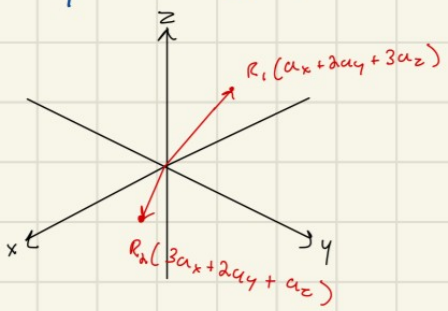
EE2FH4 - Electromagnetics 1 - MATLAB - Set 1

Exercise: Given the vectors $\vec{R}_1 = \vec{a}_x + 2\vec{a}_y + 3\vec{a}_z$, $\vec{R}_2 = 3\vec{a}_x + 2\vec{a}_y + \vec{a}_z$. Find:

a) the dot product $\vec{R}_1 \cdot \vec{R}_2$

b) the projection of $\vec{R}_1$ on $\vec{R}_2$

c) the angle between $\vec{R}_1$ and $\vec{R}_2$



a) dot product:

$$\vec{R}_1 \cdot \vec{R}_2 = (R_{1x} \cdot R_{2x}) + (R_{1y} \cdot R_{2y}) + (R_{1z} + R_{2z})$$
$$= (1 \cdot 3) + (2 \cdot 2) + (3 \cdot 1)$$
$$= 3 + 4 + 3$$

$$\therefore \boxed{\vec{R}_1 \cdot \vec{R}_2 = 10}$$

b) projection of $\vec{R}_1$ on $\vec{R}_2$:

$$\text{Proj}_{\vec{R}_2} \vec{R}_1 = \frac{\vec{R}_1 \cdot \vec{R}_2}{|\vec{R}_2|^2} \cdot \vec{R}_2$$
$$= \frac{10}{14} \cdot (3\vec{a}_x + 2\vec{a}_y + \vec{a}_z)$$

$\vec{R}_1 \cdot \vec{R}_2 = 10$ (from part a)

$|\vec{R}_2|^2 = \left|\sqrt{1^2 + 2^2 + 3^2}\right|^2$

$|\vec{R}_2|^2 = 14$

$$\therefore \boxed{\text{Proj}_{\vec{R}_2} \vec{R}_1 = 2.143\vec{a}_x + 1.429\vec{a}_y + 0.714\vec{a}_z}$$

(rounded to 3 decimal points - as done in lab manual example)

c) angle (θ) between $\vec{R}_1$ and $\vec{R}_2$:

$$\cos\theta = \frac{\vec{R}_1 \cdot \vec{R}_2}{|\vec{R}_1||\vec{R}_2|}$$

$$\theta = \cos^{-1}\left(\frac{10}{\sqrt{14} \cdot \sqrt{14}}\right)$$
$$= \cos^{-1}\left(\frac{10}{14}\right)$$

$\vec{R}_1 \cdot \vec{R}_2 = 10$ (from part a)

$|\vec{R}_1| = \sqrt{1^2 + 2^2 + 3^2}$
$= \sqrt{14}$

$|\vec{R}_2| = \sqrt{3^2 + 2^2 + 1^2}$
$= \sqrt{14}$

$$\boxed{\theta = 44.42^\circ}$$

(rounded to 2 decimal places as in lab manual example)