9 Appendix

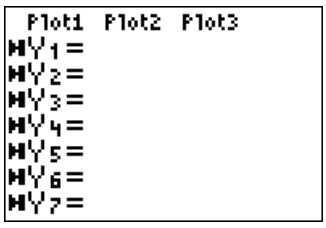
Graphing Calculator Software Applications (Apps) are pieces of software that you can download onto your calculator as you would add software to a computer to enhance its capabilities. Apps not only allow you to customize your TI calculator to meet your class needs, but also to upgrade it from one year to the next.

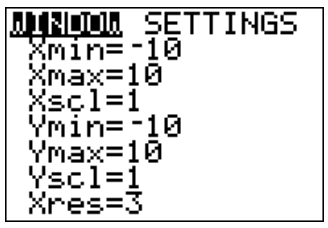
You can download Apps, as well as detailed guidebooks, for free from www.education.ti.com, Downloads.

9.1 Transformation Graphing

Transformation Graphing allows visualizing dynamically how changes in a function's parameters effect its graph. This application enables students to discover several properties in terms of a function's parameters: roots, increasing and decreasing, symmetry, period, … It can also be used for modelling by manipulating coefficients to fit equations to data points.

Transformation Graphing is an application that once it's started it keeps running in the background. It changes the **Y=** window as follows and adds the menu **SETTINGS** to the **WINDOW** screen.





To quit Transformation Graphing you need to activate it again in the **APPS** menu and then select **1: Uninstall**. Note that it is not possible to run Transformation Graphing and Inequality Graphing at the same time.

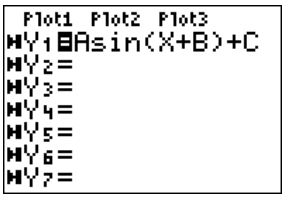
With Transformation Graphing is possible to observe the effects of changing parameter values on the graph without leaving the graph screen. It is only available in the function mode and when it's active it's only possible to plot one function.

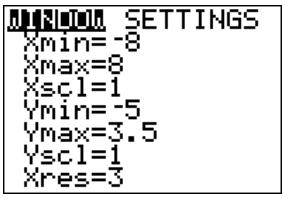
Transformation Graphing allows the use of four parameters: A, B, C, and D. All the others act like constants, using the value in the RAM memory.

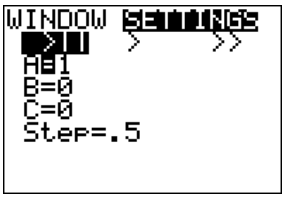
Transformation Graphing has three play types.

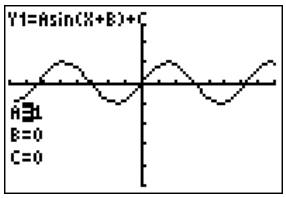
PLAY-PAUSE (>||)	lets you change the parameter and plot the graph.
PLAY (>||)	stores a series of changes and shows the corresponding graphs in a continuous slide show.
PLAY-FAST (>||)	stores a series of changes and shows the corresponding graphs in a fast continuous slide show.

We will use the function $f(x) = A\sin(Bx) + C$ to illustrate how Transformation Graphing works. We will start with the following **WINDOW** settings.



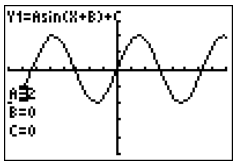


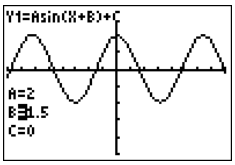


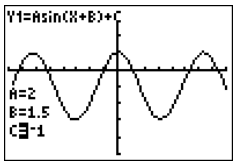


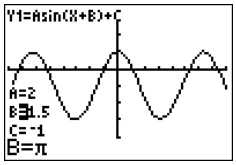
PLAY-PAUSE (>||)

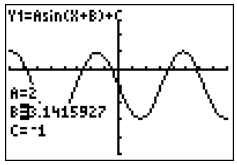
Press ◄ ► to change the selected parameter and ▲ ▼ to select a different parameter. The graph will change automatically. It is also possible to enter a value manually. Select the parameter, enter the value and press **ENTER**.





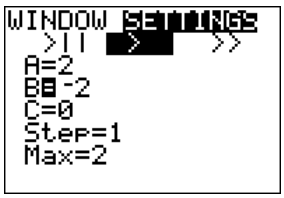


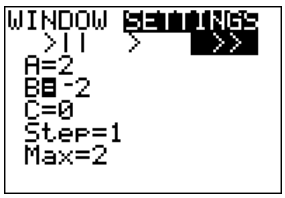


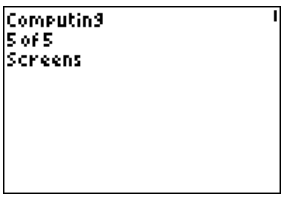


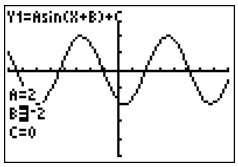
PLAY (>||) and **PLAY-FAST** (>||)

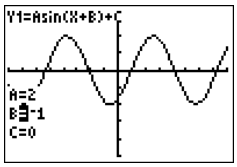
With these options you can define a slide show per parameter. By putting the cursor on the equality sign and pressing enter you can select another parameter. Press **GRAPH** to start generating the screens for the slide show. The definitions below will generate 5 screens for the parameter B: from -2 to 2 in steps of size 1.

