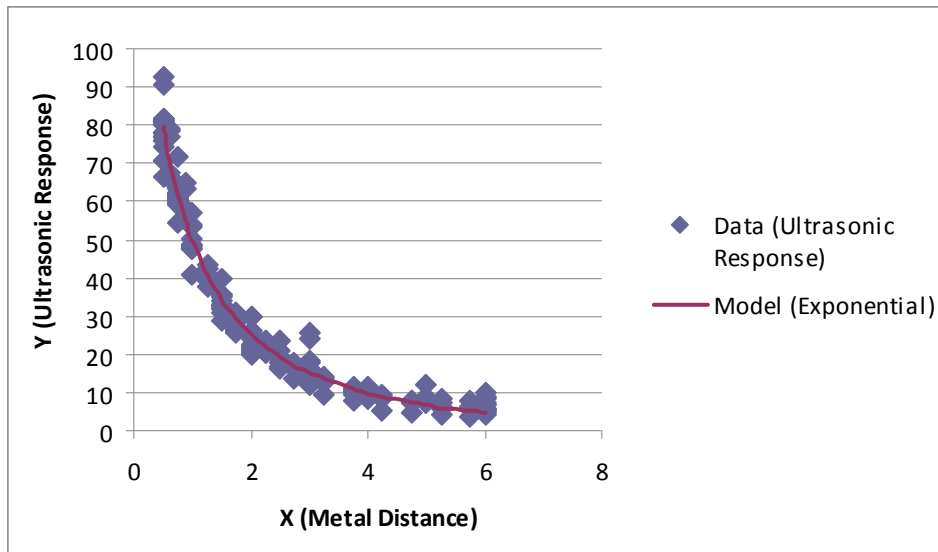


Engin 103 October 12, 2010  <a href="#">back to e-syllabus</a>	Topics: <a href="#">CW5</a> <a href="#">Introduction to LabVIEW</a> <a href="#">CW6</a> <a href="#">Circuit Analysis with LabVIEW I</a> <a href="#">Circuit Analysis with LabVIEW II</a> <a href="#">Project 1 Progress Reports</a> <a href="#">Logbook questions</a>
<p style="text-align: center;"><b>Engineering 103 –UMass Boston</b>  <b>CW 5</b>  (In-Class-Work 5)</p>	
<p>1.- Import the data (metal distance and ultrasonic response) from <a href="http://www.itl.nist.gov/div898/handbook/pmd/section6/pmd631.htm">http://www.itl.nist.gov/div898/handbook/pmd/section6/pmd631.htm</a> into Excel (it helps to save them into a text file and then use 'Data/Get External Data/Import text file' with the 'fixed width' option). Produce a non-linear fit of the ultrasonic response Y' as a function of the metal distance X, with model <math>Y' = \exp(-b_1 * X) / (b_2 + b_3 * X)</math>. When importing data, note that in that website, the ultrasonic response (Y) appears in the first column, and the metal distance (X) in the second column. Plot the data and best fit on a same plot. Then copy the plot into a Word file. Also provide b1, b2, b3, and the final 'standard' deviation coefficient.</p> <p>2.- Answer the following questions about data modeling</p> <p>a) Using more coefficients in a model for a given data set will lead to a lower parameter s. True or false and why?</p> <p>b) In studying a phenomenon, when doing data modeling, would scientists use more or less coefficients in their models, why? What would engineers do?</p> <p>c) Does the way you build your physical system affect the quality of the mathematical model you can construct? Yes or no and why?</p>	
<p><b>In each team, students working together at a computer numbered between 1 and 10 will submit file cw5_XX_a.xlsx, students working at a computer numbered between 11 and 20 will submit file cw5_XX_b.xlsx, to the <i>files</i> folder in the server. Replace XX by 01 if team 1, etc. Include your name within the files.</b></p>	
<p>*Remember that this is an individual work (turn it in, as instructed, with your name and date). Home-works and class-works count 20% toward the course grade. Class-works are done in class.</p> <p>Your Excel graph should look like:</p>	



CWS\_XX.xlsx - Microsoft Excel

Home Insert Page Layout Formulas Data Review View

From Access From Web From Text From Other Sources Get External Data Existing Connections Refresh All Edit Links Connections Sort & Filter Filter Reapply Advanced Text to Columns Remove Duplicates Validation Data Tools Consolidate What-If Analysis

