LAB B2: INTRODUCTION TO GRAPHING ON THE TI-82

Objectives:

1. Graph functions.
2. Plot points.
3. Use menus related to graphing.
4. Represent functions graphically, analytically and numerically.

Discussion:

One of the primary uses of the TI-82 is to graph functions and data. In order to effectively graph functions, you need to be able to create appropriate Graphing windows. In this lab, you will learn to use the following keys:

ZOOM   GRAPh   STAT
WINDOW   TRACE   STATPLOT

Before starting this lab, reset your calculator as described in Lab B1.

The Graphing Window

You can graph functions in the standard Graphing window using the Y= key to enter the function into the Function window and pressing ZOOM 6.

For example, to graph \( y = x^2 - 4 \),

> Press Y= to get into the Function window.
> Enter \( x^2-4 \)  ➨ Reminder: Press X,T,θ, \( x^2 \) - 4
> Press ZOOM
   - You will see the ZOOM menu as follows:

```
- ZOOM MEMORY
1:ZoomBox
2:Zoom In
3:Zoom Out
4:ZoomDecimal
5:Zoom Square
6:Zoom Standard
7:Zoom Trig
```

> Press 6 for ZStandard to select the standard Graphing window.

As the function is graphing, a small vertical bar appears in the upper right-hand corner of the screen. This bar indicates that the calculator is busy graphing. You cannot give the calculator any more instructions until it finishes graphing.

You can pause the calculator while it is graphing by pressing ENTER. Pressing ENTER again causes the calculator to resume graphing.

> Press ZOOM 6 ENTER
   - You should see a dotted vertical bar in the right hand corner. This indicates that graphing has been paused.

> Press ENTER
   - The moving vertical bar replaces the dotted bar and the calculator resumes graphing.
You can stop the calculator in the middle of graphing by pressing the ON key.

> Press ZOOM 6 ON
- The calculator should stop graphing and there should be no busy or pause indicator in the upper right corner of the screen.

**Graphing Window Settings**

The standard Graphing window shows the rectangular coordinate system with x-values going from -10 to 10 and y-values going from -10 to 10. To see the Graphing window settings

1. > Press WINDOW
- You will see the current settings for the Graphing window as follows:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xmin</td>
<td>-10</td>
</tr>
<tr>
<td>Xmax</td>
<td>10</td>
</tr>
<tr>
<td>Xscl</td>
<td>1</td>
</tr>
<tr>
<td>Ymin</td>
<td>-10</td>
</tr>
<tr>
<td>Ymax</td>
<td>10</td>
</tr>
<tr>
<td>Yscl</td>
<td>1</td>
</tr>
</tbody>
</table>

Xmin tells you the smallest x-value shown in the Graphing window. Xmax tells you the largest x-value shown in the Graphing window. Xscl tells you the distance between successive scale marks on the x-axis. Ymin tells you the smallest y-value shown in the Graphing window. Ymax tells you the largest y-value shown in the Graphing window. Yscl tells you the distance between successive scale marks on the y-axis.

You can change the settings using the down arrow key to access each line and making a new entry on that line.

For example, to change to a Graphing window that shows -100 to 100 by 10 on both the x and y-axes,

> Press v and type -100 Use the (-) key for the negative sign.
> Press v and type 100
> Press v and type 10
> Press v and type -100
> Press v and type 100
> Press v and type 10

To see the graph in the new customized Graphing window,

> Press GRAPH

NOTE: Whenever you press GRAPH, the TI-82 will use the current settings designated by WINDOW.

Notice that the graph of \( y = x^2 - 4 \) looks different in the customized Graphing window than it did in the standard Graphing window. Each time you change the Graphing window settings, you are looking at the graph on a different scale.
Which scale displays the graph better, the standard scale or the new customized scale? Why?

In order to interpret any graph on the TI-82, you will need to be aware of the scale. The settings in WINDOW will always contain information about scale.

