EGR 120
Introduction to Engineering
File: N120L11M

Lecture #11 (Excel Lecture B)

Reading Assignment:

Chapter 14 in Engineering Fundamentals – An Introduction to Engineering, 3rd Edition, by Saeed Moaveni.
The following Excel Examples (passed out in class or available from the instructor's web page):

- ***Linear Regression using Microsoft Excel***
- ***Exponential Regression using Microsoft Excel***
- ***Power Regression using Microsoft Excel***
- ***Logarithmic Regression using Microsoft Excel***
- ***Polynomial Regression using Microsoft Excel***
- ***Linear Regression (with full regression statistics) using Microsoft Excel***

Handout: Linear Regression (by hand)

Graphing:

Many software packages, including Excel, have excellent graphing capabilities. However, if care is not taken to use good graphing practices and standards, the computer might easily be used as a tool to generate poor graphs. Several features related to good graphing practices are discussed below.

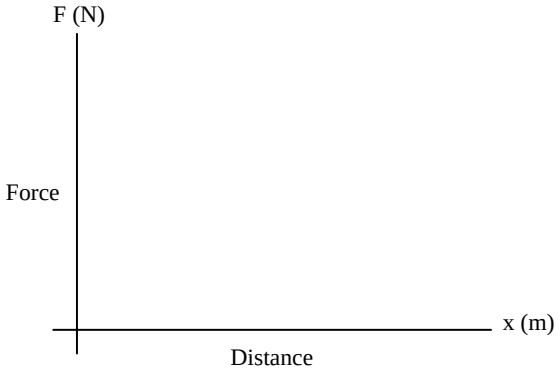
Good Graphing Practices and Graphing Terminology

1. Identify the independent and dependent variables.

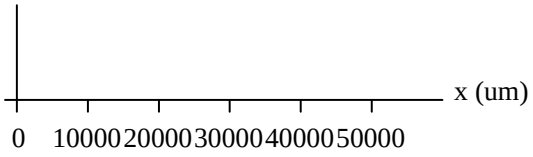
- The x-axis is used to display the ***independent variable***.
- The y-axis is used to display the ***dependent variable.***
- Note that in an equation y = f(x), the value of y ***depends*** on the value of x inserted into the function.
- For some operations (such as regression), Excel will ask the user to specify which are the independent variables (it will not ask for the "y variable").

2. **Include a title with each graph**.

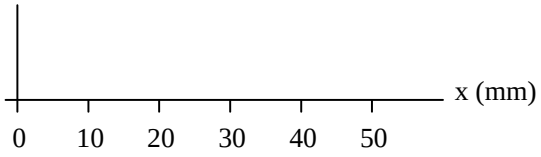
3. **Label the variable name, variable symbol, and units on each axis**. For example:



4. **<u>Avoid crowding the axis</u>** (use prefixes if necessary).
Example:



(axis is too crowded)

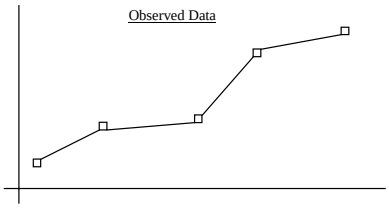


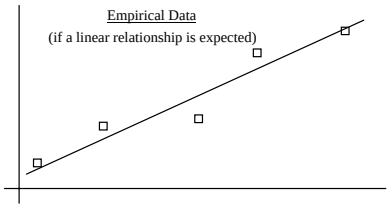
(the prefix was changed to eliminate the crowding)

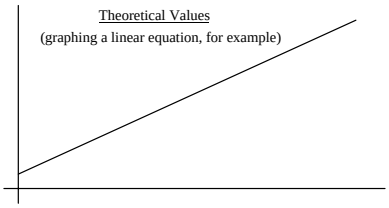
- Discuss how this would be handled in a spreadsheet

5. **<u>Choose proper calibrations on each scale</u>**.
   - Graphs with poor calibrations are difficult to interpolate.
   - Use the "1, 2, 5 rule". Pick calibrations that are 1, 2, or 5 times 10^N, where N is an integer.
   - Show an example.