A3 92.9000 0.5000

	A	B	C	D	E	F	G	H	I
1	Name	CWS	Date						
2									
3	0000	0.0000							
4	1.7000	0.6250							
5	1.2000	0.7500							
6	1.9000	0.8750							
7	1.1000	1.0000							
8	1.3000	1.2500							
9	1.1000	1.7500							
10	1.6000	2.2500							
11	1.0500	1.7500							
12	1.7750	2.2500							
13	1.7375	2.7500							
14	1.8000	3.2500							
15	1.5875	3.7500							
16	1.4125	4.2500							
17	1.7250	4.7500							
18	1.3600	5.2500							
19	1.0250	5.7500							
20	1.6000	6.0000							
21	1.9000	6.6250							
22	1.6000	7.7500							
23	1.6000	8.8750							
24	1.0000	1.0000							
25	1.2000	1.2500							
26	1.3000	1.7500							
27	1.4000	2.2500							
28	1.1750	1.7500							
29	1.1250	2.2500							
30	1.5125	2.7500							
31	1.2500	3.2500							
32	1.4800	3.7500							
33	1.1600	4.2500							
34	1.9125	4.7500							
35	1.4750	5.2500							
36	1.1125	5.7500							
37	1.0000	6.0000							
38	1.0000	6.6250							

Text to Columns

Separate the contents of one Excel cell into separate columns.

For example, you can separate a column of full names into separate first and last name columns.

In Word, use this feature to convert the selected text into a table, splitting the text into columns at each comma, period, or other character you specify.

Press F1 for more help.

Ready

Convert Text to Columns Wizard - Step 1 of 3

The Text Wizard has determined that your data is Delimited.  
If this is correct, choose Next, or choose the data type that best describes your data.

Original data type

Choose the file type that best describes your data:

☐ Delimited - Characters such as commas or tabs separate each field.

☒ Fixed width - Fields are aligned in columns with spaces between each field.

Preview of selected data:

3	92.9000	0.5000
4	78.7000	0.6250
5	64.2000	0.7500
6	64.9000	0.8750
7	57.1000	1.0000

Cancel < Back Next > Finish

Convert Text to Columns Wizard - Step 2 of 3

This screen lets you set field widths (column breaks).  
Lines with arrows signify a column break.

To CREATE a break line, click at the desired position.  
To DELETE a break line, double click on the line.  
To MOVE a break line, click and drag it.

Data preview

10 20 30 40 50 60	
92.9000	0.5000
78.7000	0.6250
64.2000	0.7500
64.9000	0.8750
57.1000	1.0000

Cancel < Back Next > Finish

The image displays two screenshots of a Microsoft Excel spreadsheet titled 'CWS\_XX.xlsx'.

The top screenshot shows a worksheet with the following data:

1	Name	CWS	Date
2	Y (Ultrasonic Response)	X (Metal Distance)	
3	92.9	0.5	
4	78.7	0.625	
5	64.2	0.75	
6	64.9	0.875	
7	57.1	1	
8	43.3	1.25	
9	31.1	1.75	
10	23.6	2.25	
11	31.05	1.75	
12	23.775	2.25	
13	17.7375	2.75	
14	13.8	3.25	
15	11.5875	3.75	
16	9.4125	4.25	
17	7.725	4.75	
18	7.35	5.25	
19	8.025	5.75	
20	90.6	0.5	
21	76.9	0.625	
22	71.6	0.75	
23	63.6	0.875	
24	54	1	
25	39.2	1.25	

The bottom screenshot shows the same data table, but with a context menu open over cell D2. The menu options are: Cut, Copy, Paste, Paste Special..., Insert Cut Cells, Delete, Clear Contents, Format Cells..., Column Width..., Hide, and Unhide. The 'Delete' option is highlighted.

B1						
Name						
A	B	C	D	E	F	G
1 CW5	Name	Date				
2 X (Metal Distance)	Y (Ultrasonic Response)					
3 0.5	92.9					
4 0.625	78.7					
5 0.75	64.2					
6 0.875	64.9					
7 1	57.1					
8 1.25	43.3					
9 1.75	31.1					
10 2.25	23.6					
11 1.75	31.05					
12 2.25	23.775					
13 2.75	17.7375					
14 3.25	13.8					
15 3.75	11.5875					
16 4.25	9.4125					
17 4.75	7.725					
18 5.25	7.35					
19 5.75	8.025					
20 0.5	90.6					
21 0.625	76.9					
22 0.75	71.6					
23 0.875	63.6					
24 1	54					
25 1.25	38.2					