2. Use WINDOW to set up your Graphing window with x going from -4 to 6 by 2 and with y going from -4 to 2 by 2. Press GRAPH. Sketch the resulting graph, including axes and scale, below.

The Function Window

When you press the Y= key, you get into the Function window. You have used this window already. This section gives you additional information for using the Function window.

1. You can graph more than one function at a time.

   > Press Y=

   You will see the Function window. You should have one function, Y1, defined. You can define up to 10 functions at a time. You can see 8 possible functions, Y1- Y8, on the screen. Two more, Y9 and Y0, are off the bottom of the screen. To see this, press v key until the cursor is next to Y0.

   > Use the arrow keys to position the cursor after Y2=.
   > Enter x^3 – 4x. You should see:
     \[ Y_1 = x^2 - 4 \]
     \[ Y_2 = x^3 - 4x \]

   Notice that the = signs are highlighted for the two functions you have defined.

   > Graph both functions in the standard Graphing window by pressing ZOOM 6.

2. You can turn a function off (so that its graph will not show up in the Graphing window) without deleting it.

   > Press Y=
   > Press < to move the cursor over the = sign in Y1=x^2-4
   > Press ENTER
- You will see
  \[ Y_1 = x^2 - 3 \]
  \[ Y_2 = x^3 - 4x \]

> Press **GRAPH**. You should see only the graph of \( y = x^3 - 4x \).

When the equal sign is not highlighted, the function is off and will not appear in the Graphing window.

To turn a function back on,
> Press **Y=**
> Use the arrow keys to move the cursor over the = sign in \( Y_1 = x^2 - 3 \)
> Press **ENTER**
  - The = sign should be highlighted again.

3. If you want to turn off all functions in the Function window, you can either turn them off one by one, or you can use the **Y-VARS** key as follows:

> Press **2nd VARS** for **Y-VARS**
  - You will see:

  ![Y-VARS menu]

> Press 5 for 5:On/Off...
  - You will see:

  ![On/Off menu]

> Press 2 for 2:FnOff
  - You will see **FnOff** in the Home window
> Press **ENTER**

All functions in the function window are now turned off. To verify this,
> Press **GRAPH**
  - No graphs should appear in the Graphing window
> Press **Y=**
  - None of the = signs are highlighted, but the functions have not been deleted from the calculator’s memory.

4. If you want to **delete** your functions (that is, remove them from the Function window completely) you can use the **CLEAR** key.

> Use the arrow keys to move the cursor after the \( Y_1 = \) and press **CLEAR**
> Use the arrow keys to move the cursor after the \( Y_2 = \) and press **CLEAR**
  - The two functions should be deleted from the Function window.
**Zooming**

Many graphs will not show up well in the standard Graphing window. As you have seen, you can use **WINDOW** to adjust the scale. You can use also the **ZOOM** window to change the scale of the Graphing window.

1. > Graph \( y = x^2 - 20x + 85 \) in the standard Graphing window.
   
   **HINT:** Press **Y=**, define \( Y_1 = x^2 - 20x + 85 \) and press **ZOOM 6**

   Notice that it is not clear what the graph looks like.

   > Press **ZOOM 3** for **3:Zoom Out**
   
   - You should see the Graphing window with the origin flashing and the coordinates \( x = 0 \) and \( y = 0 \) at the bottom of the screen.

   The coordinates tell you that when you zoom out, the new Graphing window will be centered at \((0, 0)\).

   > Press **ENTER**
   
   - You should see the new Graphing window centered at \((0,0)\) and the graph of the parabola well within the Graphing window.

   Notice that you cannot read any scale marks along the axes. **Zoom Out** does not change the scale marks, and at the current scale they are too close together to be seen. To change the scale marks,

   > Press **WINDOW**
   
   - You will see

   ![WINDOW FORMAT](image)

   Notice that the \( X_{min}, Y_{min}, X_{max}, \) and \( Y_{max} \) values have changed by a factor of 4, but the \( X_{scl} \) and \( Y_{scl} \) values have not changed.

