CSE-303: COMPUTER GRAPHICS

PROFESSOR DR. SANJIT KUMAR SAHA

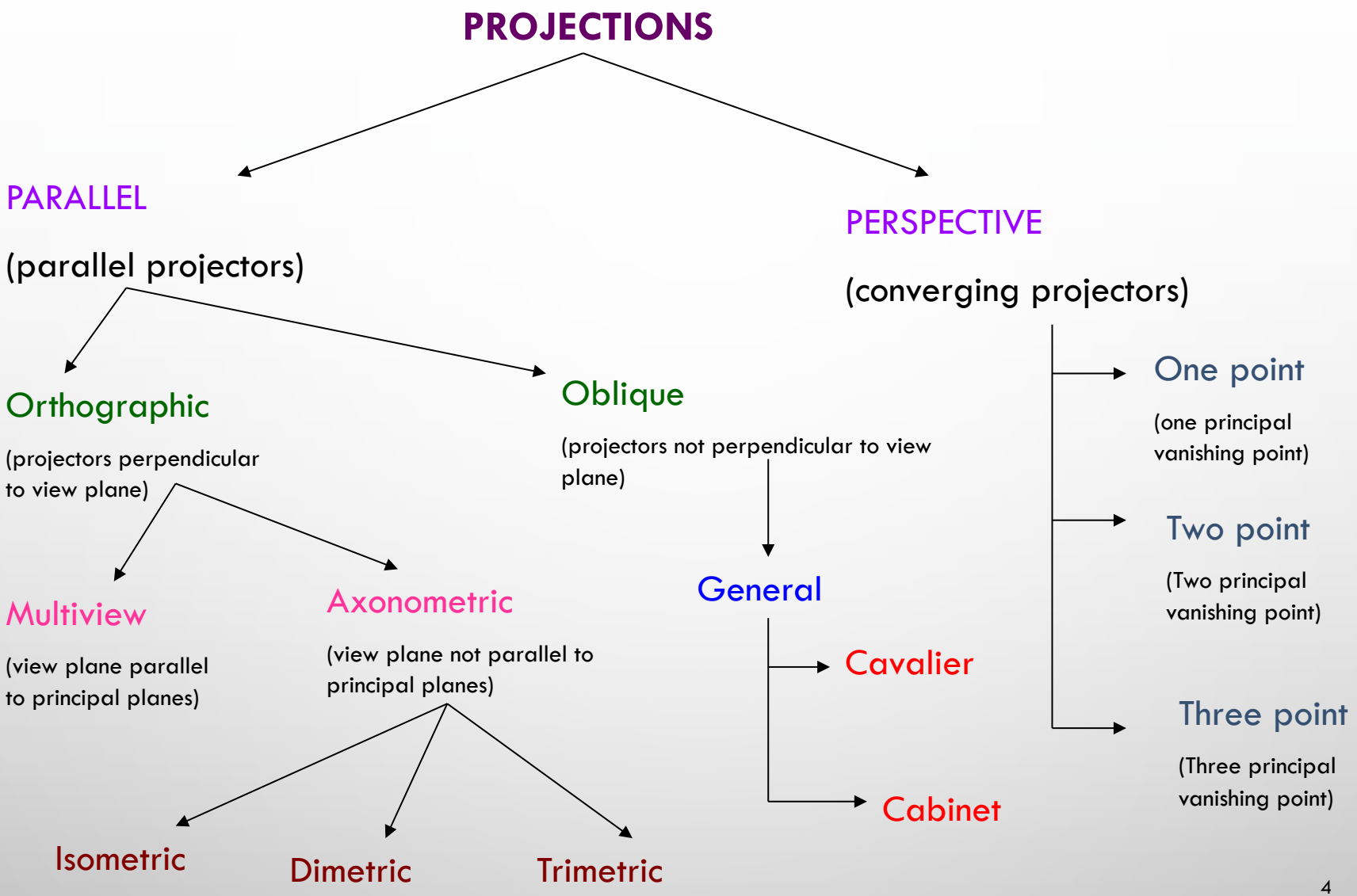
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

