



Tomsk Polytechnic University

**DESCRIPTIVE GEOMETRY
ENGINEERING GRAPHICS**

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Lecture 4

SURFACES



Plan

- 1. Determining and Specifying Surfaces in a Drawing. Classification.**
- 2. Polyhedral Surfaces and Polyhedrons. A Polyhedron Cut by a Plane.**
- 3. A Point and a Line on the Surface.**
- 4. Conical and Cylindrical Surfaces.**
- 5. Rotation Surfaces.**



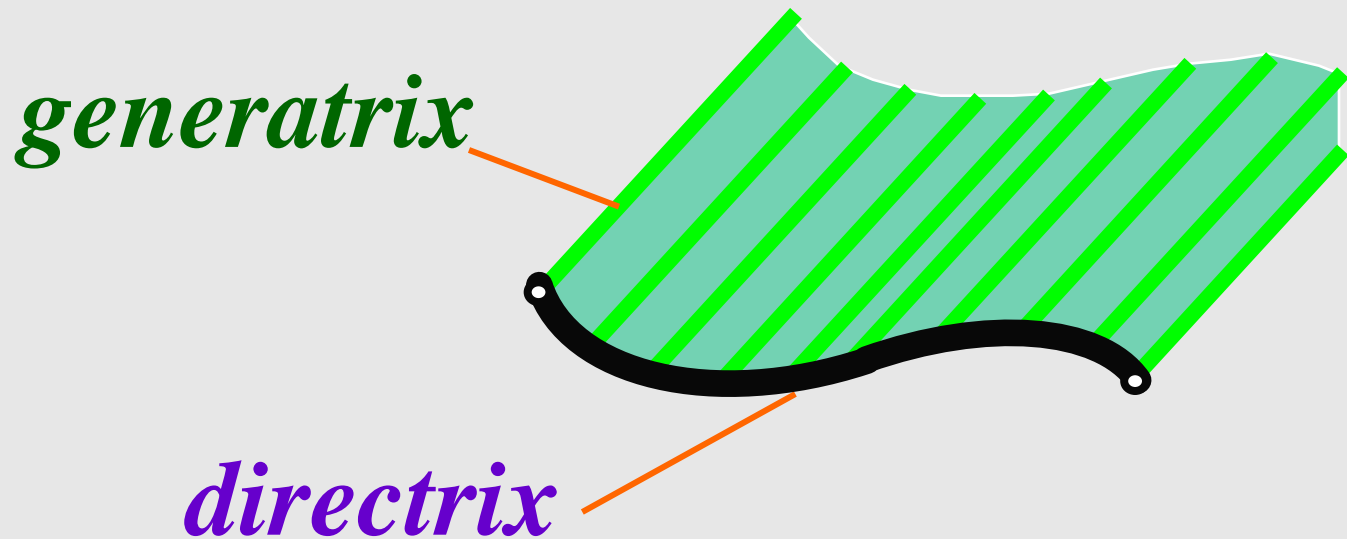
Determining and Specifying Surfaces in a Drawing Classification



Kinematic method

SURFACE - set

All consecutive positions Moving line





Analytical way Tasks of a surface

SURFACE a geometrical place of points or lines satisfying the equation $F(X,Y,Z) = 0$

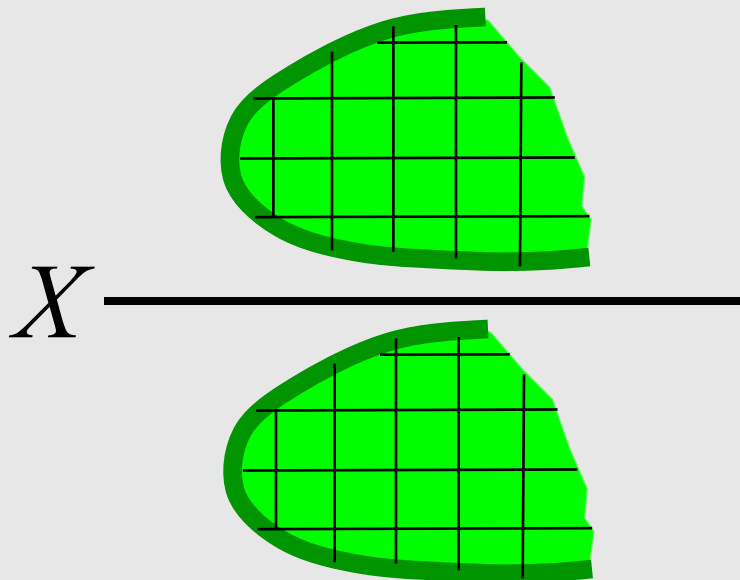
For example, $x^2+y^2+z^2=r^2$



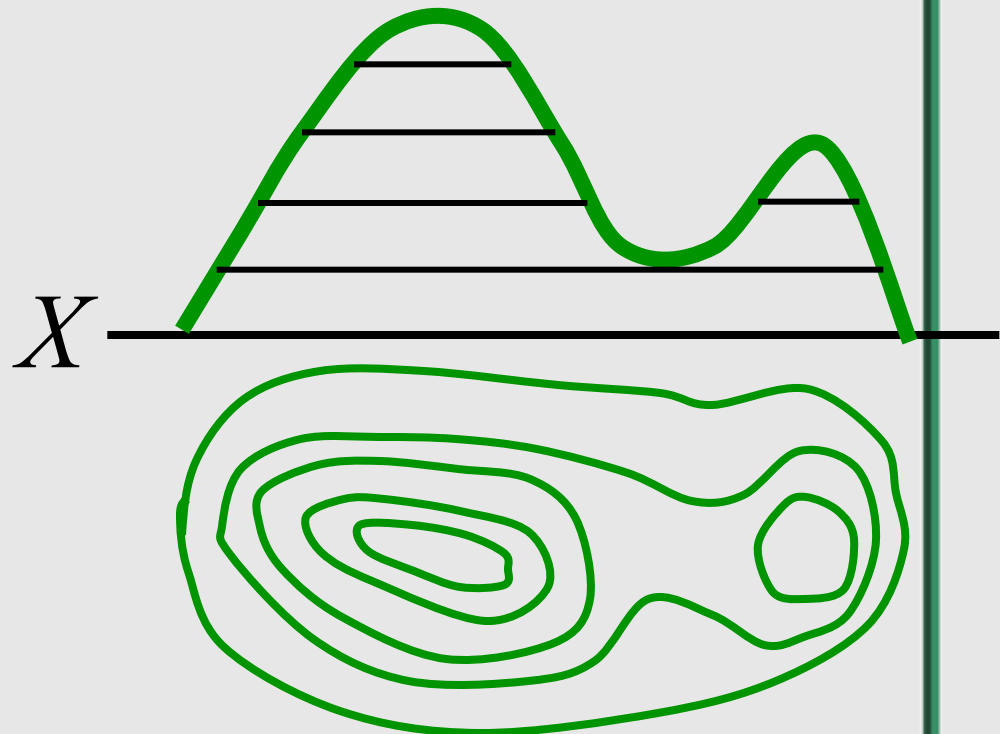
The frame method

The SURFACE is set by family of the lines belonging to a surface (frame)

The frame:



Mesh, linear, dot





To specify a surface in a complex drawing it is necessary to present in it only those elements of a surface which give the opportunity to construct each of its points.

A collection of these elements is called **surface determinant**.



The determinant will consist of 2 parts
Geometrical and algorithmic.

Geometrical part-

Geometrical elements

Surfaces (a point, a line, etc.)

Algorithmic part

The law of formation of a surface



Classification of the Surfaces

1. **Regular** and **nonregular** surfaces;
2. **Ruled** surfaces (formed by a travel of a straight line) and **nonruled** (curve-lined) surfaces;
3. **Developable** surfaces (or torses) and **nondevelopable** ones;
4. Surfaces with **generatrix** of a constant form and of a **variable** form;
5. Surfaces with translational, rotary and helical motion of generatrix.



Polyhedral Surfaces and Polyhedrons. A Polyhedron Cut by a Plane



A polyhedral surface is a surface formed by a travel of a **linear generating line** along a **polygonal directrix**.

Polyhedral surfaces are divided into two kinds: **pyramidal and prismatic surfaces**.

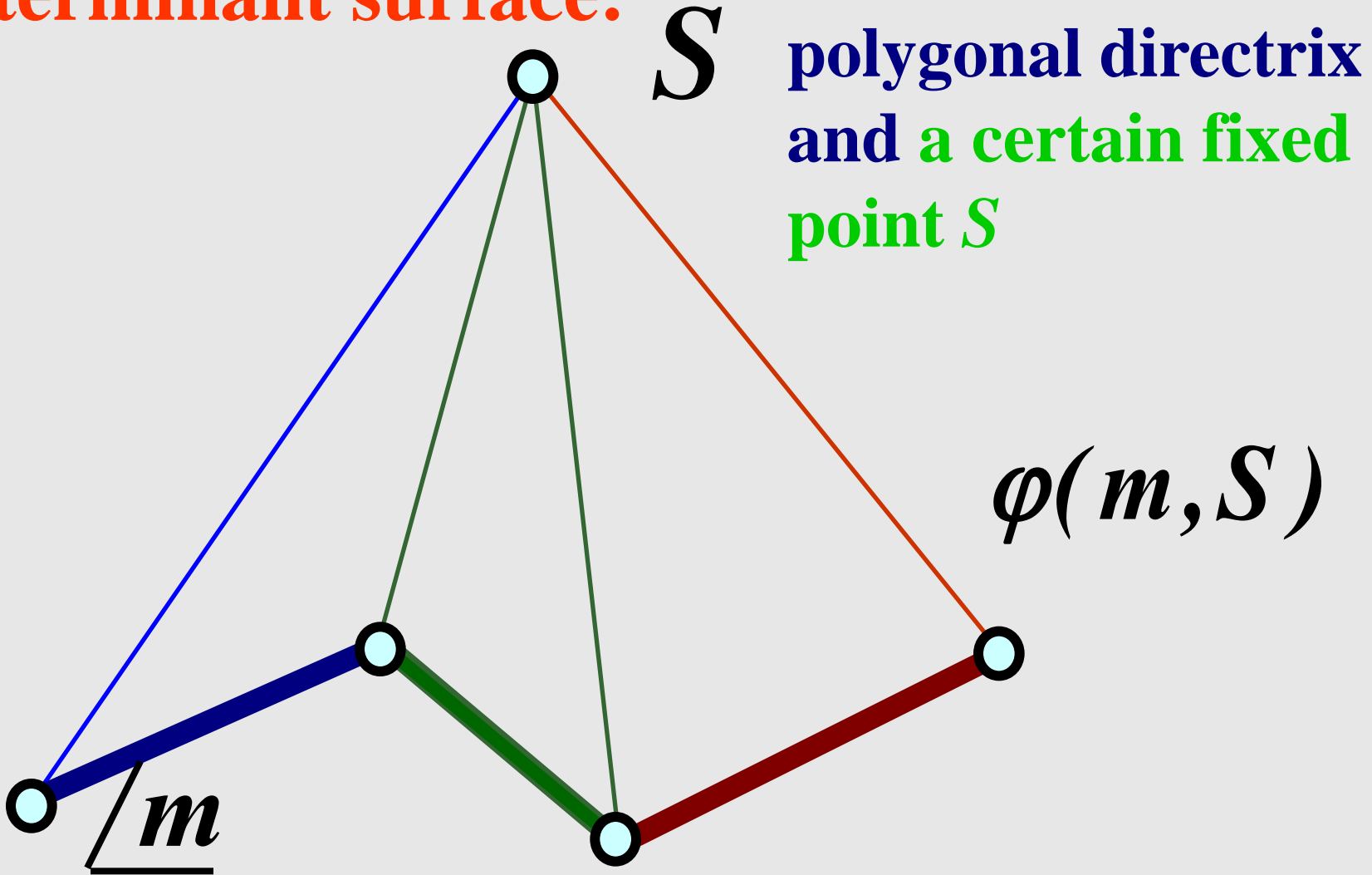


A pyramidal surface is a surface obtained by a travel of a linear **generatrix along a polygonal directrix.**

Note: All generating lines pass through a certain fixed point S .



