**TI-84 Plus CE and TI-83 Premium CE Vectors Program**

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Storage: 1,048 bytes

**Introduction**

The program VECTORS calculates the following of the three dimensional vectors [A] and [B]:

\* Dot product of [A] and [B]

\* Euclidean norm of vectors [A] and [B]

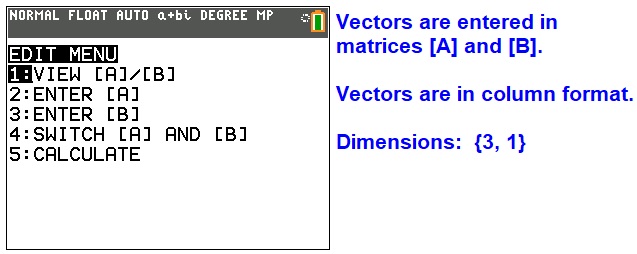
\* Angle between vectors [A] and [B] in degrees

\* Cross product of [A] × [B]

\* Tensor product of [A] ⊗ [B]

The program uses the system matrices [A] and [B] and formats them as 3 rows, 1 column matrices. The program changes the angle mode to Degrees.

When you first run VECTORS, you first get the EDIT MENU.



1) View [A]/[B]: View both vectors [A] and [B]

2) Enter [A]: Enter the elements of vector [A]. The values must be real numbers.

3) Enter [B]: Enter the elements of vector [B]. The values must be real numbers.

4) Switch [A] and [B]: Switch the values of vectors [A] and [B]. This is an important option because the cross product and tensor product do not follow the commutative property.

5) Calculate: Executes the operations on vectors [A] and [B].

**Normalization of Vectors**

In the Enter [A] and Enter [B] options, you are offered a choice to normalize the vectors after entering the elements. A normalized vector has a Euclidean norm of 1.

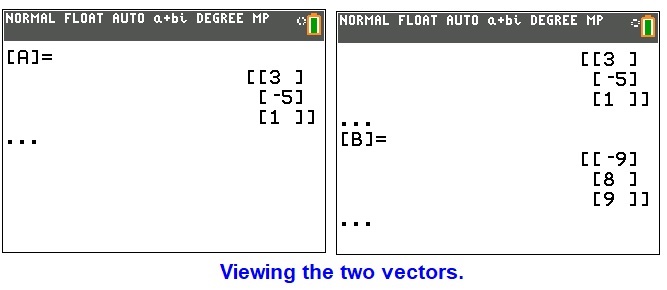
The normalized vector is calculated by (||V||₂)⁻¹ \* [V].

**Switching [A] and [B]**

Option 4 switches the elements of vectors [A] and [B].

For example, let [A] = [[1][2][3]] and [B] = [[9][8][7]]

After applying the switch option: [A] = [[9][8][7]] and [B] = [[1][2][3]]



**Calculations**

Choosing the Calculate option will execute all the vector operations in the program.

You are given an option of viewing the results or exiting the program from that point. Regardless of which option you choose, the following results are stored in the following variables:

D = Dot Product

M = Euclidean Norm of [A]

N = Euclidean Norm of [B]

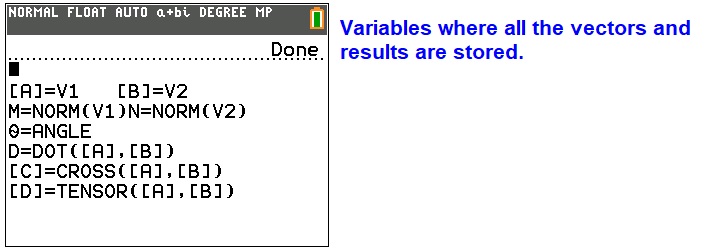
θ = Angle between vectors [A] and [B]

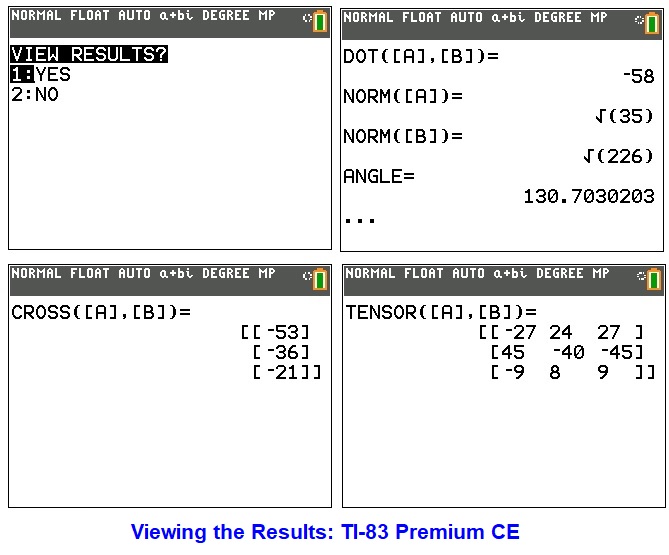
[C] = Cross product = [A] × [B]

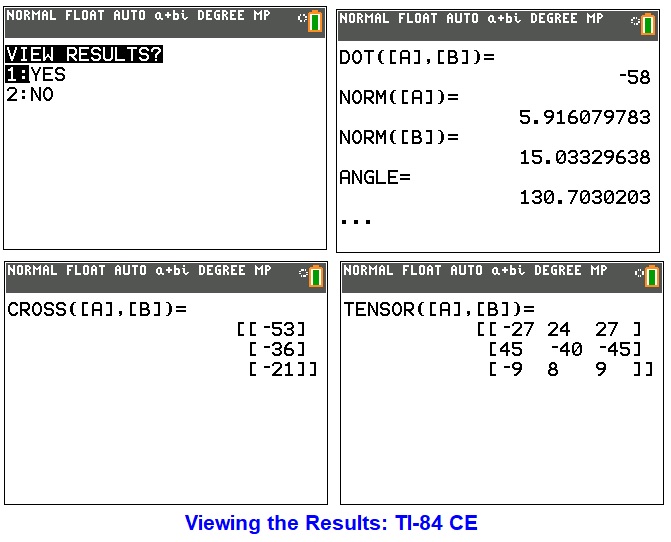
[D] = Tensor product = [A] ⊗ [B]

When you view the results, the program will ask you if you want to go back and edit the vectors and redo calculations (“AGAIN?”). You do not get that option if you decide to skip viewing the results.

Depending on the calculator used, results will be shown in either exact format (TI-83 Premium CE) or approximate format (TI-84 CE).







**Calculations Used**

Let [A] and [B] be the column vectors:

[A] = [[a1][a2][a3]]

[B] = [[b1][b2][b3]]

Dot Product:

[A] • [B] = a1 \* b1 + a2 \* b2 + a3 \* b3 = [A]ᵀ [B]

Euclidean Norm:

||[A]||₂ = √(a1² + a2² + a3²) = √([A]ᵀ [A])

||[B]||₂ = √(b1² + b2² + b3²) = √([B]ᵀ [B])

Angle Between Two Vectors:

θ = arccos(([A] • [B]) ÷ (||[A]||₂ \* ||[B]||₂))

Cross Product:

[A] × [B] = [C] where:

c1 = a2 \* b3 – a3 \* b2

c2 = -a1 \* b3 + a3 \* b1

c3 = a1 \* b2 – a2 \* b1

The result is a 3 x 1 matrix.

Tensor Product:

[A] ⊗ [B] = [A] [B]ᵀ

The result is a 3 x 3 matrix.

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