Technical Drawing in Engineering

Lecture 2. Orthographic Projection: Basic concepts
What is Orthographic Projection

- Orthographic means straight projection.
- It stands for the projection of the shadow of the object on a plane.
Basic concepts I

- **European system**
Basic concepts II

- American system
Basic concepts III

- **European system**
  - Solids in O.P.
  - Edges
  - Visible and hidden lines
  - "Transparent solid"

- **American system**
  - Solids in O.P.
  - Edges
  - Visible and hidden lines
  - "Transparent solid"

- **To represent simple objects:**
  - 2 projection planes

- **To represent complicated object:**
  - 3 projection planes
Basic concepts IV

- Double orthogonal projection in two perpendicular planes called **vertical** and **horizontal projection planes**.

- Division by quadrants:
  - 4 quadrants with the following projection planes:
    - 1st quadrant: $V^+ \ H^+$
    - 2nd quadrant: $V^+ \ H^-$
    - 3rd quadrant: $V^- \ H^-$
    - 4th quadrant: $V^- \ H^+$
Basic concepts V

- 2 bisectors + 8 octants
Basic concepts VI

Reference line
Representation of a point I

A (width, depth, height)
Representation of a point II

Positions of the points

- 1st quadrant
- 2nd quadrant
- 3rd quadrant
- 4th quadrant
Representation of a point II

Special positions of the points

A point that belongs to the horizontal plane

A point that belongs to the vertical plane

A point that belongs to the 1st bisector

A point that belongs to the 2nd bisector
Representation of a point III

Profile view
Visible and hidden parts of a line:
The visible parts of a line are those that belong to the **first quadrant**.
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Particular positions of a line
Representation of a plane

3 NON ALLIGNED POINTS

POINT AND LINE

TWO LINES THAT CUT EACH OTHER

DEFINITION OF A PLANE

\[ v_\alpha \]

\[ h_\alpha \]
Special positions of a plane

- horizontal
- frontal
- edgewise
- vertical
- generic
- // to the R.L.
- profile

A plane passes through the R.L. and point A.
Membership

- A point \textit{belongs} to a line if its \textit{projections} are included in the line’s \textit{projections}.

- A line \textit{belongs} to a plane if its \textit{traces} are included in the \textit{traces} of the plane.

- A point \textit{belongs} to a plane, if it \textit{belongs} to a line that is included in this plane.
Intersection between lines

\begin{align*}
& \text{Line } r_1 \\
& \text{Line } s_1 \\
& \text{Point } B_1 \\
& \text{Line } r_2 \\
& \text{Line } s_2 \\
& \text{Point } B_2
\end{align*}
Special lines of a plane I

- Horizontal lines
- Frontal lines
Special lines of a plane II

- **Lines of maximum slope:** Is a line that belongs to the plane and has the **maximum angle** with respect to the **horizontal projection** of the plane.  
  - *Perpendicular to the horizontal projection of the plane.*

- **Lines of maximum inclination:** Is a line that belongs to the plane and has the **maximum angle** with respect to the **vertical projection** of the plane.  
  - *Perpendicular to the vertical projection of the plane.*
Special planes and their lines

Vertical

Parallel to the R.L.

Parallel to the 1st bisector

edgewise

Perpendicular to the 2nd bisector
Intersection of planes I

If the intersection of the projections of the planes is out of the paper

Use auxiliary plane
Intersection of planes II

- Draw a frontal plane $\gamma$
- Find the intersection of $\gamma$ with $\alpha$ and $\beta$ (s&t)

If both intersections of the plans projections are out of the paper, see video: [http://www.youtube.com/watch?v=9r-nWoubXec](http://www.youtube.com/watch?v=9r-nWoubXec)
Intersection of plans II

- Draw a frontal plane $\gamma$
- Find the intersection of $\gamma$ with $\alpha$ and $\beta$ (s&t)
- Projections of s&t would meet at point I
- And $\alpha$&$\beta$ at point P

If both intersections of the plans projections are out of the paper, see video:
http://www.youtube.com/watch?v=9r-nWoubXec
Intersection of plans II

- Draw a frontal plane $\gamma$
- Find the intersection of $\gamma$ with $\alpha$ and $\beta$ (s&t)
- Projections of s&t would meet at point I
- And $\alpha$&$\beta$ at point P
- Joining I & P we get $r$ (the line where both plans intersect)

If both intersections of the plans projections are out of the paper, see video:
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Intersection of planes III

Coinciding planes in the same point on the R.L.

\[ \mathbf{v}_\alpha \quad \mathbf{v}_\beta \]

\[ \mathbf{h}_\alpha \quad \mathbf{h}_\beta \]
Intersection of planes III

Coinciding planes in the same point on the R.L.
Intersection of planes III

Coinciding planes in the same point on the R.L.

$v_\beta \ i_2 \ v_\alpha \ v_\gamma = r_2 = s_2$

$h_\beta \ h_\alpha \ I_1 \ I_2 \ I_1 \ I_2$
Intersection of planes III

Coinciding planes in the same point on the R.L.

Planes parallel to the R.L.
Intersection between a line and a plane

1. Create a plane $\gamma$ that includes the line $r$. (easiest option vertical plane)
Intersection between a line and a plane

1. Create a plane $\gamma$ that includes the line $r$. (easiest option vertical plane)
2. Calculate the intersection between plane $\gamma$ and plane $\beta$ -> Line $t$
1. Create a plane $\gamma$ that includes the line $r$. (easiest option vertical plane)

2. Calculate the intersection between plane $\gamma$ and plane $\beta$ -> Line $t$

3. Calculate the intersection of line $t$ with given line $r$ -> Point $B$
**Relative positions: Parallelism I**

**LINE WITH LINE:**

2 lines are parallel if their projections are also parallel.

**PLANE WITH PLANE:**

Their traces are parallel as well.
Relative positions. Parallelism II

PLANES PARALLELS TO THE R.L.: their profile traces should be parallel as well
Relative positions. Perpendicularity

- A line and a plane are perpendicular when the projections of the line are perpendicular to the plane traces. The perpendicularity line-line and plane-plane is not visible in the vertical or horizontal projection.

- If a line is perpendicular to a plane it is perpendicular to all the lines r, s, t, etc. that belong to the plane.

- A plane is perpendicular to another plane if a line of one of the planes is perpendicular to the other plane.

- If a line (plane) is perpendicular to a plane (line) it is also perpendicular to all of its parallel plans (lines).