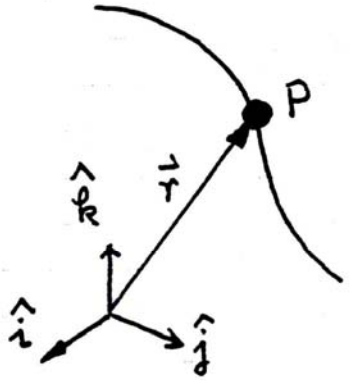
PARTICLE KINEMATICS

Cartesian Coordinates



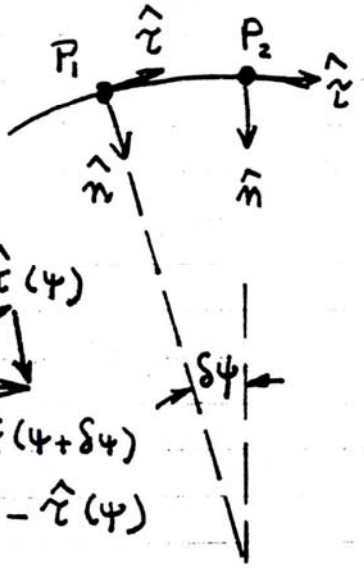
$$\vec{r} = x\,\hat{i} + y\,\hat{j} + z\,\hat{k}$$

$$\vec{v} = \dot{x}\,\hat{i} + \dot{y}\,\hat{j} + \dot{z}\,\hat{k} = \frac{d\vec{r}}{dt}$$

$$\vec{a} = \ddot{x}\,\hat{i} + \ddot{y}\,\hat{j} + \ddot{z}\,\hat{k} = \frac{d^2\vec{r}}{dt^2}$$

Natural Coordinates

$$\frac{d\hat{\tau}}{d\psi} = \hat{n}$$



$$\vec{v} = v\,\hat{\tau}$$

$$\vec{a} = \frac{dv}{dt}\hat{\tau} + v\frac{d\hat{\tau}}{d\psi}\cdot\frac{d\psi}{ds}\cdot\frac{ds}{dt}$$

$$= \frac{dv}{dt}\hat{\tau} + \frac{v^2}{\rho}\hat{n}$$

$$\delta\hat{\tau} = \hat{\tau}(\psi+\delta\psi) - \hat{\tau}(\psi)$$

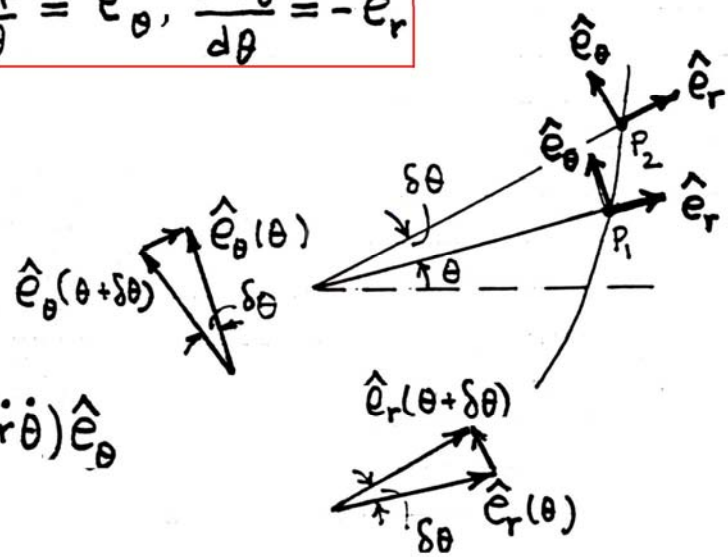
Plane Polar Coordinates

$$\frac{d\hat{e}_r}{d\theta} = \hat{e}_\theta, \quad \frac{d\hat{e}_\theta}{d\theta} = -\hat{e}_r$$

$$\vec{r} = r\,\hat{e}_r$$

$$\vec{v} = \dot{r}\,\hat{e}_r + r\frac{d\hat{e}_r}{d\theta}\cdot\dot{\theta}$$

$$= \dot{r}\,\hat{e}_r + r\dot{\theta}\,\hat{e}_\theta$$



$$\vec{a} = (\ddot{r} - r\dot{\theta}^2)\hat{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\hat{e}_\theta$$