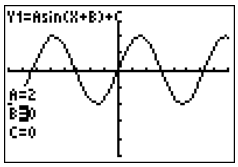


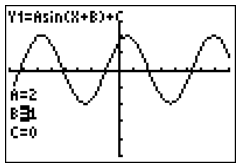


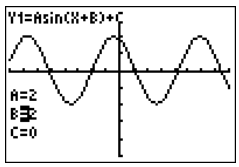








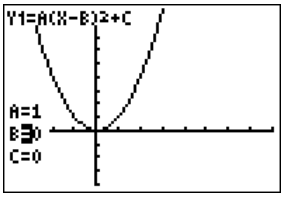


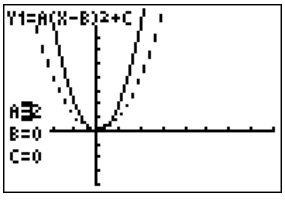


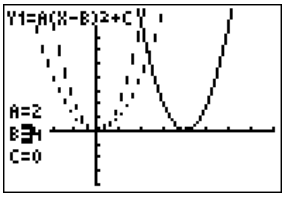
Press **ENTER** to pause the show and again to resume it and press and hold **ON** to stop.

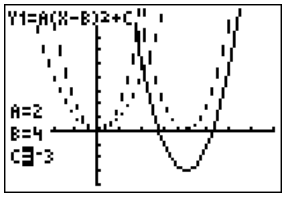
Transformation Graphing also adds an extra setting to the graph format screen, **2nd[FORMAT]**: **TrailOff** or **TrailOn**.

With **TrailOn** you will see better the effect of changing a parameter because the previous graphs stay on the screen in a dotted format.







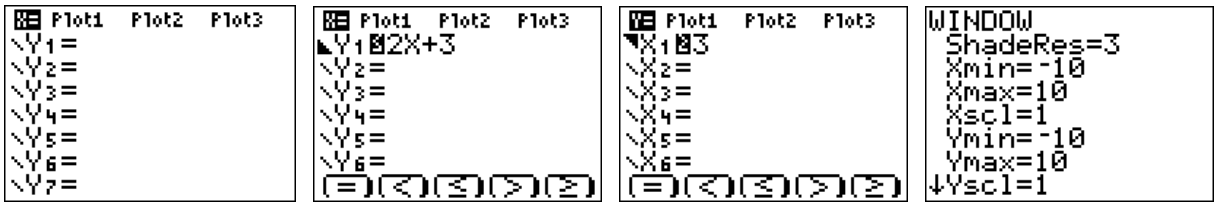


9.2 Inequality Graphing

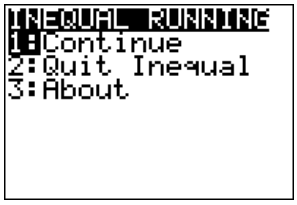
Inequality Graphing enables to enter inequalities using symbols, even inequalities involving vertical lines in an **X=** editor. It is possible to plot the inequalities, including union and intersection shades, and to store the intersection points between the corresponding functions.

With this application it is possible to add very easily a graphical approach to solving systems of linear equations (two variables) and to linear programming.

Inequality Graphing is an application that once it is started it keeps running in the background. It changes the **Y=** window as follows and adds an **X=** editor to it. It also adds a shade resolution item (ShadeRes) to the **WINDOW** settings.



To quit Inequality Graphing you need to activate it again in the **APPS** menu and then select **2: Quit Inequal**. Note that it is not possible to run Inequality Graphing and Transformation Graphing at the same time.

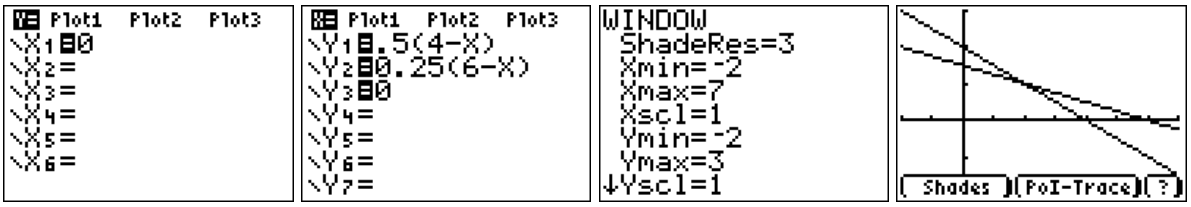


The following two examples will show how Inequality Graphing works.

