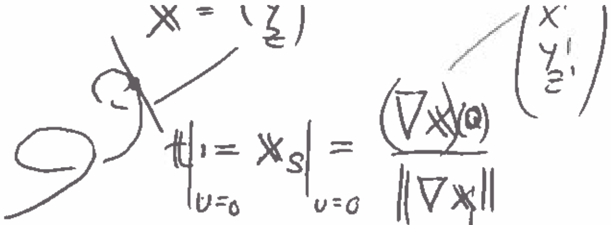
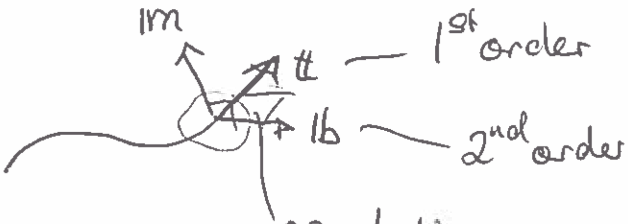


$$\mathbb{t} \Big|_{u=0} := \mathbb{x}_s \Big|_{u=0} = \frac{(\nabla \mathbb{x})(0)}{\|\nabla \mathbb{x}\|}\Big|_{u=0}$$

NOTE: m and b should be exchanged!



planes

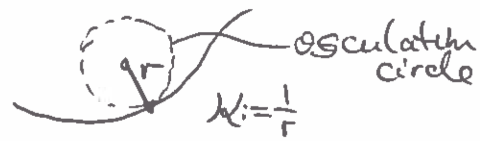
"moving out" of the osculating plane

τ "torsion"

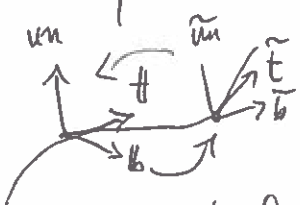
"bend" inside the o.p.

κ "curvature"

2d: $\mathbb{R} \to \mathbb{R}^2$ "planar"



"pull back"



"push forward"

for planar curves the curvature equals the inverse radius of the osculating circle

Ex

$\begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix} = c_3$

$\begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix} = c_2$

$c_0 = \begin{pmatrix} -1 \\ -1 \\ -1 \end{pmatrix}$ $\begin{pmatrix} 1 \\ -1 \\ -1 \end{pmatrix} = c_1$

m normal of osculating plane

$$\underbrace{(c_1 - c_0) \times (c_2 - c_1)}_{\text{normalize}} \sim \underbrace{\begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix} \times \begin{pmatrix} 0 \\ 2 \\ 0 \end{pmatrix}}_{\text{norm}} = \begin{pmatrix} 0 \\ 0 \\ 4 \end{pmatrix} \Big/ \text{norm} = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$$

$$x_{ss} \cdot x_s = \kappa = \frac{\|\nabla^2 \mathbb{x} \wedge \nabla \mathbb{x}\|}{\|\nabla \mathbb{x}\|^3} \sim$$

assume: $\mathbb{x}$ is "regular" $:\Leftrightarrow \nabla \mathbb{x} \neq \begin{pmatrix} 0 \\ 0 \end{pmatrix}$ $\Leftrightarrow \|\nabla \mathbb{x}\| \neq 0$

p 183 of book has

$$\tau = [\mathbb{x}_{sss}, x_{ss}, x_s] / \kappa^2$$

/ det