Instructions for MA101 Labs

by

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Content

1. Basic Operations in Microsoft Excel

1.1 Working with Cells

To start, open a new Excel Spreadsheet. You will see a number of columns and rows of cells. Rows are named by numbers and columns by letters so each cell has a different name.

There are two basic ways to work with cells. If you type text or numbers in a cell not starting with symbol =, the typed symbols will be displayed on the screen. In this case, the cell entry is considered a **constant**.

If you want to use cell content as **formula**, you must start to enter the data in the cell by symbol "**=**". For example, if you type 3*6-4 in a cell, 3*6-4 will be displayed. However, if you type =3*6-4, the value of this expression, 14, will be displayed.

You can **reference a cell content** and use it in a different cell. For example, suppose that the result of our previous calculation "=3*6-4" is in cell A1. Say that we need to square this answer 14 and place the result in the cell B1. Move the cursor to the cell B1 and type "=A1^2". The result will be 196.

You can reference more than one cell. For example, let us divide the content of cell B1 with the content of the cell A1 and place the result in cell A3. Move the cursor to cell A3 and type "=B1/A1". If "=3*6-4" is in A1 and "=A1^2" is in B1, the answer, 14, will be displayed in cell A3.

Suppose that we want the answer of this division to more than two decimals. To do this, we need to **format the cell** so that more decimal places are displayed. Go to **Format** menu and choose **Cells** option. A new window will open. In the window choose **Number** option and select the desired number of decimal places.

1.2 Basic Functions

Addition, subtraction, multiplication and division are performed using the usual symbols: +, -, * and /. You can use the symbol ^ to perform the power operation. For taking the square root, you can use **sqrt** command. For example, typing "=sqrt(16)" in a cell will produced the desired answer 4.

The functions **sin, cos, tan,** and **ln** have the same representation in Excel as in your TI83. The natural exponential function is represented as **exp**. For example, to evaluate e^2 type "=exp(2)".

The number π is represented as **pi**.

1.3 Creating Lists

We often work with the list of data. For example, suppose that a teacher needs to calculate the median and mean of students' grades: 80, 97, 64, 90, 83, 77. Enter the following six grades is any row or column. For example, we can enter them in cells A1 to A6. The Excel command that refers to the list of these numbers is

A1,A2,A3,A4,A5,A6

or shorter

A1:A6

The built-in function for median and average mean are MEDIAN and AVERAGE followed by the desired list in parenthesis. For example, the commands

=median(A1:A6)

and

=average(A1:A6)

will produce the median 81.5 and arithmetical mean 81.83 of the above list.

To sum the entries of the list, use the command SUM followed by the list in parenthesis. For example "**sum(A1:A6)**" will produce the answer 491.

The command **sum** works also with the individual entries as well as the lists. For example, if the entry of the cell B3 is 50 and we need to add that entry to the sum of entries in cells A1 to A4 and A6, we can type

= sum(A1:A4, A6, B3)

To find the largest and the lowest entry of the list, type

=max(A1:A6)

and

=min(A1:A6)

Often one needs to **create a list of values by specifying the first and last entry and a rule for creating the entries in between**. For example, let us create a list of even numbers between 0 and 20. We can start by entering 0 to a desired cell, say A1. To create the next cell in, say, A2 we can type the command "=A1+2" in A2. Copying and pasting this command in A3 will produce the entry "=A2+2" in A3. Just copying and pasting this same command in cells A4 to A11 will produce the list of even numbers from 0 to 20.

Alternatively, this can be done using the menu **Edit** and option **Fill** followed by **Series**. Highlight the first 11 cells in the first column and choose **Edit-->Fill-->Series**. A new window will open. Choose the start value to be 0, the end value to be 20 and the increment to be 2 and press OK. The outcome will be the same list.

1.4 Defining and Evaluating a Function

Let us consider functions given by formulas on specified independent variable values. For example, let us consider the function x^2-2x on domain of integer values between -1 and 6. Let us place the list of independent variable values in the first and the list of dependent variable values in the second column. Let us denote the columns by "x" and "y" by placing these symbols in the first row. Then create the list of integers between -1 and 6 in cells A2 to A9.

To obtain the *y*-values using the given *x*-values and the specified formula, you can type "=A2^2-2*A2" in cell B2 and copy and paste the result to the cells B3 to B9. <u>Careful: you have to type * for multiplication when entering 2*A2</u>. The outcome will be:

x	y
-1	3
0	0
1	-1
2	0
3	3
4	8
5	15
6	24

Having defined a function as a list of x and y-values, you can **evaluate a function** for any other value of independent variable. For example, to evaluate a function x^2-2x for value x=7, enter 7 in any cell, say, A10, copy the content of any of the cells B2 to B9 and paste it to the cell B10. This will produce the answer 35 in B10.