   > Change \( X_{scl} \) to **5**, \( Y_{scl} \) to **5** and regraph the function (press **GRAPH**).
   
   - You should be able to see the scale marks along the axes. The distance between scale marks is now 5 units.

2. You can change the magnification factor by using **ZOOM MEMORY**

   > Press **ZOOM** for the ZOOM window.
   > Press > to highlight **MEMORY**
   
   - You will see:

   ![ZOOM MEMORY](image)
> Press 4 for 4:SetFactors…  
- You will see:

This window indicates that every time you zoom out, the Graphing window will be enlarged by a factor of 4. If you zoom in, the Graphing window will shrink by a factor of 4.

> Change the Zoom Factors to XFact=2 and YFact=2.

> Press ZOOM 2 for Zoom In   Do NOT press ENTER
> Press  > > v v
- You will see a cross with a flashing center. The cross tells you where the center of the Graphing window will be after you Zoom. The coordinates of the cross are given at the bottom of the screen.

> Use the arrow keys to move the cross over the vertex of the parabola.
> Press ENTER

What happens?

Finding Coordinates: Moving the Cross

In the previous section, you were able to move the cross around the Graphing window and read its coordinates at the bottom of the screen.

1. Find the coordinates of the vertex of \( y = -x^2 + 5x - 2 \) graphically.

> Define \( Y_1 = -x^2 + 5x - 2 \) and graph in the standard Graphing window.  
> Use the arrow keys to move the cross over the vertex of the parabola.

What are the coordinates of the vertex of the parabola?

( ___________ , ___________ )

2. Use the TRACE key and arrow keys to move the cross along the graph.

> Press TRACE

What are the coordinates of the cross? ( ___________ , ___________ )

The number 1 is displayed in the upper right-hand corner of the screen. This tells you that the cross will trace along the function \( Y_1 \).
> Press > until the cross is over the vertex of the graph.

**NOTE:** The up and down arrows will not move the cross along the function when you use **TRACE**. If you had graphed more than one function, the up and down arrows would move the cross between the different functions’ graphs.

What are the coordinates of the vertex?  (___________, ___________)

Did you get the same answer as in #1?  ______________

Note that the calculator tells you the coordinates of the cross, which may be close to but not exactly over the vertex.

3. You can get “nice” numbers for the coordinates of the cross by using **ZDecimal** or **ZInteger**.

a. > Press **ZOOM 4** for 4:ZDecimal

> Press > > ^ ^

- The x-coordinate of the cross changes by 0.1 each time you press >
- The y-coordinate of the cross changes by 0.1 each time you press ^

Notice that the vertex of the parabola is not on the screen. While **ZDecimal** allows you to move the cross by 0.1 every time you use the arrow keys, **ZDecimal** also shows you a very limited Graphing window and always centers on (0, 0).

b. When you use **ZInteger**, the coordinates of the cross are given in integer values, the Graphing window shows a relatively large region of the coordinate plane, and centers on the cross.

> Press **ZOOM**

> Press v until the 8 is highlighted

- Initially, the 8 is off the bottom of the screen.

> Press **ENTER** for ZInteger

- You will see the Graphing window.

> Press **ENTER**

- The Graphing window scale changes and the window centers over the vertex of the parabola.

> Press **WINDOW**. What are the Graphing window settings?

    Xmin = Xmax = Xscl =

    Ymin = Ymax = Yscl =

c. > Press **TRACE**

- You should see graph with the flashing cross and it coordinates.

> Press > several times. Notice that the x-coordinate changes by 1 each time you press the arrow key.

> Use the arrow keys to move the cross back over the vertex.

The vertex coordinates are (___________, ___________)
d. Now, to find the coordinates of the vertex to the within 0.1, you can zoom in on
the vertex by a factor of 10.

> Press ZOOM > 4 for ZOOM MEMORY 4:SetFactors
> Set XFact=10 and YFact=10
> Press ZOOM 2 for 2:Zoom In
> Use the arrow keys to move the cross over the vertex of the parabola. -
> Press ENTER
- The Graphing window should zoom in on the vertex.
> Press TRACE
> Press > several times. Notice that the x-coordinate changes by 0.1 each time
you press the arrow key.
> Use the arrow keys to move the cross back over the vertex.

