Lecture on Engineering Drawing

Topics of this lecture: Isometric View, Auxiliary View, and Sections

Desired Outcome after the Lecture:

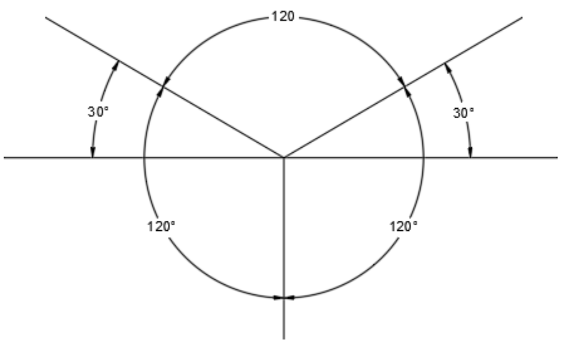
1. The students will learn why Isometric View, Auxiliary View, and Sections are used in real world.
2. The students will learn how to draw Isometric View, Auxiliary View, and Sections.

Isometric View:

An isometric view is a type of pictorial representation in which an object is drawn in three dimensions, but it doesn't show the true size of the object. Isometric views are useful because they allow an object to be viewed from multiple angles while still maintaining its true proportions. The view shows all the visible faces and features, but internal features of the object are largely hidden from view (Hidden lines are usually omitted). The three corners meet to form equal angles of 120 degrees and is called isometric axis (Fig 1 (a) & (b) – blue circle). This can be useful when creating technical drawings of complex objects or machines.

There are three main rules to isometric drawing:

1. Horizontal edges are drawn at 30 degrees (Fig 1 (a)).
2. Vertical edges are drawn as vertical lines (Fig 1 (b) – Red Lines).
3. Parallel edges appear as parallel lines (Fig 1 (b) – Green Lines).



(a) Isometric Axis

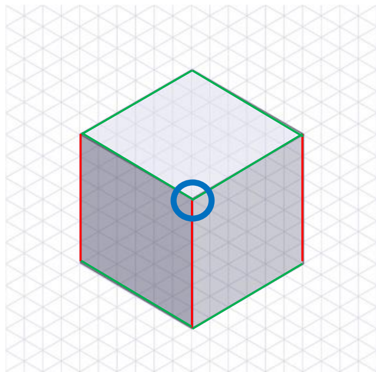
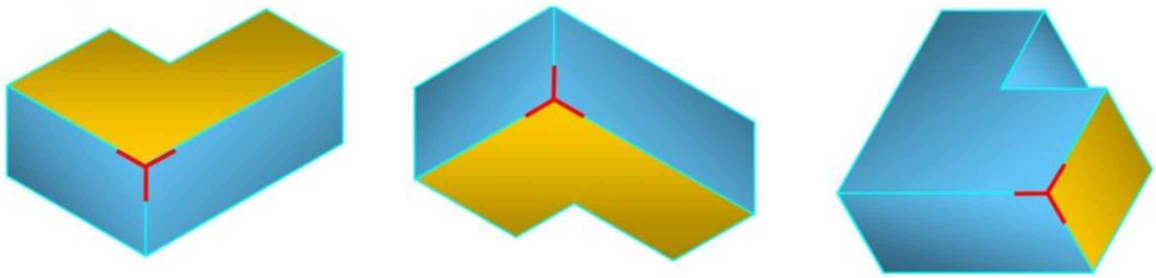

(b) Isometric View

Fig 1: Rules of Isometric Drawing

Types of Isometric Drawing:

Depending on the positioning of the isometric axis different isometric vies can be obtained. The basic isometric views are-

1. Regular Isometric View: You Look down on an object.
2. Reverse Axis Isometric View
3. Long Axis Isometric View



(a) Regular Isometric (b) Reverse Axis Isometric (c) Long Axis Isometric

Fig 2: Types of Isometric Drawing

Construction Technique:

There are two common techniques that are generally used for making isometric drawings. These are the *centerline layout technique* and *box technique. Box technique* is the most popular and commonly used method. In this method we start by drawing a bonding box along the principal axis. To draw objects using isometric drawing technique the steps involve-

1. Define the origin of the object and then create the isometric axes.
2. Draw the bounding box using the principal dimensions of the object.
3. Use the dimensions from the other views (Top – Front – Side) to identify all the features on the bounding box.
4. Locate and create all the features on the faces of the bounding box.

Translations of features from 2D space to Isometric space is done as follows-

1. Vertical edges on 2D view remains vertical on isometric view.
2. Horizontal edges are drawn at isometric axis.
3. Circles are drawn as ellipses on isometric view and arcs appear as partial isometric ellipse.

Converting Circles and Arcs to Isometric Ellipse and Partial Ellipses:

While doing such conversion, the minor diameter of the ellipse always coincides with the axis of cylinder, and the major diameter of ellipse is always at right angles to the minor diameter.

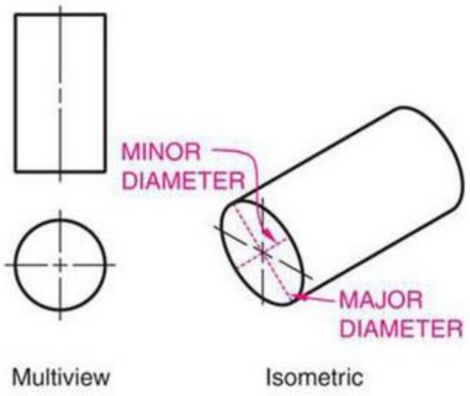
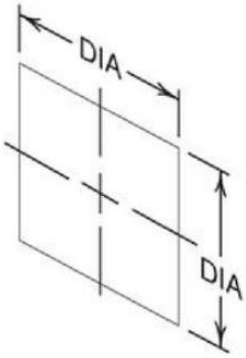