JAHANGIRNAGAR UNIVERSITY, SAVAR, DHAKA

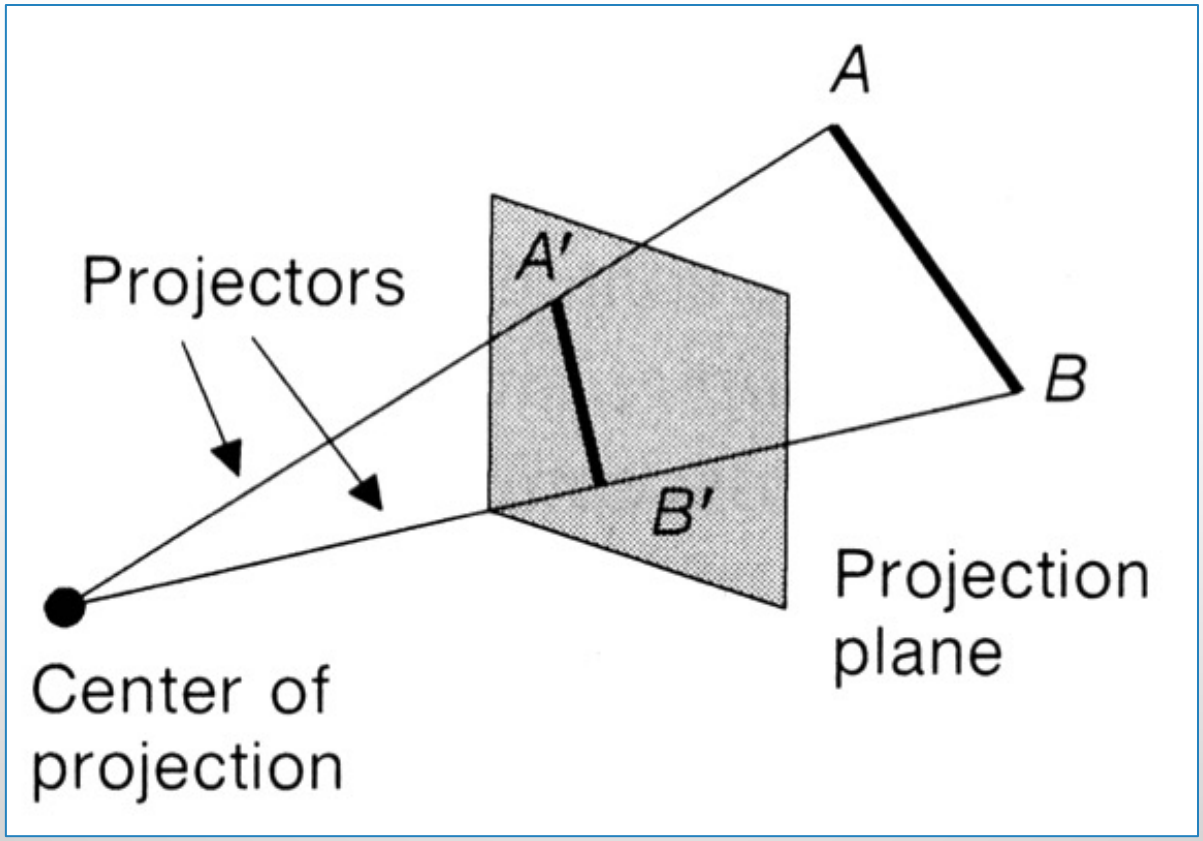
3D PROJECTION

PROJECTION

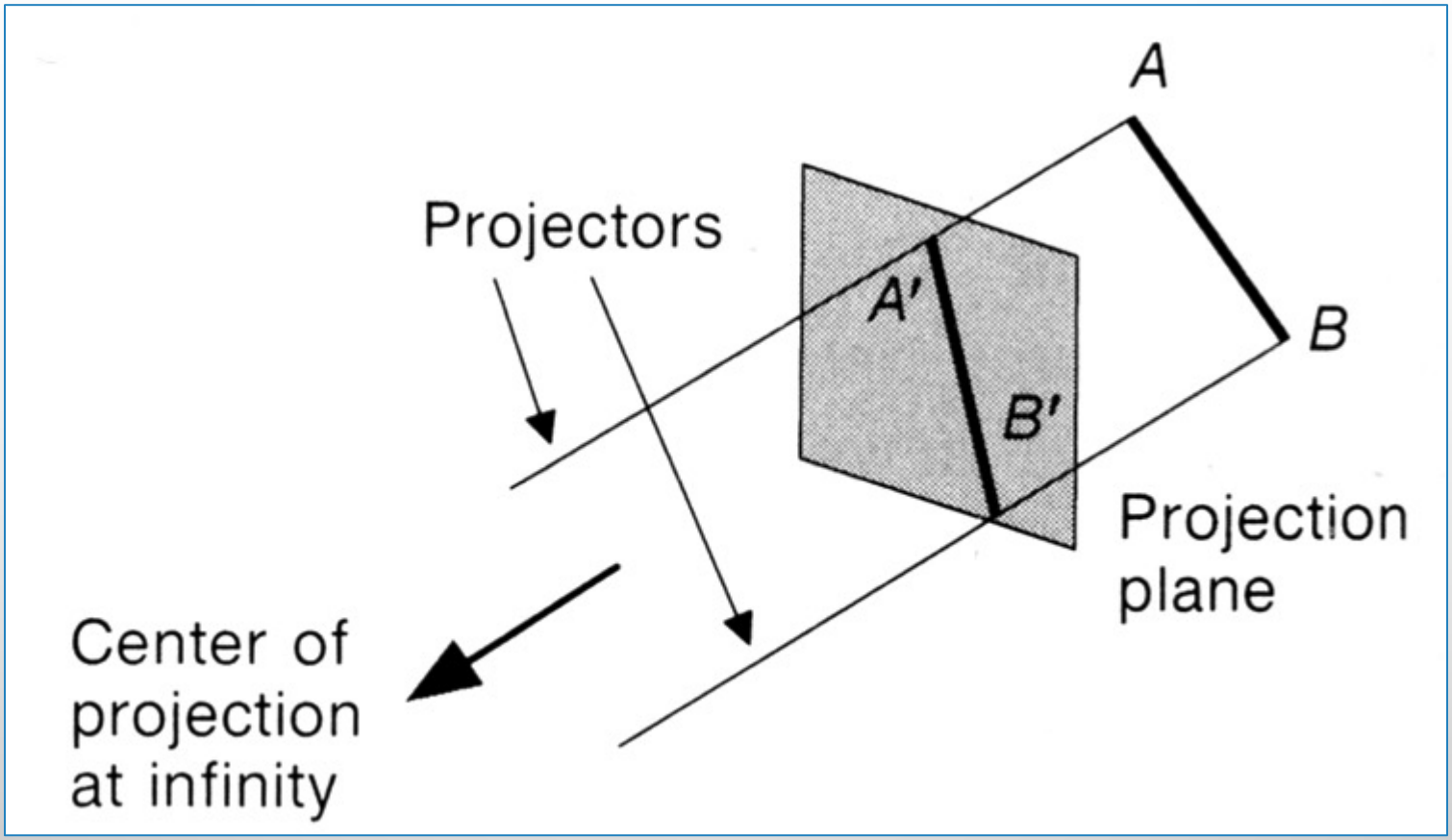
- Transform 3D objects on to a 2D plane
- **2 types of projections**
  - **parallel projection**, coordinate positions are transformed to the view plane along parallel lines.
  - **perspective projection**, object position are transformed to the view plane along lines that converge to a point called **projection reference point (center of projection)**


PROJECTIONS
PARALLEL
(parallel projectors)
PERSPECTIVE
(converging projectors)
Orthographic
(projectors perpendicular to view plane)
Oblique
(projectors not perpendicular to view plane)
One point
(one principal vanishing point)
Two point
(Two principal vanishing point)
Three point
(Three principal vanishing point)
Multiview
(view plane parallel to principal planes)
Axonometric
(view plane not parallel to principal planes)
General
Cavalier
Cabinet
Isometric
Dimetric
Trimetric

PERSPECTIVE PROJECTION



PARALLEL PROJECTION



PERSPECTIVE VS. PARALLEL

- **Perspective:**
  - Visual effect is similar to human visual system...
  - Has 'perspective foreshortening'
    - Size of object varies inversely with distance from the center of projection. Projection of a distant object are smaller than the projection of objects of the same size that are closer to the projection plane.
- **Parallel:**

  it preserves relative proportion of object.
  - Less realistic view because of no foreshortening
  - However, parallel lines remain parallel.

PERSPECTIVE PROJECTIONS

Characteristics:

- Center of Projection (CP) is a finite distance from object
- Projectors are rays (i.e., non-parallel)
- *Vanishing points*
- Objects appear smaller as distance from CP (eye of observer) increases
- Difficult to determine exact size and shape of object
- Most realistic, difficult to execute

