

BASIC SURFACES FOR ENGINEERING



Figure 00. Main stairs of Engineering School of Bilbao II. Picture made by the authors, 2018.

1. Surfaces: Basic concepts

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1. Surfaces. Basic concepts

The treatment that has been given to this study of surfaces is a practical approach. It is not intended to be an exhaustive and in-depth study of the subject of surfaces.

In this course the basic surfaces such as the prismatic, cylindrical, pyramidal, conical and spherical surfaces are covered. Although we generally talk about the bodies associated with them: the prism, the cylinder, the pyramid, the cone and the sphere.

At the end of this topic, students are expected to be able to:

- Define and identify the basic surfaces and know the nomenclature.

1.1 Surface or geometric body

The concept of surface and that of body are different. The body has a limited extension and, therefore, a specific and limited volume. The surface is a conceptual entity, without thickness and can be unlimited. Surfaces can be considered as the limits where the faces of the body rest.

In a practical way, limited surfaces are used, in order to facilitate their representation and operability.

1.2 Surfaces generation

Surfaces can be generated as a locus of points that meet a certain condition (Figure 1.1, Figure 1.2, Figure 1.3 and Figure 1.4).

The pyramidal and conical surface can be considered as the locus of the positions of a line, called the generatrix, which moves in space leaning on another line, called the guideline, and which in all its positions passes through a fixed point, called vertex.

The prismatic and cylindrical surface can be considered as the locus of the positions of a line, called the generatrix, which moves in space parallel to itself and leaning on another line, called the guideline.

The spherical surface can be considered as the locus of points in space equidistant from another fixed point, called the center.

When the generatrix is a straight line, the resulting surface is called the ruled surface. When the generating line is curved, the resulting surface is called an unregulated or double curvature surface.

When the generatrix always passes through a fixed point, proper or improper, the resulting surface is called the radiated surface. The fixed point, called the vertex, is

the center of the radiation. The guideline can be a flat or warped line, curved or polygonal, open or closed.

The prismatic, cylindrical, pyramidal and conical surfaces are ruled and radiated surfaces. Ruled surfaces are unlimited, since the generatrix is a line, and by definition a line is unlimited.

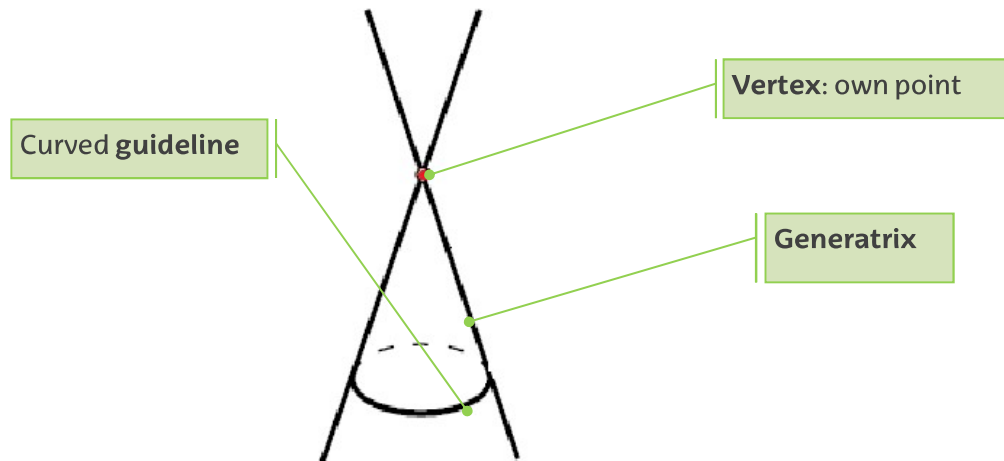


Figure 1.1 Conical surface.