Determinant surface:

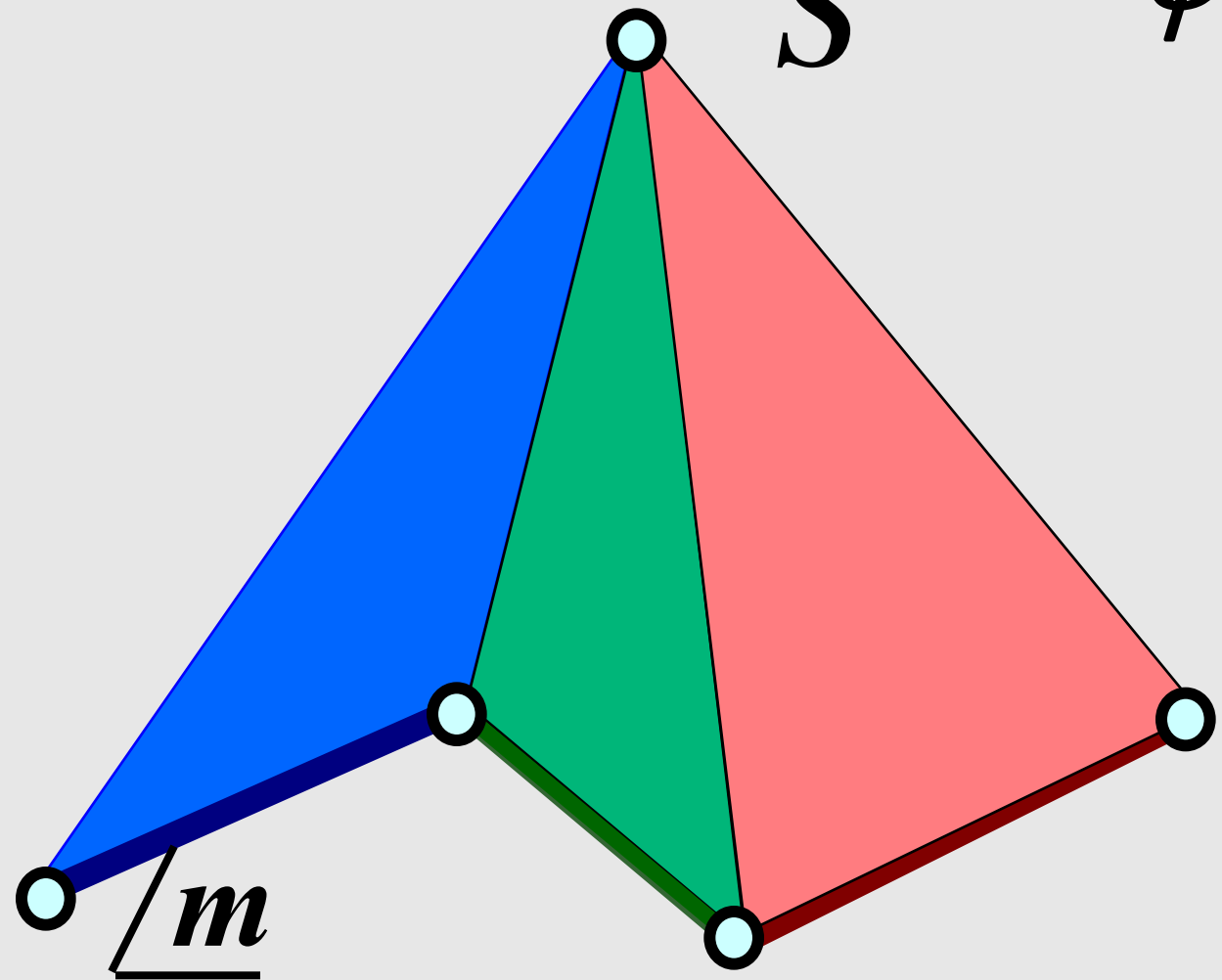


A pyramidal surface



$$\varphi(m, S)$$

S



A pyramidal surface

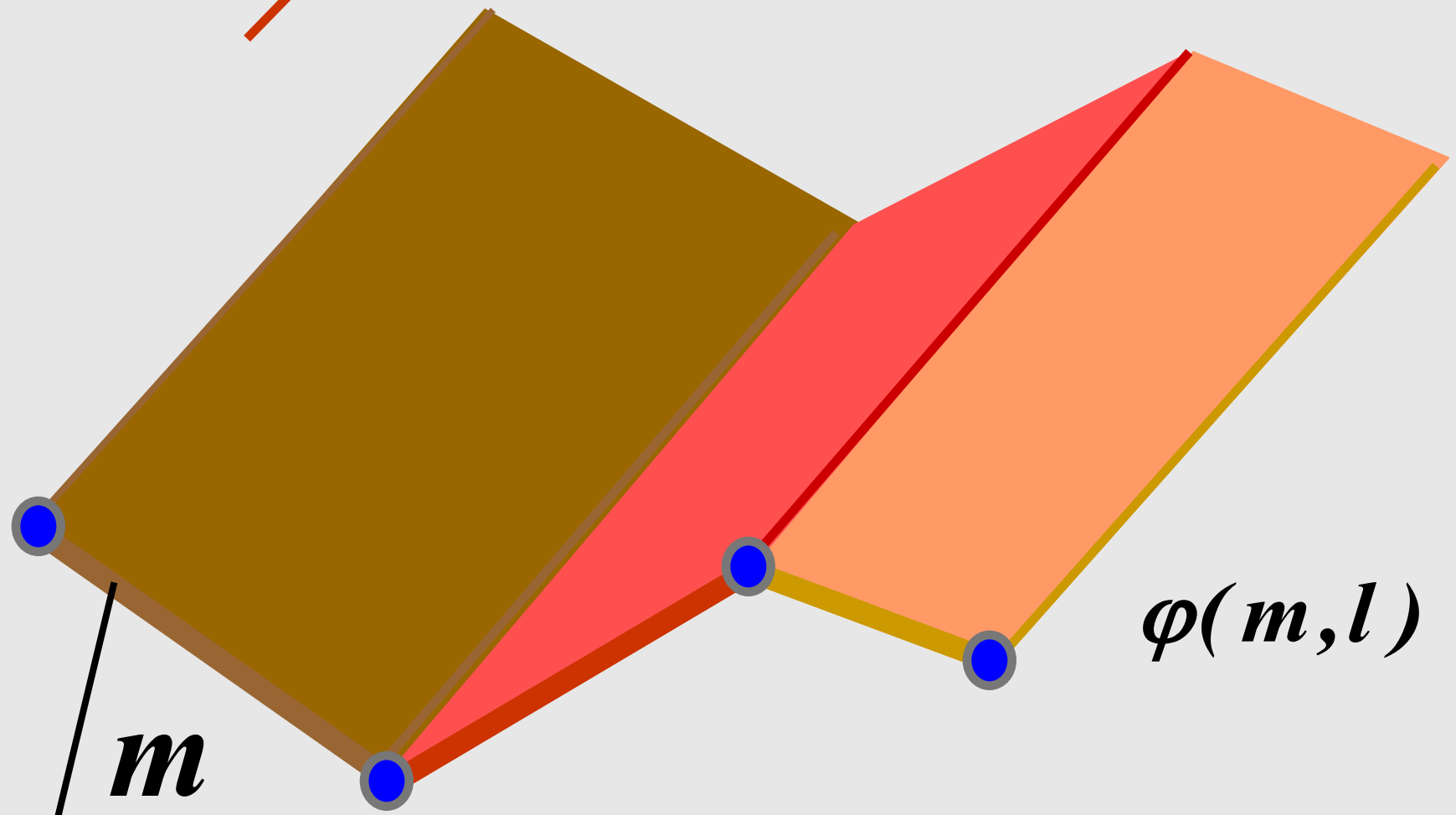


A prismatic surface is a surface obtained by a travel of a linear **generatrix along a polygonal directrix.**

Note: **All generating lines** are **parallel** to a certain **given direction l .**



A prismatic surface



$$\varphi(m, l)$$

m

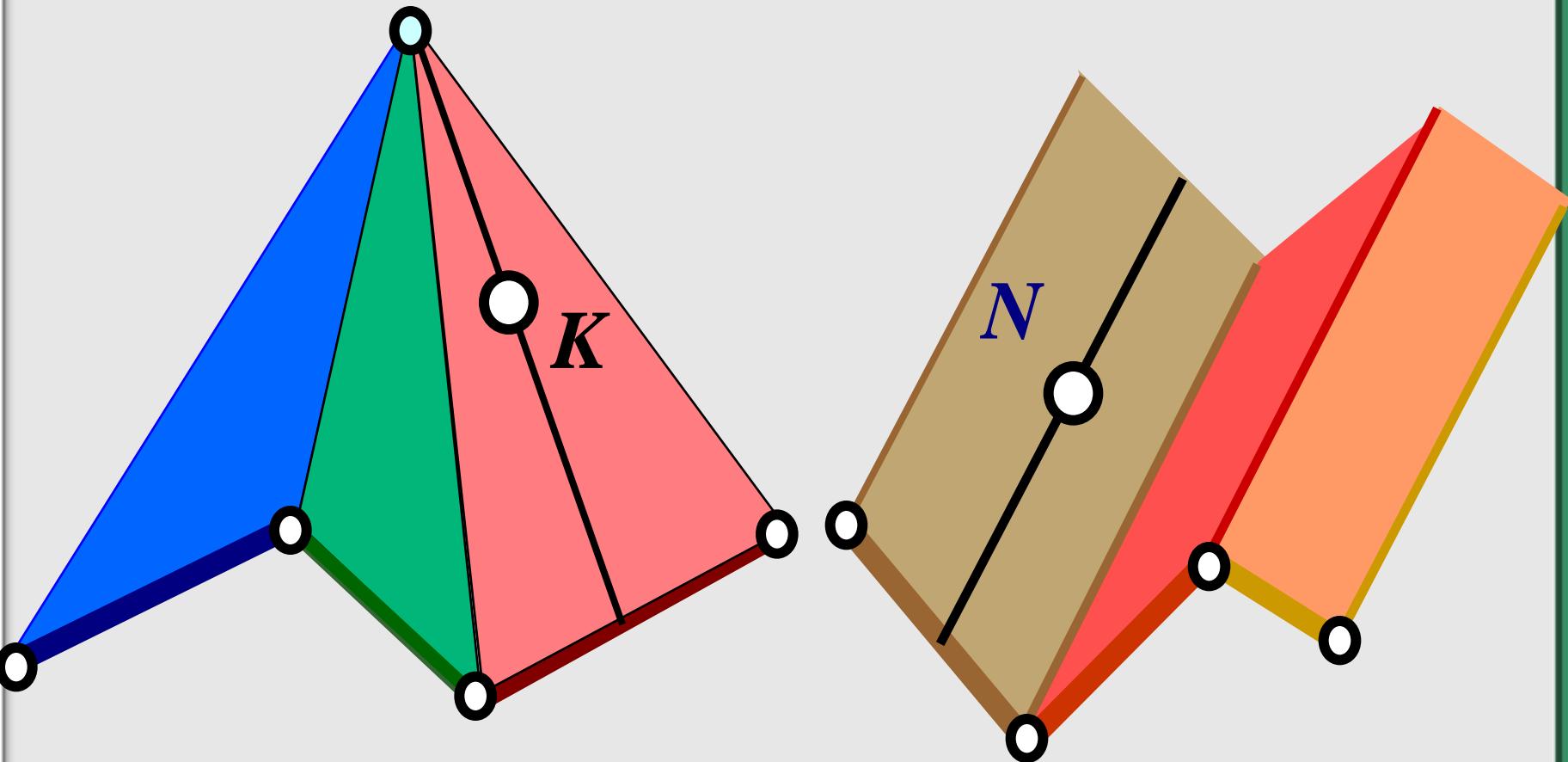
Determinant surface: polygonal directrix and given direction l



