Pre-Calculus: Algebra on the TI-85/TI-86

Conics

Example#1: Graphing the conic $2x^2-12x+3y^2+24y=0$.

1. Solve for y by hand.

$$
\begin{aligned}
2x^2-12x+3y^2+24y &= 6\\
3(y^2+8y\quad) &= 6+12x-2x^2\\
3(y^2+8y+16) &= 6+12x-2x^2+48\\
3(y+4)^2 &= 54+12x-2x^2\\
(y+4)^2 &= (54+12x-2x^2)/3\\
y+4 &= \pm\sqrt{54+12x-2x^2}\,/\,3\\
y &= -4 \pm\sqrt{54+12x-2x^2}\,/\,3
\end{aligned}
$$

2. Enter the function(s) into the calculator.
   Set y1=-4+√((54+12x-2x²)/3) and y2=-4-√((54+12x-2x²)/3).
3. Graph them in an appropriate window.
   In this case the standard window will work.
4. Why didn't it connect the ends of the ellipse?

Other conics are graphed the same way. Though some require only one function, y1.

Matrices

A matrix is stored in the calculator as a vector of row vectors. Where a vector is a 1 dimensional matrix and a row vector is a vector formed by one row of the matrix.

Entering matrices:

Example#2:Storing $\begin{bmatrix}2 & 3\\ -1 & 5\end{bmatrix}$ into A from the command line.

1. Enter **2nd [2nd [2 , 3 2nd] 2nd [(-) 1 , 5 2nd] 2nd] STO► A ENTER**.
   Note that you must put commas between numbers in each row vector, but you must NOT put commas between the row vectors.
2. It returns "[[2 3] "
   [-1 5]] .
   Note the the calculator didn't use commas anywhere in the matrix.

Example#3: Storing $\begin{bmatrix}5 & -2\\ 0 & 4\end{bmatrix}$ into B using the matrix editor.

1. Enter the matrix editor.
   Press **2nd MATRX F2:EDIT**.
2. Enter the name for the matrix.
   First notice that the cursor is in ALPHA mode, and that the name A of the matrix we entered in example#2 is in the menu as well as any other matrix stored in the calculator.
   Press **B ENTER**.
3. Enter the dimensions of the matrix.
   Since this matrix is 2by2, type **2 ENTER 2 ENTER**.
4. Enter the matrix row by row.
   Press **5 ENTER (-) 2 ENTER** to enter the top row.
   Press **0 ENTER 4 ENTER** to type in the bottom row.
5. Exit the editor.
   Type **EXIT**.
6. Confirm B contains the matrix.
   Type **ALPHA B ENTER**.
7. It returns "[[5 -2] "
   [0 4]] .

The Matrix Menu Explained:

NAMES	displays a menu with all the names of the stored matrices.
EDIT	enters the matrix editor.
►COL	(TI-85 only) goes to the previous column.
COL►	(TI-85 only) goes to the next column.
INSr	inserts a row into the matrix at the cursor's position.
DELr	deletes a row from the matrix at the cursor's position.
INSc	inserts a column into the matrix at the cursor's position.
DELc	deletes a column from the matrix at the cursor's position.
►REAL	not needed for PC:Algebra.
MATH	
det	takes the determinant of a matrix.
T	interchanges the rows and columns.
the rest aren't needed for PC:Algebra.	
OPS	
dim	gives the dimensions of a matrix as a list.
Fill	fills a matrix with a specified number.
ident	returns an identity matrix.
rSwap	swaps two rows of a matrix.
rAdd	adds two rows of a matrix.
multR	multiplies a row of a matrix by a number.
mRAdd	multiplies one row of a matrix and add it to another row.
the rest aren't needed for PC:Algebra.	
CPLX	not needed for PC:Algebra.

Basic Operations:

The following examples assumes that you have the matrices A and B from examples 2&3 above.