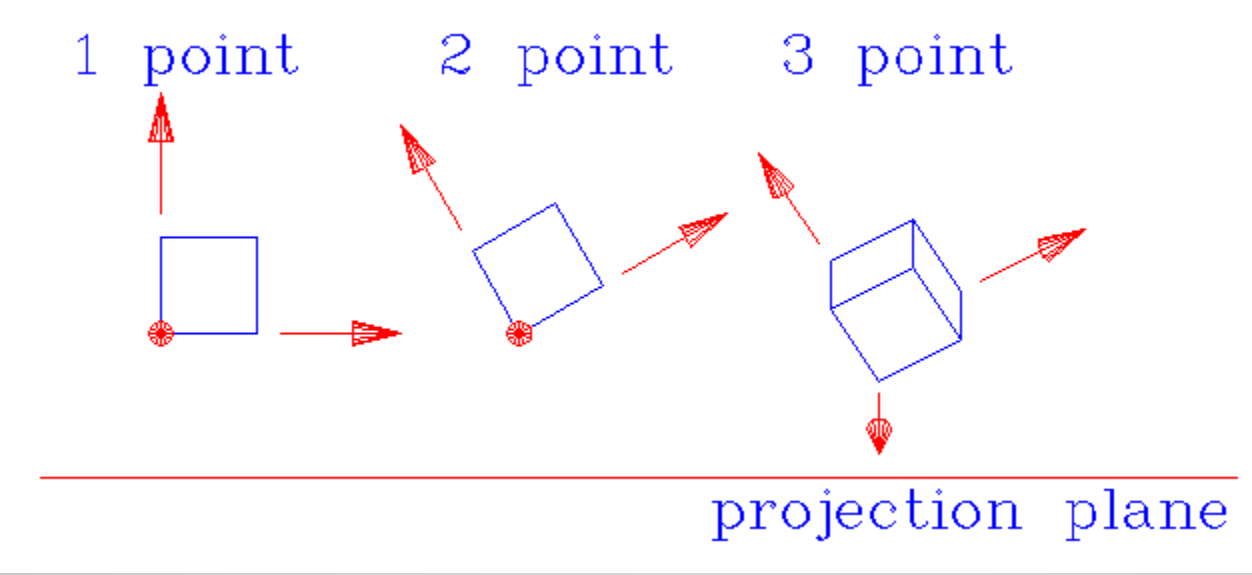
- When a 3D object is projected onto view plane using perspective transformation equations, any set of parallel lines in the object that are *not* parallel to the projection plane, converge at a vanishing point.
  - There are an infinite number of vanishing points, depending on how many set of parallel lines there are in the scene.
- If a set of lines are parallel to one of the three principal axes, the vanishing point is called a *principal vanishing point*.
  - There are at most 3 such points, corresponding to the number of axes cut by the projection plane.

VANISHING POINTS

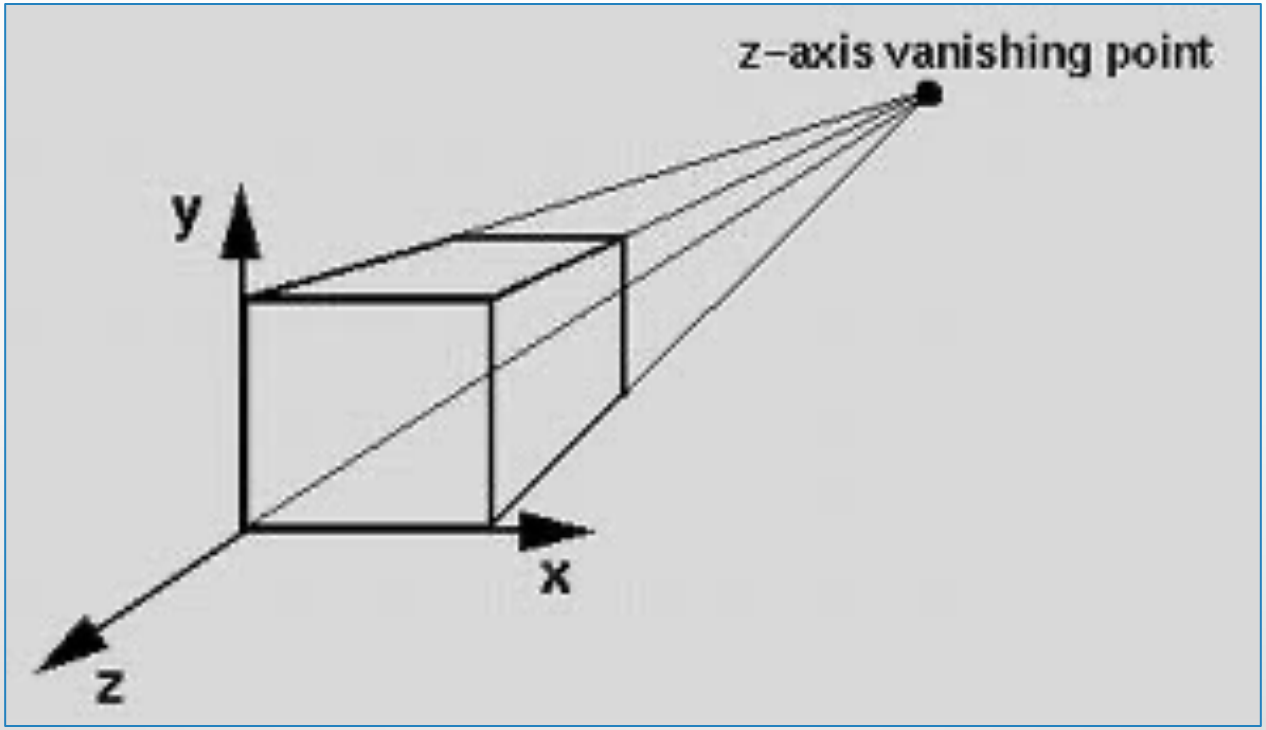
- Certain set of parallel lines appear to meet at a different point
  - The *vanishing point* for this direction
- Principal vanishing points are formed by the apparent intersection of lines parallel to one of the three principal x, y, z axes.
- The number of principal vanishing points is determined by the number of principal axes intersected by the view plane.
- Sets of parallel lines on the same plane lead to *collinear* vanishing points.
  - The line is called the *horizon* for that plane