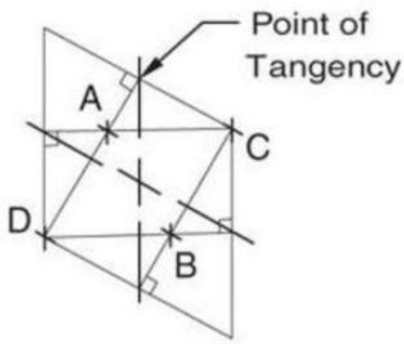
Fig 3: Isometric view of a cylinder

How to draw them the ellipse-

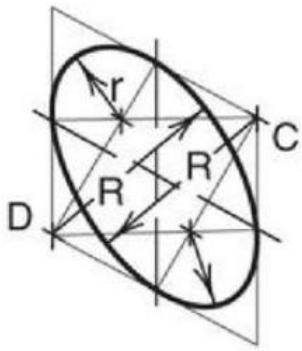
Step 1: A equilateral parallelogram to the diameter of the circle is drawn.



Step 2: Draw a line between the midpoint of each side of the parallelogram to closest endpoint of the opposite side.

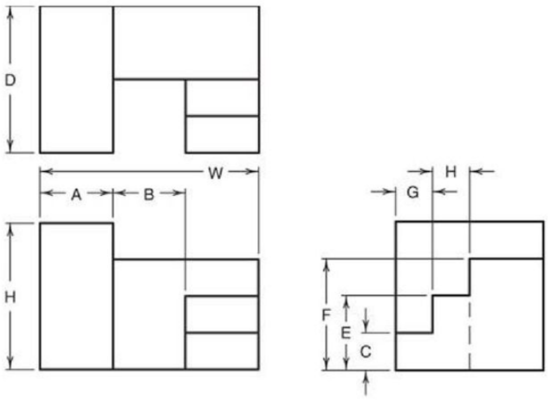


Step 3: Draw two small arcs with radius “r” and two large arcs with radius “R”.

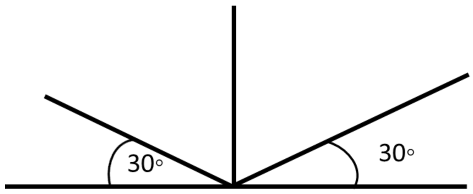


Complete (Simple) Example:

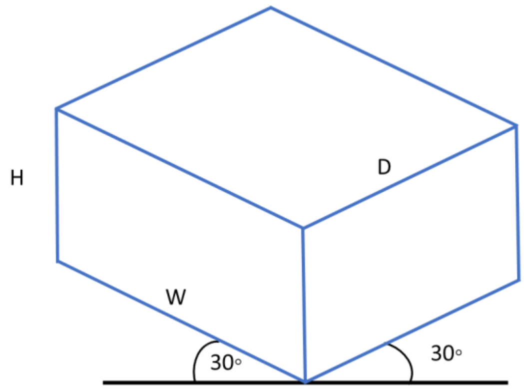
Let's say we are given the following multi-view sketch and we have to create the Isometric view (Note: The sketch is not done at scale)



Step 1: We identify origin and draw the isometric axes.

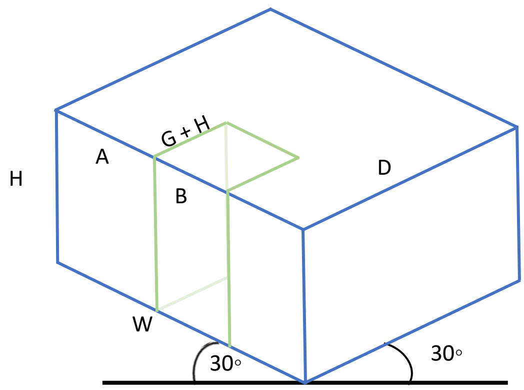


Step 2: Create the Isometric Planes (The bounding box) using the major dimensions (W, H, D)

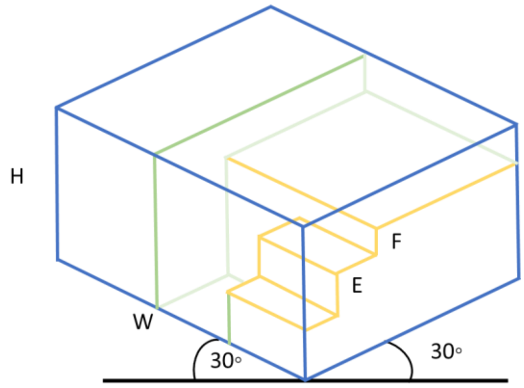


Step 3: Transfer features from Multiview drawing into the bounding box.

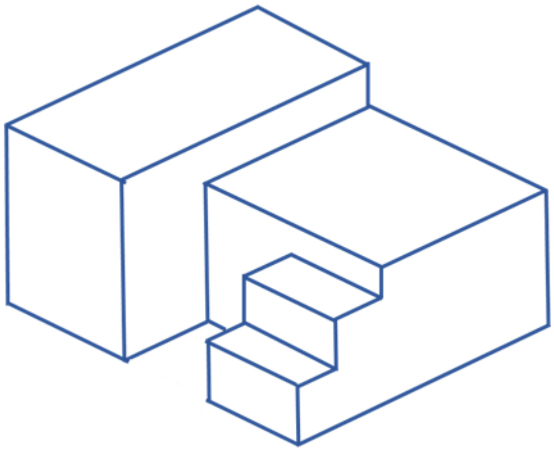
Step 3a: Transferring one feature as an example.



