. The box is then "opened up and folded flat" (see below).

- Each "projection" (drawing) of the object is aligned with the Front View projection

1ˢᵗ and 3ʳᵈ angle projections…

Make a 3ʳᵈ angle projection:

- Look at object from front and project (draw) what you see onto the _front_ of the box

- Do the same from the top and left sides (right side is optional)

- Fold out the top and sides of the box along the edge they share with the front projection

☞ **_Viewer →Box →Object_**
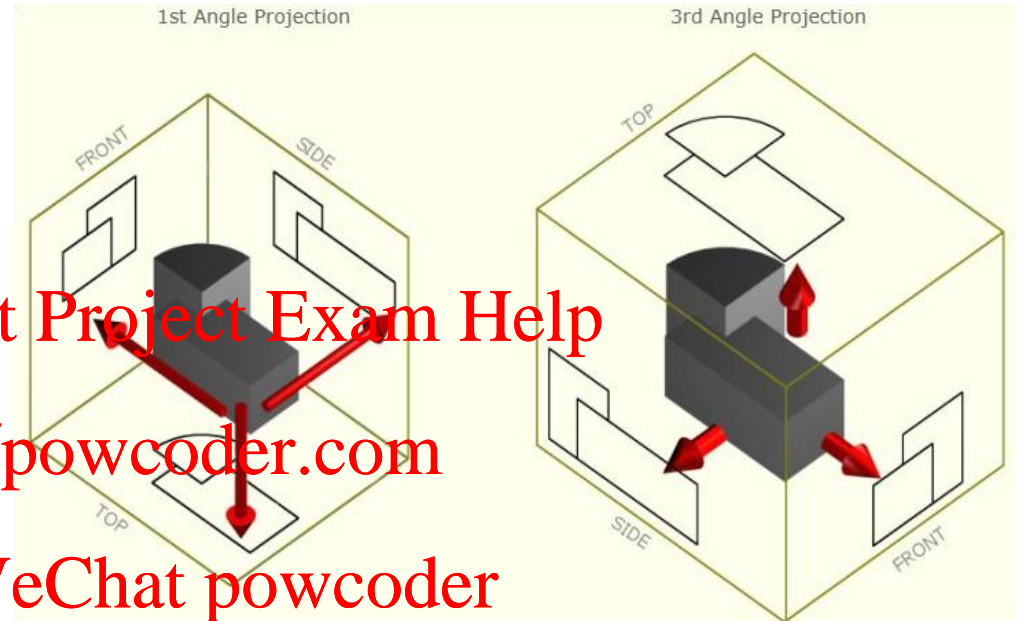
Make a 1ˢᵗ angle projection:

- Like 3ʳᵈ angle projection, but

☞ **_Viewer →Object →Box_**

1st Angle Projection   3rd Angle Projection

FRONT   SIDE   TOP   SIDE   FRONT   TOP

FRONT   SIDE   TOP   SIDE   FRONT   TOP
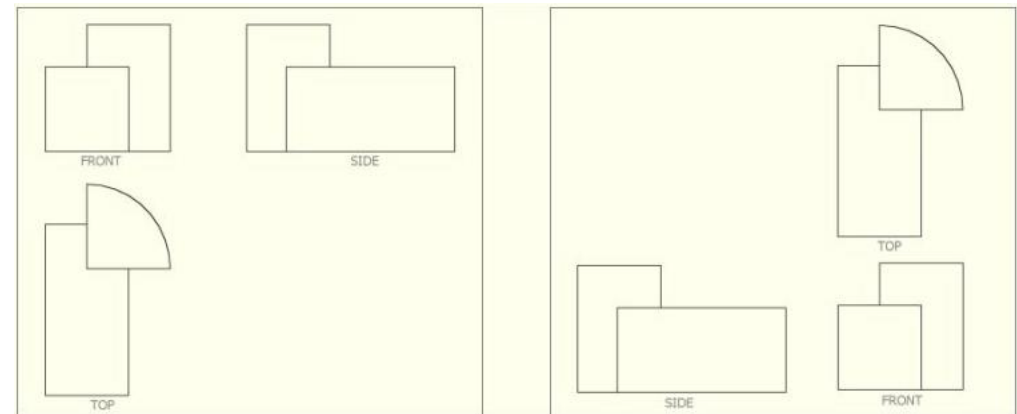
_(www.rab3d.com/tut_blen_guide-4.php, accessed 19/3/17)_

