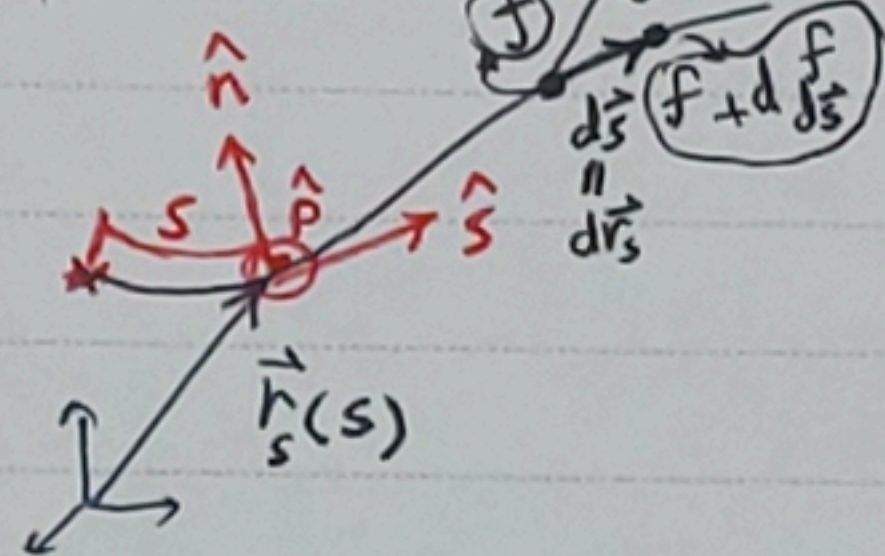
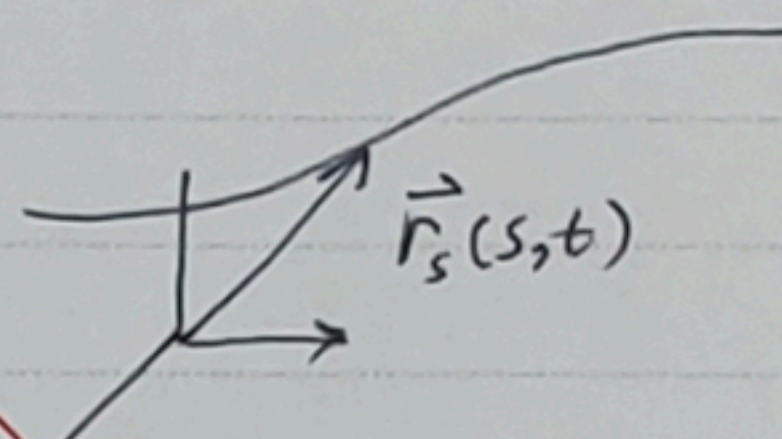


یادآوری (ریاضی ۲): دستگاه مختصات خط جریا - ناسی بارامتری مبدئی

جریان دایمی



جریان غیردایمی



$$d\vec{r}_s = \hat{s} ds \equiv d\vec{s}$$

$$ds \rightarrow \partial s$$

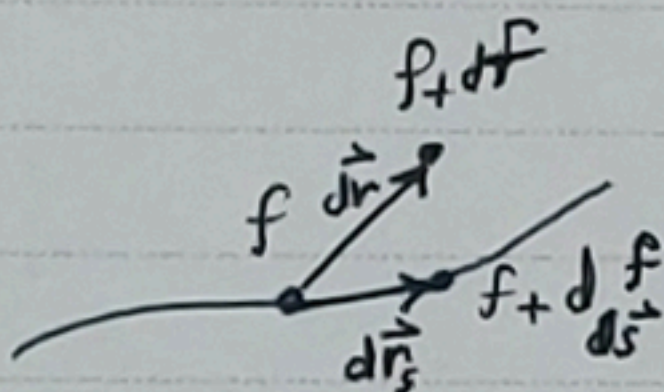
$$\hat{s} = \frac{d\vec{r}_s}{ds}$$

$$\hat{n} = \frac{d^2\vec{r}_s/ds^2}{|d^2\vec{r}_s/ds^2|} = \frac{R}{|d^2\vec{r}_s/ds^2|} \underbrace{(d^2\vec{r}_s/ds^2)}_{\frac{d\hat{s}}{ds}}$$

$$\hat{p} = \hat{s} \times \hat{n}$$

$$\hat{s} = \frac{\partial \vec{r}_s}{\partial s}$$

$$\hat{n} = \frac{\partial^2 \vec{r}_s / \partial s^2}{|\partial^2 \vec{r}_s / \partial s^2|}, \quad R = |\partial^2 \vec{r}_s / \partial s^2|^{-1}$$



$$(f+df) - f = df = d\vec{r}_s \cdot \vec{\nabla} f$$

$$(f+d_s f) - f = d_s f = d\vec{s} \cdot \vec{\nabla} f = ds \hat{s} \cdot \vec{\nabla} f$$

$$\rightarrow \frac{d_s f}{ds} = \hat{s} \cdot \vec{\nabla} f$$

$$\frac{\partial f}{\partial s} = \hat{s} \cdot \vec{\nabla} f$$

$$\vec{V} = V \hat{s}$$

$$\vec{a} = \frac{\partial \vec{V}}{\partial t} + \underbrace{\vec{V} \cdot \vec{\nabla} \vec{V}}_{\substack{\text{local} \\ \frac{\partial \vec{V}}{\partial s}}} = \frac{\partial \vec{V}}{\partial t} + V \underbrace{\hat{s} \cdot \vec{\nabla} \vec{V}}_{\text{convective}} \quad (12.8)$$

$$\text{Convective: } V \frac{\partial \vec{V}}{\partial s} = V \frac{\partial}{\partial s} (V \hat{s}) = V \frac{\partial V}{\partial s} \hat{s} + V^2 \frac{\partial \hat{s}}{\partial s} = V \frac{\partial V}{\partial s} \hat{s} + \frac{V^2}{R} \hat{n} \quad (12.9)$$

$$\text{local: } \frac{\partial \vec{V}}{\partial t} = \frac{\partial}{\partial t} (V \hat{s}) = \frac{\partial V}{\partial t} \hat{s} + V \frac{\partial \hat{s}}{\partial t} = \frac{\partial V}{\partial t} \hat{s} + V (\vec{\omega}' \times \hat{s}) \quad (12.10)$$