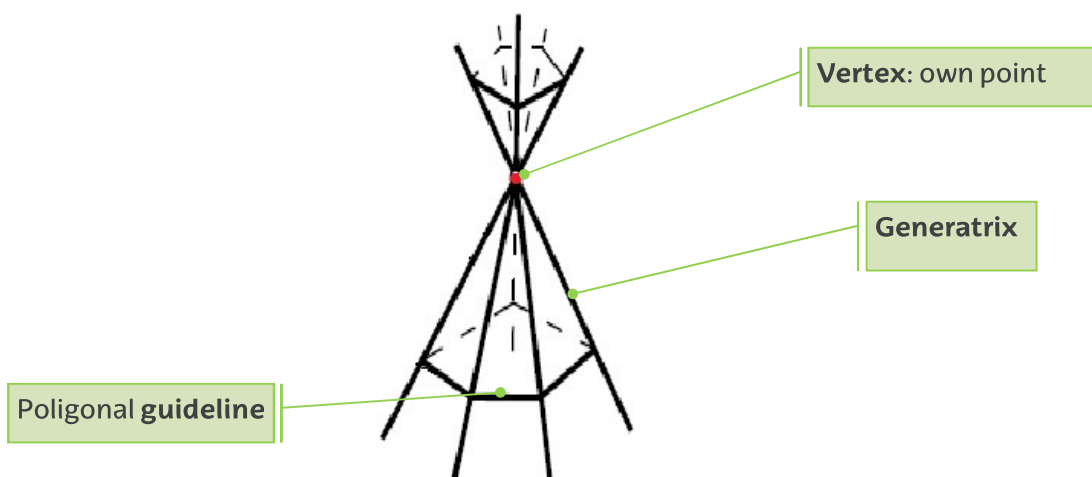


Figure 1.2 Pyramidal surface.

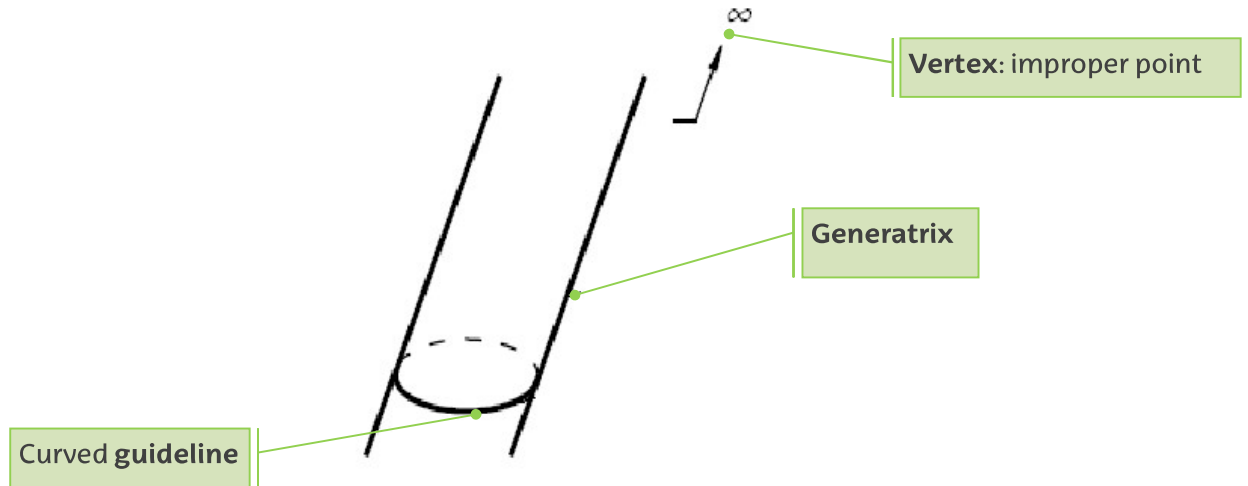


Figure 1.3 Cylindrical surface.