Practice drawing a real object

This exercise will be to draw and dimension a 3rd angle projection of the simple "elbow" below:

Practice drawing a real object

The completed drawing should look something like:

Practice drawing a real object
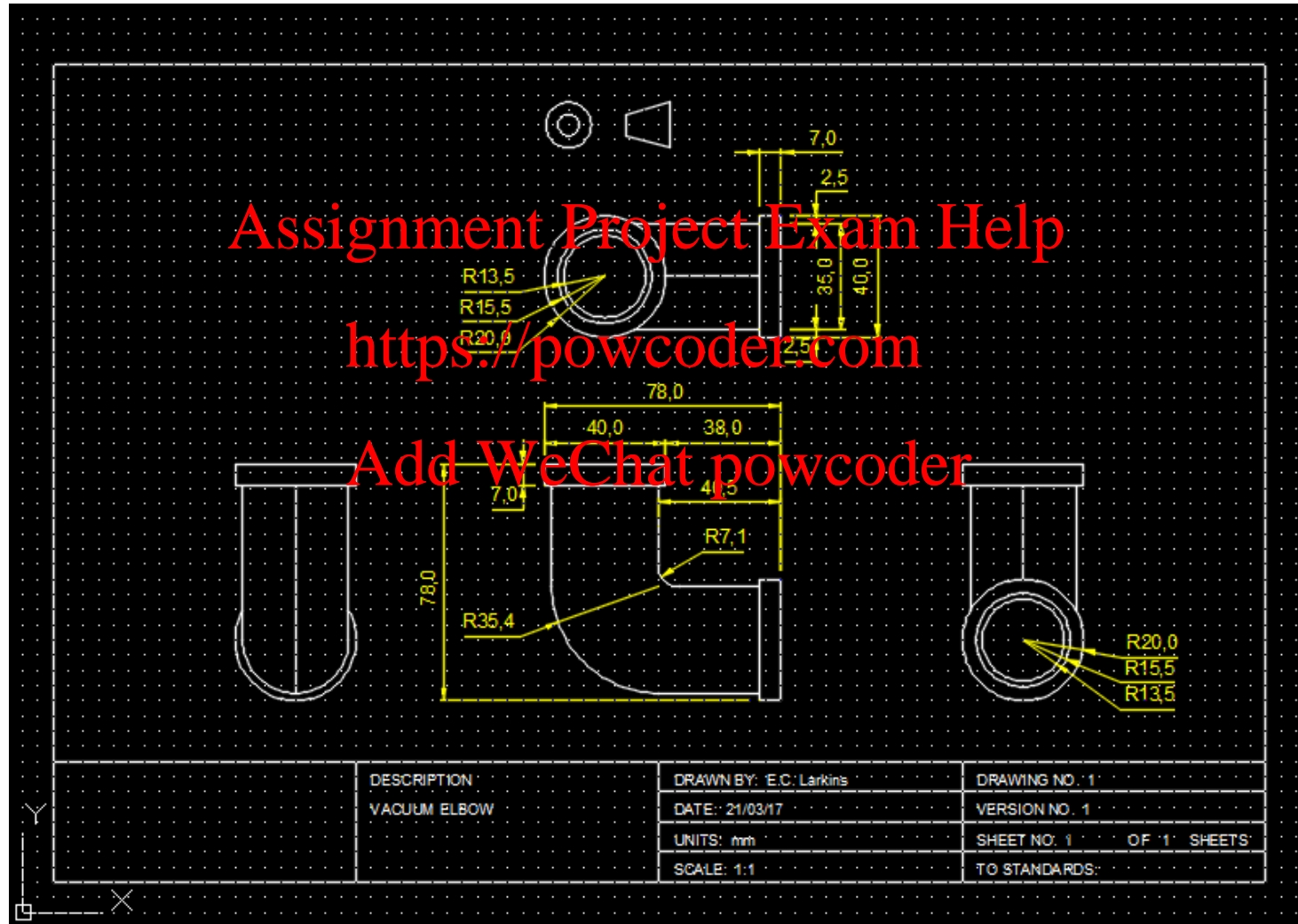
39) Open the Layer Properties dialog box and do the following:

- Create a new Layer named "*Dimensions*", colour it *yellow,* and turn it *On*
- Create a new Layer named "*Elbow*", colour it *white*, turn it *On*, and make it the *Current Layer*
- Turn *Off* the Layer "*Doodle*"

