

## Question 2.3.3

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### 1 Question:

If  $\mathbf{a}$ ,  $\mathbf{b}$ ,  $\mathbf{c}$  are three non-zero unequal vectors such that  $\mathbf{a}^T \mathbf{b} = \mathbf{a}^T \mathbf{c}$ , then find the angle between  $\mathbf{a}$  and  $\mathbf{b} - \mathbf{c}$ .

### 2 Solution:

The angle  $\theta$  between two vectors  $\mathbf{a}$  and  $\mathbf{b}$  is given by the formula:

$$\theta = \arccos \left( \frac{\|\mathbf{a}^T \mathbf{b}\|}{\|\mathbf{a}\| \|\mathbf{b}\|} \right) \quad (1)$$

In this case, we would need to find

$$\theta = \arccos \left( \frac{\|\mathbf{a}^T (\mathbf{b} - \mathbf{c})\|}{\|\mathbf{a}\| \|\mathbf{b} - \mathbf{c}\|} \right) \quad (2)$$

$$\theta = \arccos \left( \frac{\|\mathbf{a}^T \mathbf{b} - \mathbf{a}^T \mathbf{c}\|}{\|\mathbf{a}\| \|\mathbf{b} - \mathbf{c}\|} \right) \quad (3)$$

$$\theta = \arccos(0) = 90^\circ \quad (4)$$

$$\because \mathbf{a}^T \mathbf{b} = \mathbf{a}^T \mathbf{c} \text{ and } |\mathbf{a}| \neq 0, |\mathbf{b} - \mathbf{c}| \neq 0 \quad (5)$$

Therefore, the angle between the vectors  $\mathbf{a}$  and  $\mathbf{b} - \mathbf{c}$  is  $90^\circ$ .