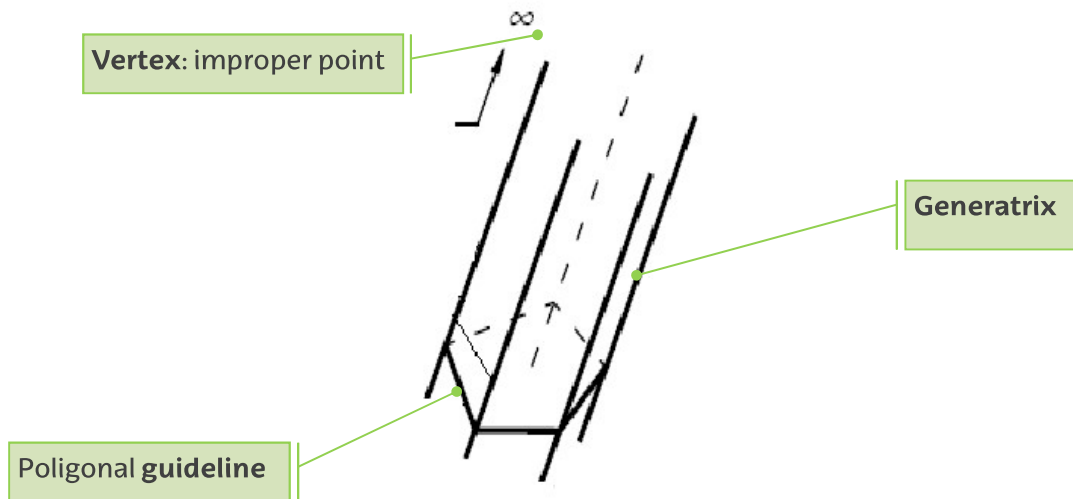


Figure 1.4 Prismatic surface.

In the pyramidal and conical surfaces, the body between two planes is called the pyramid trunk or cone trunk respectively.

On the prismatic and cylindrical surfaces, the body between two non-parallel planes that cut all the generatrices is called the prism trunk or cylinder trunk respectively.

The spherical surface is an unregulated or double curvature surface that is also obtained by revolution of a semicircle.

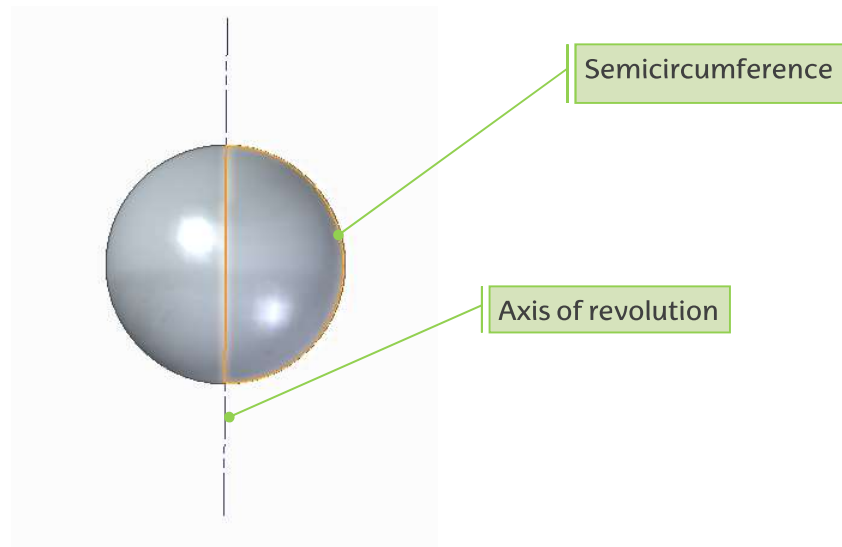


Figure 1.5. Generation of a sphere by revolution of a semicircle around its diameter (Image made with Solid Edge).

1.3 Definitions on surfaces

Ruled surfaces have the following parameters:

- **Base (B):** the one determined by the polygon or directive curve. The pyramid and the cone have a base, while the prism and the cylinder are delimited by two equal bases.
- **Height (h):** the distance from the base plane to the a) vertex of the pyramid or cone, or b) the plane of the opposite base in the prism and the cylinder.
- **Axis (e):** line that joins the vertex with the center of the base when it is a pyramid or a cone, or the centers of the two bases in the case of the prism and the cylinder.
- **Edge (a):** intersection segment of two faces of the pyramid or prism, including the base.
- **Pyramid apothem (ap):** distance from the vertex to one side of the base. It only exists in regular pyramids. Since the lateral faces in this case are isosceles triangles, the apothem of the pyramid is also the height of the lateral faces (Figure 1.6).
- **Base apothem (apb):** distance from one side of the base to the center of the base. It only exists in regular pyramids (Figure 1.6).

