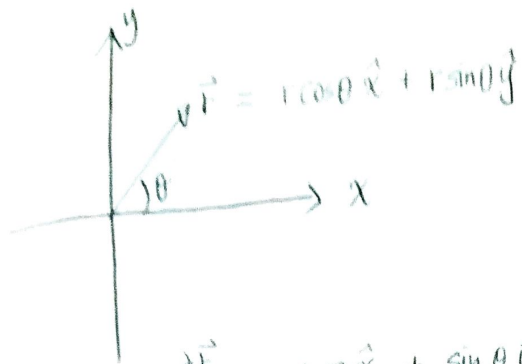


In polar coordinate,



$$\frac{\partial \vec{r}}{\partial r} = \cos \theta \hat{x} + \sin \theta \hat{y} = h_r \hat{r}, \quad h_r = \left| \frac{\partial \vec{r}}{\partial r} \right| = 1,$$

$$\rightarrow \hat{r} = \cos \theta \hat{x} + \sin \theta \hat{y}$$

$$\frac{\partial \vec{r}}{\partial \theta} = -r \sin \theta \hat{x} + r \cos \theta \hat{y} = h_\theta \hat{\theta}, \quad h_\theta = \left| \frac{\partial \vec{r}}{\partial \theta} \right| = r,$$

$$\rightarrow \hat{\theta} = -\sin \theta \hat{x} + \cos \theta \hat{y}$$

找各种 basis 的步驟:

1. 從原點畫一根向量 \vec{s}

2. \vec{s} 對新的 basis 參數偏微 ($ex, r, \theta \dots$)

3. 找到偏微後各向量的長度 ($h_r, h_\theta \dots$)

4. scale 到長度 = 1, 得到新的 basis.

Orthogonal matrix $A^{-1} = A^T$ (real elements)

Hermitian matrix

$$A = A^\dagger = (A^T)^*$$

Unitary matrix

$$A^{-1} = A^\dagger = (A^T)^*$$

\Rightarrow complex elements