The vertex coordinates are ( ________ , ________ )

Graphing Functions with Restricted Domains

You can graph a function with a restricted domain by entering the function along with
its domain in the Function window.

1. Graph y = x^2 for x \leq 0.

> Define Y1=X^2(X\leq0) in the Function window.
   To get \leq press 2nd MATH for TEST then press 6 for 6:≤
   ☞ NOTE: Parentheses are required around the domain.
> Graph in the standard Graphing window
What do you see?

2. Graph f(x) = \begin{cases} x^2, & x \leq 0 \\ x + 1, & 2 < x < 4 \end{cases}

Notice that the first piece of f(x) is the same as #1 above. To graph the second
piece, you need to add it to the first piece in the definition of Y1.

> Press Y=
> Use the arrow keys to move the cursor after Y1=X^2(X\leq0)
> Enter + (X+1)(2<X)(X<4)
   To get < press 2nd MATH for TEST then press 5 for 5:<
   - You should see Y1=X^2(X\leq0)+(X+1)(2<X)(X<4)
   ☞ NOTE: You must use parentheses around x + 1 since it has more than one term.
   ☞ NOTE: The TI-82 will not understand 2<x<4. You must use (2<x) (x<4)
> Graph the function in the standard Graphing window.
The graph is not correct. The TI-82 is graphing in connected mode and assumes that the function is equal to zero outside the given domain. In connected mode, the TI-82 connects the pieces to each other or to the x-axis. To eliminate this problem, you can change to dot mode.

> Press **MODE**
> The fifth line down says: **Dot**
> Use the arrow keys to highlight **Dot**
> Press **ENTER**
> Press **GRAPH**

What do you see?

3. Graph in **Dot** mode: 

\[ f(x) = \begin{cases} 
-2x, & x \leq 3 \\
\frac{1}{2}x, & x > 3 
\end{cases} \]

☞ **WARNING:** Use explicit multiplication for \( \frac{1}{2}x \)

What do you see?

**BEFORE CONTINUING, CLEAR ALL FUNCTIONS AND RETURN TO CONNECTED MODE.**

**Plotting Points**

To plot points on the TI-82, you must first enter them into the Stat List window.

1. Plot the points \((2, 5)\) \((5, 6)\) \((7, 4)\) and \((11, 7)\)

a. > Press **STAT**
   - You will see
     
     ![Stat Menu](image)

   > Press 1 for 1:Edit…
   - You will see
     
     ![Stat List](image)
Enter the points with the x-values in L1 and the y-values in L2. It will be easiest to enter all the x-values first and then all the y-values.

> Press 2  
- You will see L1(1)=2 at the bottom of the screen.
> Press ENTER  
- The 2 is entered into L1
> Press 5 ENTER 7 ENTER 11 ENTER  
- L1 should contain the four x-coordinates
> Press > to move the cursor to the L2 column.
> Press 5 ENTER 6 ENTER 4 ENTER 7 ENTER  
- You should see

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>----</td>
</tr>
</tbody>
</table>

If you entered any wrong numbers, use the arrow keys to highlight the list entry, retype the entry, and press ENTER. Note that the highlighted entry is always shown at the bottom of the screen.

b. To graph the points, use STATPLOT.

> Press 2nd Y= for STATPLOT  
- You should see

```
STATPLOT
1:Plot1...
Off L1 L2 L3
2:Plot2...
Off L1 L2 L3
3:Plot3...
Off L1 L2 L3
A:PlotOff
```

This window tells you that you can have up to 3 STAT PLOTS (graphs of data), but currently all 3 are off.

