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NAME: OLUNADARA, Kolade Oluwagbemileke

DEPARTMENT: Electrical Electronics Engineering

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QUESTION: If  $A = 2i - j$ ,  $B = 3i + j - 11k$  and  $C = 4i + 4j - 5k$ , find

i)  $-3A + 7B - 8C$

ii) If  $K = 2A + 4B - C$ , find the direction cosine of  $K$

iii)  $A \times (B \times C)$

iv)  $(3A \times B) \cdot (A \times 2B)$

v)  $A - 2B - C$

SOLUTION

i)  $-3A + 7B - 8C$

where  $-3A = -3(2i - j) = -6i + 3j$

$7B = 7(3i + j - 11k) = 21i + 7j - 77k$

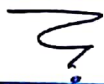
$-8C = -8(4i + 4j - 5k) = -32i - 32j + 40k$

$\therefore -3A + 7B - 8C$

$= (-6i + 3j) + (21i + 7j - 77k) + (-32i - 32j + 40k)$

$= (-6 + 21 - 32)i + (3 + 7 - 32)j + (-77 + 40)k$

$= 17i - 22j - 37k$



ii) If  $K = 2A + 4B - C$ , find the direction cosine of  $K$   
 where  $2A = 2(2i - j) = 4i - 2j$

$$4B = 4(3i + j - 11K) = 12i + 4j - 44K$$

$$-C = -(4i + 4j - 5K) = -4i - 4j + 5K$$

$$K = 2A + 4B - C$$

$$= (4i - 2j) + (12i + 4j - 44K) + (-4i - 4j + 5K)$$

$$= (4 + 12 - 4)i + (-2 + 4 - 4)j + (-44 + 5)K$$

$$= 12i - 2j - 39K$$

$$|K| = \sqrt{(12)^2 + (-2)^2 + (-39)^2}$$

$$= \sqrt{144 + 4 + 1521}$$

$$= \sqrt{1669}$$

$$= 40.85$$

$$\cos K = \frac{12i - 2j - 39K}{40.85}$$

$$\therefore l = \cos \alpha = \frac{12}{40.85}$$

$$m = \cos \beta = \frac{-2}{40.85}$$

$$n = \cos \gamma = \frac{-39}{40.85}$$

iii)  $A \times (B \times C)$

$B \times C =$	$i$	$j$	$k$
	3	1	-11
	4	4	-5

$= i$	1	-11	$-j$	3	-11	$+k$	3	1
	4	-5		4	-5		4	4

$$= i(-5 + 44) - j(-15 + 44) + k(12 - 4)$$

$$= 3qi - 2qj + 8k$$

$$\therefore A \times (B \times C) =$$

i	j	k
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2	-1	0
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3q	-2q	8
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= i	-1	0	-j	2	0	+k	2	-1
	-2q	8		3q	8		3q	-2q

$$= i(-8+0) - j(16-0) + k(-58+3q)$$

$$= -8i - 16j - 19k$$

iv)  $(3A \times B) \cdot (A \times 2B)$

Where  $A = 2i - j$

$$3A = 3(2i - j) = 6i - 3j$$

$$B = 3i + j - 11k$$

$$2B = 2(3i + j - 11k) = 6i + 2j - 22k$$

$$(3A \times B) =$$

i	j	k
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6	-3	0
---	----	---

3	1	-11
---	---	-----

= i	-3	0	-j	6	0	+k	6	-3
	1	-11		3	-11		3	1

$$i(33-0) - j(-66-0) + k(6+9)$$

$$= 33i + 66j + 15k$$

$$(A \times 2B) = \begin{array}{|c|c|c|} \hline i & j & k \\ \hline 2 & -1 & 0 \\ \hline 6 & 2 & -22 \\ \hline \end{array}$$

$$= i \begin{array}{|c|c|} \hline -1 & 0 \\ \hline 2 & -22 \\ \hline \end{array} - j \begin{array}{|c|c|} \hline 2 & 0 \\ \hline 6 & -22 \\ \hline \end{array} + k \begin{array}{|c|c|} \hline 2 & -1 \\ \hline 6 & 2 \\ \hline \end{array}$$

$$= i(22 - 0) - j(-44 - 0) + k(4 + 6)$$

$$= 22i + 44j + 10k$$

$$\therefore (3A \times B) \cdot (A \times 2B)$$

$$= (33i + 66j + 15k) \cdot (22i + 44j + 10k)$$

$$= 726 + 2904 + 150$$

$$= 3708$$

$$v) A - 2B - C$$

$$-2B = -2(3i + j - 11k)$$

$$= -6i - 2j + 22k$$

$$-C = -(4i + 4j - 5k) = -4i - 4j + 5k$$

$$A - 2B - C = (2i - j) + (-6i - 2j + 22k) + (-4i - 4j + 5k)$$

$$= (2 - 6 - 4)i + (-1 - 2 - 4)j + (22 + 5)k$$

$$= -8i - 7j + 27k$$

② Define perpendicular and co-planar vectors

PERPENDICULAR VECTORS are said to be two vectors  $A$  &  $B$ , where by their dot product is equal to zero. i.e.  $(A \cdot B) = 0$

CO-PLANAR VECTORS are three vectors  $A$ ,  $B$  and  $C$ , if  $A \cdot (B \times C) = 0$ .