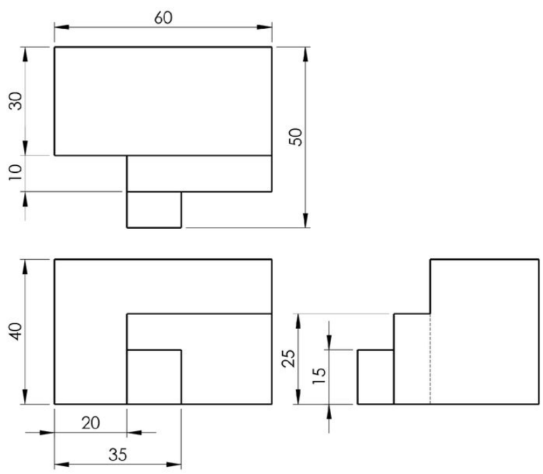
Step 3b: Transferring all the features (Remaining ones).



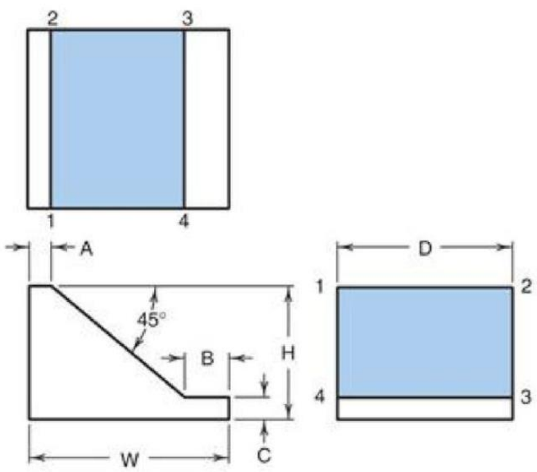
Step 4: Remove all the construction or boundary lines and darken the visible lines to get the final view. (Add dimension as needed)



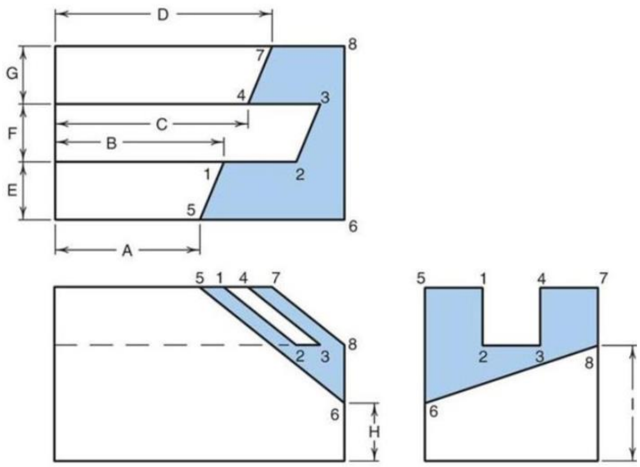
Practice for Students:



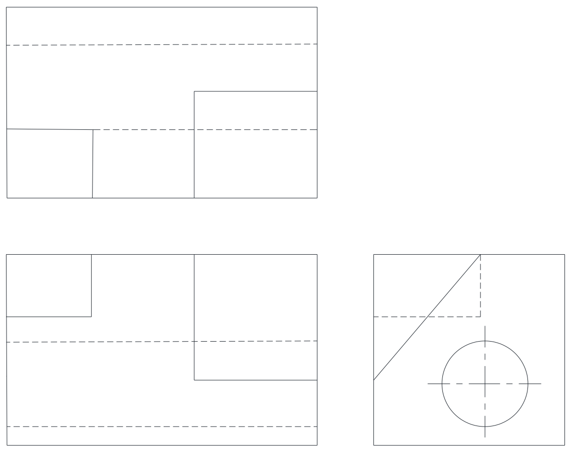
Practice 1



Practice 2



Practice 3



Practice 4
(Will be covered as an example for Ellipse during class)

Additional Reading Resources for Isometric Views:

1. https://byjus.com/maths/isometric-sketch/#
2. https://learning.hccs.edu/faculty/trung.bui/common-resources/isometric-drawing/view (This one has additional practice problems)
3. https://9to5civil.com/isometric-projection/

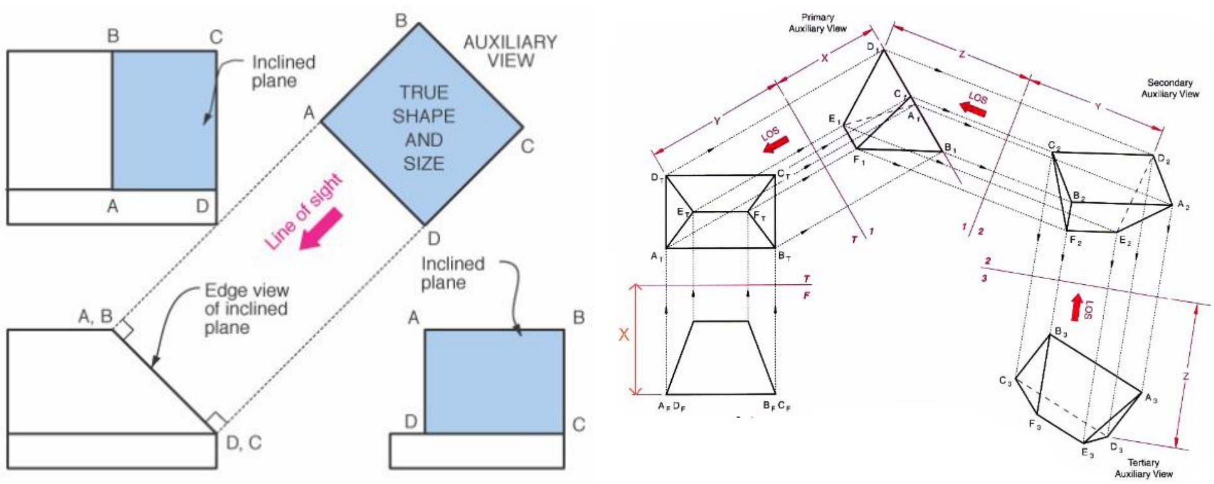
Auxiliary View

An auxiliary view is a view of an object that is not parallel to the main view. It is typically used to show an angled view of an object that cannot be seen in the main view. The auxiliary view is created by projecting lines from the main view onto an imaginary plane that is perpendicular to the main view. This helps to show the true shape of an object that might otherwise appear distorted. Only a limited number of auxiliary views are normally needed in technical drawing to fully describe an object. *An auxiliary view is not one of the six principal views*.