Front View

40) Draw the following objects:

- 2 rectangles from (172,141) to (212,148) and from (243,70) to (250,110)
- 2 lines from (174.5,141) to (174.5,60) and from (209.5,141) to (209.5,60)
- 2 lines from (165,72.5) to (243,72.5) and from (165,107.5) to (243,107.5)

41) Use Circle (tan, tan, radius) to draw 2 circles with:

- Radius 7.07, tangent to the 2 lines from (209.5,141) to (209.5,60) and from (165,107.5) to (243,107.5)
- Radius 35.36, tangent to the 2 lines from (165,72.5) to (243,72.5) and from (174.5,141) to (174.5,60)

42) Use the 2 lines as cutting edges to *Trim* each circle to complete the *Front View and remember to **Save** the drawing!*

43) Use each circle as a cutting edge to *Trim* 2 lines (i.e. 4 lines total)

Practice drawing a real object

Top View

44) Draw the following objects:

- 1 circle with diameter *40* at (192,210)
- 1 circle with diameter *39* at (192,210) [Can also be done with Offset…]
- 1 circle with diameter *27* at (192,210) [Can also be done with Offset…]

45) *Copy* the right hand rectangle and two lines intersecting it from the Front View, so that the copied objects move vertically by *(0,120)*

46) *Extend* the two lines to join the circle with radius *40* to complete the Top View

47) Using *Osnap*, draw the center line from the center of the rectangle to the perpendicular (center) intersection with the circle. ***Save**!*

Side View (Right)

48) Create a *Copy* of the entire Top View drawing with the center of the circles shifted from (192,210) to (330,90)

49) Rotate the copy 90 in the counter-clockwise direction around the center of the circles at (330,90)

Practice drawing a real object

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Side View (Left)

50) From the Front View, Copy the <u>left-hand</u> rectangle and 2 vertical lines intersecting it, so that the copied objects move horizontally by the vector *(-102,0)*

51) Draw a horizontal line from (60,60) to (120,60)

52) *Extend* the two vertical lines to the horizontal line

53) *Erase* the horizontal line

54) Draw the following objects:
   - 1 circle with diameter *40* at (90,90)
   - 1 circle with diameter *35* at (90,90) [Can also be done with Offset…]

55) Use the 2 vertical lines as to *Trim* both circles from the region between the lines

56) Use the inside circle to Trim the vertical lines

57) Using *Osnap*, draw the center line from the center of the rectangle to the perpendicular intersection with the circle *and* ***Save****!*