A Point and a Line on the Surface



1. A point belongs to a surface when it belongs to a line of the surface

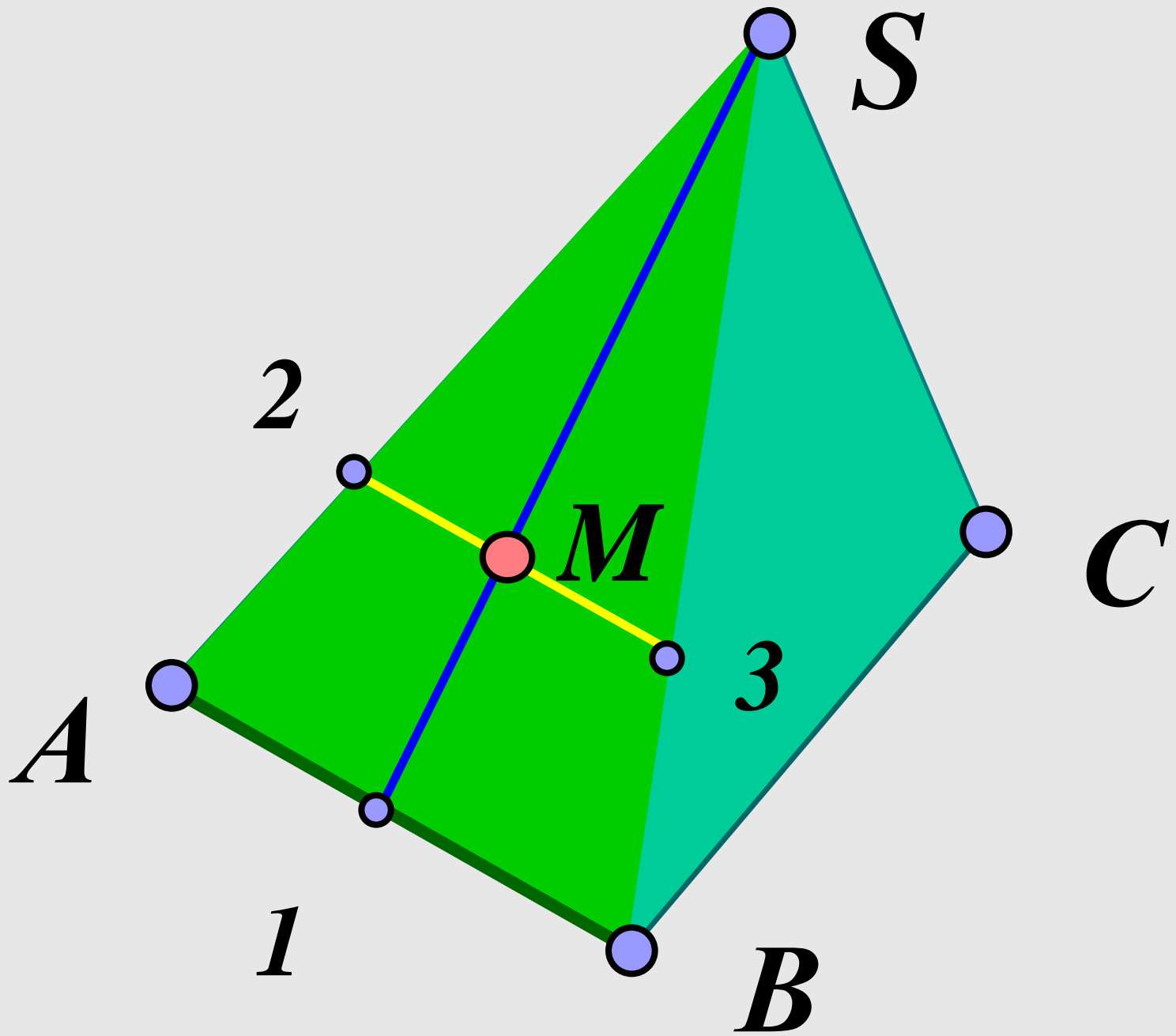


The points K and N belong to a pyramidal and prismatic surfaces respectively, as they belong to the straight lines contained in these surfaces.



2. A **line belongs** to a **surface** when it passes **through** the **points of the surface**.

3. A **straight line** belongs to a **surface** when it passes through **two points** belonging to **the surface**.





Hence, if a point belongs to a surface, its projections belong to the like projections of the surface line.




Polyhedron



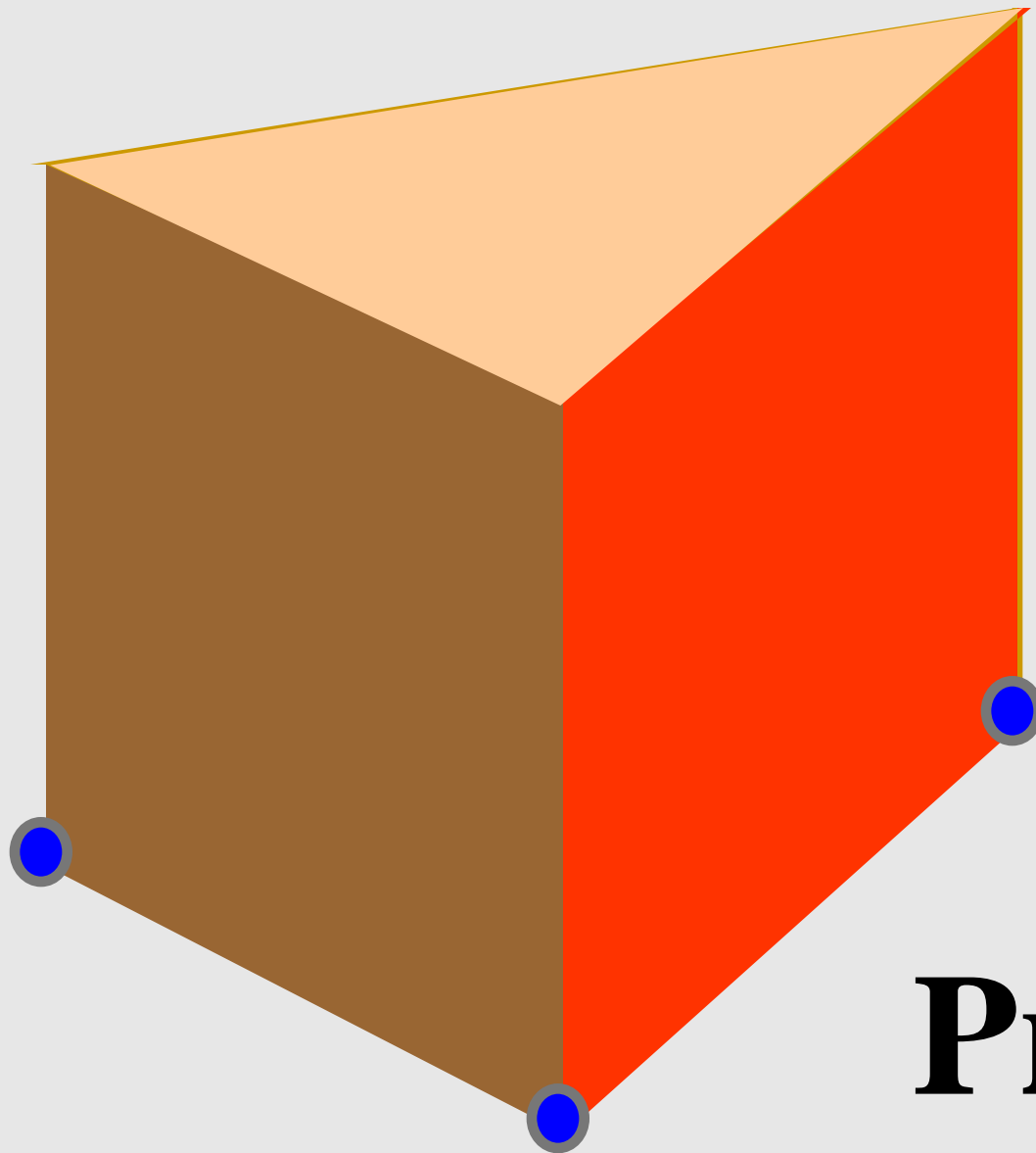
A body bounded by plane polygons is called a *polyhedron*.

A part of space bounded in all directions by a surface is called a *body*.



Prism is a polyhedron with the bases being equal **mutually parallel** faces and the **sides being parallelograms**.


If the edges of the sides are **perpendicular** to the base, the prism is a **right prism**.



