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1

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19/ENG05/010 Mechatronics Engineering

$$D \quad \vec{A} = 3\vec{i} + 7\vec{j} - 2\vec{k}, \quad \vec{B} = \vec{i} + 3\vec{j} + 7\vec{k}$$

$$\vec{C} = 9\vec{i} - 4\vec{j} + 6\vec{k}$$

$$|\vec{A}| = \sqrt{(3)^2 + (7)^2 + (-2)^2}$$
$$= \sqrt{62} = 7.87$$

$$|\vec{B}| = \sqrt{(1)^2 + (3)^2 + (7)^2}$$
$$= \sqrt{59} = 7.68$$

$$|\vec{C}| = \sqrt{(9)^2 + (-4)^2 + (6)^2}$$
$$= \sqrt{133} = 11.53$$

$$\vec{A} \cdot \vec{C} = (3\vec{i} + 7\vec{j} - 2\vec{k}) \cdot (9\vec{i} - 4\vec{j} + 6\vec{k})$$
$$= 27 - 28 - 12$$
$$= -13$$

$$\vec{B} \cdot \vec{C} = (\vec{i} + 3\vec{j} + 7\vec{k}) \cdot (9\vec{i} - 4\vec{j} + 6\vec{k})$$
$$= 9 - 12 + 42$$
$$= 39$$

i) θ between \vec{A} and \vec{C}

$$\cos \theta = \frac{\vec{A} \cdot \vec{C}}{|\vec{A}| |\vec{C}|}$$

$$\theta = \cos^{-1} \left(\frac{\vec{A} \cdot \vec{C}}{|\vec{A}| |\vec{C}|} \right)$$

$$\theta = \cos^{-1} \left(\frac{-13}{\sqrt{62} \sqrt{133}} \right) = \cos^{-1} \left(\frac{-13}{7.87 \times 11.53} \right)$$

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$$\theta = \cos^{-1}(-0.1434)$$

$$\theta = 98.24^\circ$$

ii) θ between B and C

$$\cos \theta = \frac{B \cdot C}{|B| |C|}$$

$$\theta = \cos^{-1} \left(\frac{39}{7.68 \times 11.53} \right)$$

$$\theta = \cos^{-1}(0.4404)$$

$$\theta = 63.87$$

iii) $U = A + B + C$

$$U = 3i + 7j - 2k + i + 3j + 7k + 9i + 4j + 6k$$

$$U = 13i + 11j + 11k$$

$$e_U = \frac{U}{|U|}$$

$$|U| = \sqrt{13^2 + 11^2 + 11^2}$$

$$= \sqrt{326} = 18.06$$

$$e_U = \frac{1}{18.06} (13i + 11j + 11k)$$

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②

$$S = x + y + z$$

$$S = -8t^2i + (t^2 - 4t)j + (t+1)k$$

$$\frac{dS}{dt} = -16ti + (2t-4)j + k$$

$$\frac{d^2S}{dt^2} = -16i + 2j$$

$$\left. \frac{d^2S}{dt^2} \right|_{t=1} = -16i + 2j$$

③ $A = 4i + 2j - 4k$

$B = 8i - 2j + k$

$C = i + 4j - 3k$

$$(A \times B) = \begin{vmatrix} i & j & k \\ 4 & 2 & -4 \\ 8 & -2 & 1 \end{vmatrix}$$

$$= i(2-9) + j(4+32) + k(-8-16)$$

$$= i(-6) + 36j - 24k$$

$$(A \times B) \times C = \begin{vmatrix} i & j & k \\ -6 & 36 & -24 \\ 1 & 4 & -3 \end{vmatrix}$$

$$= i(+108+96) - j(9+24) + k(-24+36)$$

$$= 204i - 33j + 12k$$