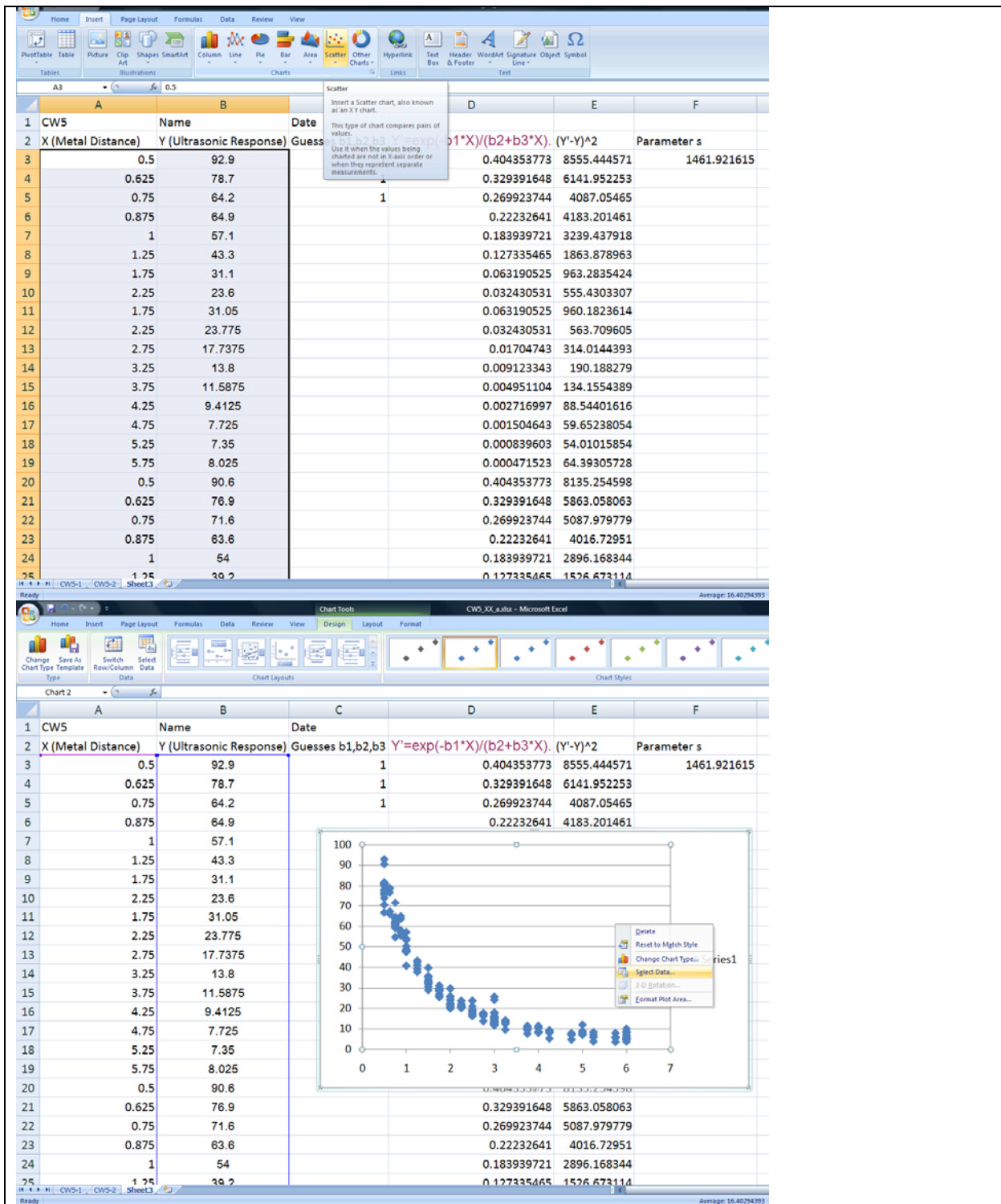
  

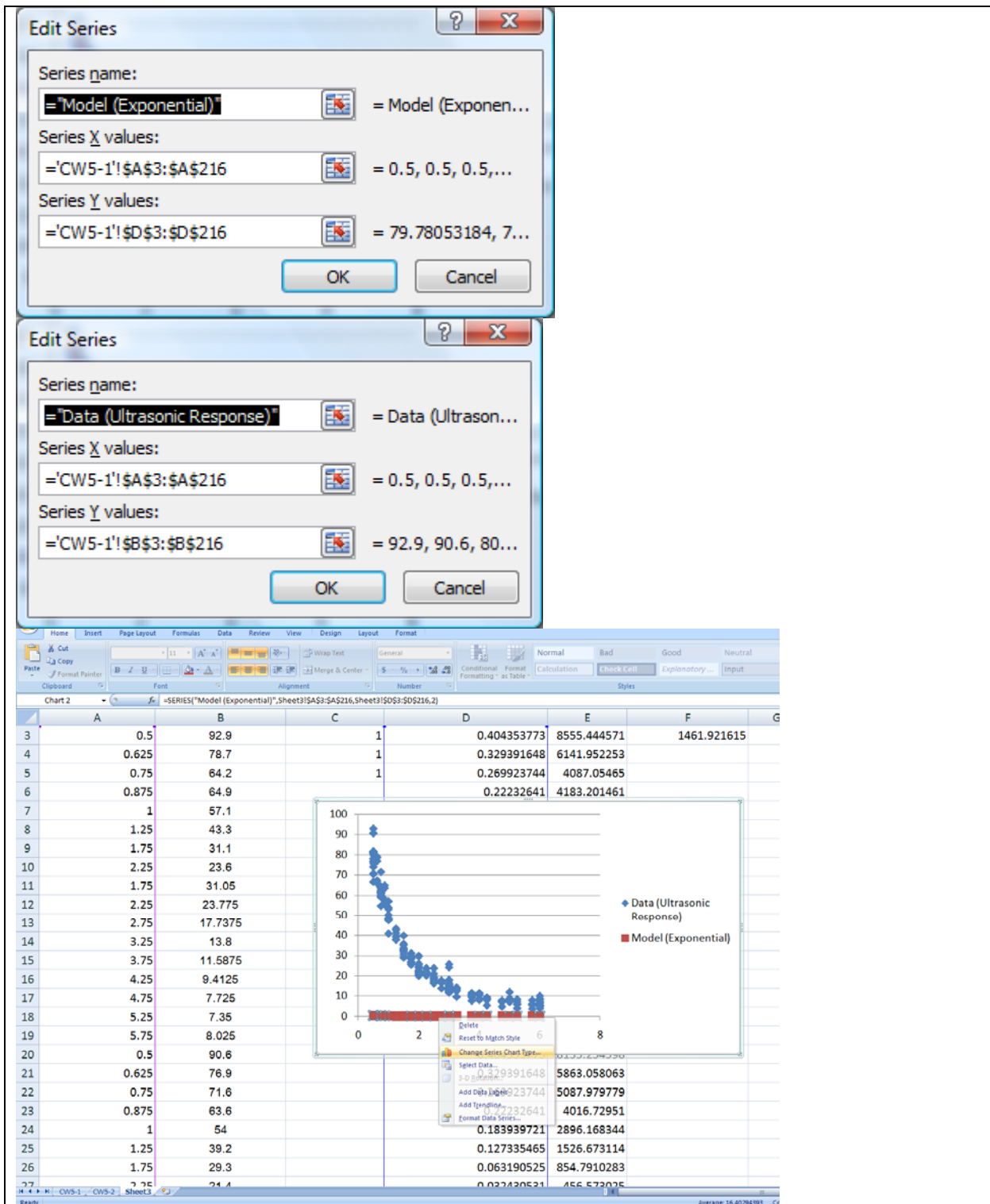
SUM						
=EXP(-SC\$3*A3)/(SC\$4+SC\$5*A3)						
A	B	C	D	E		
1 CW5	Name	Date				
2 X (Metal Distance)	Y (Ultrasonic Response)	Guesses b1,b2,b3	$Y' = \exp(-b1 \cdot X) / (b2 + b3 \cdot X)$			
3 0.5	92.9	1	$=EXP(-SC$3 \cdot A3) / (SC$4 + SC$5 \cdot A3)$			
4 0.625	78.7	1				
5 0.75	64.2	1				
6 0.875	64.9					
7 1	57.1					
8 1.25	43.3					
9 1.75	31.1					
10 2.25	23.6					
11 1.75	31.05					
12 2.25	23.775					
13 2.75	17.7375					
14 3.25	13.8					
15 3.75	11.5875					
16 4.25	9.4125					
17 4.75	7.725					
18 5.25	7.35					
19 5.75	8.025					
20 0.5	90.6					
21 0.625	76.9					
22 0.75	71.6					
23 0.875	63.6					
24 1	54					
25 1.25	38.2					

SUM						
= (D3-B3)^2						
A	B	C	D	E	F	G
1 CW5	Name	Date				
2 X (Metal Distance)	Y (Ultrasonic Response)	Guesses b1,b2,b3	$Y' = \exp(-b1 \cdot X) / (b2 + b3 \cdot X)$	$(Y' - Y)^2$		
3	0.5	92.9	1	0.404353773		
4	0.625	78.7	1	0.329391648		
5	0.75	64.2	1	0.269923744		
6	0.875	64.9		0.22232641		
7	1	57.1		0.183939721		
8	1.25	43.3		0.127335465		
9	1.75	31.1		0.063190525		
10	2.25	23.6		0.032430531		
11	1.75	31.05		0.063190525		
12	2.25	23.775		0.032430531		
13	2.75	17.7375		0.01704743		
14	3.25	13.8		0.009123343		
15	3.75	11.5875		0.004951104		
16	4.25	9.4125		0.002716997		
17	4.75	7.725		0.001504643		
18	5.25	7.35		0.000839603		
19	5.75	8.025		0.000471523		
20	0.5	90.6		0.404353773		
21	0.625	76.9		0.329391648		
22	0.75	71.6		0.269923744		
23	0.875	63.6		0.22232641		
24	1	54		0.183939721		
25	1.25	30.2		0.127335465		

