Let $\vec{v} = \begin{pmatrix} 2 \\ 1 \\ 0 \\ 3 \end{pmatrix} \in \mathbb{R}^4$. Find a unit vector $\vec{u}$ in the direction opposite to that

of $\vec{v}$.

Solution:

Given that $\vec{v} = \begin{pmatrix} 2 \\ 1 \\ 0 \\ 3 \end{pmatrix}$, then its nomalizing factor(magnitude) is;

$$\left| \vec{v} \right| = \left| \begin{pmatrix} 2 \\ 1 \\ 0 \\ 3 \end{pmatrix} \right| = \sqrt{(2)^2 + 1^2 + 0^2 + 3^2} = \sqrt{14}$$

$\therefore$ the unit vector $\hat{u}$ in the direction of $\vec{v}$ is given by;

$$\hat{u} = \frac{\vec{v}}{\left| \vec{v} \right|} = \frac{1}{\left| \vec{v} \right|} \vec{v} = \frac{1}{\sqrt{14}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ 3 \end{pmatrix} = \frac{1}{\sqrt{14}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ 3 \end{pmatrix}$$

$\implies$ the unit vector $\vec{u}$ in the direction opposite to that of $\vec{v}$ is given by;

$$-\hat{u} = -\frac{\vec{v}}{\left| \vec{v} \right|} = -\frac{1}{\left| \vec{v} \right|} \vec{v} = -\frac{1}{\sqrt{14}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ 3 \end{pmatrix} = -\frac{1}{\sqrt{14}} \begin{pmatrix} 2 \\ 1 \\ 0 \\ 3 \end{pmatrix} = \begin{pmatrix} -\frac{1}{7}\sqrt{2}\sqrt{7} \\ -\frac{1}{14}\sqrt{14} \\ 0 \\ -\frac{3}{14}\sqrt{14} \end{pmatrix}$$