7	35

Sometimes it might be more efficient to work with symbol x for the independent variable than to change the notation for it from cell to cell. In this case, you can create a name for the entries in the first column and use the name for the entries in the second column. Say that we want to call the entries in cells A2 to A9 with x. Select the entries A1 to A9 and choose the menu **Insert-->Name-->Create.** A new window will open asking you about the name you want to create. As you want to call the variables x, just choose the option "top row" as your top row already has entry *x* in it. This allows you to use the symbol x when working with the function formula x^2-2x. So, to obtain the list of y-values just paste "=x^2-2*x" to cells B2 to B9.

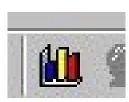
If you need to evaluate a function in an additional *x*-value, just add the value to the list of *x*-values, make sure it is included in the list of names of *x* and then copy and paste the above formula in the cell in which you want the appropriate *y*-value to be stored.

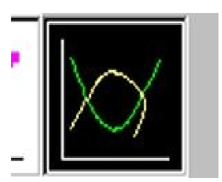
2. Graphing

2.1 Graphing Functions

To graph the function, you first need to generate the list of function values, as explained in the previous section. For example, let us graph the function x^2-2x on the domain [-1, 6] using the lists of *x* and *y*-values placed in cells A2 to A9 and B2 to B9 respectively.

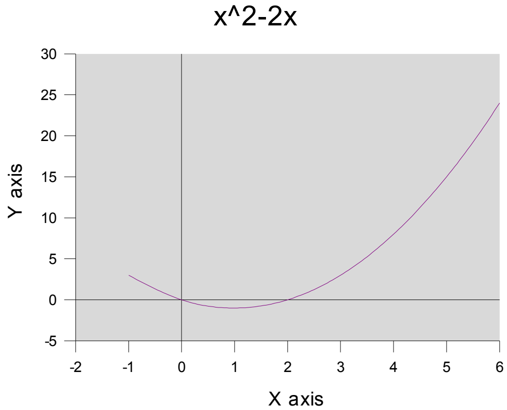
Select cells A2 to B9. Select icon
or go to the menu **Insert** and select **Chart**.





Then choose **XY scatter plot** and select the type of the graph to be

Click on **Next** and label the axis as you prefer, and then click on **Finish**. You can also choose if you want the graph to be placed in the same or in a new Excel sheet.



You can edit the graph by double-clicking on different parts of it. For example, to change the format of *x*-axis, select it and double-click on it. You can change different parameters such as the minimum and maximum *x*-value displayed, fonts or patterns used, color or width of the curve and the position of *y*-axis. By clicking on the graph, you can change its color, pattern and other features.

2.2 Graphing multiple Functions

To graph more than one function simultaneously, edit them in various lists and proceed similarly as when graphing a single function. For example, let us graph $f(x)=x^2-2x$ and $g(x)=x^2$ on the same graph. If you have the lists of *x* and *f(x)*-values placed in cells A2 to A9 and B2 to B9 respectively as in previous example, add the list of *g(x)*-values in cells C2 to C9 and repeat the process from previous section, as you would have graphed a single function. The output will be a chart with *f(x)* and *g(x)* graphed. Similarly you can graphed more than one function.

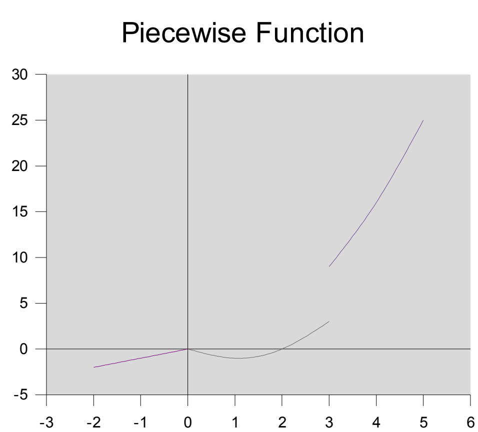
2.3 Graphing a Piecewise Functions

Let us graph a function

$$y = \begin{cases} x & x < 0 \\ x^2 - 2x & 0 \leq x < 3 \\ x^2 & x \geq 3 \end{cases}$$

on the domain [-2, 5]. Make the list of x-values similarly as in previous sections. Enter the y-values in the following three columns formated to calculate the values of *x*, x^2-2x, and x^2 respectively leaving blanks for the y-values not defined. The outcome will be:

x	y1	y2	y3
-2	-2		
-1	-1		
0	0	0	
1		-1	
2		0	
3		3	9
4			16
5			25



Then select all the cells above and repeat the usual process for graphing functions. The outcome will be the graph of desired piecewise function.