Auxiliary views are created by positioning a new line of sight relevant to the object. For complex auxiliary designs, it is possible to draw multiple auxiliary views from an existing auxiliary view. As an example

- A primary auxiliary view is a single view projected from one of the six principal views.
- A secondary auxiliary view is a single view projected from a primary auxiliary view.
- A tertiary auxiliary view is a single view projected from a secondary or another tertiary auxiliary view.

Fig 4 (a) shows an example of sample projected auxiliar view for the given orthographic views. Fig 4 (b) shows three different auxiliary views.



(a) Primary Auxiliary view

(b) Multiple Auxiliary view from existing Auxiliary view

Fig 4: Shows a sample auxiliary view.

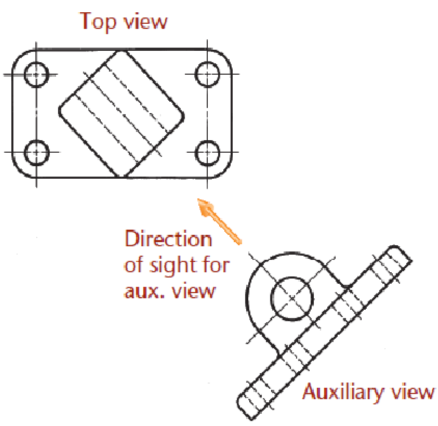


Fig 5: Inclined and oblique faces

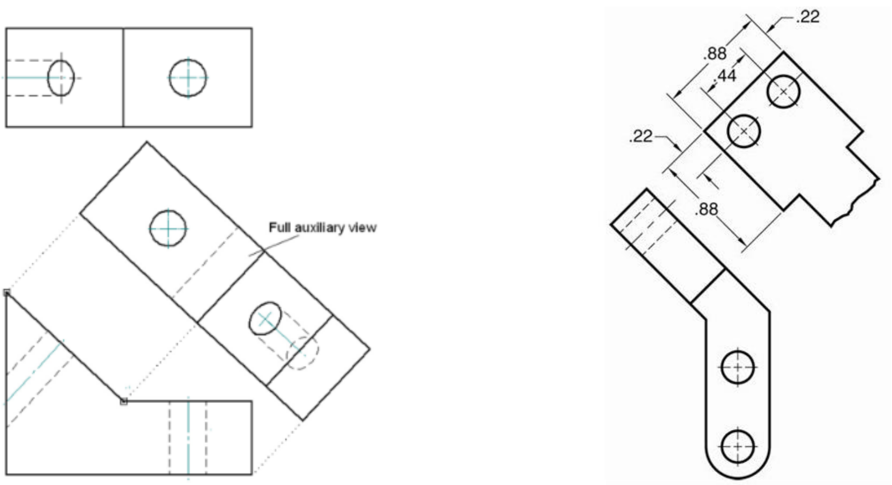
Why need auxiliary views:

1. When we have inclined or oblique or features in object where primary views have distorted representation of the feature.
2. Multi-Auxiliary views can show the details of all the features present in the object.

Types of Auxiliary Views:

Depending on if you want to show all the features (even the ones that can be seen on another principal view) there are two types of auxiliary view-

1. ***Full auxiliary view***: All elements and features on the object as seen from the view direction are represented on the auxiliary view.
2. ***Partial auxiliary view***: Only the features on an inclined or oblique face are represented on the auxiliary view (*most often needed/used view*)

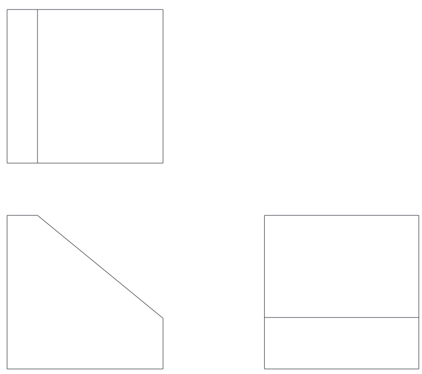


(a) Full Auxiliary View (b) Partial Auxiliary View

Fig 6: Types of auxiliary view

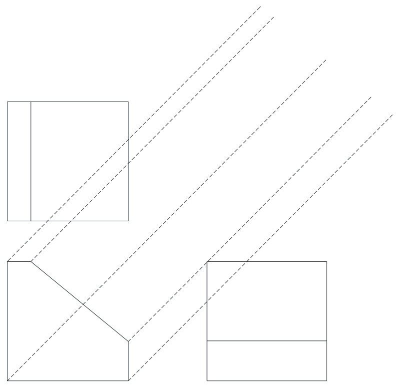
Complete (Simple) Example:

Let’s say we are given the following multi-view sketch and we have to create the Auxiliary view (Note: The sketch is not done at scale)

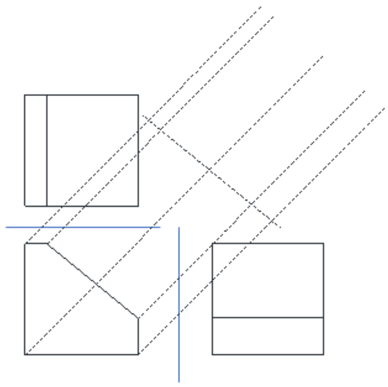


Step 0: If instead of views an isometric view of an object is given, then we need to generate at least two standard views before proceeding with the next steps.

