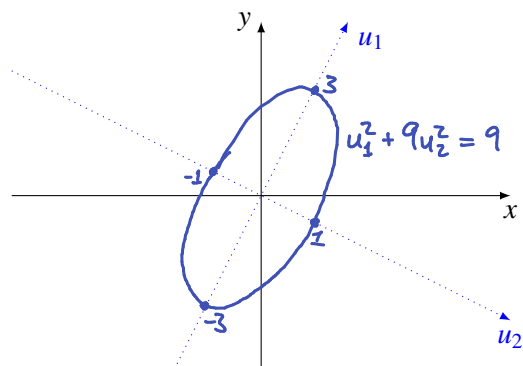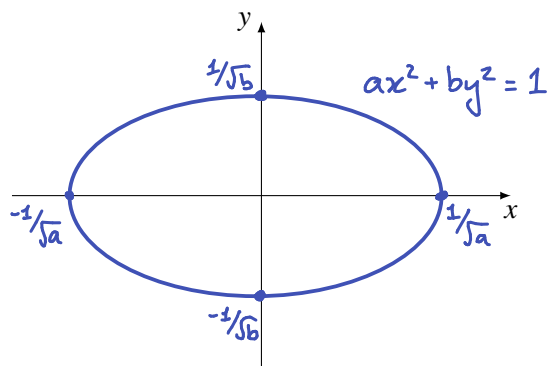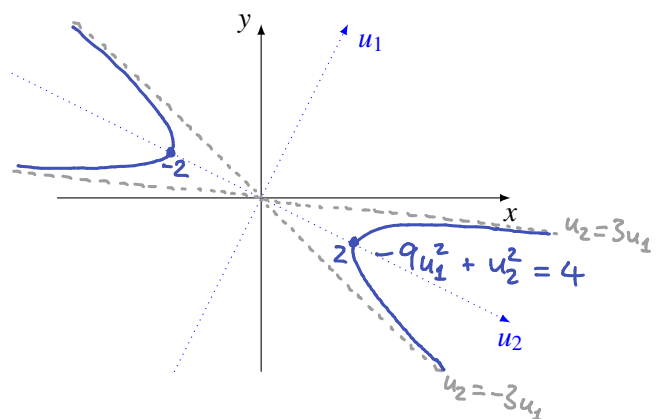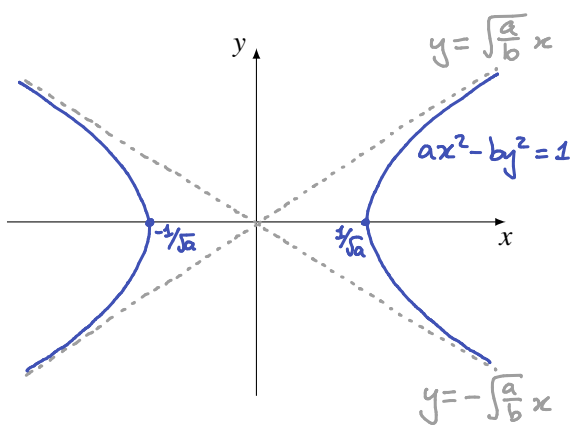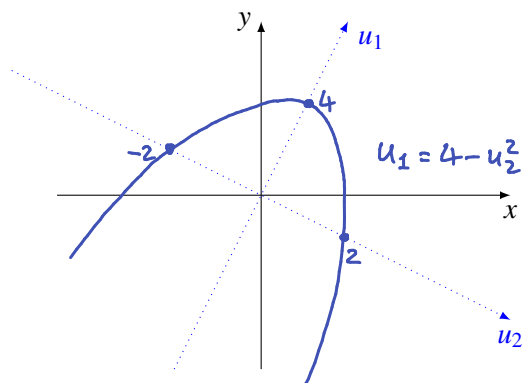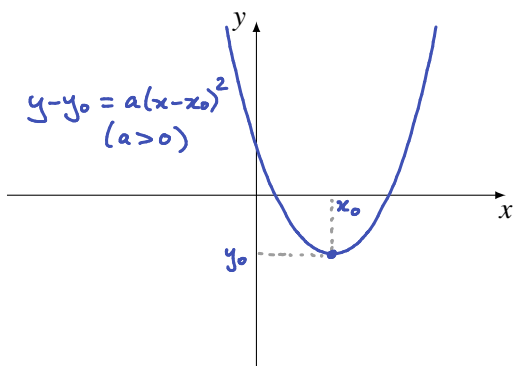# Quadrics in $\mathbb{R}^2$ (conic sections)