CLASSES OF PERSPECTIVE PROJECTION

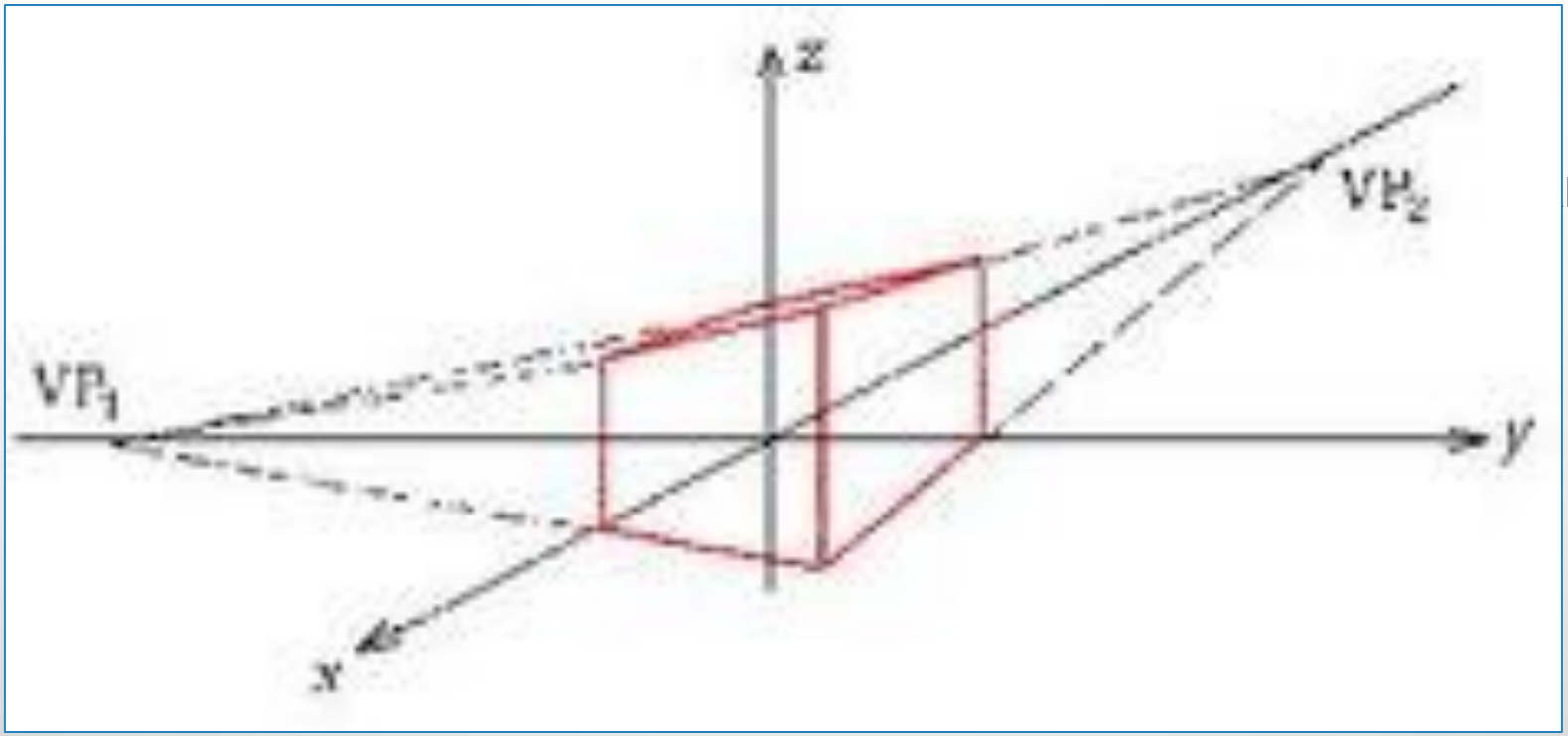
- One-point perspective
- Two-point perspective
- Three-point perspective