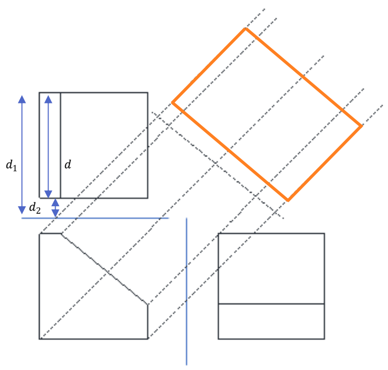
Step 1: Draw projection lines for auxiliary view.



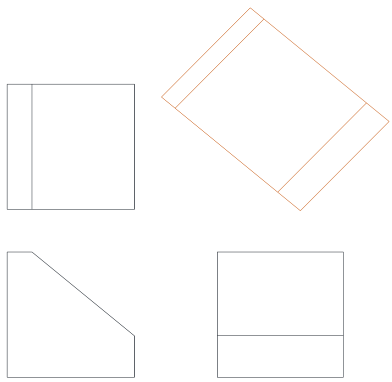
Step 2: Draw the outline of inclined face/fold line.



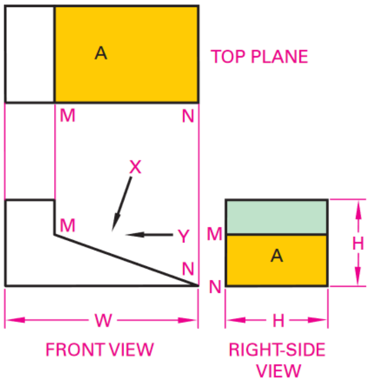
Step 3: Transfer the distances from either top side view or side view. Once done, draw the lines.



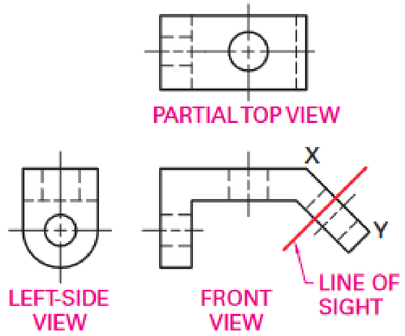
Step 4: Remove the projection line to complete the auxiliary view.



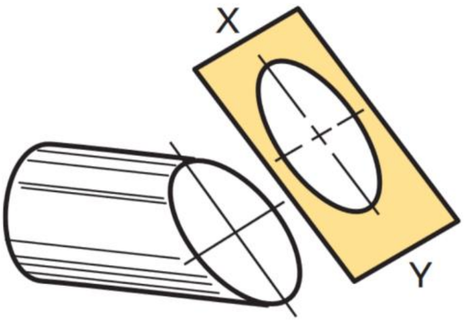
Practice for Students:



Practice 1



Practice 2



Practice 3

Additional Reading Resources for Auxiliary Views:

1. https://www.britannica.com/technology/production-system
2. https://learning.hccs.edu/faculty/trung.bui/dftg1333/1333-lecture-5-auxiliary-view/1333-lecture-5-auxiliary-view
3. https://learning.hccs.edu/faculty/edward.osakue/dftg-1333-mechanical-drafting/course-notes/unit-6-auxiliary-view-drawings/view

Section View:

A section view is a drawing that shows the internal structure of an object by cutting away a portion of it. This type of view is typically used to show the internal details of a complex object or machine. It is important to note that section views are not actual views of a physical object, but rather a representation of what the object would look like if it were cut open.

This is done to understand the intricate details of the object that are otherwise not visible. While it can be argued why not just use hidden lines to so. The answer would be, while simple shape is hidden in the section a complex design will need detailed dimensions and viewing to completely understand. Thus, section views are used. A simple decision-making diagram can be as follows-

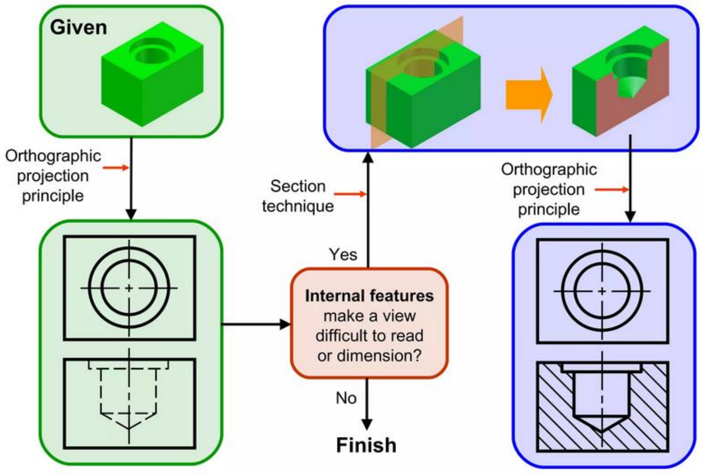


Fig 7: Decide either to use section view or not.

The following concepts are important for section views (also identified by numbers in Fig 8)-

(a) **Cutting Plane Line**: The plan (imaginary) that passes through the object at the position of interest is called *cutting plane*. Cutting planes can change direction within an object. The change in direction is decided depending on which details of the object are to be shown. The edge view of cutting plane is the cutting plane line.

(b) **View Direction**: This is the line of sight or direction of the cutting plane which will be visible.

