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Calculator Lesson 25

Basic Vector Operations

Vectors are represented on the calculator in the form $[v_1 v_2 \cdots v_n]$. For example to enter the vector $\mathbf{v} = \langle 1, 2, 3 \rangle$ in the calculator press LS \square 1 SPC 2 SPC 3 ENTER. NOTE: The calculator does not want the commas you normally see in vectors seen in print.

There are three other ways to create vectors. Press LS MTH F1-VECTR to open a menu of special vector commands. The command F5 \rightarrow V2 will take the elements from level 2 and level 1 and create a 2 dimensional vector; the command F6 \rightarrow V3 will take the elements from level 3, level 2 and level 1 and create a 3 dimensional vector. For example, the sequence 2 ENTER 1 +/- ENTER 2 +/- ENTER F6 \rightarrow V3 will create the vector [2 -1 -2]. The command F4-V \rightarrow will disassemble the vector on level 1 and place the elements on the stack. For example pressing F4-V \rightarrow with [2 -1 -2] on level 1 of the stack will change it to 2 on level 3, -1 on level 2 and -2 on level 1.

The third way to create vectors can be found in the programming menu. Press LS PRG F5-TYPE to find the two commands that may be of interest to us. The command F1-OBJ \rightarrow will disassemble a vector as described above except that it also leaves a number in braces on level 1 indicating the dimension of the original vector. For example, with [1 3 5 7] on level 1 of the stack, pressing F1-OBJ \rightarrow will leave the stack with 1 on level 5, 3 on level 4, 5 on level 3, 7 on level 2 and {4} on level 1. The command F2 \rightarrow ARRY reverses the process. For example, suppose you have the numbers 3 on level 5, -2 on level 4, 6 on level 3, 1 on level 2, and -8 on level 1 and you want to put them into a vector of dimension 5. Press LS {} 5 ENTER F2 \rightarrow ARRY and [3 -2 6 1 -8] will be placed on level 1.

The fourth way to create a vector is to use the Matrix Writer. To enter the vector [1 -2 3 -4] press LS MTRW to open the Matrix Write. Make sure that the prompt for F2 is VEC \blacksquare and F5 is GO \rightarrow \blacksquare . If the black square is missing from either of these press the corresponding key to turn the feature on (with the square) or off (without the square). Now press:

1 ENTER 2 +/- ENTER 3 ENTER 4 +/- ENTER ENTER,

and the desired vector will be on level 1 of the stack. The Matrix Writer is also the tool used to edit a vector. Suppose you have the vector [1.23 2.44 3.45] on level 1 of the stack, and you realize the middle coordinate is wrong, it should be 2.34. Press DA and the Matrix Write will open with the vector in the top row. Use RA to highlight the offending coordinate then press F1-EDIT. The value from that cell is now in the command line with the cursor pointing to the last character. Use LA until the cursor is pointing to the incorrect digit, press \leftarrow to erase the wrong digit, type the correct digit, then press ENTER. If that is the only required correction, press ENTER again and the corrected vector will now be on level 1 of the stack.

NOTE: There is a complete discussion of the Matrix Writer in Lesson 30.

To add or subtract two vectors just put them on the stack and press + or – as the case may be, the same as if you were adding or subtracting two numbers. Scalar multiplication is accomplished with \times . Most texts write this with the scalar to the left of the vector, $c\mathbf{v}$, but the operation is commutative on the calculator. With a vector on level 1 of the stack the ABS function will compute the Euclidean norm, (the length) of a vector. Texts generally do not define scalar division. To find a vector 1 fifth the length of a given vector is generally described as multiplying by $1/5$. The calculator, however, does allow a vector to be divided by a scalar. This is particularly handy when trying to find a unit vector in the direction of a given vector. For example, suppose you wish to find a unit vector in the direction of the vector $[3, -4]$. The following sequence will get the job done: LS [] 3 SPC 4 +/- ENTER ENTER LS ABS \div . The answer $[\.6, -.8]$ will be on level 1 of the stack.

Two other important products associated with vectors are the dot product and the cross product. These can be found in the vector menu mentioned above found by the sequence LS MTH F1-VECTR. Note that F1 is the ABS command, F2 is the dot product and F3 is the cross product. Remember that the dot product is commutative, so the order in which the vectors are on the stack does not matter. The cross product, however, is NOT commutative, so the position of the vectors on the stack is important. To find the cross product $\mathbf{v} \times \mathbf{w}$ you must have \mathbf{v} on level 2 and \mathbf{w} on level 1. For example to find the cross product $[3 \ -2 \ 4] \times [-1 \ 6 \ 4]$ press LS [] 3 SPC 2 +/- SPC 4 ENTER LS [] 1 +/- SPC 6 SPC 4 ENTER F3-CROSS and we see the answer $[-32 \ -16 \ 16]$.

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