Vectors

$\mathbf{u} = \langle u_x, u_y, u_z \rangle, \mathbf{w} = \langle w_x, w_y, w_z \rangle$

$\|\mathbf{u}\| = \sqrt{(u_x)^2 + (u_y)^2 + (u_z)^2}$

$\mathbf{u} \cdot \mathbf{w} = (u_x w_x) + (u_y w_y) + (u_z w_z) = \|\mathbf{u}\|\|\mathbf{w}\| \cos\theta$

$\mathbf{u} \times \mathbf{w} = \langle (u_y w_z - u_z w_y), (-[u_x w_z - u_z w_x]), (u_x w_y - u_y w_x) \rangle$

$\|\mathbf{u} \times \mathbf{w}\| = \|\mathbf{u}\|\|\mathbf{w}\| \sin\theta$

$\text{proj}_{\mathbf{w}}\mathbf{u} = \dfrac{\mathbf{u} \cdot \mathbf{w}}{\|\mathbf{u}\|\|\mathbf{u}\|}\mathbf{w}$

Surfaces

$(ax + by^2 = c) \Rightarrow$ parabola

$(ax^2 + by^2 = c) \Rightarrow$ circle/ellipse

$(ax^2 - by^2 = k^2 + c) \Rightarrow$ hyperbola (one-sheet)

$(ax^2 - by^2 = k^2 - c) \Rightarrow$ hyperbola (two-sheets)

Vector value functions

$\mathbf{r}(t) = \langle x(t), y(t), z(t) \rangle$

$\mathbf{v}(t) = \mathbf{r}'(t) = \langle x'(t), y'(t), z'(t) \rangle$

$\mathbf{a}(t) = \mathbf{v}'(t) = \langle x''(t), y''(t), z''(t) \rangle$

$L = \displaystyle\int_a^b \|\mathbf{v}(t)\| dt$

$\mathbf{T}(t) = \dfrac{1}{\|\mathbf{v}\|}\mathbf{v}$

$\mathbf{N}(t) = \dfrac{1}{\|\mathbf{T}'(t)\|}\mathbf{T}'(t)$

$k = \|\mathbf{T}'(t)\| \dfrac{1}{\|\mathbf{v}\|}$

$\mathbf{a}(t) = a_{\mathbf{T}}\mathbf{T} + a_{\mathbf{N}}\mathbf{N}$

linear component: $a_{\mathbf{T}} = \dfrac{d^2 s}{dt^2} = \dfrac{\mathbf{v} \cdot \mathbf{a}}{\|\mathbf{v}\|}$

angular component: $a_{\mathbf{N}} = \left(\dfrac{ds}{dt}\right)^2 k = \dfrac{\|\mathbf{v} \times \mathbf{a}\|}{\|\mathbf{v}\|}$