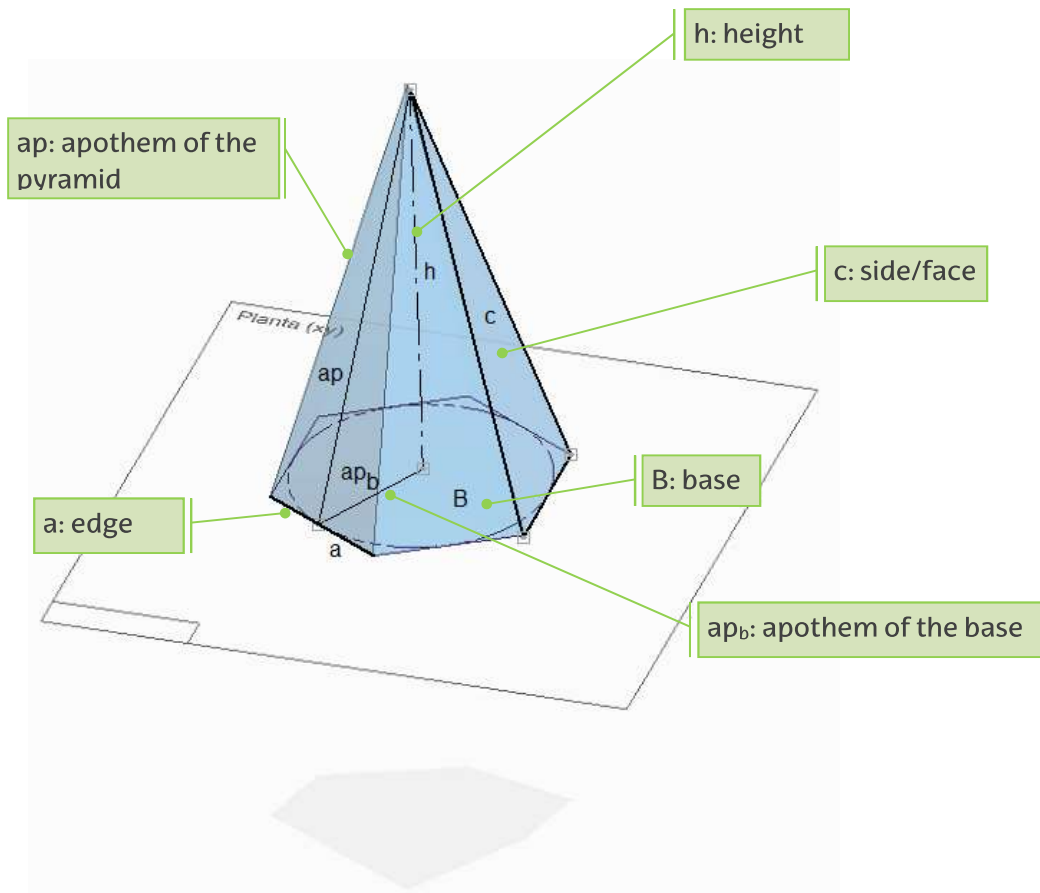


Figure 1.6. Parameters of a pyramid (Image made with Solid Edge).