Dimensions

Dimension the drawings

58) Make the Layer "Dimensions" the *Current Layer*

59) Open the *Dimension Manager Style* dialog box under the *Annotate* menu tab by clicking "↘" button under *Dimensions*
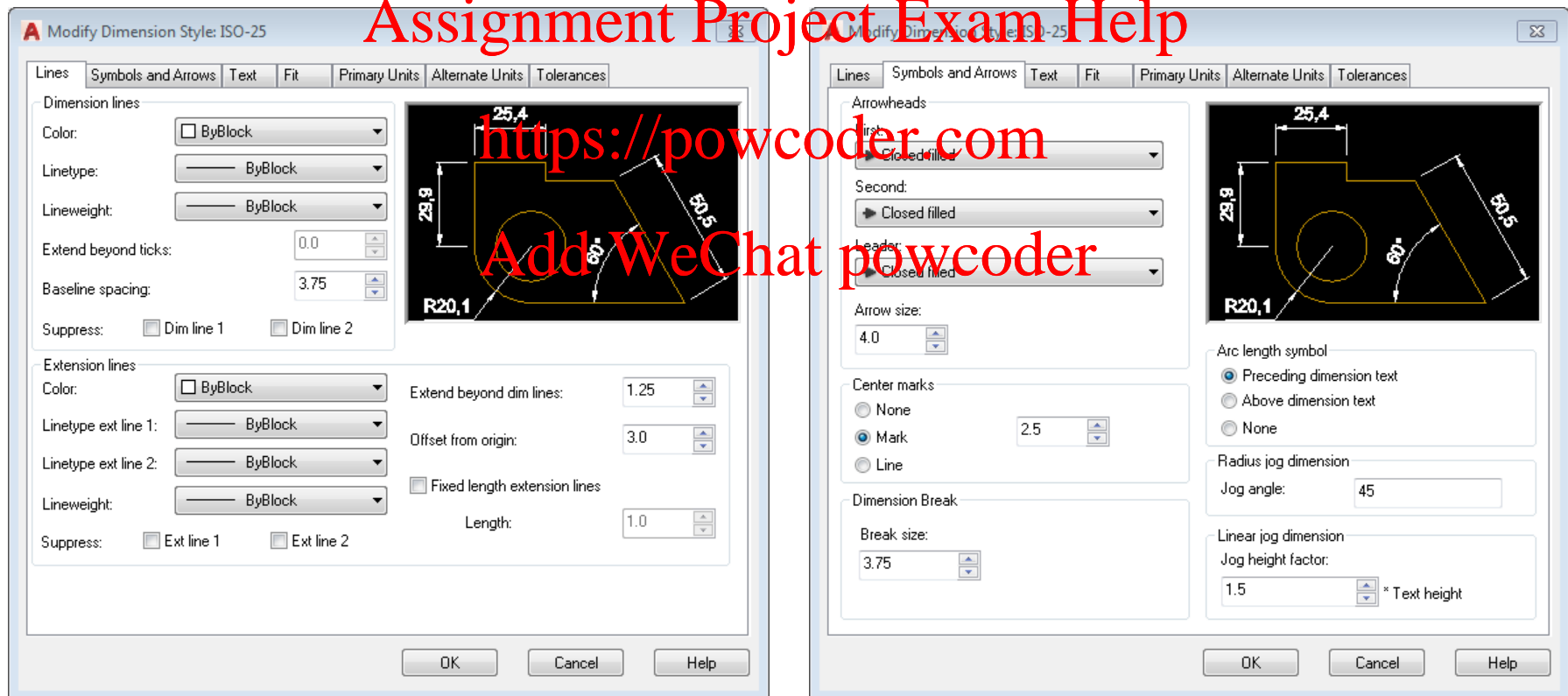
Dimensions

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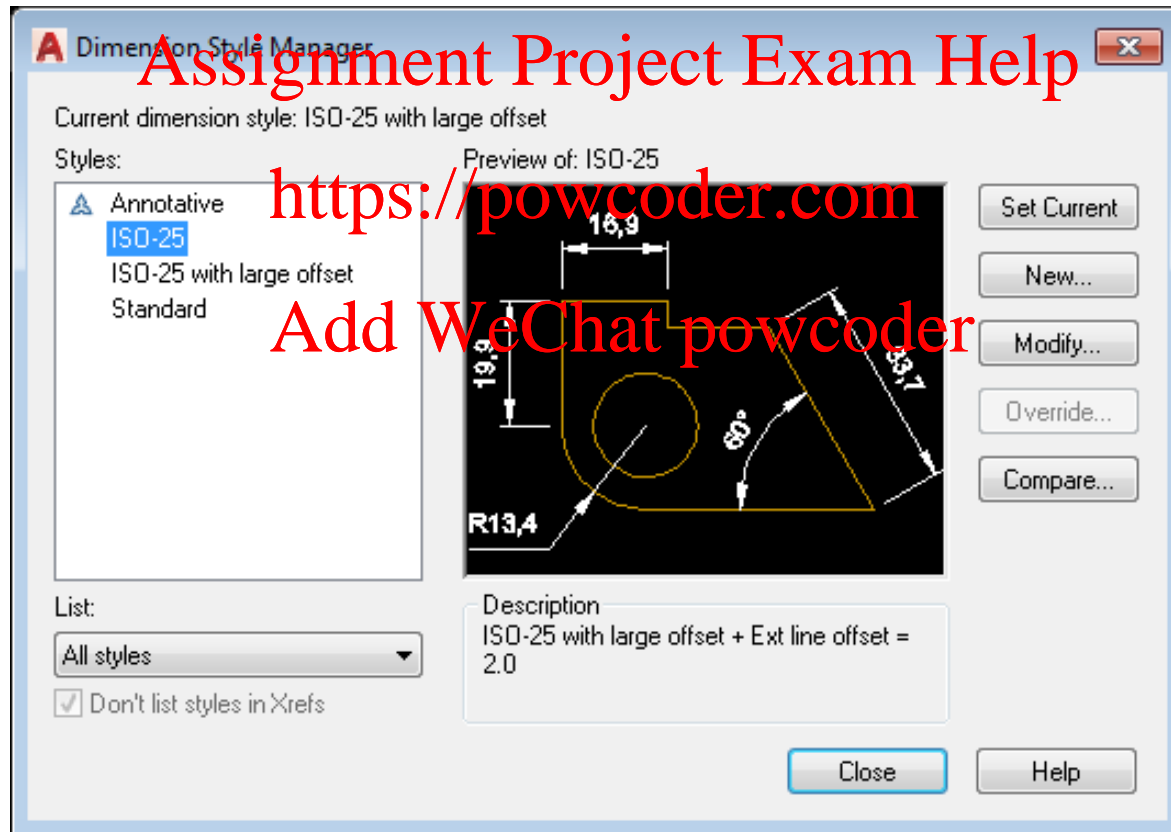
60) Click *ISO-25* to load ISO-based dimension formatting and click the *Modify* softkey to edit the dimension settings