ONE-POINT PERSPECTIVE



TWO-POINT PERSPECTIVE PROJECTION



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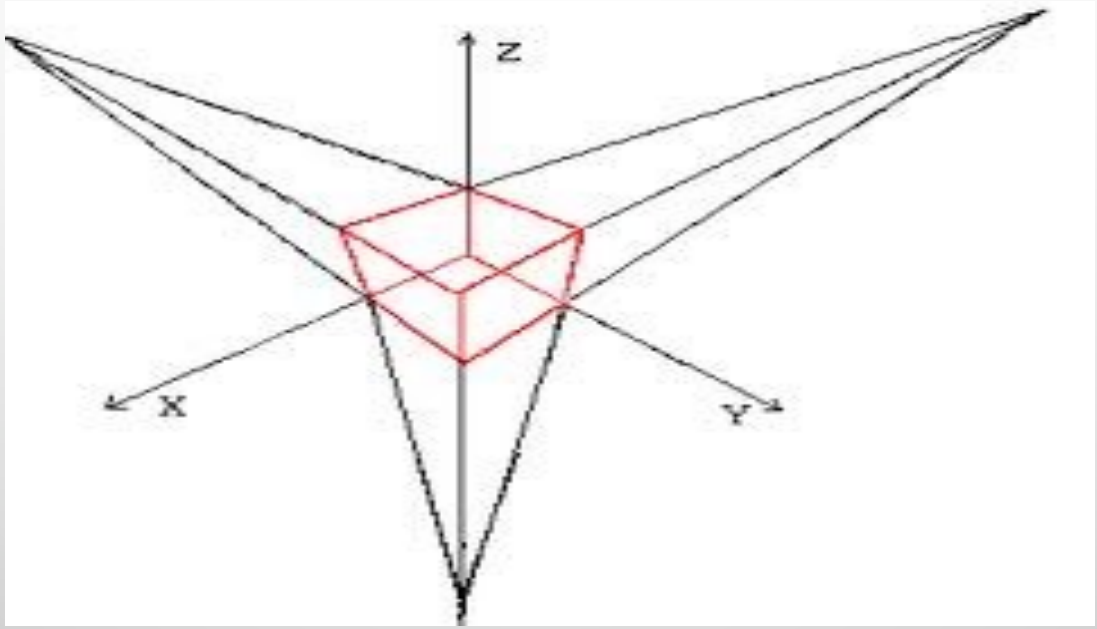
THREE-POINT PERSPECTIVE PROJECTION

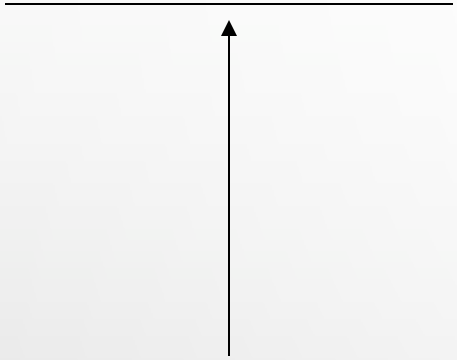
- Three-point perspective projection is used less frequently as it adds little extra realism to that offered by two-point perspective projection



PARALLEL PROJECTIONS

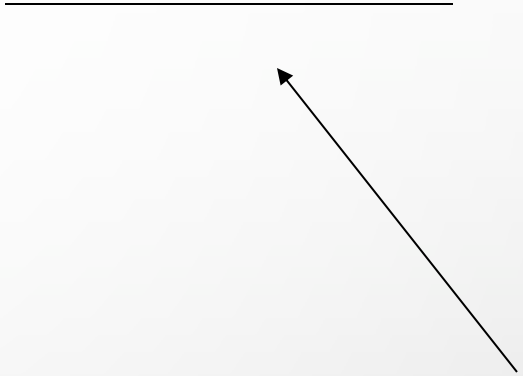
- We can define a parallel projection with a projection vector that defines the direction for the projection lines.
- 2 types:
  - **Orthographic** : when the projection is perpendicular to the view plane. In short,
    - Direction of projection = normal to the projection plane.
    - The projection is perpendicular to the view plane.
  - **Oblique** : when the projection is not perpendicular to the view plane. In short,
    - Direction of projection ≠ normal to the projection plane.
    - Not perpendicular.