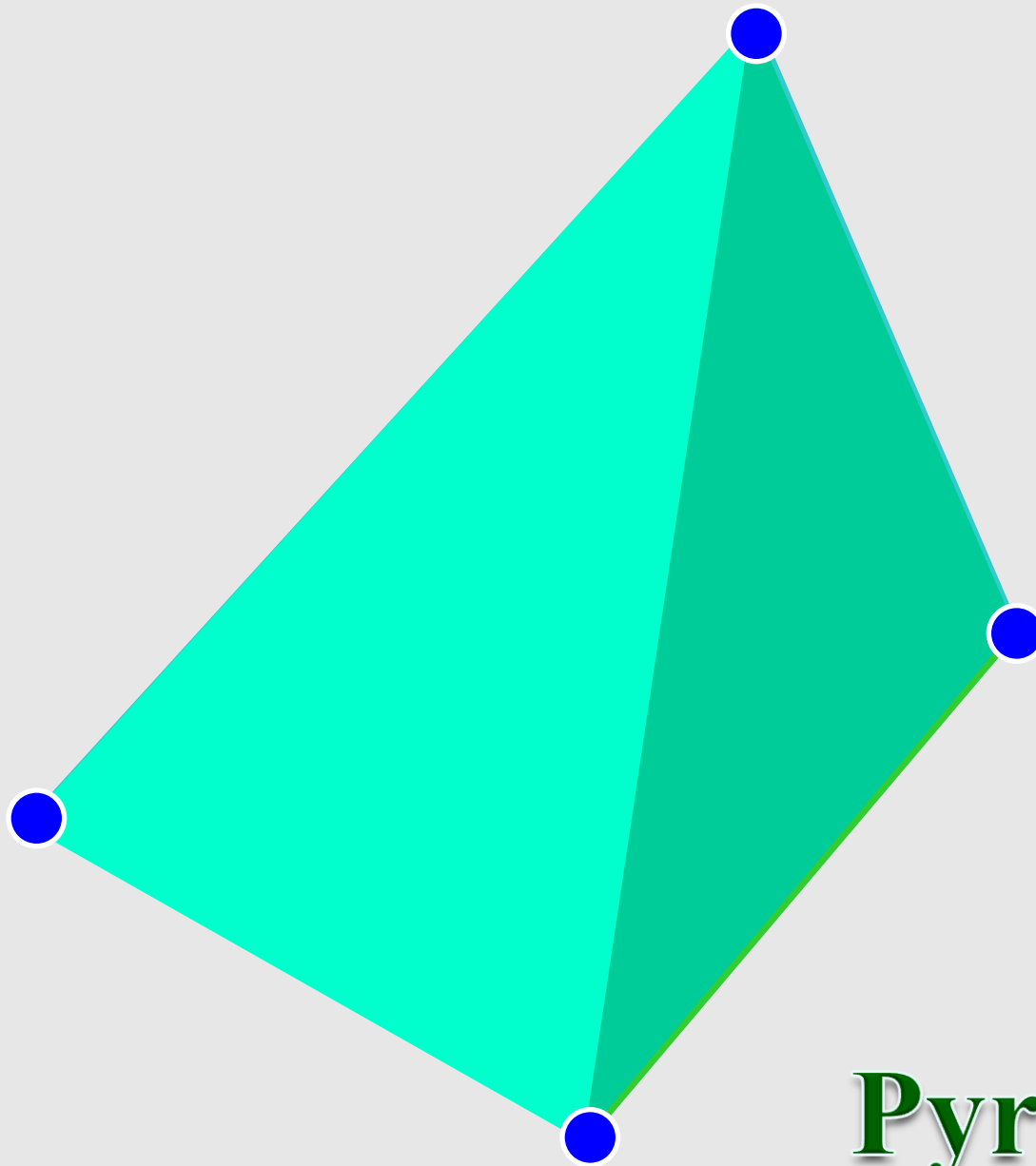
Prism



To specify a prism it is necessary to specify its base and a lateral edge



Pyramid is a polyhedron one face of which is an **arbitrary polygon** taken **for the base**, the **other faces** (lateral) are the **triangles** with the common **vertex S** being called the **vertex** of pyramid.



Pyramid



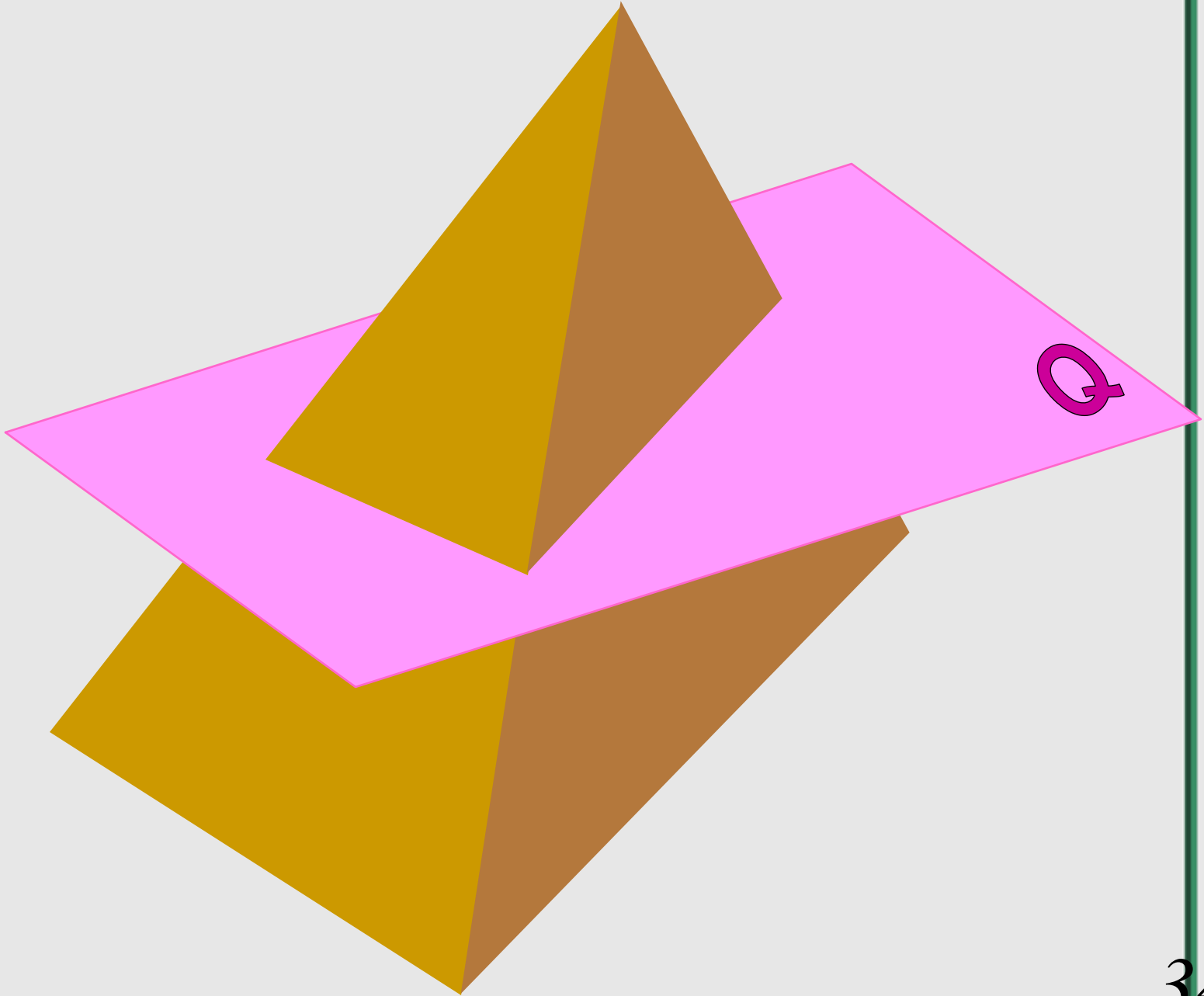
To specify a pyramid it is necessary to specify its base and vertex.