> Press 1 for Plot1...  
- You should see

```
Plot1
In [ ]
Type: ▲ ▼ X
Xlist: L1 L2 L3 L4 L5 L6
Ylist: L1 L2 L3 L4 L5 L6
Mark: · · ·
```

On Off tells you if Plot1 is ON or OFF (currently OFF).
Type tells you the type of plot: Data points only, Line graph (connect the data points), Boxplot or Histogram.
Xlist tells you the Stat List that will be used for the independent (input) data.
Ylist tells you the Stat List that will be used for the dependent (output) data.
Mark tells you the symbol that marks each data point.
This Plot1 window says that the TI-82 will graph the data points without connecting them, using \( L_1 \) for the x-coordinates, \( L_2 \) for the y-coordinates, and marking each point with a ❏.

> Press ENTER to turn Plot1 ON.

> Press ZOOM 6 to graph the points in the standard Graphing window.

How many points do you see? __________

To see all the points, you will need to change the Graphing window settings so that all the x-coordinates of the points fall between \( X_{\text{min}} \) and \( X_{\text{max}} \) and all the y-coordinates fall between \( Y_{\text{min}} \) and \( Y_{\text{max}} \).

> Adjust the Graphing window settings so that you can see all four points.
☞ HINT: Press WINDOW and make \( X_{\text{max}} \) larger.

How many points do you see? ________

d. You can get better graphs of the points in #1 by using ZoomStat

> Press ZOOM
> Press v to highlight 9:
> Press ENTER for 9:ZoomStat

ZoomStat gives you the smallest Graphing window that contains all the points, thus giving you a nice close-up view. This will be helpful when you are looking for patterns in data. However, the axes do not show, so it is hard to read the graph. To see the axes,

> Adjust the Graphing window settings to include \( x = 0 \) (the y-axis) and \( y = 0 \) (the x-axis)
☞ HINT: Press WINDOW and set \( X_{\text{min}}=0 \) and \( Y_{\text{min}}=0 \)

2. Suppose you wish to plot certain points on the graph of a function. You must enter the points directly into the Stat List window.

Make a table of values for \( f(x) = x^2 - 4 \), for \( x \) going from -4 to 5 by 1 and plot the points.

> Enter \( f(x) = x^2 - 4 \) in the Function window.
> Go to the Stat List window. ☞ HINT: Press STAT 1

To clear the current data from the \( L_1 \),
> Press ^ to highlight \( L_1 \)
> Press CLEAR ENTER
- \( L_1 \) should clear

> Enter the x-values -4, -3, -2, -1, 0, 1, 2, 3, 4, 5 into \( L_1 \)
☞ HINT: Type -4 ENTER -3 ENTER etc.
> Use the arrow keys to highlight L2
> Press CLEAR ENTER  
  - L2 should clear

You will define L2=Y1(L1)
> Press ^ to highlight L2
  - You should see L2= at the bottom of the screen
> Press 2nd VARS for Y-VARS
> Press 1 for 1:Function
> Press 1 for 1:Y1
> Type ( 
> Press 2nd 1 for L1
> Type )
  - You should see L2=Y2(L1) at the bottom of the screen
> Press ENTER
  - L2 should fill with the y-values corresponding to the x-values in L1

To graph the points along with the function,
> Press ZOOM 9 for 9:ZoomStat

What do you see?

To graph the points without the function,
> Turn off Y1
  ☞ HINT: Press Y=, highlight the = sign after Y1 and press ENTER
> Press ZOOM 9

What do you see?

3. The TI-82 holds up to six lists. To see this,
> Press STAT 1 to edit the data lists
> Press > until you can see L6
> Press < to return to L1

4. You should turn off your Stat Plots when you are done with them.
> Press 2nd Y= for STATPLOT
> Press 4 for 4:PlotsOff
  - You should see PlotsOff in the Home window
> Press ENTER
Representing a function analytically, numerically and graphically

You are now able to represent functions in three ways using the TI-82:

1. analytically (using equations)
2. numerically (using tables)
3. graphically.

For example, consider the function $f(x) = x^3 - 5x + 15$.