61) Under the *Lines* tab, set "offset from origin" to *3.0*

62) Under the *Symbols and Arrows* tab, set Arrow size to *4.0*

Dimensions

63) Under the *Text* tab, set Text height to *3.0* [Use 4.5, if printing on A4 paper]

64) Under the *Primary Units* tab, set Precision to *0.0*
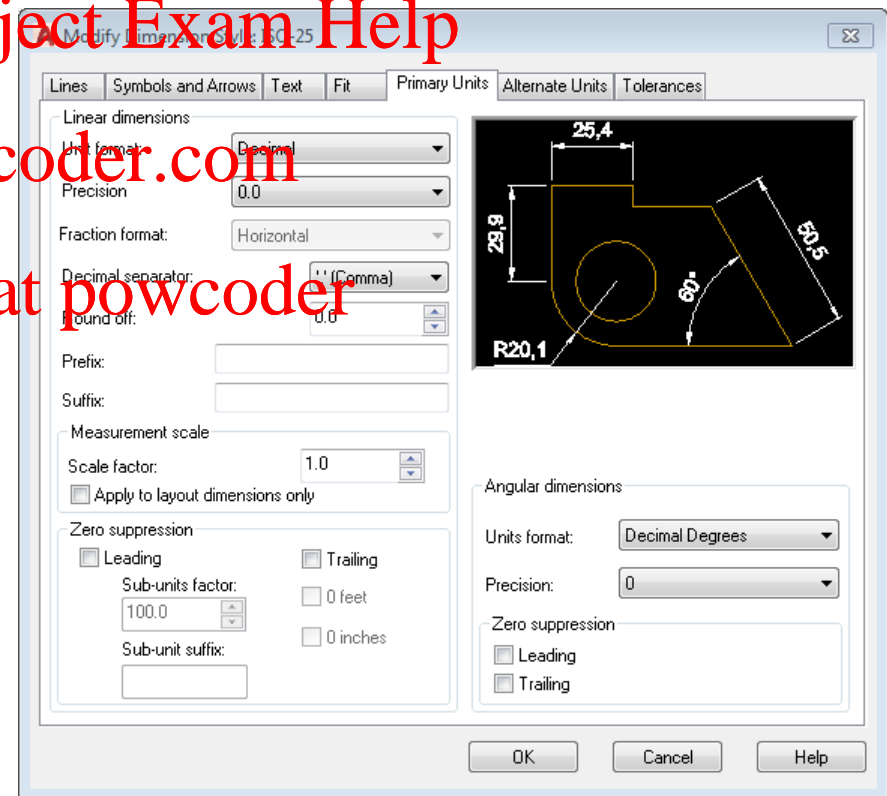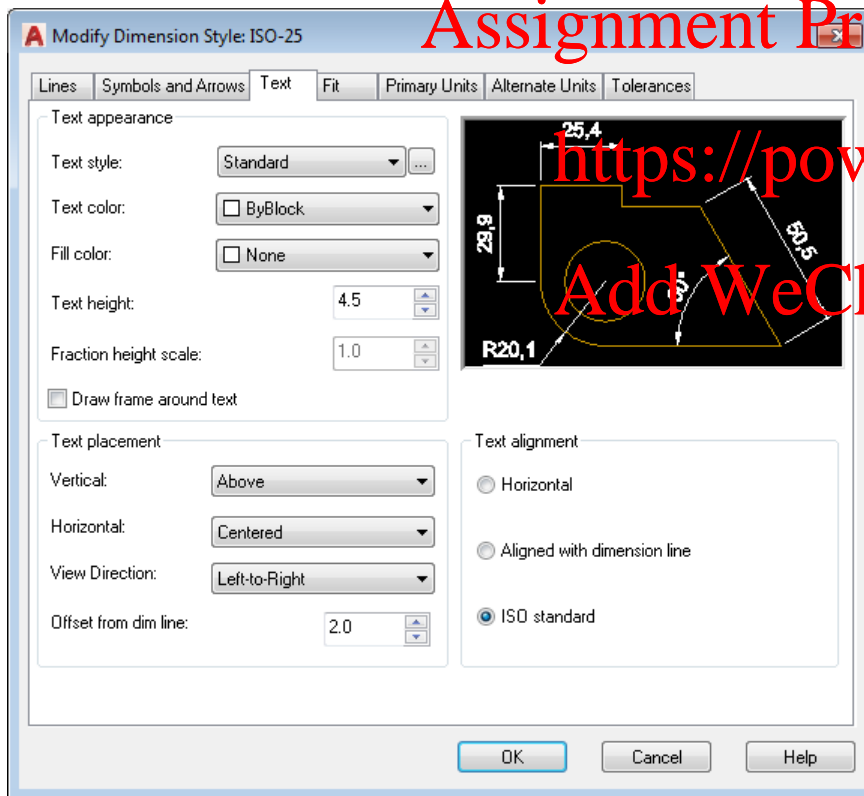
Plotting