Ellipse — typical form: $a(x - x_0)^2 + b(y - y_0)^2 = 1$, with $a, b > 0$

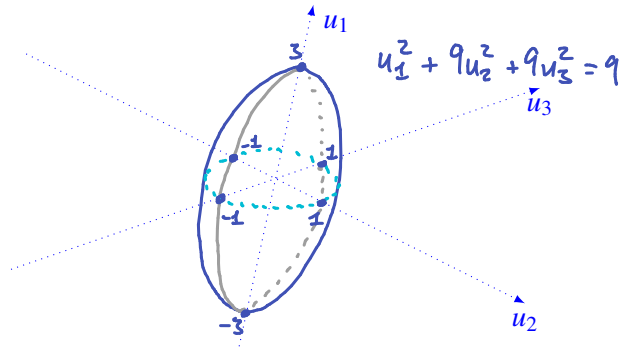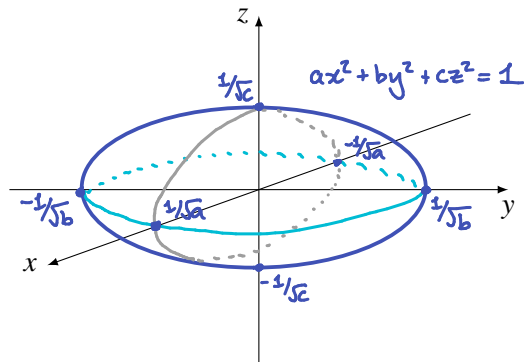**Hyperbola** — typical form: $a(x - x_0)^2 - b(y - y_0)^2 = 1$, with $a, b > 0$

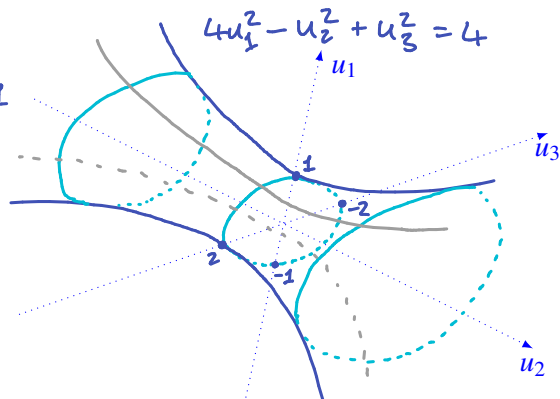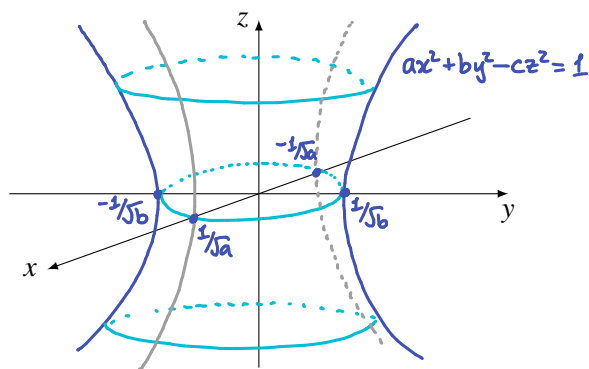**Parabola** — typical form: $y - y_0 = a(x - x_0)^2$, with $a \neq 0$

2

Quadrics in $\mathbb{R}^3$ (quadric surfaces)