6. **<u>Display the results correctly</u>**.
Should you show the data points? It depends.
Should you connect the points? It depends.
There are essentially three types of quantities that are graphed and there are different rules for displaying each type.
   A. <u>Observed data</u>
      - This type of data has no assumed form (we do not expect it to follow some mathematical formula).
      - Show data points and connect them ("dot-to-dot").
   B. <u>Empirical data</u>
      - This type of data is assumed to follow some mathematical formula and thus should be displayed using a "smooth curve" rather than by connecting the points.
      - Most engineering data will be of this type.
   C. <u>Theoretical values</u>
      - We sometimes wish to graph a mathematical function. This requires generating a few "points" in a spreadsheet, but the points picked are not data, so <u>the points should not be shown.</u>







7. Drawing a smooth curve (for empirical data)

Consider three ways to draw a smooth curve.

A. Visual estimation
- Problem: This method is not precise and results will vary.

B. Method of least averages
- This is a statistical method intended to generate the line (or curve) that will result in the least average error between the line and the data points.
- This seems to be the best method intuitively.

C. Method of least mean squares (linear regression)
- This is a statistical method intended to generate the line (or curve) that will result in the least average square error between the line and the data points.
- This is generally considered to be the best fit.
- Most mathematics and spreadsheet software packages include linear regression.
- See the hand example for performing linear regression.
- Discuss the purpose of the **correlation coefficient, R**.

8. Linear versus log scales

Various types of relationships (equations) can be determined through graphing and analysis, including:

a) linear equation: $y = mx + b$
- an equation of this form will exhibit a straight-line relationship on linear scales used for the x and y axes

b) exponential equation: $y = be^{mx}$
- taking the natural log of both sides of the equation yields $\ln(y) = mx + \ln(b)$
- an equation of this form will exhibit a straight-line relationship if the y-axis is on a log scale and the x-axis is on a linear scale.

c) logarithmic equation: $y = m\ln(x) + b$
- an equation of this form will exhibit a straight-line relationship if the y-axis is on a linear scale and the x-axis is on a log scale.

d) power equation: $y = bx^m$
- taking the log of both sides of the equation yields $\log(y) = m\log(x) + \log(b)$
- an equation of this form will exhibit a straight-line relationship if both the y-axis and the x-axis are on log scales.

e) polynomial equation: $y = A_0 + A_1x + A_2x^2 + A_3x^3 + \ldots + A_Nx^N$ (Nth-order polynomial)
- the data does not typically exhibit a straight-line relationship with any combination of log or linear scales, so both the y-axis and the x-axis are on linear scales.

Note that Excel will perform a regression analysis (by adding a trendline) for any of the types of equations listed above no matter what scales are used on the axes. However, it is common to use the types of axes indicated below:

Type of equation	x-axis	y-axis
Linear	Linear	Linear
Exponential	Linear	Log
Logarithmic	Log	Linear
Power	Log	Log
polynomial	Linear	Linear

Excel Demonstration

Various examples will be shown using different types of trendlines.

Basic steps in creating an xy graph:

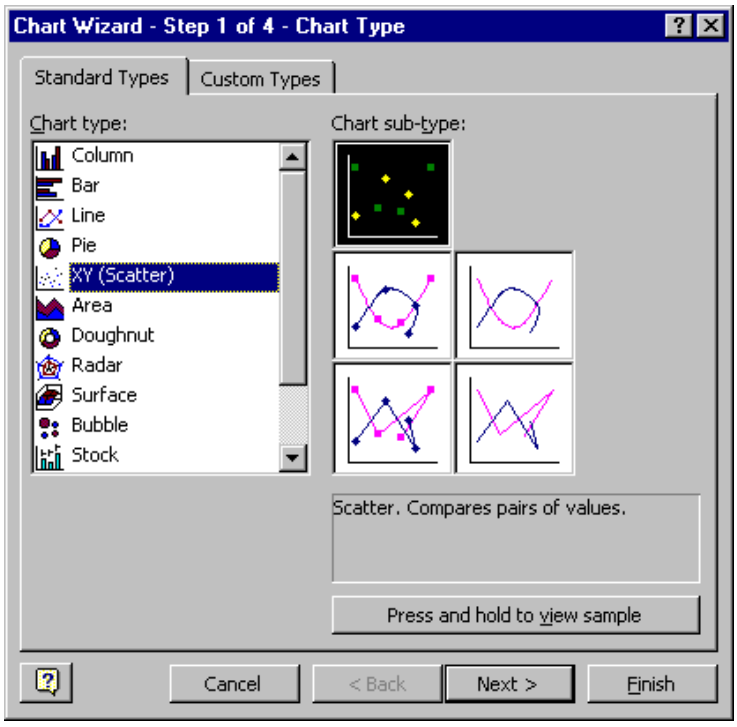
1. Create the table of information. It is easiest is the x (independent) values are in the column to the left of the y values, but it is not necessary.