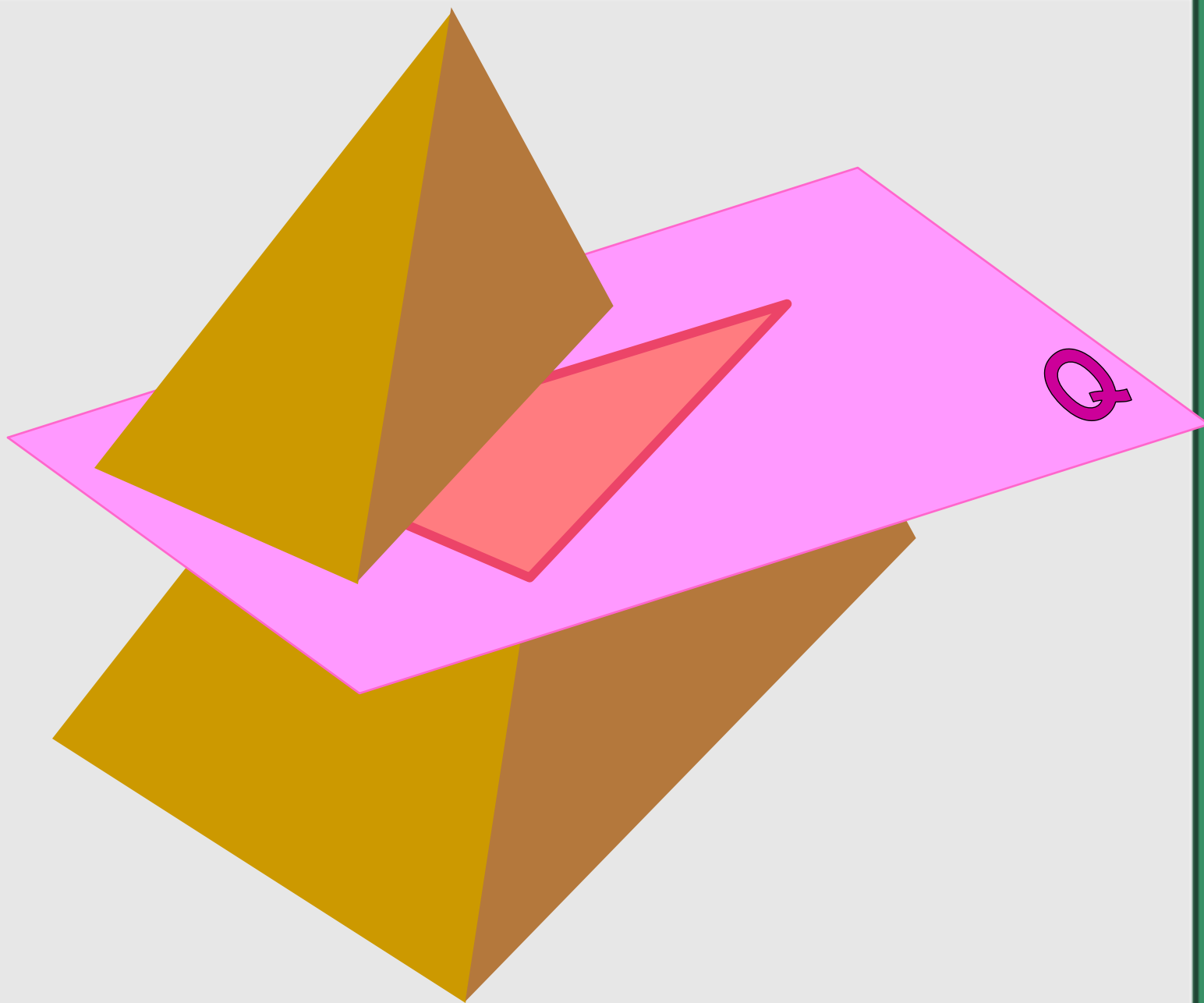


A Polyhedron Cut by a Plane

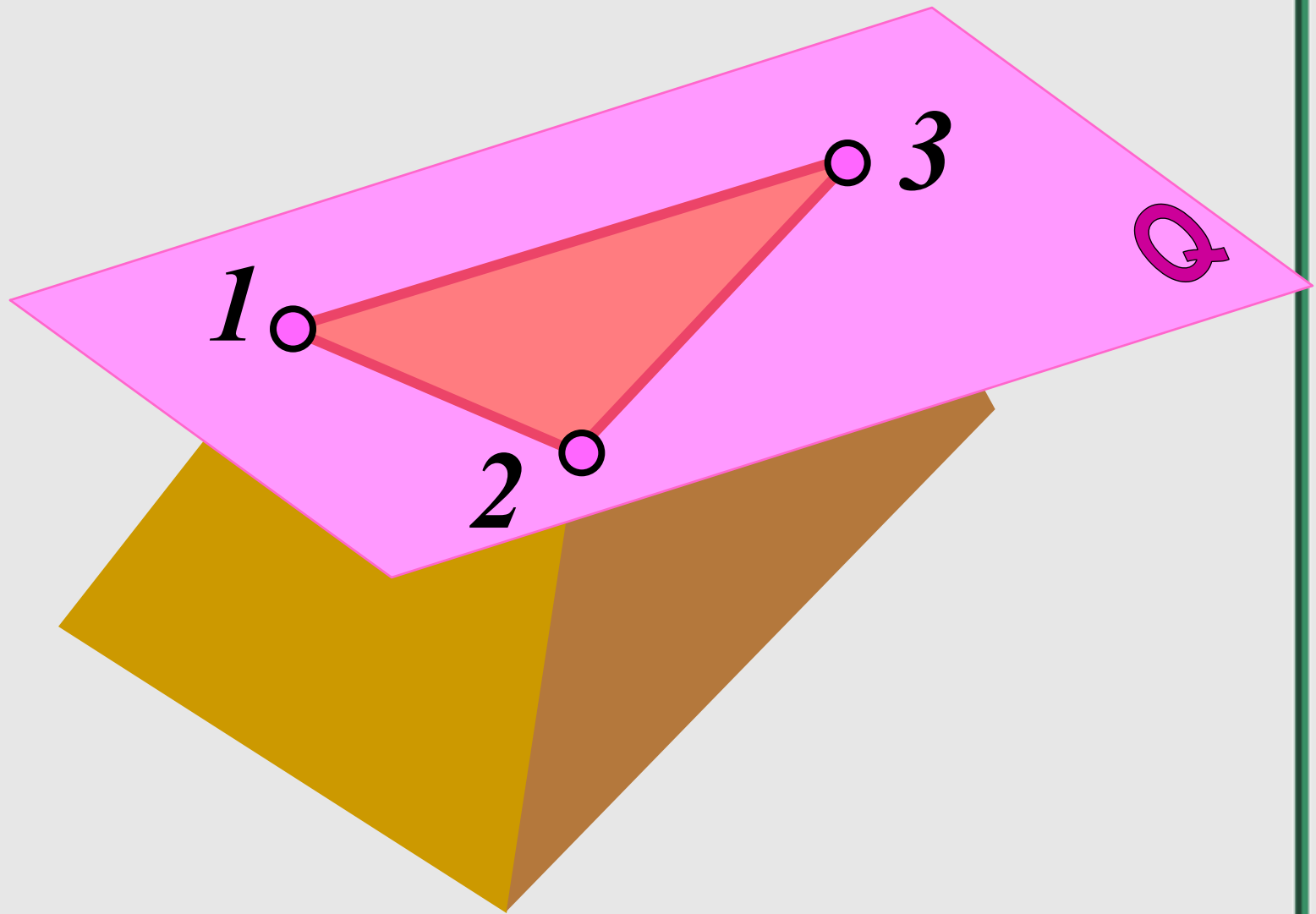


When polyhedral surfaces are cut by planes we obtain polygons in the section, whose vertices are determined as the points of intersection of the polyhedron edges with a cutting plane.





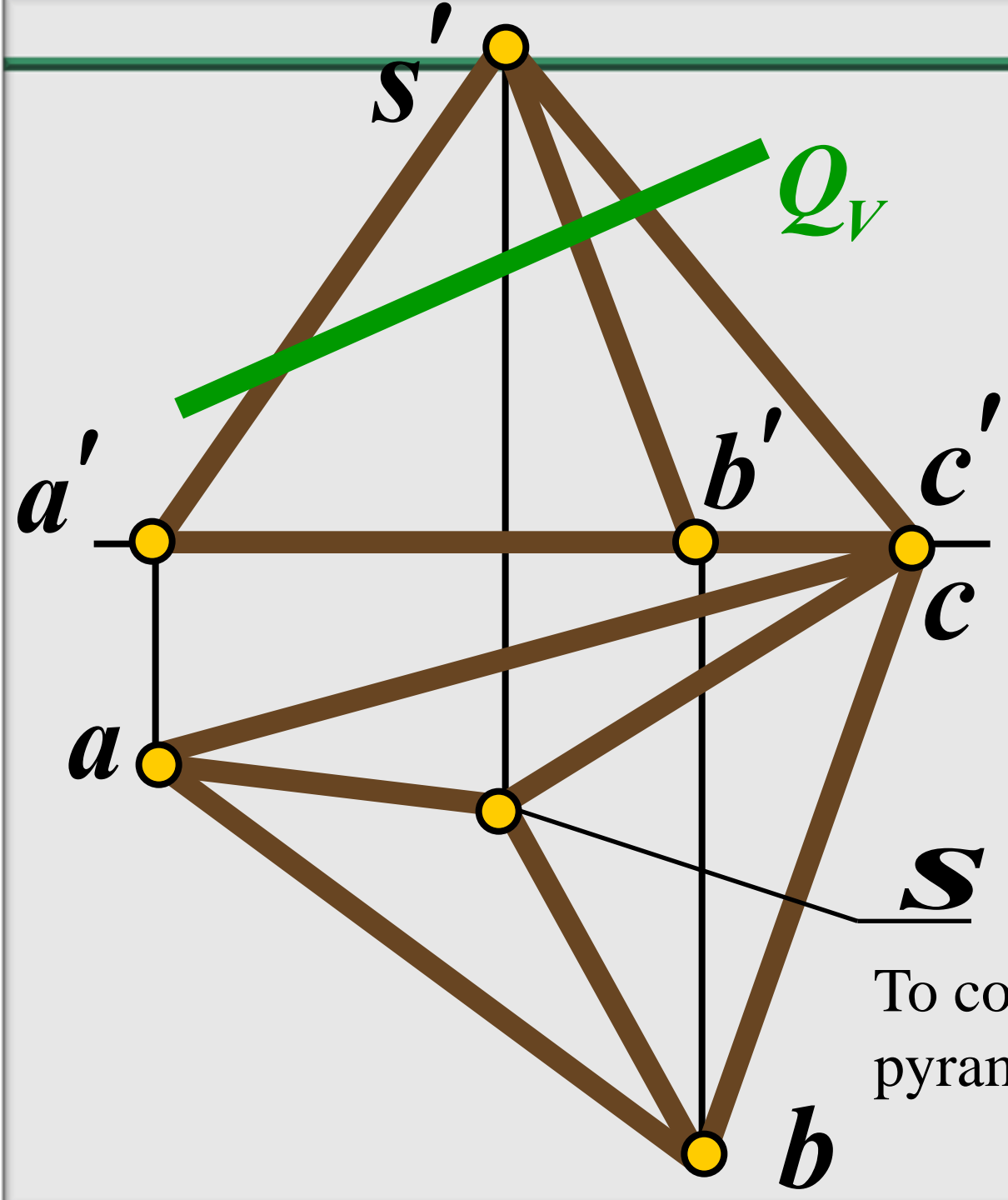
Q





A polygon obtained by cutting may be determined in two ways:

1. Its vertices may be found in the points of intersection of straight lines (the edges) with a cutting plane;
2. Its sides may be distinguished as the lines of intersection of polyhedron planes (the faces) with a cutting plane.



Ω - Pyramid
 $SABC$

$$Q \perp V$$

$$\Omega \cap Q = \Delta 123$$

S

To construct section of a pyramid a plane Q.



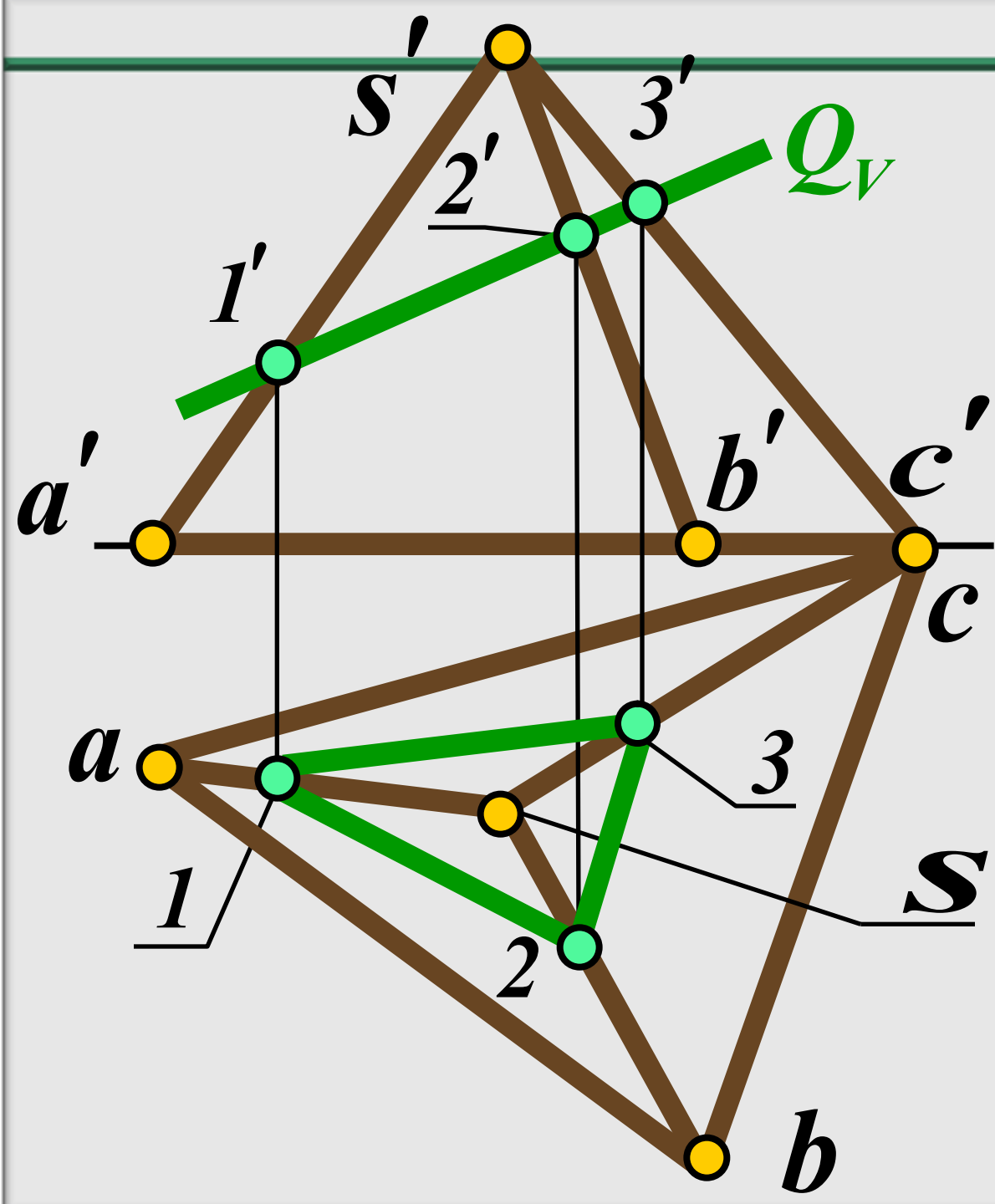
1. The cutting plane is a frontal projecting plane, therefore, all lines lying in this plane, including the section figure, coincide with the frontal trace QV of the plane Q .