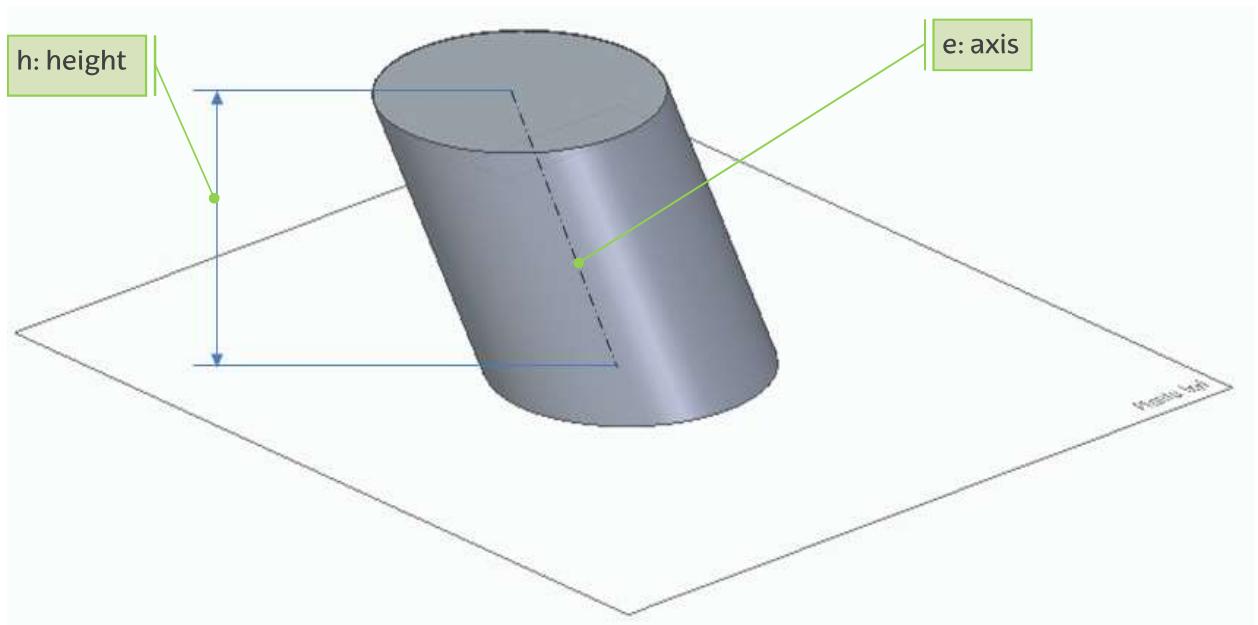


Figure 1.7. Parameters of an oblique cylinder (Image made with Solid Edge).

In the case of the sphere, the parameters are defined (Figure 1.8):

- **Meridians:** are the circumferences generated by the intersection of planes that contain the axis of rotation.
- **Parallel:** are the circumferences generated by the intersection of planes perpendicular to the axis of rotation. The major parallel is called the **equator**.

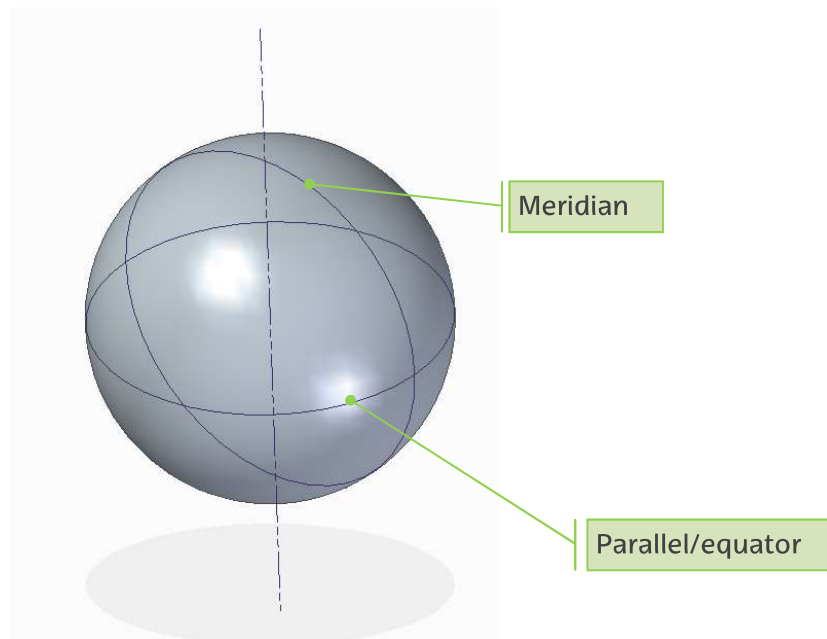


Figure 1.8. Parameters of a sphere (Image made with Solid Edge).

Looking at the base and the axis, we can classify the surfaces as follows:

- Depending on the shape of the base, polygonal or curved surfaces.
- On polygonal surfaces, depending on whether the polygon is regular or irregular, regular or irregular surfaces.
- In curved surfaces, it is necessary to differentiate between those that are formed by rotating the generating line about an axis (surface of revolution), and those that are not generated in this way (not of revolution). An example of the latter type of surface is the elliptical cone.
- Depending on whether the height coincides with the axis, and therefore the axis is perpendicular to the base or not, straight or oblique surfaces.