1. Define $f(x) = x^3 - 5x + 15$ in the Function window. This equation is an analytic representation of $f(x)$.

2. Make a table of $x$ and $f(x)$ values using the TblSet and Table windows you learned about in Lab B1. Let $x$ go from -4 to 4 at 1 unit intervals.

Write the resulting table in the space below. This table is a numeric representation of $f(x)$.

3. Use WINDOW to set the scale in the Graphing window so that all the points in the table will fit and scale marks will show along the axes. Indicate your Graphing window settings below.

   $\begin{align*}
   \text{Xmin} & = \quad \text{Xmax} = \quad \text{Xscl} = \\
   \text{Ymin} & = \quad \text{Ymax} = \quad \text{Yscl} = 
   \end{align*}$

4. Graph $f(x)$ in the Graphing window. This is a graphic representation of $f(x)$. Sketch the graph below. Be sure to indicate the scale by labeling at least one scale mark along each axis.

5. Use the Stat Lists (STAT 1) and STATPLOT as in the previous section to enter and graph the points in the table in part 2. If some of the points in the table do not appear in the Graphing window, then redo parts 3 and 4 above.
Summary of Calculator Functions

For each of the following calculator functions, write a brief description of what the function is used for and how to use it.

Y=

WINDOW

GRAPH

ZOOM

STAT

STATPLOT

Y-VARS

ZOOM FACTORS
Graphing Practice

BEFORE STARTING THESE PROBLEMS, CLEAR ALL FUNCTIONS AND STATPLOTS.

Graph the following functions and use the graphs to determine the domain and range:

1. \[ y = \sqrt{9 - x^2} \]  
   Domain______________  Range______________  
   ☞ The graph in #1 should be a semicircle. Press ZOOM 6, then ZOOM 5 for ZSquare to see this.

2. \[ y = -|x| + 4 \]  
   Domain______________  Range______________  

3. \[ y = .5x + x\sqrt{16 - x^2} \]  
   Domain______________  Range______________  

4. \[ y = .5x^2 + 4x \]  
   Domain______________  Range______________  

5. \[ y = \frac{|x|}{x} \]  
   Domain______________  Range______________  

6. \[ y = \begin{cases} -|x+3| & x < -2 \\ 2 - x^2 & x \geq -2 \end{cases} \]  
   Domain______________  Range______________  

7. a. Enter the following table on the TI-82.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.8</td>
<td>1.85</td>
</tr>
<tr>
<td>4</td>
<td>-1</td>
</tr>
<tr>
<td>-6</td>
<td>-8.5</td>
</tr>
<tr>
<td>0</td>
<td>-4</td>
</tr>
</tbody>
</table>

   b. Plot the points on the TI-82. What pattern do you see?

   c. Write an equation of the graph that passes through the points. Test your equation by graphing it to see that it passes through all the points.

   Equation: ______________________
8. Consider the function whose analytic form is \( f(x) = x\sqrt{15625 - x^3} \)

a. Enter the function in the Function window.

b. Use the *TblSet* and *TABLE* windows to make a table of values for this function with \( x \) going from -10 to 25 in increments of 5. Write your table in the space below.

c. Graph \( f(x) \) for \(-10 \leq x \leq 25\). Use the table in part a to help you choose appropriate Graphing window settings. What are your *WINDOW* settings?

\[
\begin{align*}
\text{Xmin} &= \quad \text{Xmax} = \\
\text{Ymin} &= \quad \text{Ymax} = \\
\text{Xscl} &= \quad \text{Yscl} = \\
\end{align*}
\]

d. Sketch your graph below. Be sure to indicate the scale by labeling at least one scale mark along each axis.

Extra Credit:
Make up and graph on the TI-82 a function with an interesting or unusual looking graph (you may need to experiment a bit to do this). Then make a sketch showing the labeled and scaled coordinate axes. Make a table of values for your function using the Table window and plot the points using the Stat Lists and Statplot windows to see that they do fall on the graph of the function. Include the numeric, analytic, and graphic (use graph paper or computer print out) representations of your function with the laboratory report. What advantages are there to each of these representations?