2. Thus, the intersection of the frontal projections of the pyramid edges with the trace QV yields the frontal projection of the section figure $1'-2'-3'$.



3. Find the horizontal projections of the points 1 , 2 , 3 by means of the connection lines on the horizontal projections of the corresponding edges.



Ω - Pyramid
 $SABC; Q \perp V$
 $\Omega \cap Q = \Delta 123$



Conical and Cylindrical Surfaces



Conical Surface

The conical surface is produced by the motion of a **linear generating** line along a **curved directrix**.

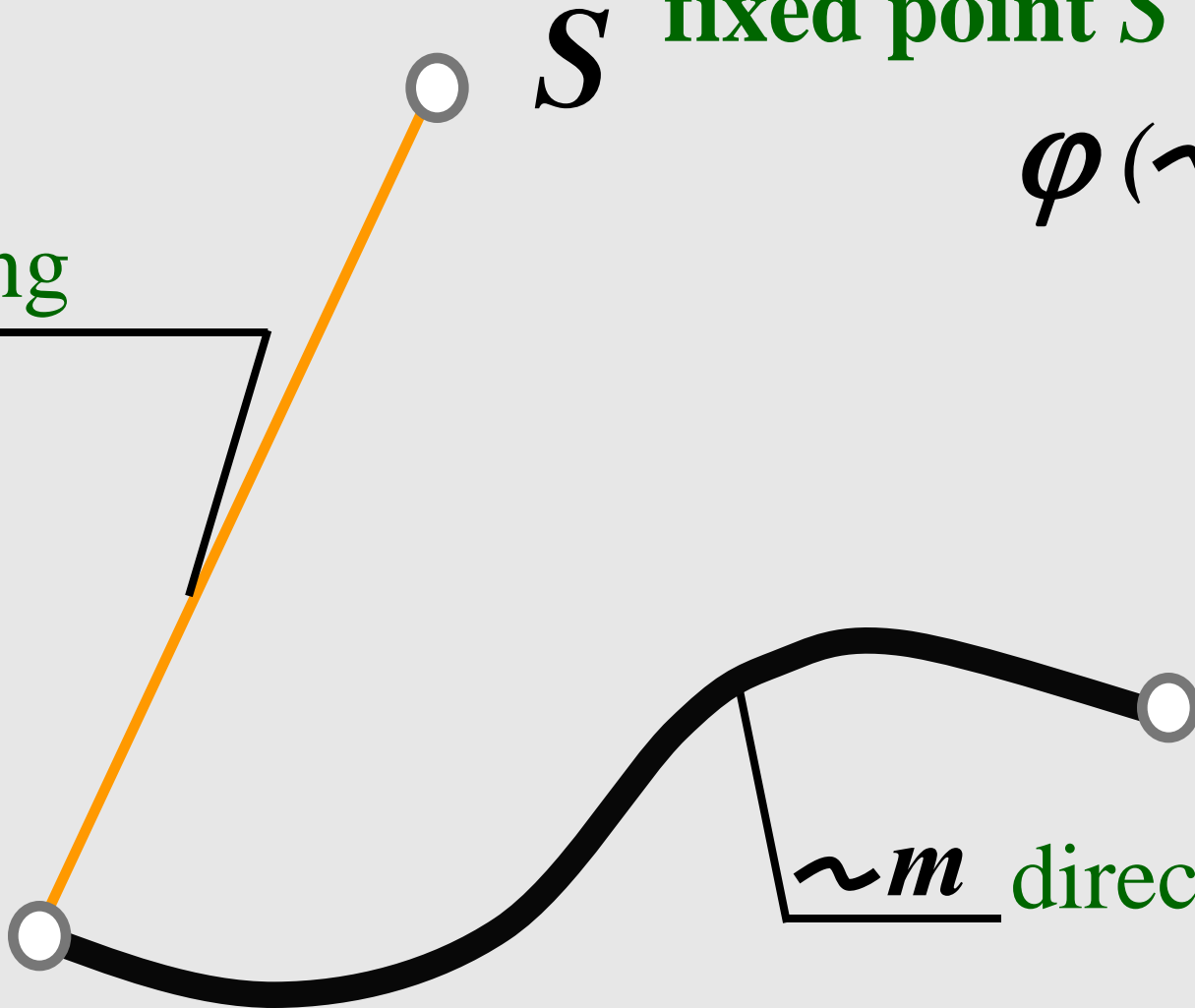
At that, the generatrix passes some fixed point S , referred to as a **vertex**.



Determinant surface: Directrix a certain fixed point S

$$\varphi(\sim m, S)$$

generating



$\sim m$ directrix

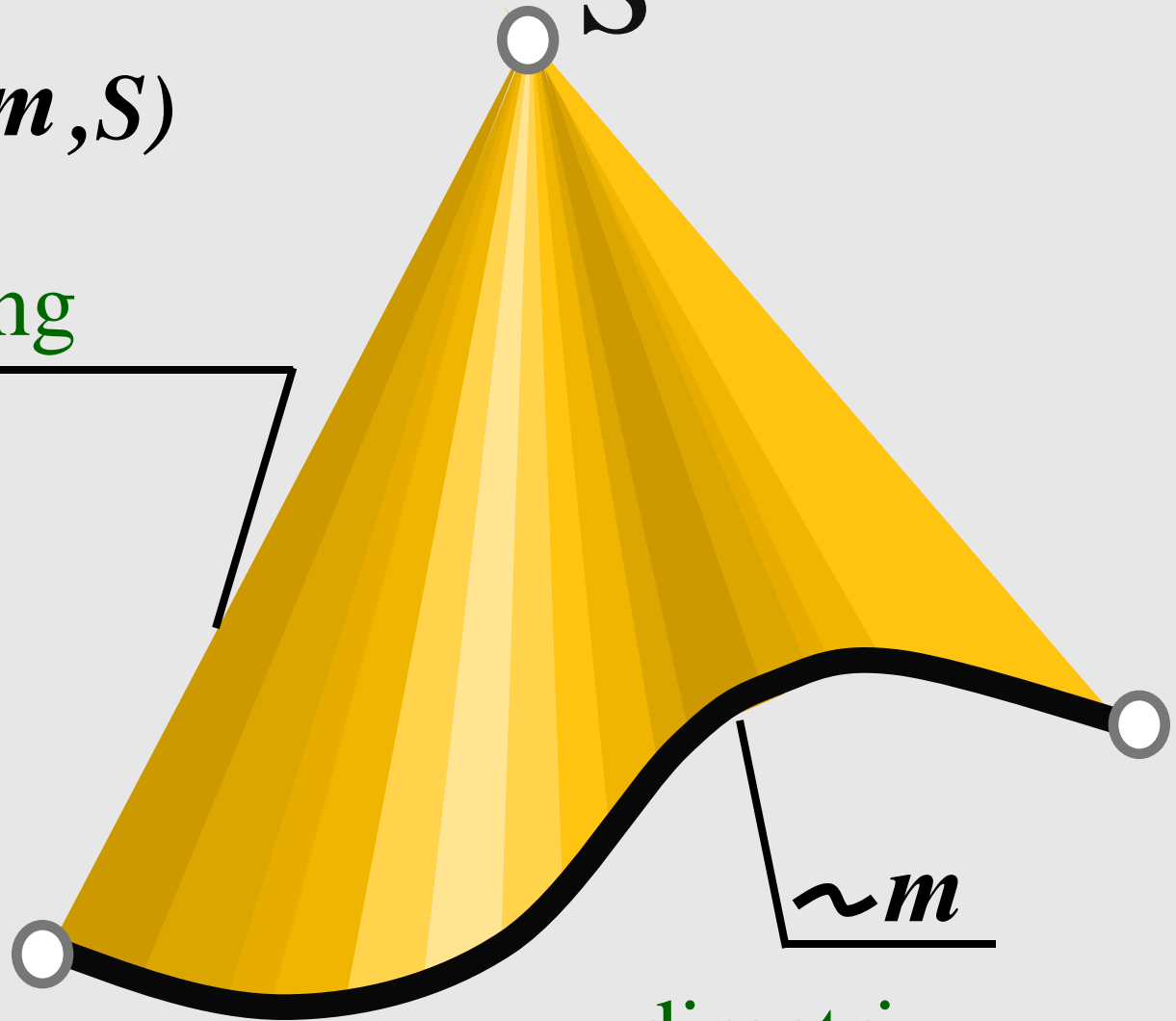


Conical

S

$$\varphi(\sim m, S)$$

generating



$\sim m$

directrix



The cylindrical surface

The cylindrical surface is produced by parallel to a given straight line l motion of a linear generating line along a curved directrix

