

## LECTURE 26

## Definition

For each  $t$  in the domain of  $r$ , a vector valued function, the unit tangent vector to  $C$  @  $t$  is  $T(t)$ :

$$T(t) = \frac{r'(t)}{\|r'(t)\|}$$

we also know that  $\|T(t)\| = 1$ .



## Definition

if  $r$  is a smooth parameterization of  $C$ ,  $T$  is the unit tangent vector, and  $T'(t) \neq 0$ , the unit normal vector to  $C$  @  $t$  noted  $N(t)$  is

$$N(t) = \frac{T'(t)}{\|T'(t)\|}$$

this always points in the inwards direction of concavity

## Example

Find unit tangent and unit normal vectors to the curve  $r(t) = \langle 1+t, t^2 \rangle$  @  $-1, 0, 1$

tangent:  $r'(t) = \langle 1, 2t \rangle$

$$\|r'(t)\| = \sqrt{1^2 + 4t^2} = \sqrt{4t^2 + 1} \quad T(t) = \left\langle \frac{1}{\sqrt{4t^2 + 1}}, \frac{2t}{\sqrt{4t^2 + 1}} \right\rangle$$

normal:  $r''(t) = \langle 0, 2 \rangle$

$$\|r''(t)\| = 2$$

$$N(t) = \langle 0, 1 \rangle$$

# Multivariable Calculus Notes

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