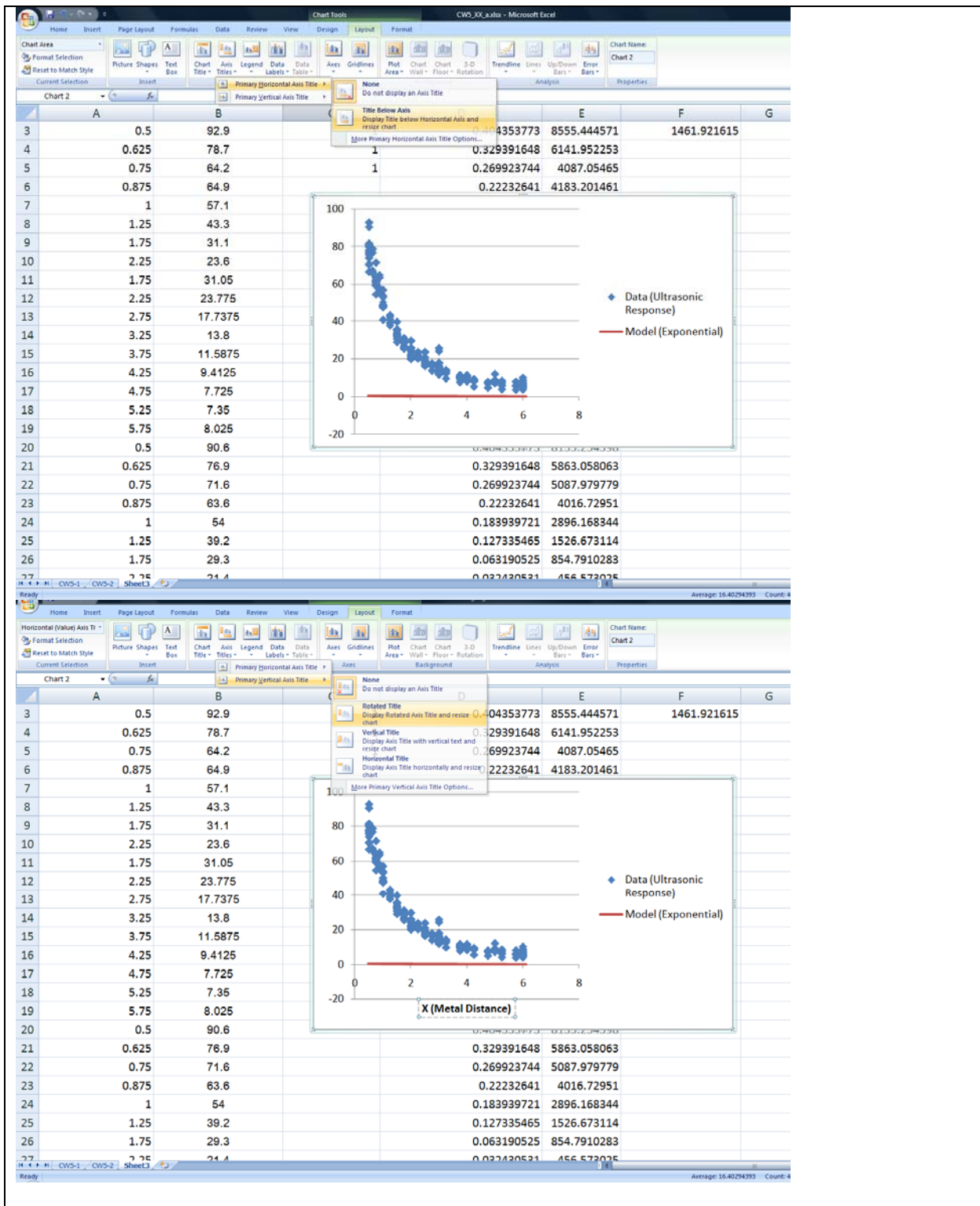
  

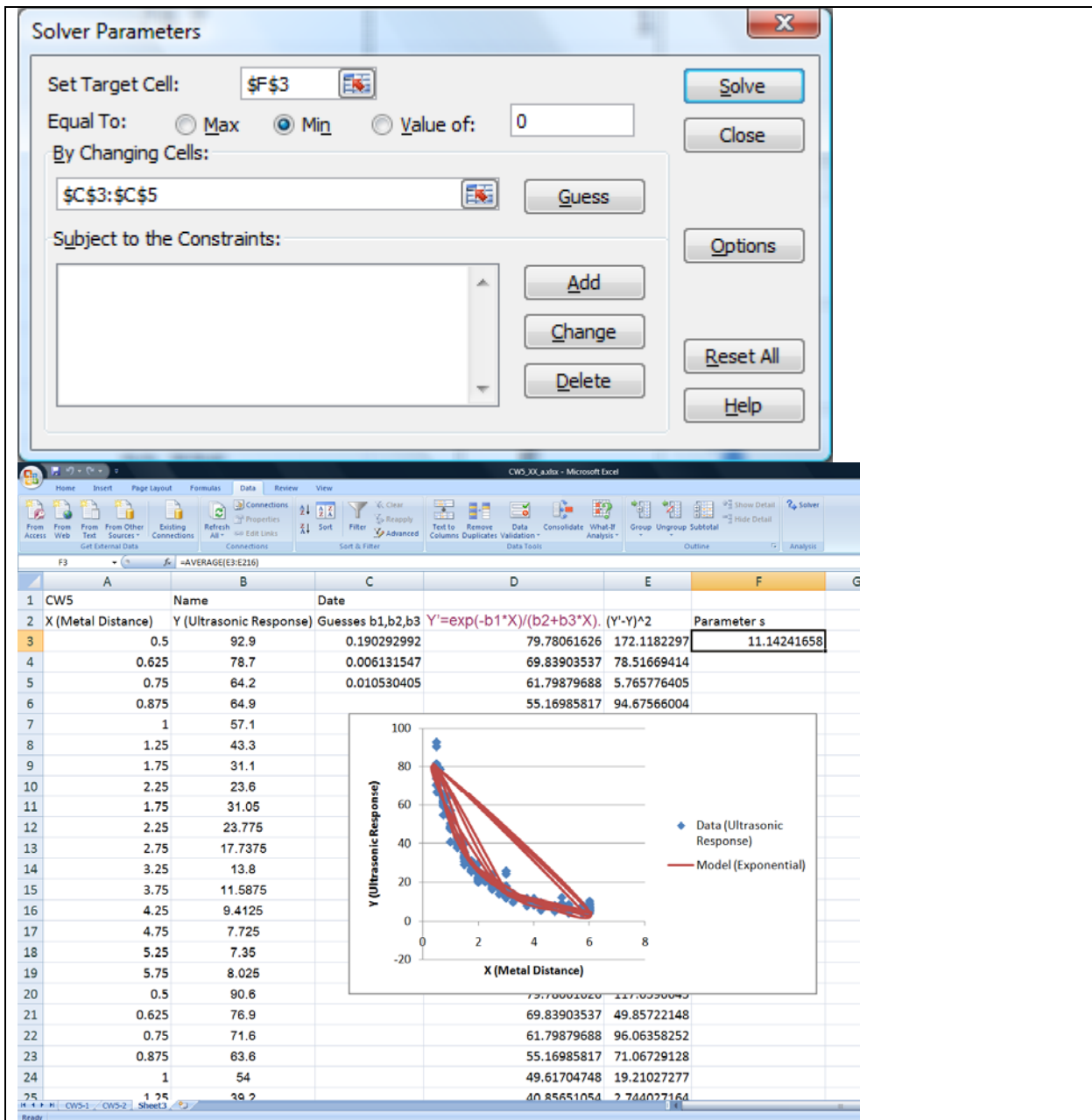
SUM						
= AVERAGE(E3:E216)						
A	B	C	D	E	F	G
1 CW5	Name	Date				
2 X (Metal Distance)	Y (Ultrasonic Response)	Guesses b1,b2,b3	$Y' = \exp(-b1 \cdot X) / (b2 + b3 \cdot X)$	$(Y' - Y)^2$	Parameter s	
3	0.5	92.9	1	0.404353773	8555.444571	
4	0.625	78.7	1	0.329391648	6141.952253	
5	0.75	64.2	1	0.269923744	4087.05465	
6	0.875	64.9		0.22232641	4183.201461	
7	1	57.1		0.183939721	3239.437918	
8	1.25	43.3		0.127335465	1863.878963	
9	1.75	31.1		0.063190525	963.2835424	
10	2.25	23.6		0.032430531	555.4303307	
11	1.75	31.05		0.063190525	960.1823614	
12	2.25	23.775		0.032430531	563.709605	
13	2.75	17.7375		0.01704743	314.0144393	
14	3.25	13.8		0.009123343	190.188279	
15	3.75	11.5875		0.004951104	134.1554389	
16	4.25	9.4125		0.002716997	88.54401616	
17	4.75	7.725		0.001504643	59.65238054	
18	5.25	7.35		0.000839603	54.01015854	
19	5.75	8.025		0.000471523	64.39305728	
20	0.5	90.6		0.404353773	8135.254598	
21	0.625	76.9		0.329391648	5863.058063	
22	0.75	71.6		0.269923744	5087.979779	
23	0.875	63.6		0.22232641	4016.72951	
24	1	54		0.183939721	2896.168344	
25	1.25	30.2		0.127335465	1526.673114	