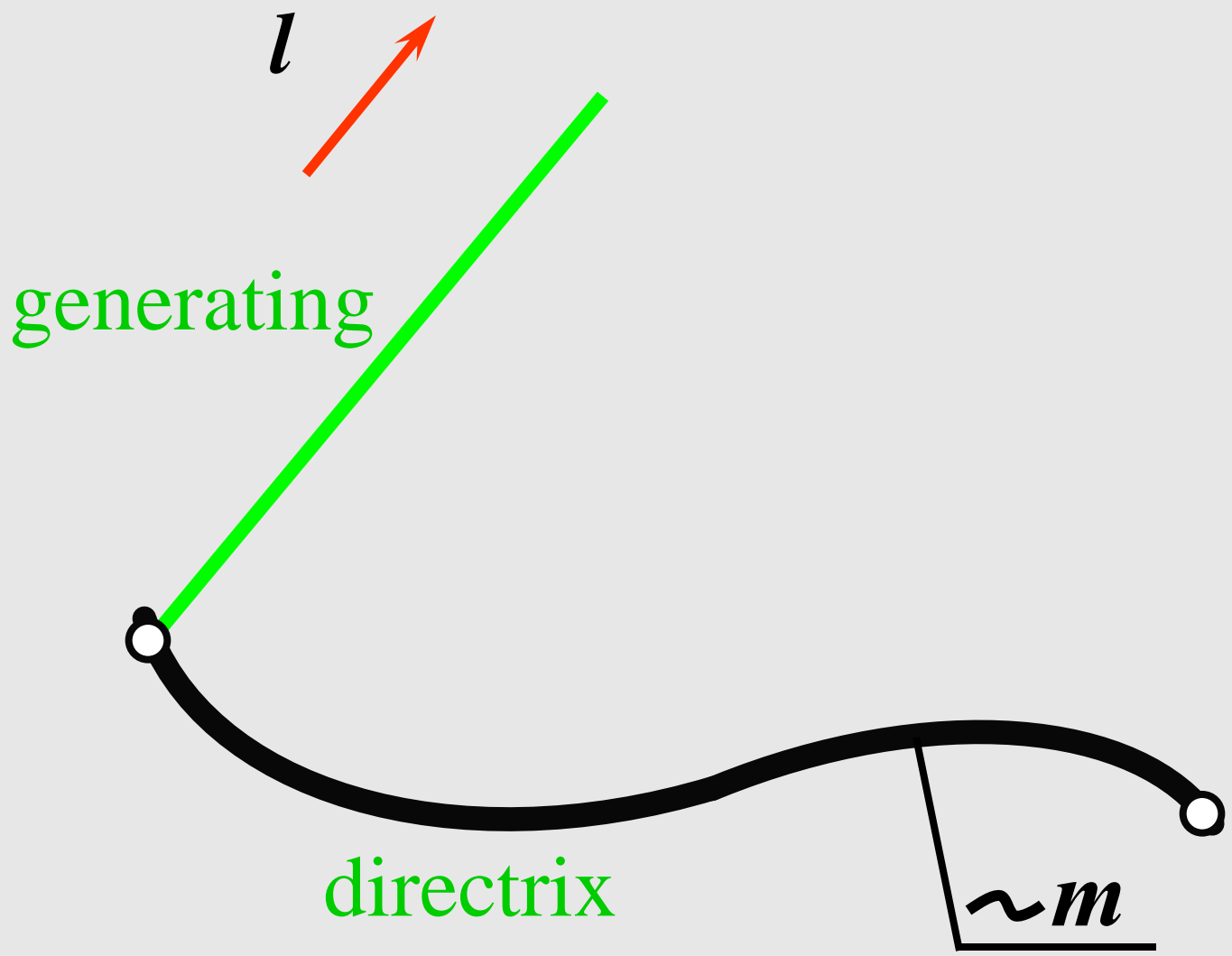


A cylindrical surface is considered to be distinguished if a directrix and a generatrix.



Determinant surface:

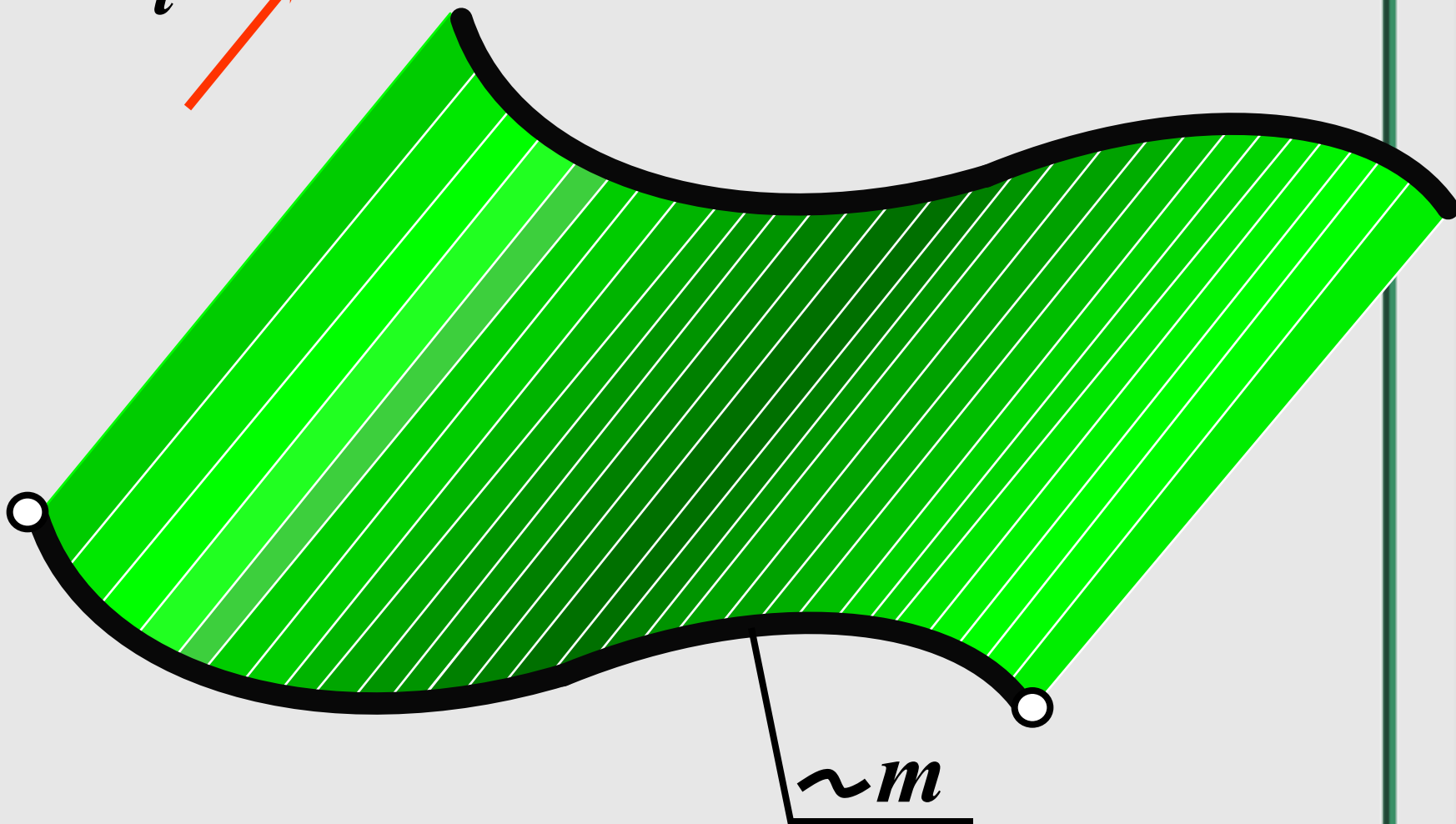
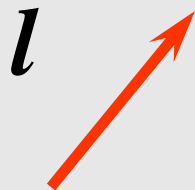
$$\varphi (\sim m, l)$$





$\varphi (\sim m, l)$

cylindrical





Rotation Surfaces

Rotation surface is a surface described by a curve (or a straight line), rotating on its axis