	B	C	D
2			
3	**x**	**y**	
4	1	12	
5	2	24	
6	3	35	
7	4	46	
8	5	57	
9	6	68	

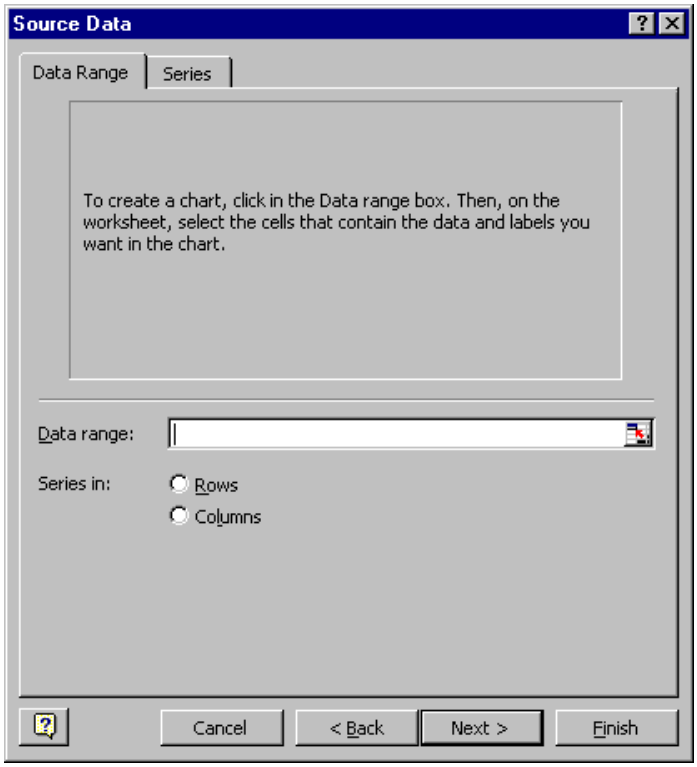
2. Select ***Insert – Chart*** from the main menu. This will open the Chart Wizard window.

(continued)

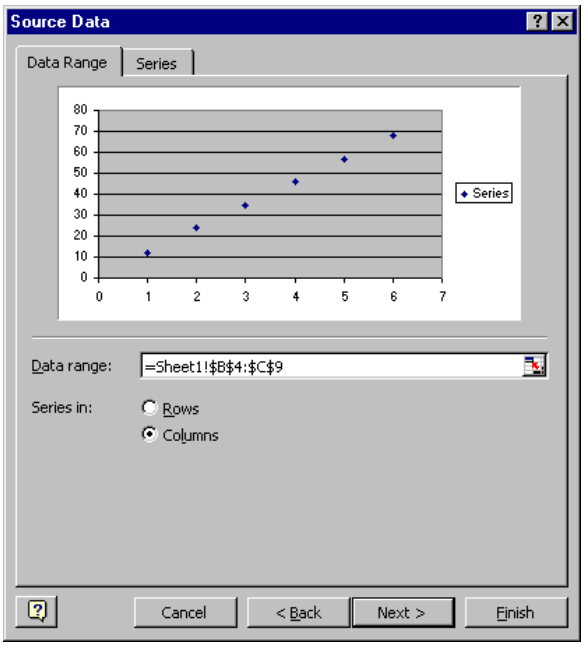
3. In Step 1 of the Chart Wizard, specify the type of chart desired. Under the Standard Types tab in the Chart Wizard, pick ***XY (Scatter).*** Under Chart sub-type, pick the icon with points only (no lines). The note below will say: ***Scatter. Compares pairs of values***. Then select the ***Next*** button.