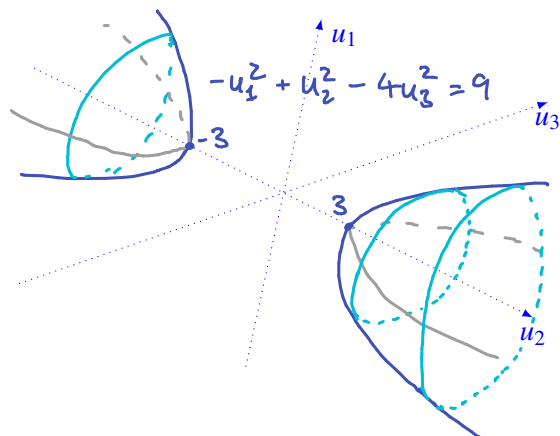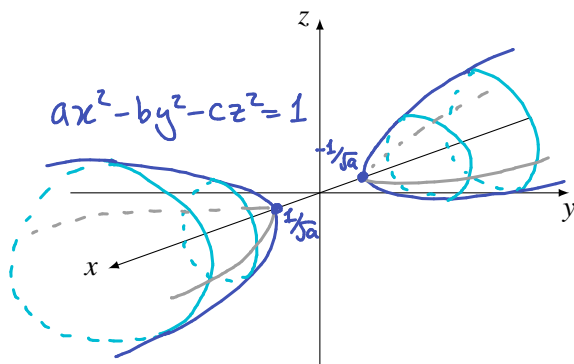**Ellipsoid** — typical form: $a(x-x_0)^2 + b(y-y_0)^2 + c(z-z_0)^2 = 1$, with $a, b, c > 0$

$$ax^2 + by^2 + cz^2 = 1$$

$$u_1^2 + 9u_2^2 + 9u_3^2 = 9$$

Hyperboloid of one sheet — typical form: $a(x-x_0)^2 + b(y-y_0)^2 - c(z-z_0)^2 = 1$, with $a, b, c > 0$

$$ax^2 + by^2 - cz^2 = 1$$
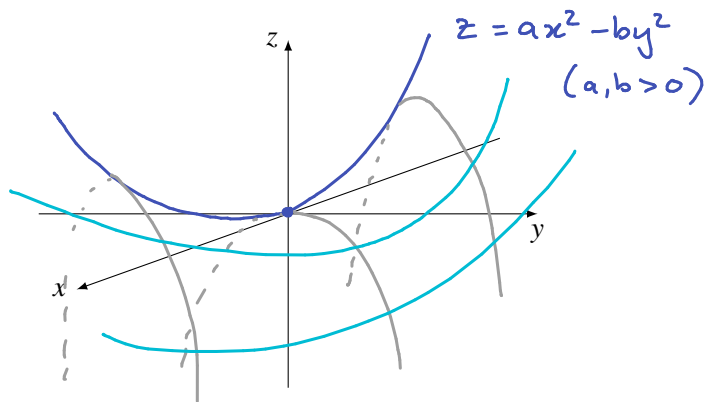
$$4u_1^2 - u_2^2 + u_3^2 = 4$$

Hyperboloid of two sheets — typical form: $a(x-x_0)^2 - b(y-y_0)^2 - c(z-z_0)^2 = 1$, with $a, b, c > 0$

$$ax^2 - by^2 - cz^2 = 1$$
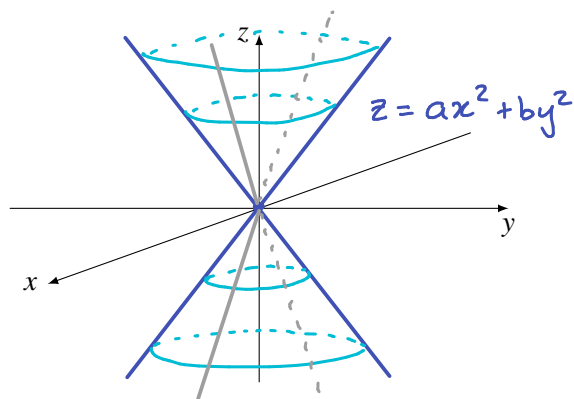
$$-u_1^2 + u_2^2 - 4u_3^2 = 9$$