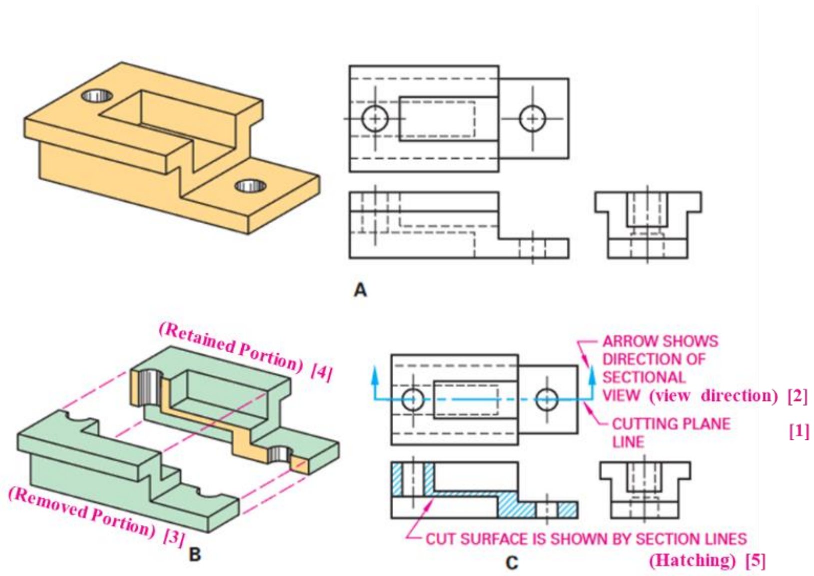
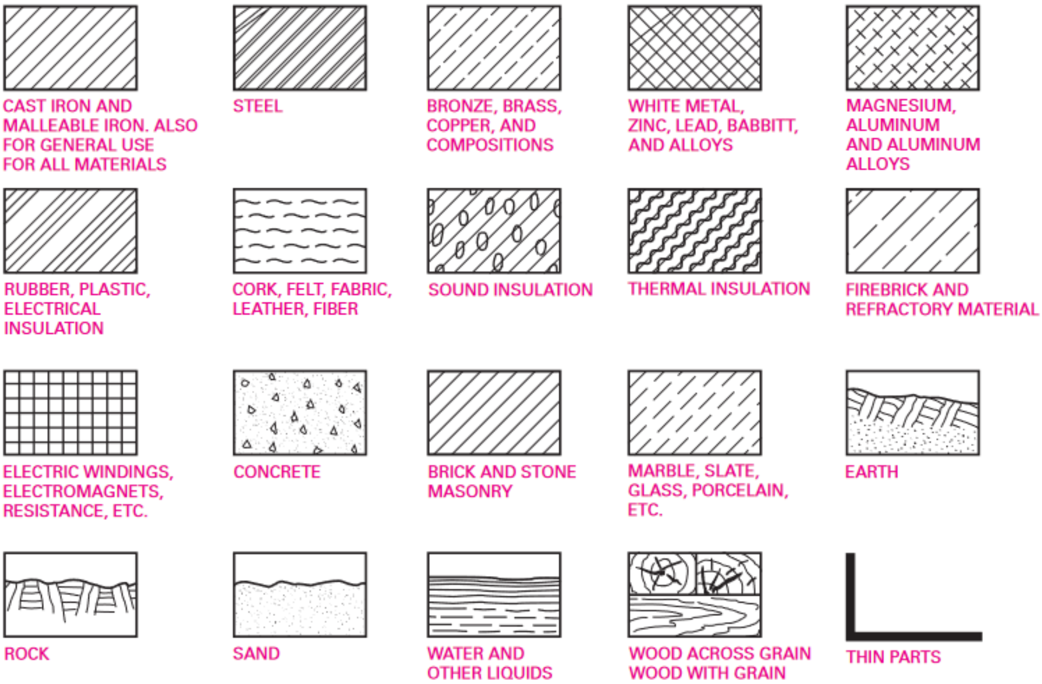


Fig 8: Basic Concepts of Section View

(c) **Removed Portion**: The cut-out portion of the object that is removed to expose the interior of the object.
(d) **Retained Portion:** The part of the cut-off object that is exposed to view.
(e) **Hatching:** The pattern of hatch lines used to indicate solid material. Hatching lines for different for different objects. Below we show a few samples of hatching line as per ASME.

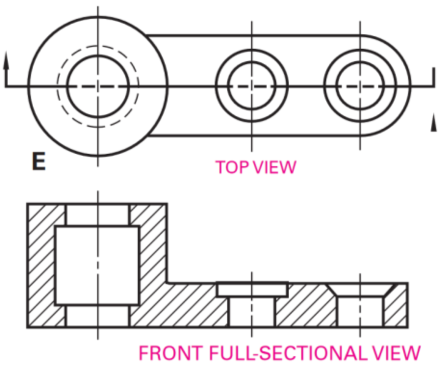


A few things to remember while doing section view:

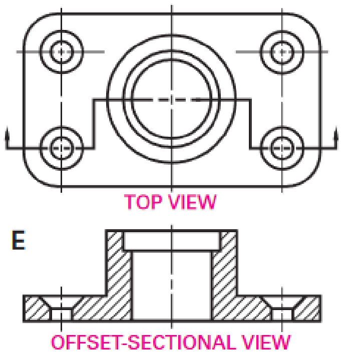
1. Cutting plane line should show the direction of the view. This is different depending on ANSI or ISO standard. Before working on your drawing make sure which standard you are following and be consistent throughout.
2. The spacing between the lines in hatching will vary from 1.5mm to 3mm. They should not be too coarse/dense or uneven spacing/orientation.
3. The hatching line should not be drawn parallel or perpendicular to contour of the view.
4. Gaps between feature segments must not be allowed (Sectioned part is not disjointed).

Types of Sectional View:

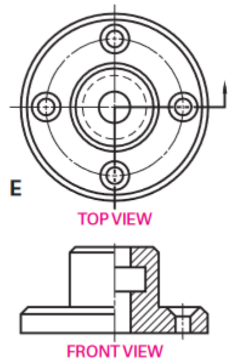
1. **Full Section:** A sectional view that shows an object as if it were cut completely across from one end or side to the other.