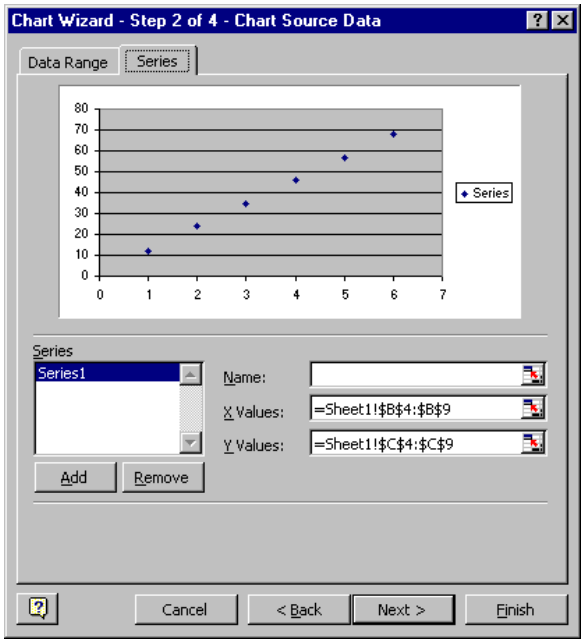
4. In Step 2 of the Chart Wizard, specify the data range. Do this by picking the arrow to the right of the place for entering the Data range and then highlight the x and y values in the spreadsheet. Click on the icon that replaced the arrow to return to the Chart Wizard. Pick the Series tab and be sure that the correct values are used for the x-values and the y-values. If not, you can change them here. Then select the ***Next*** button.