3

Elliptic paraboloid — typical form: $z - z_0 = a(x - x_0)^2 + b(y - y_0)^2$, with $a, b > 0$ or $a, b < 0$
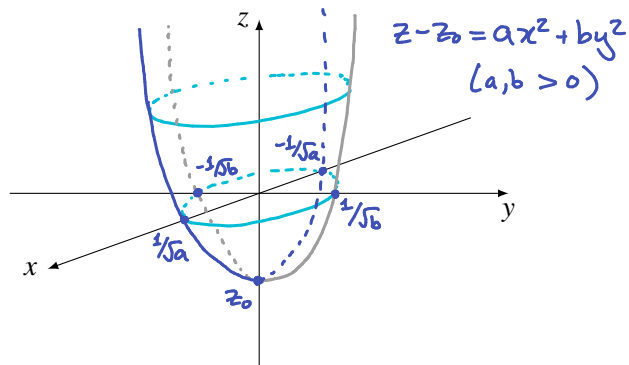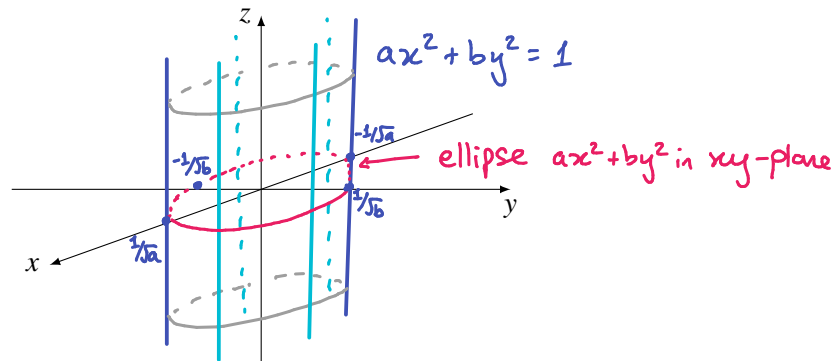

Hyperbolic paraboloid — typical form: $z - z_0 = a(x - x_0)^2 - b(y - y_0)^2$, with $a, b > 0$
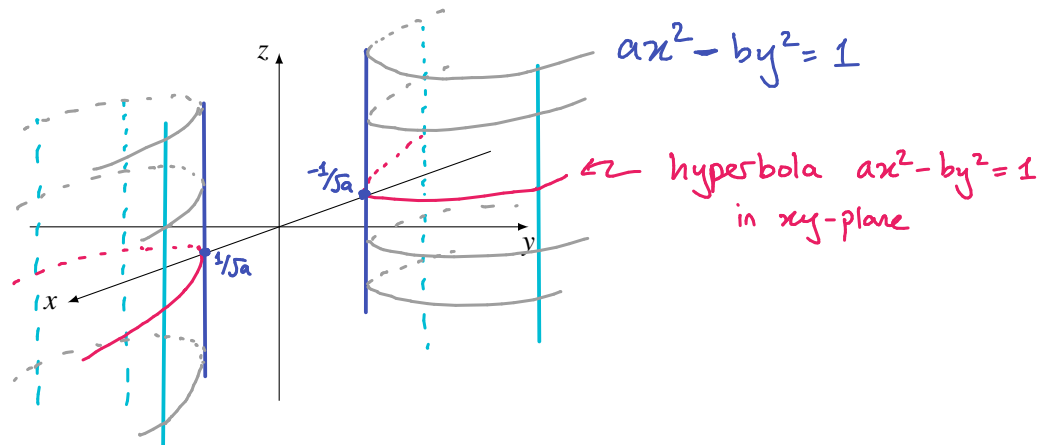

Double cone — typical form: $(z - z_0)^2 = a(x - x_0)^2 + b(y - y_0)^2$, with $a, b > 0$

4

Elliptic cylinder — typical form: $a(x-x_0)^2 + b(y-y_0)^2 = 1$, with $a, b > 0$

Hyperbolic cylinder — typical form: $a(x-x_0)^2 - b(y-y_0)^2 = 1$, with $a, b > 0$

Parabolic cylinder — typical form: $y - y_0 = a(x-x_0)^2$, with $a \neq 0$

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