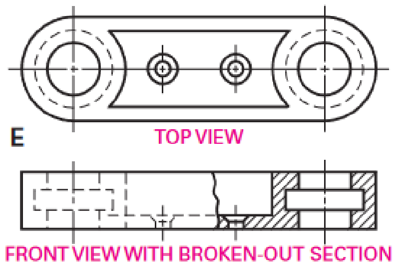
2. **Offset Section:** This is similar to full section view except the cutting plane changes direction at 90 degree at a time to show a detail or avoid a part.



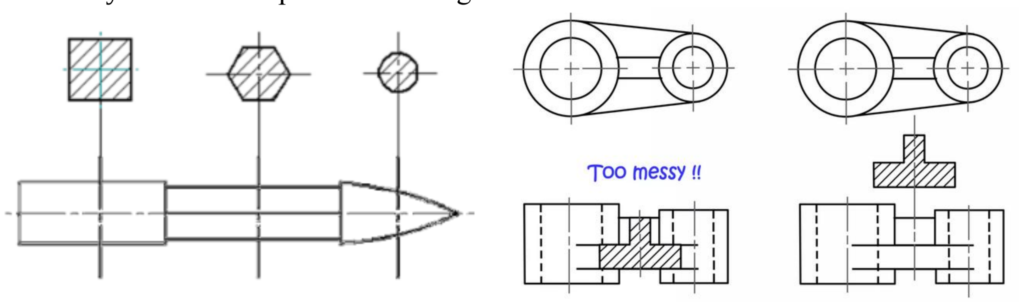
3. **Half Section:** The section view is made by passing the cutting plane halfway through an object and remove a quarter of it. Hidden line is omitted in the un-sectioned half of the view.



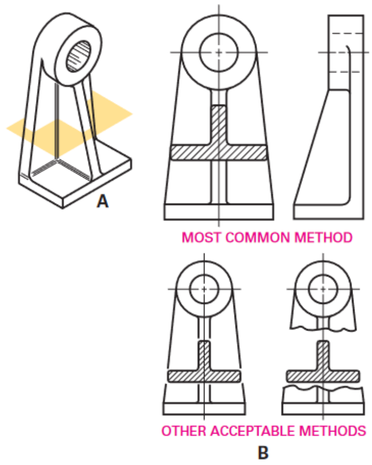
4. **Broken-out Section:** It shows an object as it would look if a portion of it were cut partly away by a cutting plane and then "broken off" to reveal the cut surface and insides.



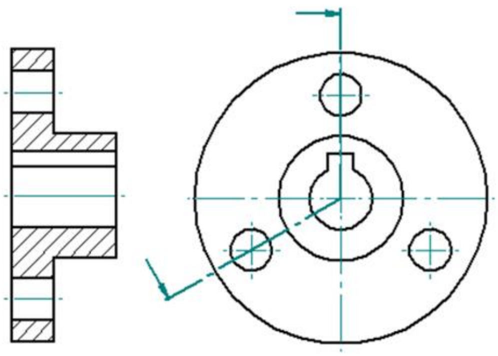
5. **Removed Section:** Removed sections are full section views placed at a convenient position from the adjacent view but linked with the cutting plane either by a line or view label. Revolved sections show cross-sectional features of a part. Section view is shown outside the view. Usually used where space isn't enough for revolved section.



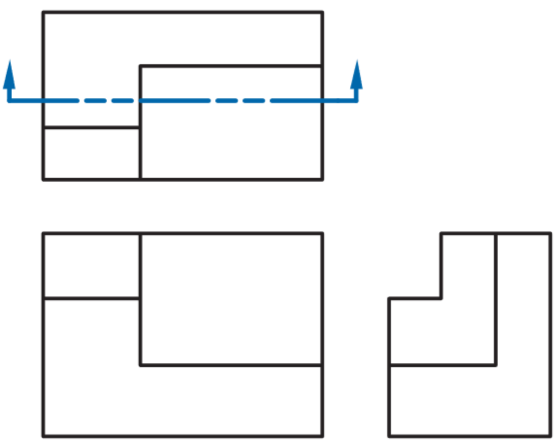
6. **Revolved Section:** Revolved sections show cross-sectional features of a part. A revolved section is similar to a removed section except that the section view is superimposed on the cutting plane after the section has been rotated through 90 degree.



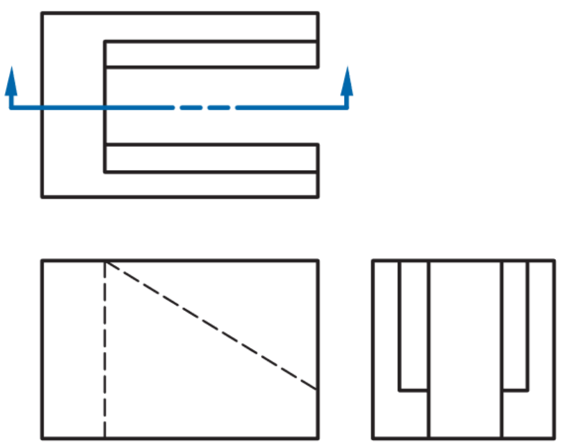
7. **Aligned Section:** In aligned sections the cutting planes are not parallel but inclined as some angle. This is done to show features in circular objects.