All these concepts are summarized in Table 1.1.

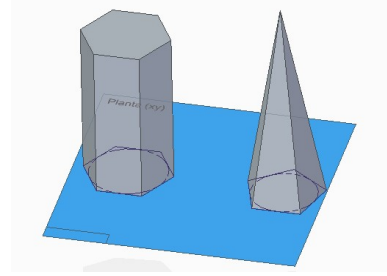
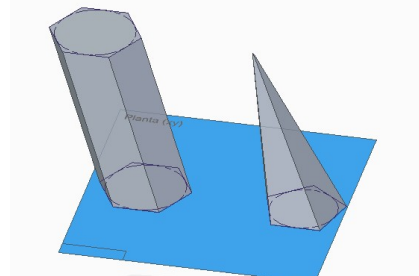
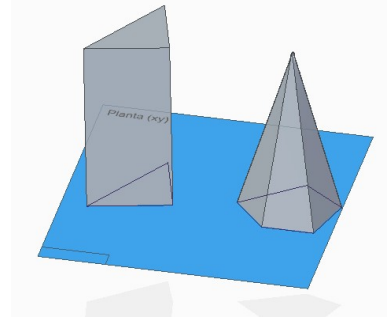
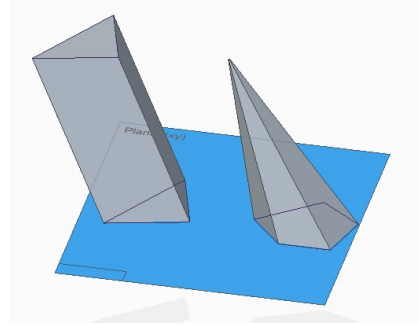
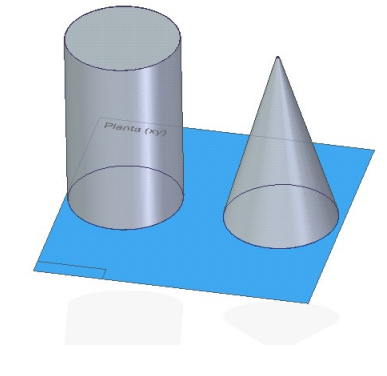
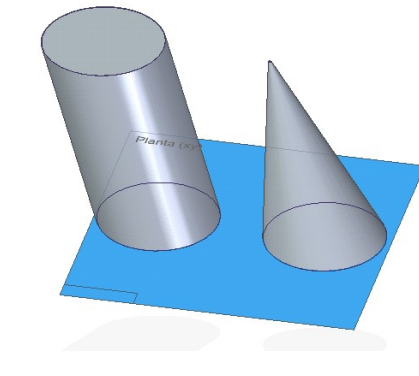
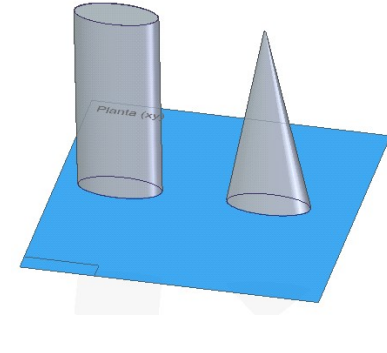
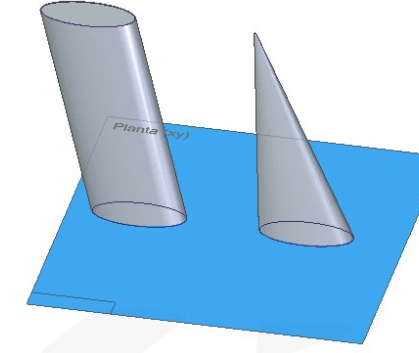
POLYGONAL	Axis	
Base	Right	Oblique
Regular		
Irregular		
CURVES	Axis	
Turn	Right	Oblique
Revolution		
Not of revolution		

Table 1.1. Summary of the classification of surfaces based on the shape of the base or the position of the axis with respect to it (Image made with Solid Edge).