3. Solving Equations

3.1 Finding x-intercepts

Let us consider the function x^2-2 and let us find the *x*-intercepts of it. Graphing it we observe that it has two *x*-intercepts, one between 1 and 2 and the other between -1 and -2. Let us first find the positive one. Enter any *x*-value close to the zero you want to find (for example 1, 2 or any other number closer to positive than to negative answer) in the cell in which you want the answer to be stored. Then enter the formula calculating the y-value in the cell next to it. For example

1	-1

Place the cursor on the y-value and choose **Tools --> Goal Seek**. A new window will open asking you for

Set cell: the name of the cell with y-value will be in it
To value: put 0 there as you want to find the zero of function
By changing cell: enter the name of the cell in which you want the desired *x*-value to be stored.

The outcome will be:

1.41	0

That means that the positive solution is 1.41. Changing the format of the cell, you can increase the accuracy of your answer.

To find the negative solution, just change the initial *x*-value you are entering before using the **Goal Seek** function. For example, with

-1	-1

you will obtain the answer

-1.41	0

On similar way, you can find the *x*-value for any given *y*-value. For example, to solve x^2-2=1, just change 0 to 1 when filling the **Goal Seek-->To value** field.

3.2 Finding intersections and Solving Equations

Finding the intersections of two functions, *f(x)* and *g(x)*, is the same as finding *x*-intercepts of *f(x)-g(x).*

$$f(x)=g(x) \quad \text{if and only if} \quad f(x)-g(x)=0.$$

So, consider the function *f(x)-g(x)* and find its *x*-intercepts using the method from previous section.

You can solve the equation of the form *f(x)=g(x)* on the same way as you would find the intersections of functions *f(x)* and *g(x):* find the *x*-intercepts of *f(x)-g(x).*

3.3 Using "Solver"

Consider the function x^2-10x+8 and let us find the extreme value. Graphing it, we observe that it has a **minimum** *y*-value, occurring at some *x*-value between 4 and 6. Enter any *x*-value close to the minimum generating value you want to find (for example 4 or 6) in the cell in which you want the answer to be stored. Then enter the formula calculating the *y*-value in the cell next to it. For example:

4	- 16

Place the cursor on the *y*-value and choose **Tools --> Solver**. A new window will open asking you for:
Set cell: the name of the cell with *y*-value will be in it.
Equal to: Check off what you want to find – in this case the minimum.
By changing cell: enter the name of the cell with the “close” *x*-value in it .
Leave the "Subject to Constraints" field blank.

Then hit **Solve**. The outcome will be:

5	- 17

Check **"Keep Solver Solution"**.
Thus, an *x*-value of 5 will produce the minimum *y*-value of -17 for the function x^2-10x+8.

Notice that you can also find the *x*-intercepts with **Solver**. Consider the function x^2-10x+8 and let us find the *x*-intercepts. Graphing it we observe that the function has an *x*-intercept between 0 and 2 and another one between 6 and 10. Enter any *x*-value close to the *x*-intercept you want to find (for example 2) in the cell in which you want the answer to be stored. Then enter the formula calculating the *y*-value in the cell next to it.

For example:

2	- 8

Place the cursor on the *y*-value and choose **Tools --> Solver**.
Set cell: the name of the cell with *y*-value will be in it.
Equal to: Check off what you want to find – in this case **Value of 0**.
By changing cell: enter the name of the cell with the “close” *x*-value in it .
Leave the "Subject to Constraints" field blank.

Then hit **Solve**. The outcome will be:

0.876894	-6.7 E -07 (which is very close to 0)

Check **"Keep Solver Solution"**.   0.876894 is the left x-intercept.

Repeat the steps using x = 10 as the "close" x-value. The outcome will be:

9.123106	-2.3 E -07 (which is very close to 0)

Check **"Keep Solver Solution"**.   9.123106 is the right x-intercept.

If you want to know what x-value gives a y-value of 25 for the function $x^2-10x+8$, follow the preceding steps but insert the number 25 after **"Value of"**. The outcome will be:

11.48074	25

So the function or y-value is 25 when x = 11.48074.

4. Regression Curves

Suppose that we need to find the linear regression for the following data set

x	0	1	2	3	4	5
y	2.5	2.29	2.1	1.95	1.81	1.5

Enter the data in two columns (or rows).