Example#4: Perform B-A.
1. Type **ALPHA B - ALPHA A ENTER**.
2. It returns "[[3 -5] "
   [1 -1]] .

Example#5: Find the determinant of A.
1. Press **2nd MATRX F3:MATH F1:det ALPHA A ENTER**.
2. It returns "13".

Example#6: Find the dimensions of B.
1. Type **2nd MATRX F4:OPS F1:dim ALPHA B ENTER**.
2. It returns "{2 2}". Thus, the dimensions are 2by2.

Example#7: Filling B with 4's.
1. Type **2nd MATRX F4:OPS F2:Fill 4 , ALPHA B) ENTER**.
2. It returns "Done".
3. Press **ALPHA B ENTER** to check.
4. It returns "[[4 4] "
   [4 4]] .

Example#8: Store a 3by3 identity matrix in C.
1. Type **2nd MATRX F4:OPS F3:ident 3 STO► C ENTER**.
2. It returns "[[1 0 0] "
   [0 1 0]
   [0 0 1]] .

Example#9: Deleting the matrices A,B and C.
1. Enter the matrix delete screen.
   Press **2nd MEM F2:DELET MORE F1:MATRX**.
2. Point the "►" at A if it isn't already. Then press **ENTER** to delete it.
3. Repeat with B and C.
4. Press **EXIT** to return to the command line.

Solving a system of equations:

The commands for solving a system of equations using an augmented matrix are:

rSwap(*matrixA* , *row1* , *row2*)
:returns a matrix with *row1* and *row2* of *matrixA* swapped.

rAdd(*matrixA* , *row1* , *row2*)
:returns a matrix with *row1*+*row2* stored in *row2*. Rows refer to *matrixA*.

multR(*number* , *matrixA* , *row1*)
:returns a matrix with *number* **row1* stored in *row1*. Rows refer to *matrixA*.

mRAdd(*number* , *matrixA* , *row1* , *row2*)
:returns a matrix with *number* **row1* + *row2* stored in *row2*. Rows refer to *matrixA*.

The commands do not affect *matrixA* unless you store their result back into *matrixA*.

Example#10: Solve $3x+y-z=-2$, $x-y+2z=9$, $x+2y-5z=-18$ using an augmented matrix on the calculator.

1. Enter the augmented matrix into a variable.
   Either type **2nd [2nd [3 , 1 , (-) 1 , (-) 2 2nd] 2nd [1 , (-) 1 , 2 , 9 2nd] 2nd [1 , 2 , (-) 5 , (-) 18 2nd] 2nd] STO► A ENTER**
   or use the matrix editor to enter the 3by4 matrix into A.
2. Goto the second page of the MATRX:OPS submenu.
   Press **2nd MATRX F4:OPS MORE**.
3. Swap rows 1 & 2.
   Type **F2:rSwap ALPHA A , 1 , 2) STO► A ENTER**.
4. Subtract 3 times row 1 from row 2.
   Type **F5:mRAdd (-) 3 , ALPHA A , 1 , 2) STO► A ENTER**.
5. Subtract row 1 from row 3.
   Type **F5:mRAdd (-) 1 , ALPHA A , 1 , 3) STO► A ENTER**.
6. Divide row 2 by 4.
   Type **F4:multR 1 / 4 , ALPHA A , 2) STO► A ENTER**.
7. Subtract 3 times row 2 from row 3.
   Type **F5:mRAdd (-) 3 , ALPHA A , 2 , 3) STO► A ENTER**.
8. Add rows 1 and 2.
   Type **F3:rAdd ALPHA A , 2 , 1) STO► A ENTER**.
9. Subtract row 3 from row 2.
   Type **F5:mRAdd (-) 1 , ALPHA A , 3 , 2) STO► A ENTER**.
10. Divide row 3 by -1.75.
    Type **F4:multR (-) 1 / 1.75 , ALPHA A , 3) STO► A ENTER**.
11. Subtract .25 times row 3 from row 1.
    Type **F5:mRAdd (-) .25 , ALPHA A , 3 , 1) STO► A ENTER**.
12. Read x,y&z from last column.
    Thus, x=1, y=-2, and z=3.