ORTHOGRAPHIC PROJECTION



when the projection is perpendicular to the view plane

OBLIQUE PROJECTION



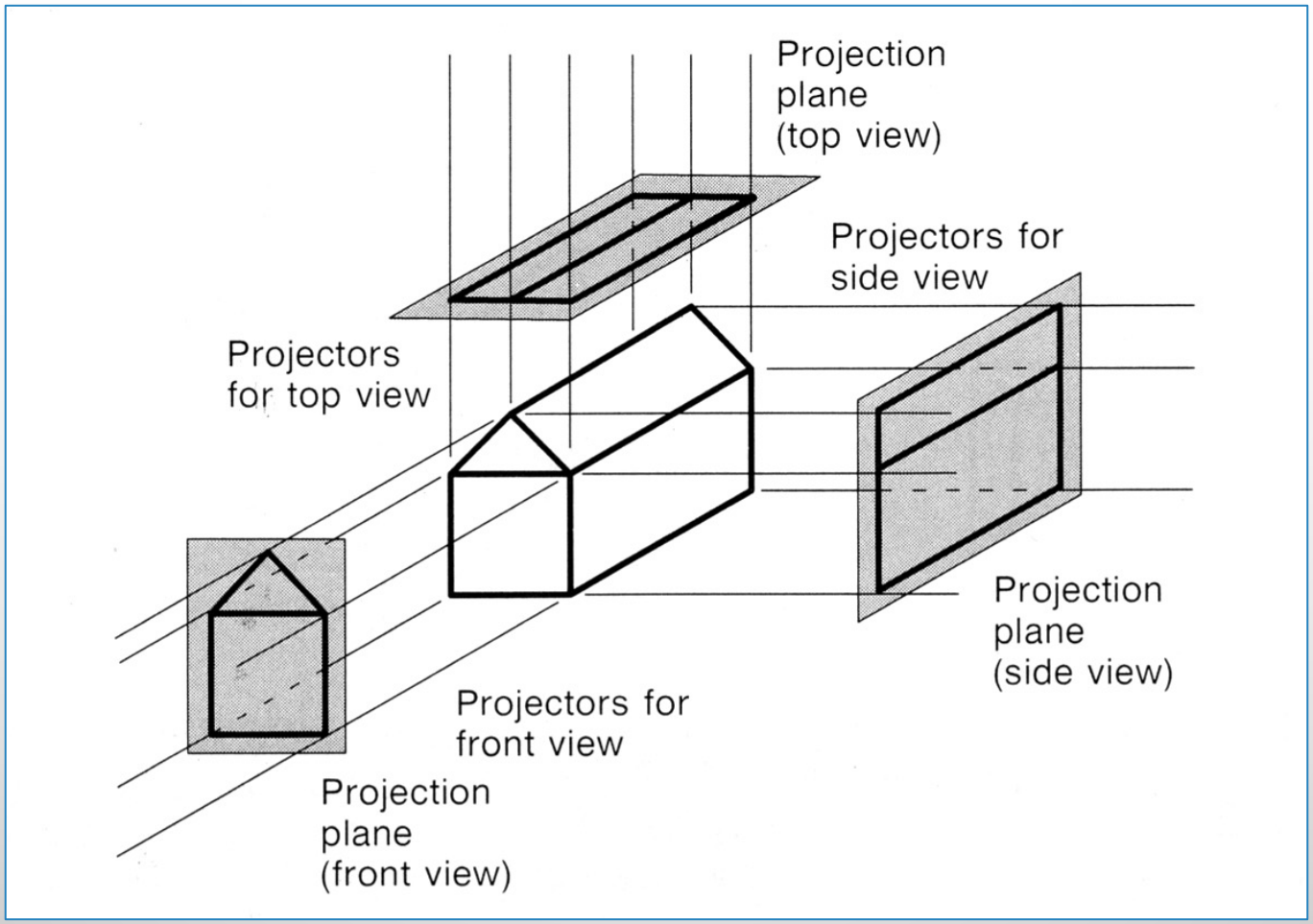
when the projection is not perpendicular to the view plane

ORTHOGRAPHIC (OR ORTHOGONAL) PROJECTIONS

- Front, side and rear orthographic projection of an object are called **elevations** and the top orthographic projection is called **plan view**.
- All have projection plane perpendicular to a principle axes.
- Here length and angles are accurately depicted and measured from the drawing, so engineering and architectural drawings commonly employee this.