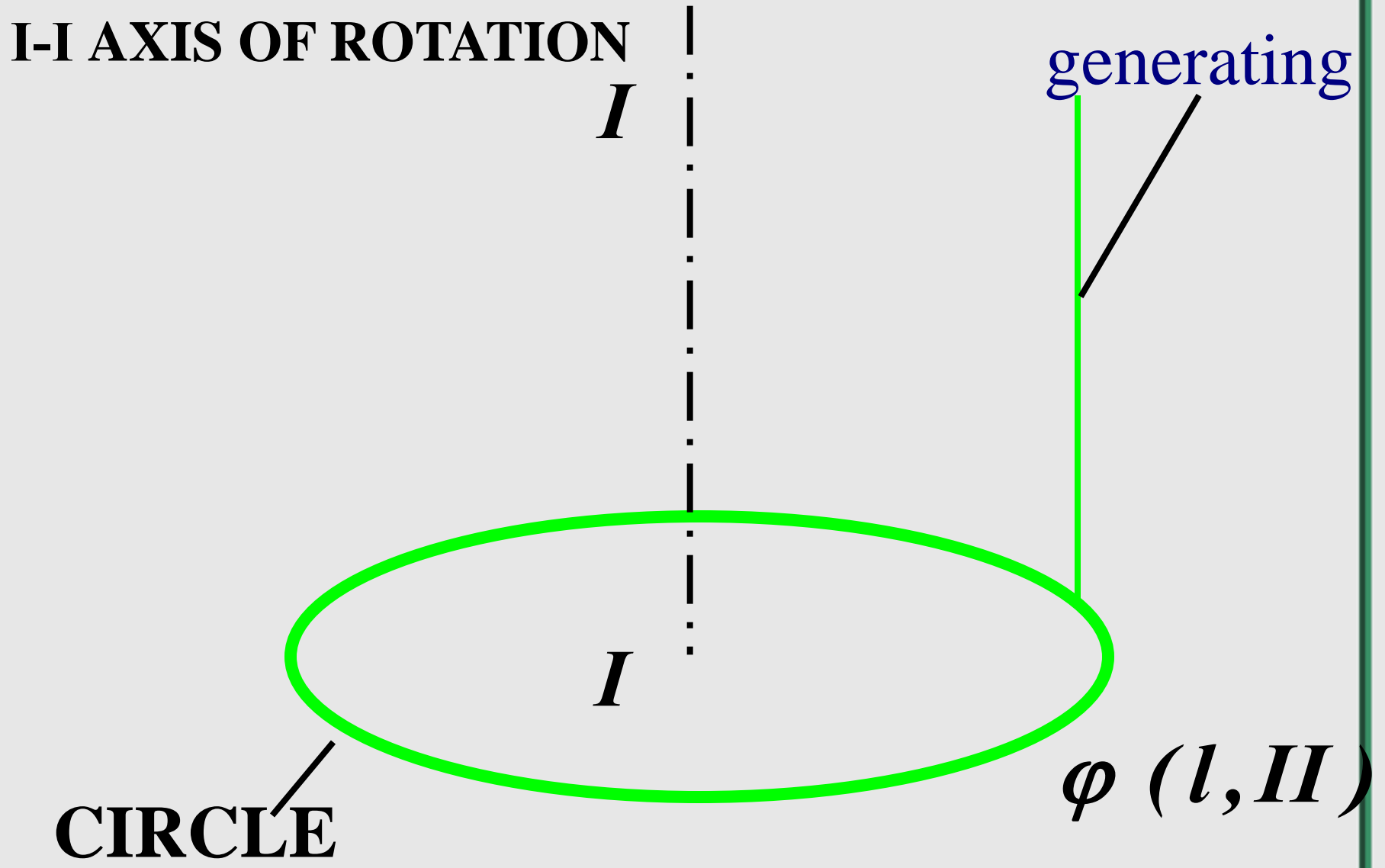


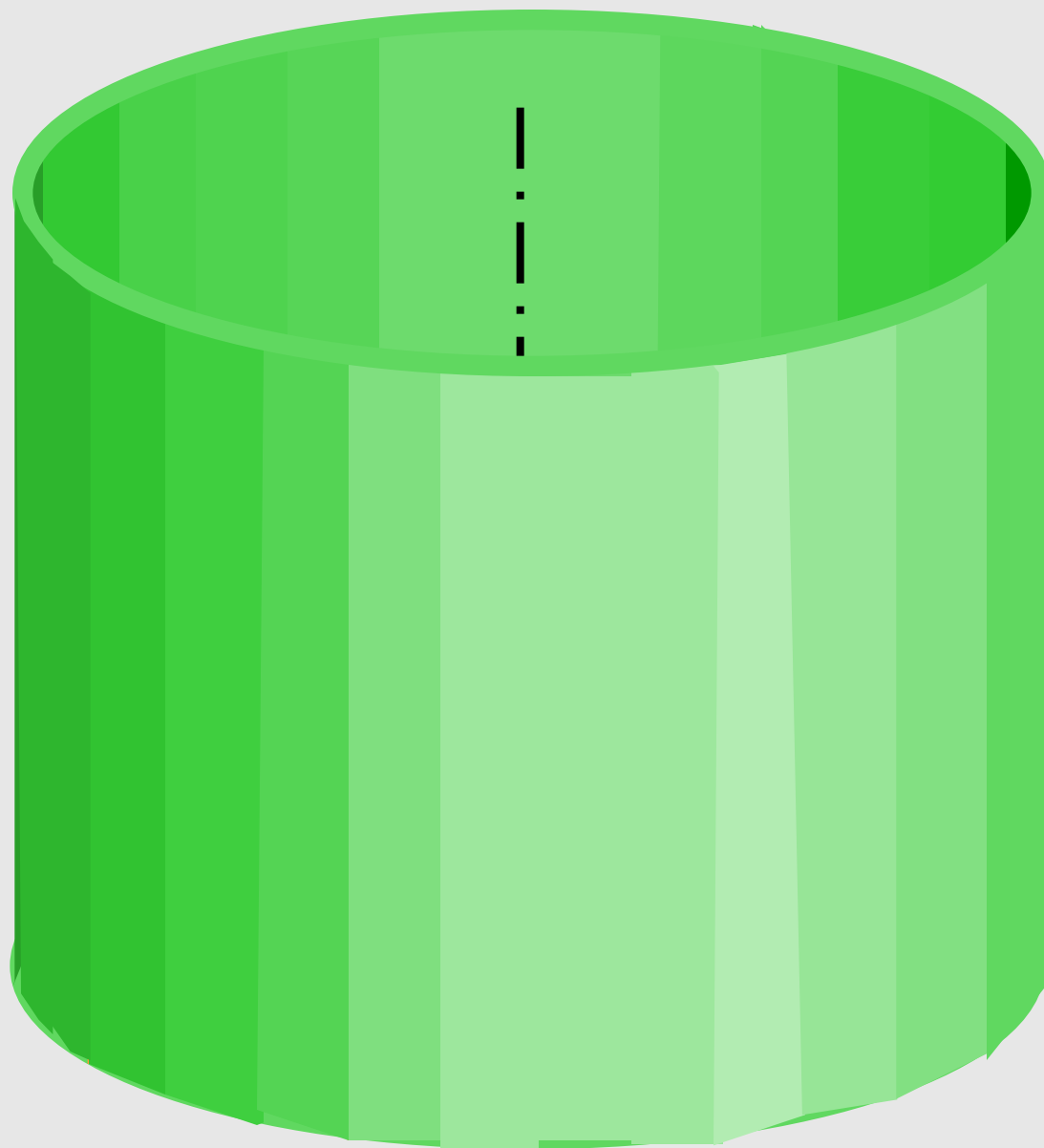
Rotation Surfaces

Cylinder of rotation - this is a surface produced by rotation of the line L round the axis I parallel to it



Cylinder of rotation





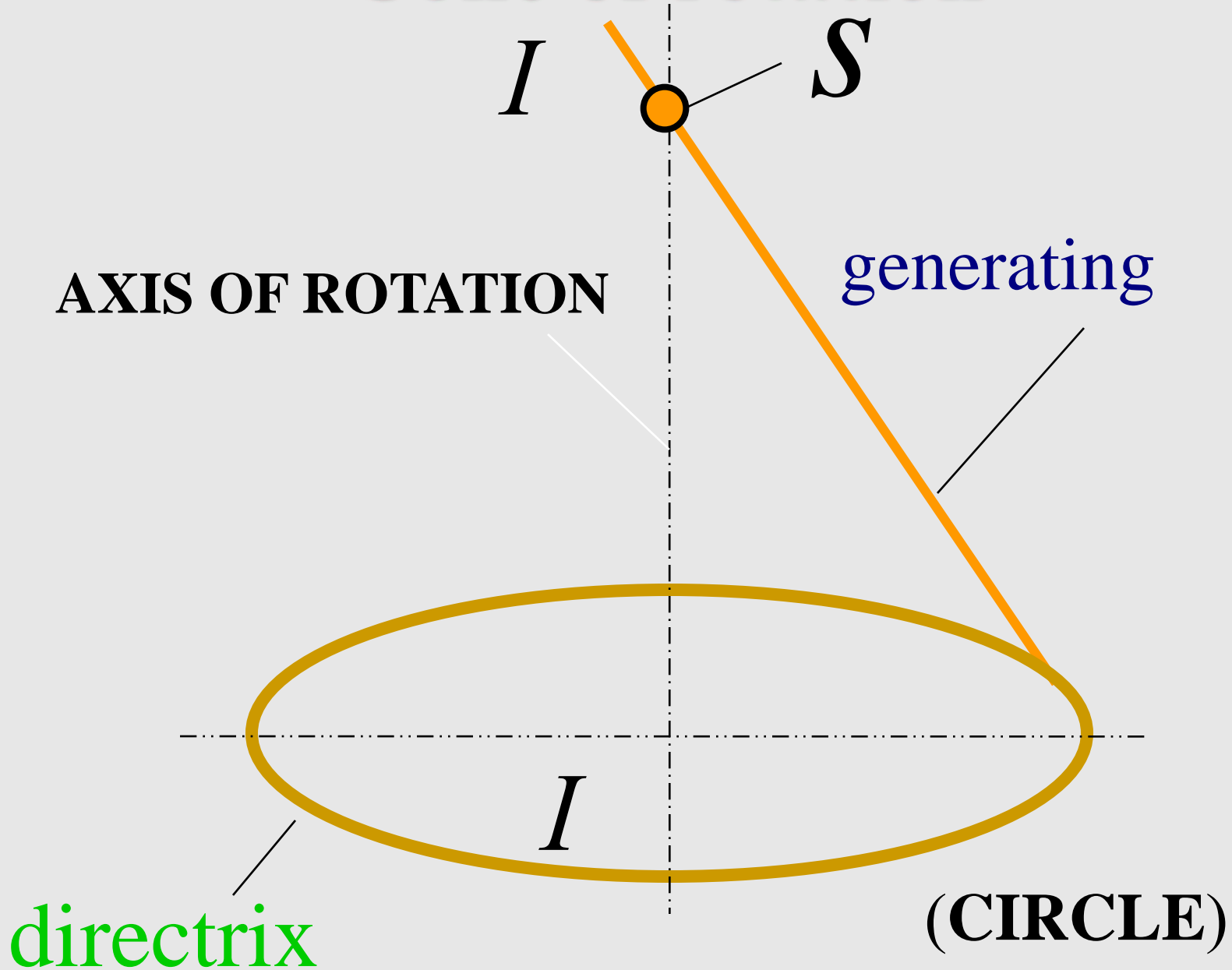


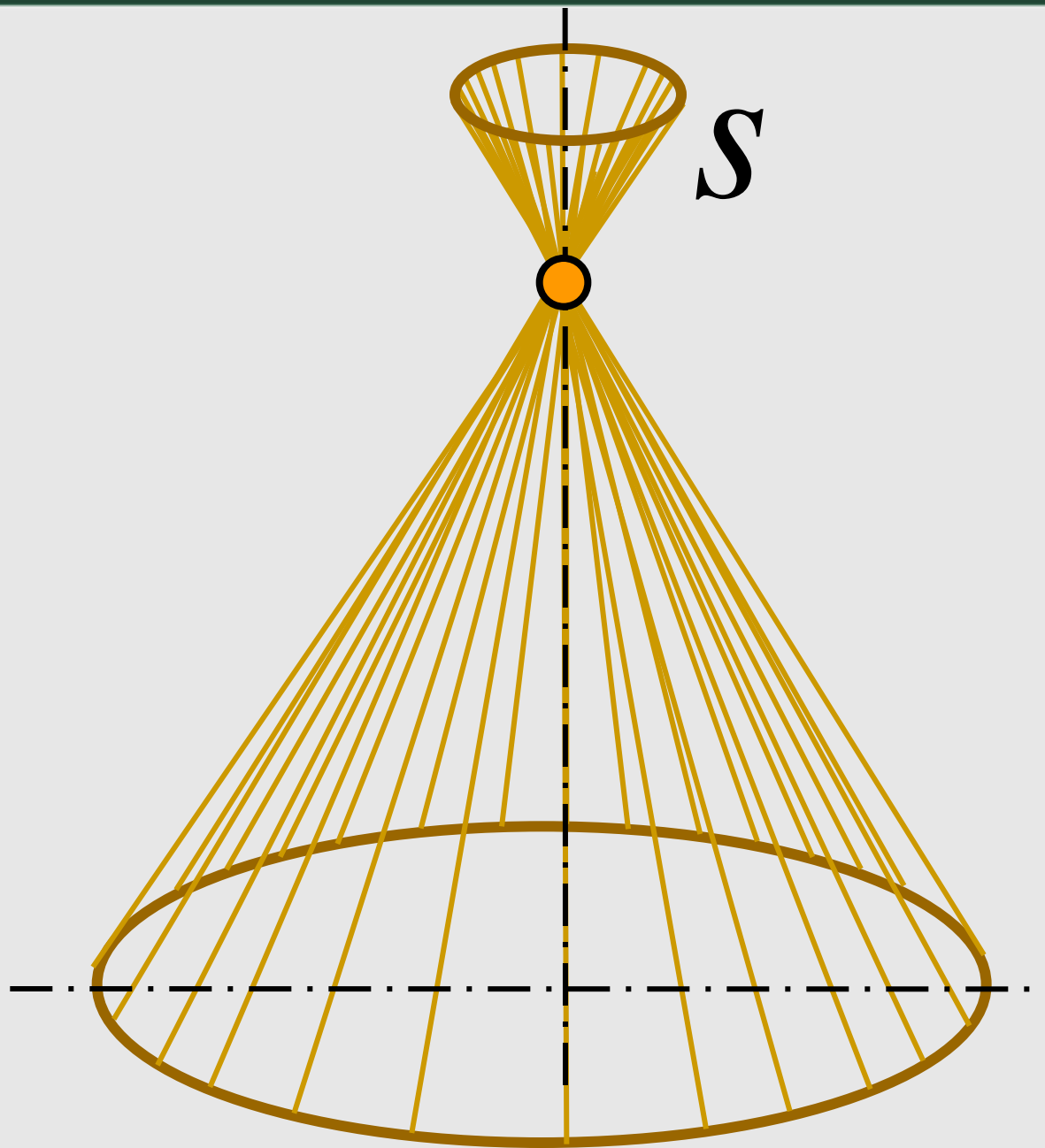
Rotation Surfaces

Cone of rotation - this is a surface produced by rotation of the line L round the axis I intersecting it



Cone of rotation







Rotation Surfaces

Sphere - this is a surface produced by rotation of a circle round its diameter



Sphere

generating
(**CIRCLE**)