First you want to graph the given points as a scatter plot. Use the usual **Insert--> Chart**, just use the option with scatter points (symbols only) instead of option with curves. By clicking on any of the points, select the points on the graph.

Choose **Chart --> Add Trendline**. Under **Type**, you can choose the regression that you want to use. Your options are

- Linear Regression;
- Polynomial Regression for which you can choose the degree:
    - Degree 2 will give you Quadratic Regression,
    - Degree 3 will give you Cubic Regression,
    - Degree 4 will give you Quartic Regression;
- Exponential Regression;
- Logarithmic Regression;
- Power Regression.

When you have selected the regression type, click on **Options**. This menu will let you display the regression formula and the coefficient of determination. Choose the option **Display equation** if you need the regression formula. For the example above, you will obtain

y= -.189x+2.496 and R^2=.986.

Similarly, you can get the other regression curves.

Having the regression equation will allow you to create a regression function in which you will be able to

- plug the given x-value and solve for y-value (as explained in 1.4)
- set the equation equal to the given y-value and solve for x-value (as explained in 3.1 and 3.2)

5. Practice Problems

1. a) Use the spreadsheet to evaluate the expression $\frac{34-\sqrt{12}}{2^3 * 3^2}$ Display the answer to four decimals.

b) Display the value of sine of the answer from a).

c) Display the value of the answer from b) raised on *e*.

Methods explained in sections 1.1 and 1.2 might be helpful.

2. Suppose that it is measured that the average temperatures in Philadelphia in the first week of September are: 75, 72, 70, 68, 71, 73, 73. Create a list containing the data. Using the list, display the

a) average b) median c) largest and d) smallest element of the list.

Methods explained in section 1.3 might be helpful.

3. Consider the function $f(x)=x^3-5x+2$ on domain [-4, 5].

a) Graph this function on given domain.

b) Evaluate this function at x=1.5 and x=12.

c) Find all x-intercepts of this function.

d) Find the x-values that correspond to y-value of -5.

e) Let $g(x)=-4x$. Find the intersection(s) of $f(x)$ and $g(x)$.

Methods and examples from sections 1.4, 2.1, 2.2, 3.1 and 3.2 are relevant.

4. Graph the piecewise function

$$y = \begin{cases} -x-2 & x < -1 \\ x & -1 \leq x < 1 \\ -x+2 & x \geq 1 \end{cases}$$

on domain [-2,2]. Methods and examples from section 2.3 are relevant.

For problems 5 to 7, methods and examples from sections 5, 1.4 and 3.2 are relevant.

5. A physician decides to measure the healing process of the area of a wound over a 5 day period and collects the following data

time (days)	0	1	2	3	4
area (mm^2)	200	174.3	148.1	122.5	92.7

Find a linear model. Interpret the slope in the context of the problem. When will the wound be completely healed?

6. A company decides to develop a cost equation based on the quantity of the product produced in a day. They collected the following data:

quantity produced	20	35	50	65	80	95	110
cost	642.35	766.48	858.82	928.83	1005.32	1078.82	1140.79

Find a linear and quadratic model for this data. Which model is better? According to the model, how much will producing 195 units cost the company? How many units could be produced for $800?

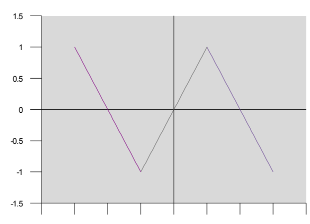
7. The table below shows the number of bacteria present in a culture *t* hours after the start of the experiment.

time (hours)	0	1	2	3	4	5
number of bacteria	250	342	521	736	1015	1483

Find the exponential model to fit this data. According to that model, how many bacteria will be in the culture in 7 hours? When will there be 5000 bacteria?

Solutions

1. a) .4241, b) .4115, c) 1.5091.
2. a) 71.71, b) 72 c) 75, d) 68.
3. a) You can check your graph using calculator. b) (1.5, -2.125) and (12, 1670). c) x-intercepts: -2.41, .414 and 2. d) x=-2.747. e) x=-1.52.
4.



5. y=-26.64x+200.8. Negative slope of -26.64 means that the area of the wound is decreasing at the rate of 26.64 mm^2 per day. The wound will be healed after 7.5 days.
6. Quadratic. 195 units cost $1287. 42 units for $800.
7. Exponential model y=247.809(1.4297)^x. 3025 bacteria. 8.4 hours (8 hours 24minutes).