65) Locate and click **A**>*Print>Page Setup.* Next, click *Modify*

66) In the Page Setup – Model dialog box (below), choose your printer, set paper size to *A3*, plot area to *Limits* and check *Center the plot*

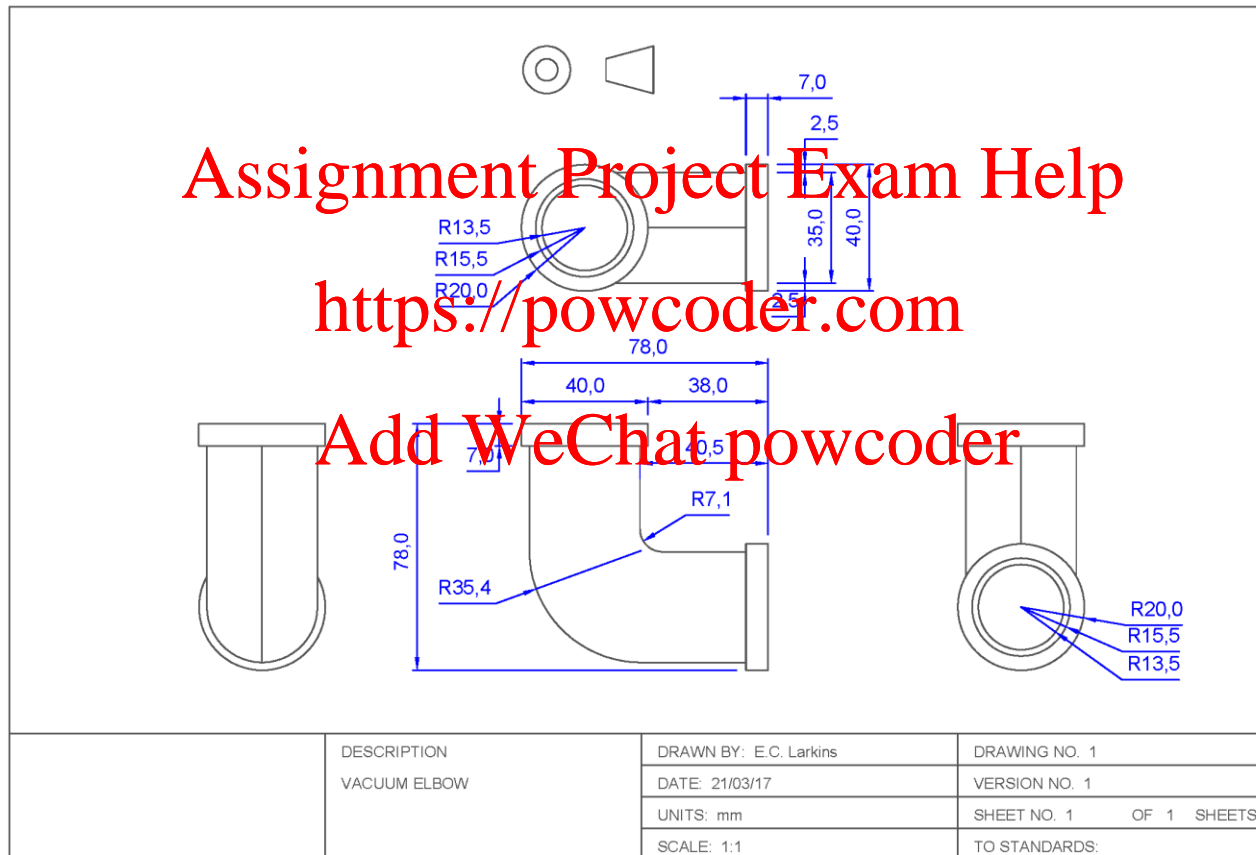67) Preview your plot and when you are satisfied, click **A**>*Print>Plot*