Example 1
We will determine the region of points (x, y) that satisfy:

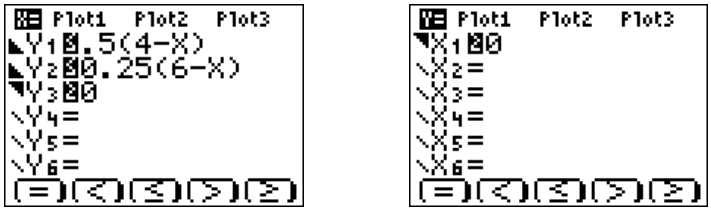
$$\begin{cases} x+2y \le 4 \\ x+4y \le 6 \end{cases} \text{ and } \begin{cases} x \ge 0 \\ y \ge 0 \end{cases}.$$

Therefore we define the linear functions **Y1=0.5(4-X)**, **Y2=0.25(6-X)**, **Y3=0**, **X1=12** and plot them with the following **WINDOW**-settings (press **TRACE ClEAR** to remove the menu at the bottom of the screen).

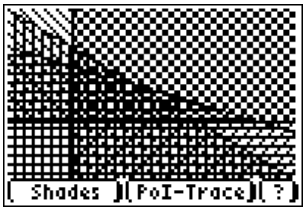


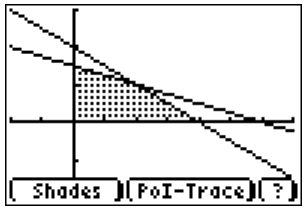
All the points in the enclosed area are solutions to our problem. It is possible to shade this area and to calculate its vertices.
To shade this area put the cursor on the equality signs to change them as follows into inequalities:

ALPHA F1 → =
ALPHA F2 → <
ALPHA F3 → ≤
ALPHA F4 → ≥
ALPHA F5 → >



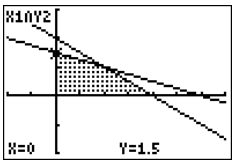
Press **GRAPH**, select **Shades (ALPHA F1)** and **1: Ineq Intersection**.

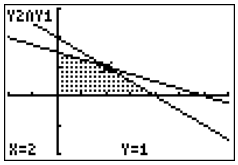


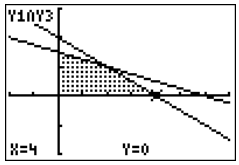


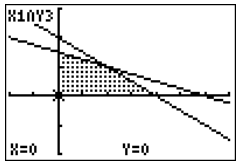
For linear inequalities it is possible to calculate the vertices the shaded area with **PoI-Trace (ALPHA F3)**: ◄ ► = change the second function & ▲ ▼ = change the first function.

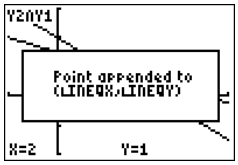
You can store a selected vertex by pressing **STO►**. The coordinates of the vertex will automatically be stored in the lists **INEQX** and **INEQY**.





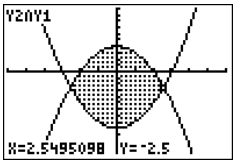


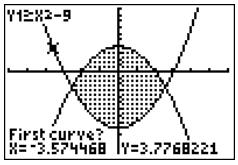


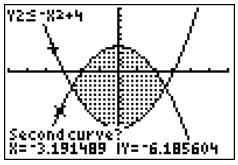


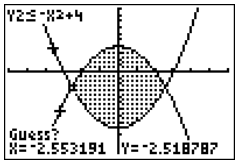
Example 2

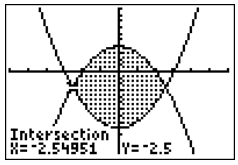
Let's try to find the area between the functions $f(x)=x^2-9$ and $g(x)=-x^2+4$. For non linear functions it is not always possible to find the intersection points through Inequality Graphing. In such a case we need to use **5: intersect** of the graphical **CALC** menu.





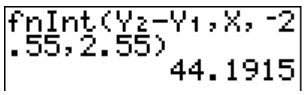






To approximate the area we can use the **fnInt** command. The calculations above are also numerical approximations of the intersection points $x_1=-\sqrt{\frac{13}{2}}\approx -2.55$ and $x_2=\sqrt{\frac{13}{2}}\approx 2.55$.

$\int_{-2.55}^{2.55}\left(g(x)-f(x)\right)dx$ is a good approximation of this area.



The intention of this booklet is offering an introduction to the use of the TI-84 Plus and its usability in the classroom.

The most important possibilities are discussed using mathematical examples without stressing the key press history too much.

In addition an example of linear programming is treated to show the various approaches for solving a problem with the TI-84 Plus, as well as the working of the applications Inequality Graphing and Transformation Graphing.

KOEN STULENS is educational consultant for Texas Instruments, T3-instructor in Flanders and attached to the department of Mathematics, Physics and Computer Science at the Hasselt University (Belgium).

www.education.ti.com