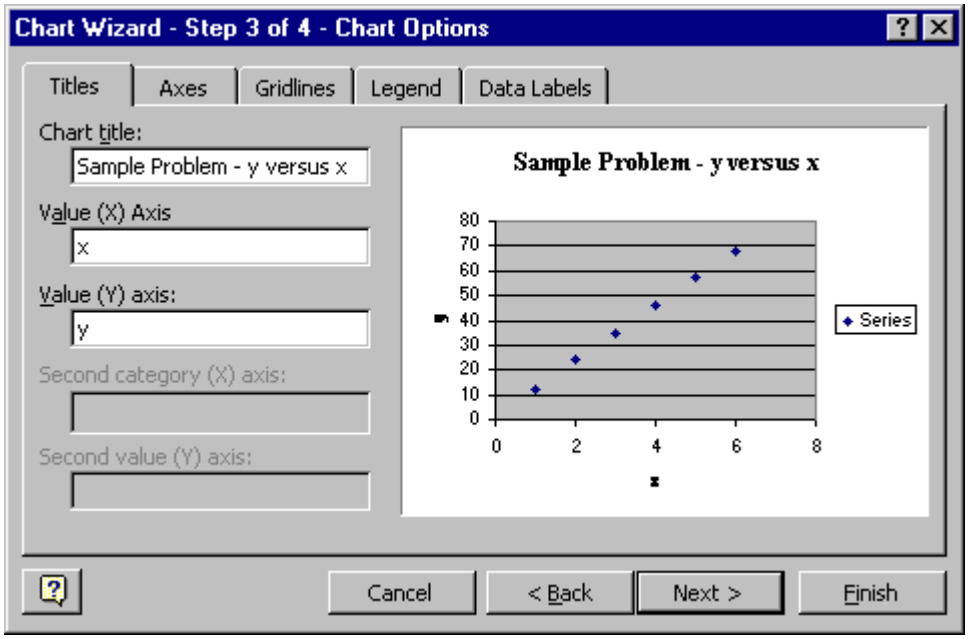
After specifying the data range



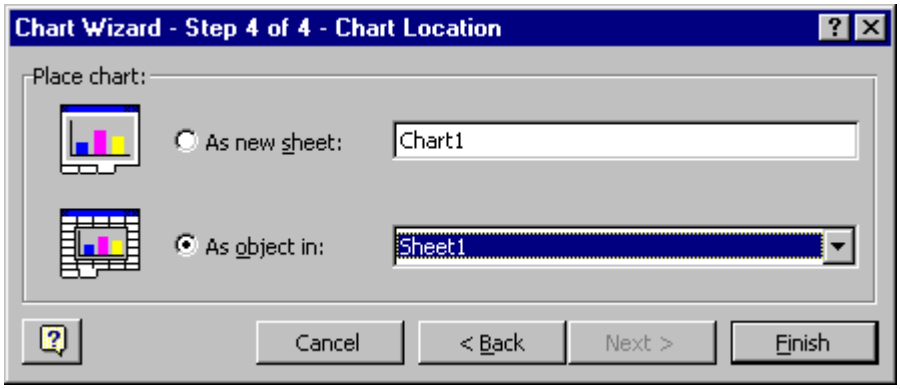
Checking the series information



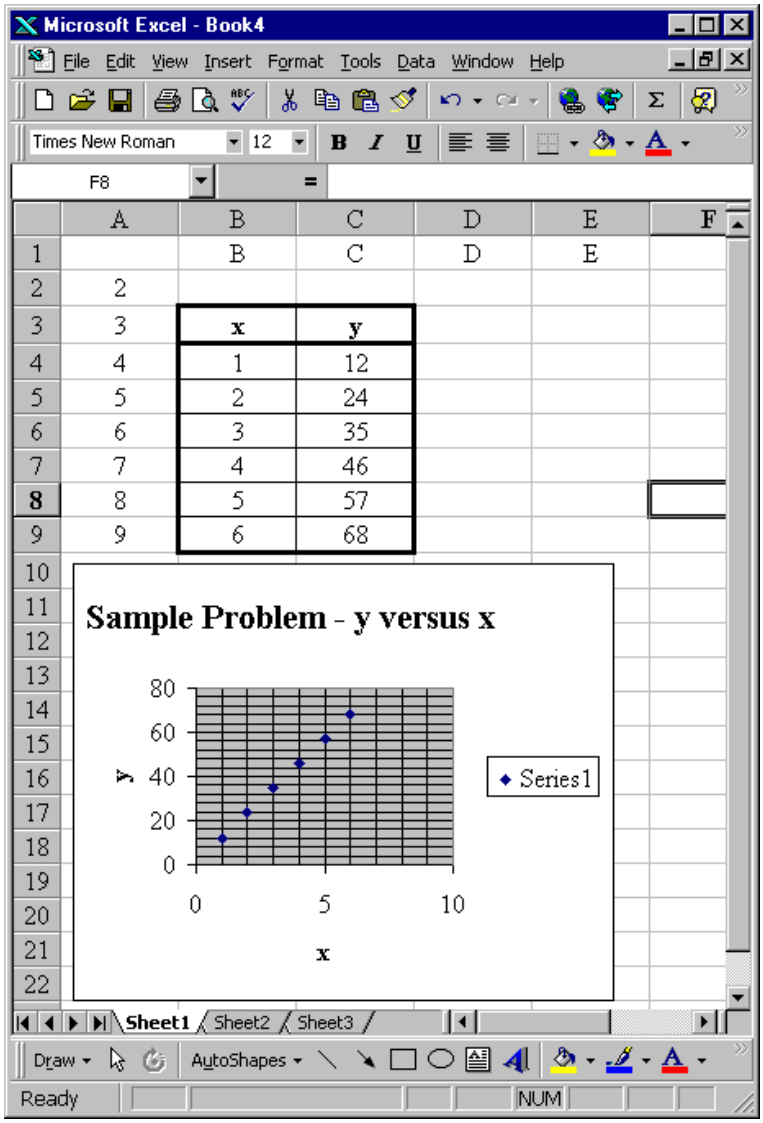
5. In Step 3 of the Chart Wizard, specify the titles, type of gridlines, etc., that you want for the graph. Then select the ***Next*** button.



6. In Step 4 of the Chart Wizard, specify the chart location. Usually the default setting of placing the chart in the worksheet is desired, so select the ***Finish*** button.



7. Now the chart should appear in the worksheet. You can drag it to any desired location and resize it. You can right-click on many features of the graph to change the related properties.



x	y
1	12
2	24
3	35
4	46
5	57
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