Note: You may need to change the layer colors, so that they print well on white paper…

Plotting
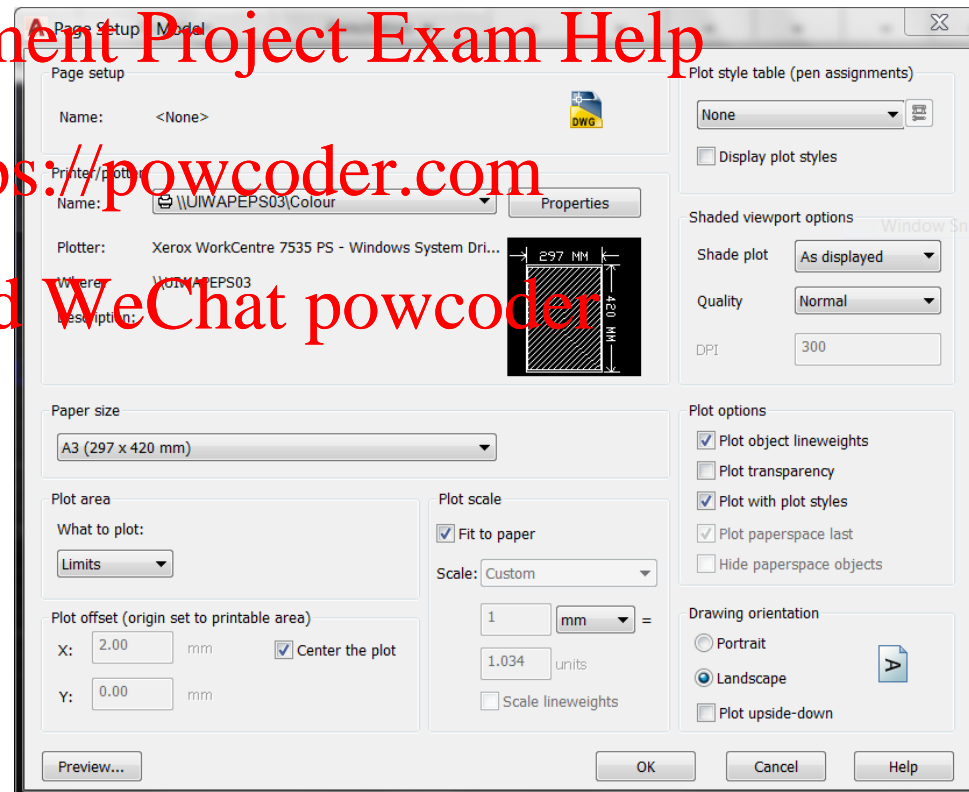
Your plot should look something like:

Commands we have used so far...

Drawing Commands

Arrayrect

Arraypolar

Circle

Copy

Erase

Extend

Line

Mirror

Move

Pan

Rotate

Text

Trim

Offset

Oops

Osnap

Scale

Select

Undo

Zoom

AutoCAD Control (Dialog Boxes)

Dimensions

Dynamic Input

Drafting Settings
- ✎ Snap and Grid
- ✎ Object Snap

Layer Properties
- ✎ Create new layer / Lock layer
- ✎ Modify layer properties (colors, etc)

Page Setup

Options

AutoCAD Control (Commands)

Units

Limits

Snapgridlegacy

Coords

Save As

AutoCAD Environment

Drawing area

Command Line

Status Bar

UCS (User Coordinate System)