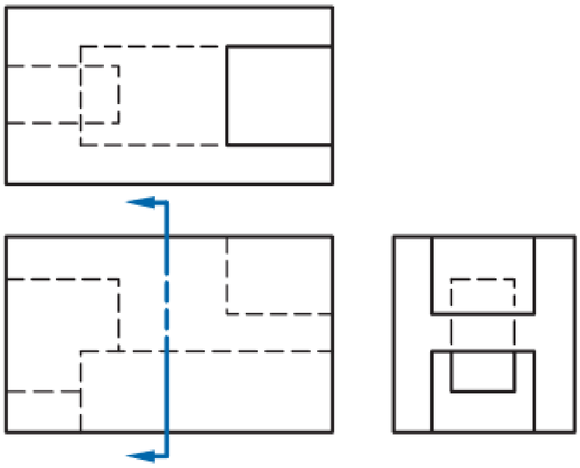
Practice for Students:



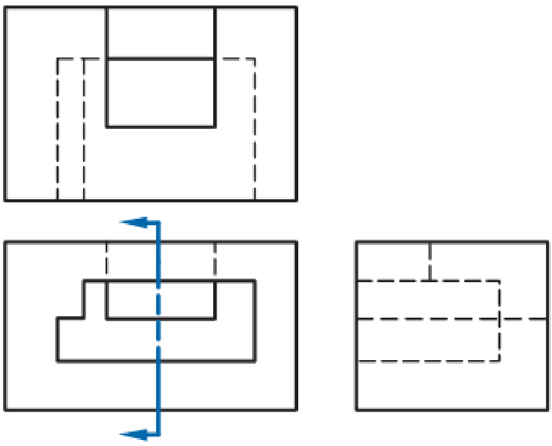
Practice 1



Practice 2



Practice 3



Practice 4

Additional Reading Resources for Section View:

1. **https://www.mycadsite.com/tutorials/level_1/section-views-in-AutoCAD-tutorial-1-13.html**
2. **https://www.slideshare.net/mokhtarpadeli/engineering-drawing-chapter-09-section**
3. **https://kmhs.typepad.com/files/Ch_08.pdf**

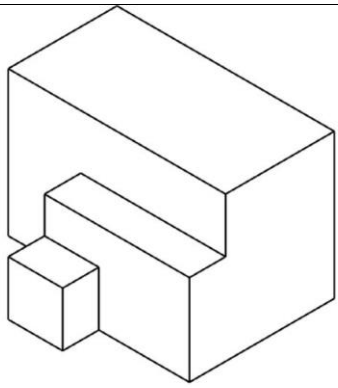
Real World Example:
Some examples of how these views are used in practice include:

- In architectural drawings, section views are used to show the internal structure of a building, such as the layout of floors, walls, and ceilings.
- In mechanical engineering, aux views are used to show the angled views of mechanical components, such as gears and levers, that cannot be seen in the main view.
- In electrical engineering, isometric views are used to show the layout of circuits and electrical components in three dimensions.
- In product design, all three types of views are used to show the different aspects of a product, including its internal structure, angled views, and overall shape.

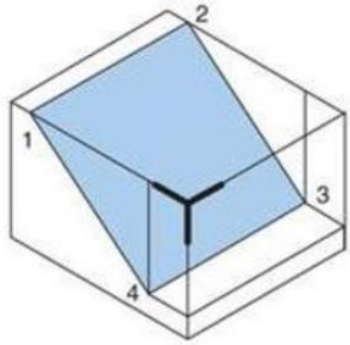
Summary of this Lecture:
To conclude, the key takeaways from this lecture are:

- Isometric views are used to show an object in three dimensions but without showing the true size.
- Auxiliary views are used to show angled views of an object that cannot be seen in the main view.
- Section views are used to show the internal structure of an object by cutting away a portion of it.
- Understanding and being able to create these views is important in technical drawing and engineering.

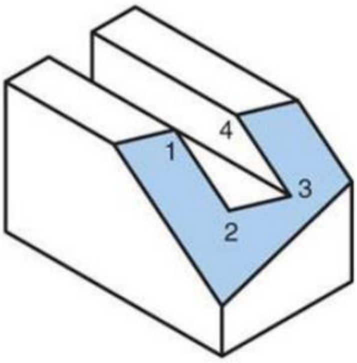
Solutions to Selected Practice problems:



Isometric View-Practice 1



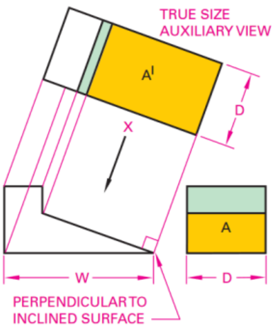
Isometric View-Practice 2



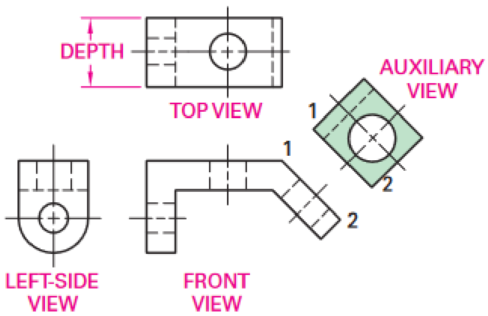
Isometric View-Practice 3

Check Class Lecture

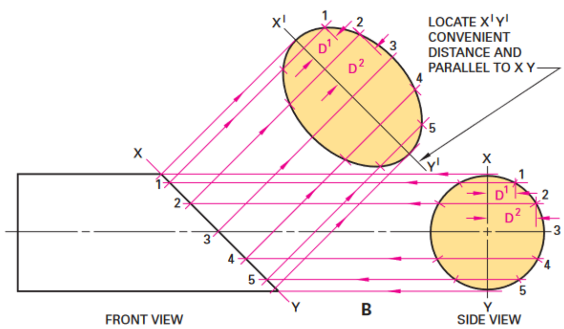
Isometric View-Practice 4



Auxiliary View-Practice 1



Auxiliary View-Practice 2



Auxiliary View-Practice 3