Note: You MUST store the result of each command back into A for use in the next command.

Example#11: Solving $4x+3y=3$, $2x-y=-11$ using an inverse matrix.

1. For AX=B, where A= $\begin{bmatrix} 4 & 3 \\ 2 & 1 \end{bmatrix}$, X= $\begin{bmatrix} x \\ y \end{bmatrix}$, and B= $\begin{bmatrix} 3 \\ -1 \end{bmatrix}$; $X=A^{-1}B$.
2. Enter $A^{-1}B$.
   Type **2nd [2nd [4 , 3 2nd] 2nd [2 , (-) 1 2nd] 2nd] 2nd x^{-1} 2nd [2nd [3 2nd] 2nd [(-) 11 2nd] 2nd] ENTER**.
3. It returns "[[-3] "
   [5]] .
4. Thus, x=-3 and y=5.

Sequences & Series

The calculator stores finite sequences as lists. For instance, the sequence 3,6,5,8 is stored on the calculator as {3,6,5,8}. Note: this isn't a set because order matters.

There are two commands used to generate and add up lists.

seq(***expression*** , ***variable*** , ***start*** , ***end*** , ***step***)

:generates a list by setting the ***variable*** to ***start*** and plugging it into the ***expression*** to get the first number of the sequence. It then adds ***step*** to the ***variable*** and finds the second number. It repeats this until the ***variable*** gets to ***end***. For instance the command "seq(x^2,x,1,7,2)" would return "{1 9 25 49}" the squares of 1,3,5 and,7 which are 2 units apart. For PC-Alg. ***step*** should be set to 1.

sum ***list***

:adds the elements of the ***list***. For example, "sum {3,5,8}" returns "16".

Example#12: Find the sum of the first 10 terms of the geometric sequence where r=2 and a_1=1.

1. Find the formula for the x^{th} term.
   Since the x^{th} term is a_1 multiplied by x-1 r's, $a_x=a_1r^{x-1}=(1)(2^{x-1})=2^{x-1}$.
2. Determine the starting and ending values of x.
   Because we want the first 10 terms, x starts at 1 and ends at 10.
3. Enter the comand.
   Press **2nd LIST F5:OPS MORE F1:sum F3:seq 2 ^ (x-VAR - 1) , x-VAR , 1 , 10 , 1) ENTER**.
4. It returns "1023".

Note: x is used as the variable solely because it is easy to type into the calculator.

Factorial & Combinations

The calculator use the same notation as writing, n!. While, combinations uses a variation on the ${}_nC_r$ notation where

$${}_nC_r = \binom{n}{r} = \frac{n!}{r!(n-r)!} .$$

The calculator's command is ***n*** ${}_nC_r$ ***r*** . Where "${}_nC_r$" is the command, and ***n*** and ***r*** are whole numbers. Therefore, the command **5 $_n$C$_r$ 3** would return 5!/[3!(5-3)!]=10.

Example#13: Find 10! on the calculator.

1. Type **10 2nd MATH F2:PROB F1:! ENTER**.
2. It returns "3628800".

Example#14: Find 500!.

1. Type **500 2nd MATH F2:PROB F1:! ENTER**.
2. Why does 500! cause an error? (HINT: look at 449!)

Example#15: Find the 5^{th} term of $(x-3)^{15}$.

1. This would be the $x^{(15-4)}=x^{11}$ term and the full term would be ${}_{15}C_4\ x^{11}(-3)^4$.
2. Calculate the combination.
   Type **15 2nd MATH F2:PROB F3:nCr 4 ENTER**.
3. It returns "1365".
4. Multiply that by $(-3)^4$.
   Press **X ((-) 3) ^ 4 ENTER**.
5. It returns "110565". Thus, the 5^{th} term is $110565x^{11}$.