- However, as only one face of an object is shown, it can be hard to create a mental image of the object, even when several views are available.

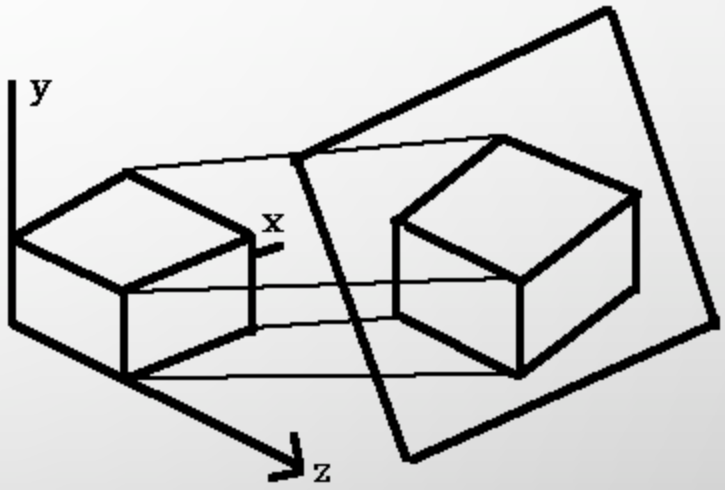
ORTHOGONAL PROJECTIONS



AXONOMETRIC ORTHOGRAPHIC PROJECTIONS

- Orthographic projections that *show more than one face of an object* are called **axonometric** orthographic projections.

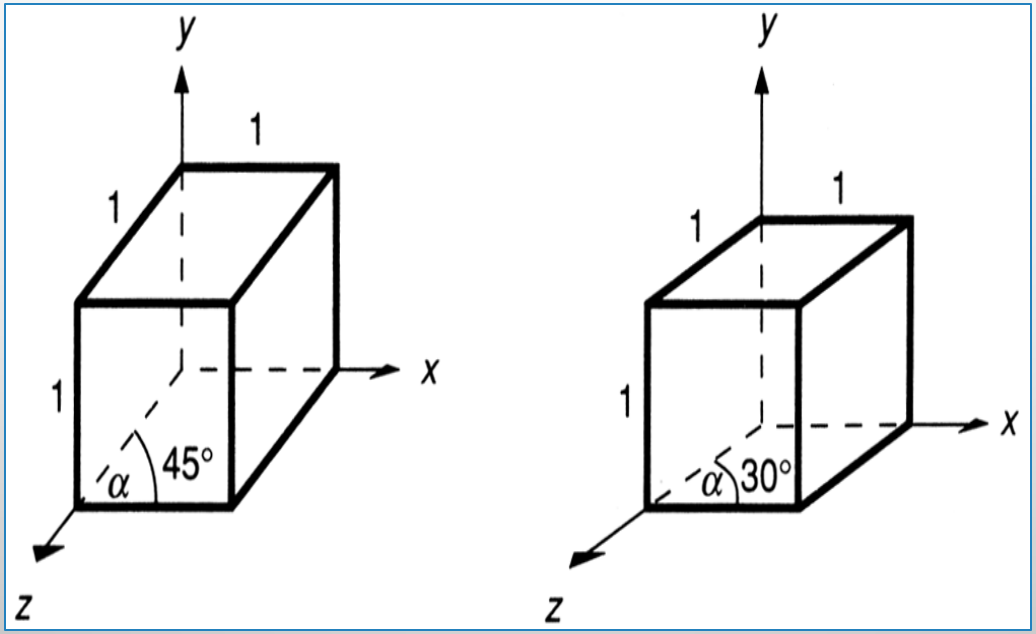
- The most common axonometric projection is an **isometric** projection where the projection plane intersects each coordinate axis in the model coordinate system at an equal distance.



2 common oblique parallel projections
Cavalier and *Cabinet*

Cavalier projection

- All lines perpendicular to the projection plane are projected with no change in length.



Cabinet projection

- Lines which are perpendicular to the projection plane (viewing surface) are projected at 1 / 2 the length .
- This results in foreshortening of the z axis, and provides a more “realistic” view.