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Exercises for EFT 1, Sheet 1
Exercises for Math. Foundations of EFT, Sheet 1

Exercise 1. Given are the vectors

$$\underline{\mathbf{A}} = \underline{\mathbf{e}}_x + 2\underline{\mathbf{e}}_y + 3\underline{\mathbf{e}}_z \quad \text{and} \quad \underline{\mathbf{B}} = 2\underline{\mathbf{e}}_x - \underline{\mathbf{e}}_y + \underline{\mathbf{e}}_z.$$

(a) Determine $\underline{\mathbf{A}} - \underline{\mathbf{B}}$, $\underline{\mathbf{A}} + \underline{\mathbf{B}}$, $\hat{\underline{\mathbf{A}}}$, $\hat{\underline{\mathbf{B}}}$, $\underline{\mathbf{A}} \cdot \underline{\mathbf{B}}$, $\underline{\mathbf{A}} \times \underline{\mathbf{B}}$.

(b) Determine the angle between $\underline{\mathbf{A}}$ and $\underline{\mathbf{B}}$.

(c) Detemine the angle between $\underline{\mathbf{A}}$ and the x-Axis.

Exercise 2. Given are the vectors

$$\underline{\mathbf{A}} = \underline{\mathbf{e}}_x + 2\underline{\mathbf{e}}_y + \underline{\mathbf{e}}_z \quad \text{und} \quad \underline{\mathbf{B}} = -\underline{\mathbf{e}}_x + \alpha\underline{\mathbf{e}}_y - \underline{\mathbf{e}}_z.$$

Determine α in such a way that

(a) $\underline{\mathbf{A}} \cdot \underline{\mathbf{B}} = 0$,

(b) $\underline{\mathbf{A}} \times \underline{\mathbf{B}} = \underline{0}$,

(c) the angle between $\underline{\mathbf{A}}$ and $\underline{\mathbf{B}}$ is 45 degree.

Exercise 3. Let $\underline{\mathbf{R}} = x\underline{\mathbf{e}}_x + y\underline{\mathbf{e}}_y + z\underline{\mathbf{e}}_z$ be the position vector. Determine

(a) $R = |\underline{\mathbf{R}}|$ und $\hat{\underline{\mathbf{R}}}$,

(b) $\frac{\partial}{\partial x}\underline{\mathbf{R}}$, $\frac{\partial}{\partial y}\underline{\mathbf{R}}$, $\frac{\partial}{\partial z}\underline{\mathbf{R}}$,

(c) ∇R, $\nabla \cdot \underline{\mathbf{R}}$, $\nabla \times \underline{\mathbf{R}}$.

Exercise 4. Let $\underline{\mathbf{R}}' = x'\underline{\mathbf{e}}_x + y'\underline{\mathbf{e}}_y + z'\underline{\mathbf{e}}_z$ be an arbitrary vector and $\underline{\mathbf{R}}$ the position vector. Determine

(a) $|\underline{\mathbf{R}} - \underline{\mathbf{R}}'|$ and $\widehat{\underline{\mathbf{R}} - \underline{\mathbf{R}}'}$,

(b) $\frac{\partial}{\partial x}(\underline{\mathbf{R}} - \underline{\mathbf{R}}')$, $\frac{\partial}{\partial y}(\underline{\mathbf{R}} - \underline{\mathbf{R}}')$, $\frac{\partial}{\partial z}(\underline{\mathbf{R}} - \underline{\mathbf{R}}')$,

(c) $\nabla|\underline{\mathbf{R}} - \underline{\mathbf{R}}'|$, $\nabla\frac{1}{|\underline{\mathbf{R}} - \underline{\mathbf{R}}'|}$.