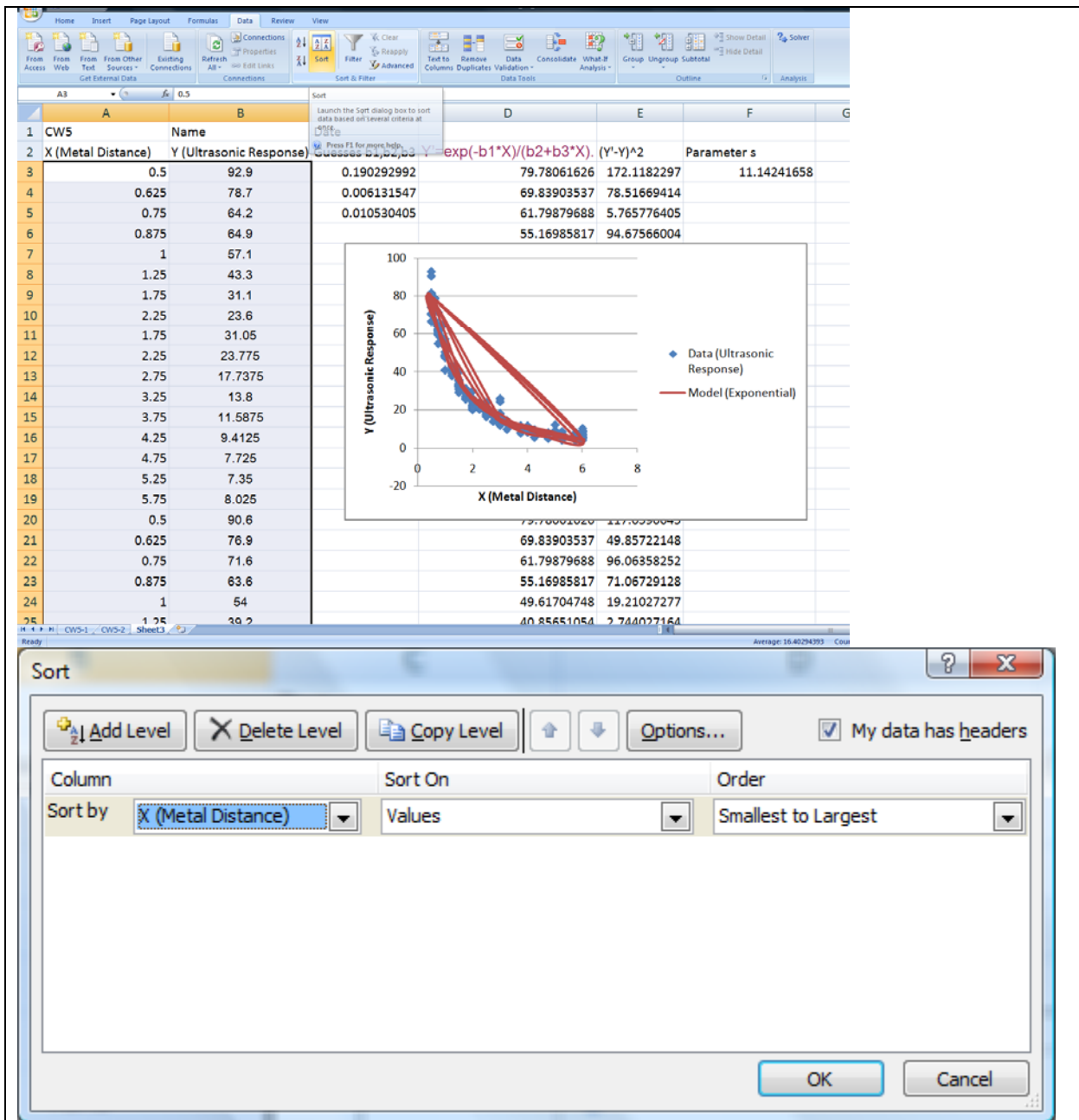


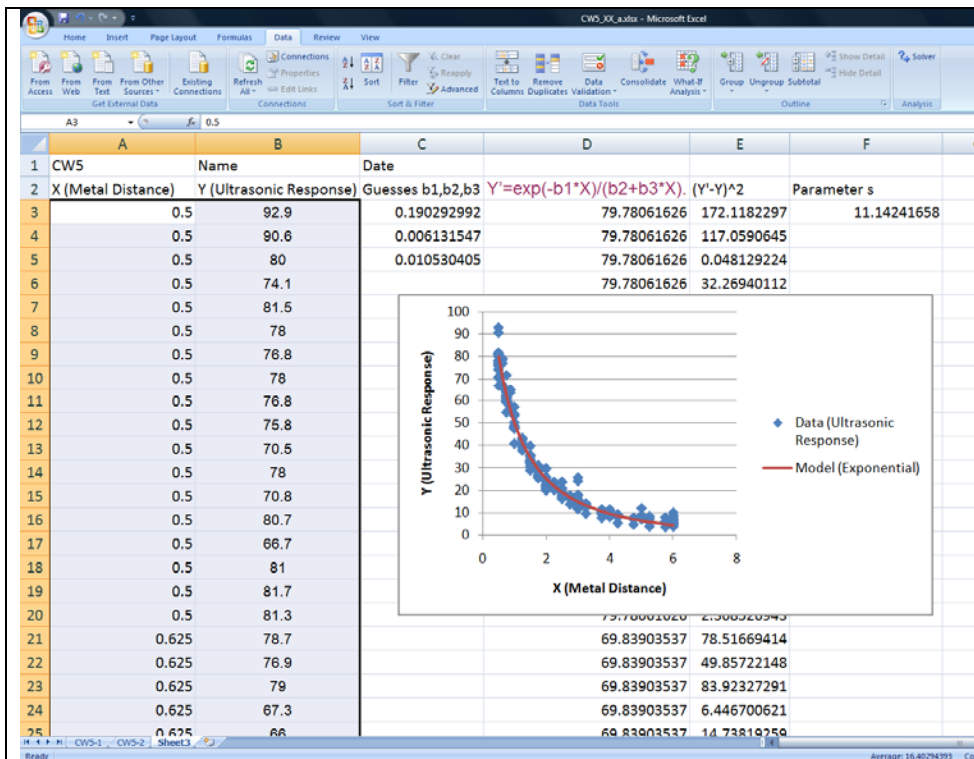












## Data Modeling and Science vs. Engineering

The summary of CW4 results is shown in the table below.

Linear	Quadratic	Cubic
Pendulum, 4 pairs of data, used all terms		
		Best
Pendulum, 42 pairs of data, used all terms		
		Best
		s=0.010853
Pendulum, 42 pairs of data, used only leading terms		
	Best	
	s=0.012326	

When only the leading term was used, the quadratic model showed the lowest s parameter. This means our data behave more in line with a quadratic term rather than a cubic or a linear term. In deed, based on Newton's Laws and the Universal Law of Gravitation, the period of an ideal pendulum (mass of string is negligible, bob is not so large, and friction is ignored) is given by

$$T = 2\pi\sqrt{\frac{L}{g}} \quad \text{or} \quad L = \frac{gT^2}{4\pi^2}$$

where T is the period, L is the length, and g is the acceleration of gravity.

**From the value of the coefficient A, you can derive the constant acceleration of gravity g. In fact a method to measure this constant at different latitudes and longitudes is to measure the periods of a pendulum of different lengths, then extract g from the coefficient of the quadratic term.**

-While doing data modeling, can we distinguish between an engineer and a scientist approach?

Engineers tend to make a more precise model of a system (getting lower s parameter) by including additional terms. Scientists tend to idealize a system in quest of a universal model that is simpler, but also less accurate when applied to a real system. Precision and universality satisfy a complementary relation similar to that of the uncertainty principle in quantum mechanics.

### Data Modeling and System Design



A good design will affect the quality of X,Y data, which will affect the quality of a mathematical model. In the two systems above, which one will allow better data, and so model, and why?

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## Introduction to LabVIEW

-LabVIEW: background for HW1 questions 4 and 5. **How to locate different functions within the Front Panel** (user interface: inputs and outputs quantities) **and within the Block Diagram** (programmer interface: operations, analysis).

-Things belonging to the Front Panel will be found under **Controls palette**, abbreviation is C, which can be brought up by 'right-clicking' (click on the mouse's right button) on the Front Panel.

-Things belonging to the Block Diagram will be found under **Functions palette**, abbreviation is F, which can be brought up by 'right-clicking' on the Block Diagram.

-Things to operate VI (Virtual Instruments) will be found under **Tools palette**, abbreviation is T, which can be brought up by clicking on Window, then select 'Show Tools Palette'

For example, where to locate 'Array'?. We start by guessing whether this is an input/output or

an operation, it is more of a numeric input utility, so right-click on the Front Panel to bring up the Controls palette (C), then select sub-palette All Controls, then select sub-palette Array and Cluster, to find Array in the first button. So the complete location for Array reads C/All Controls/Array and Cluster.

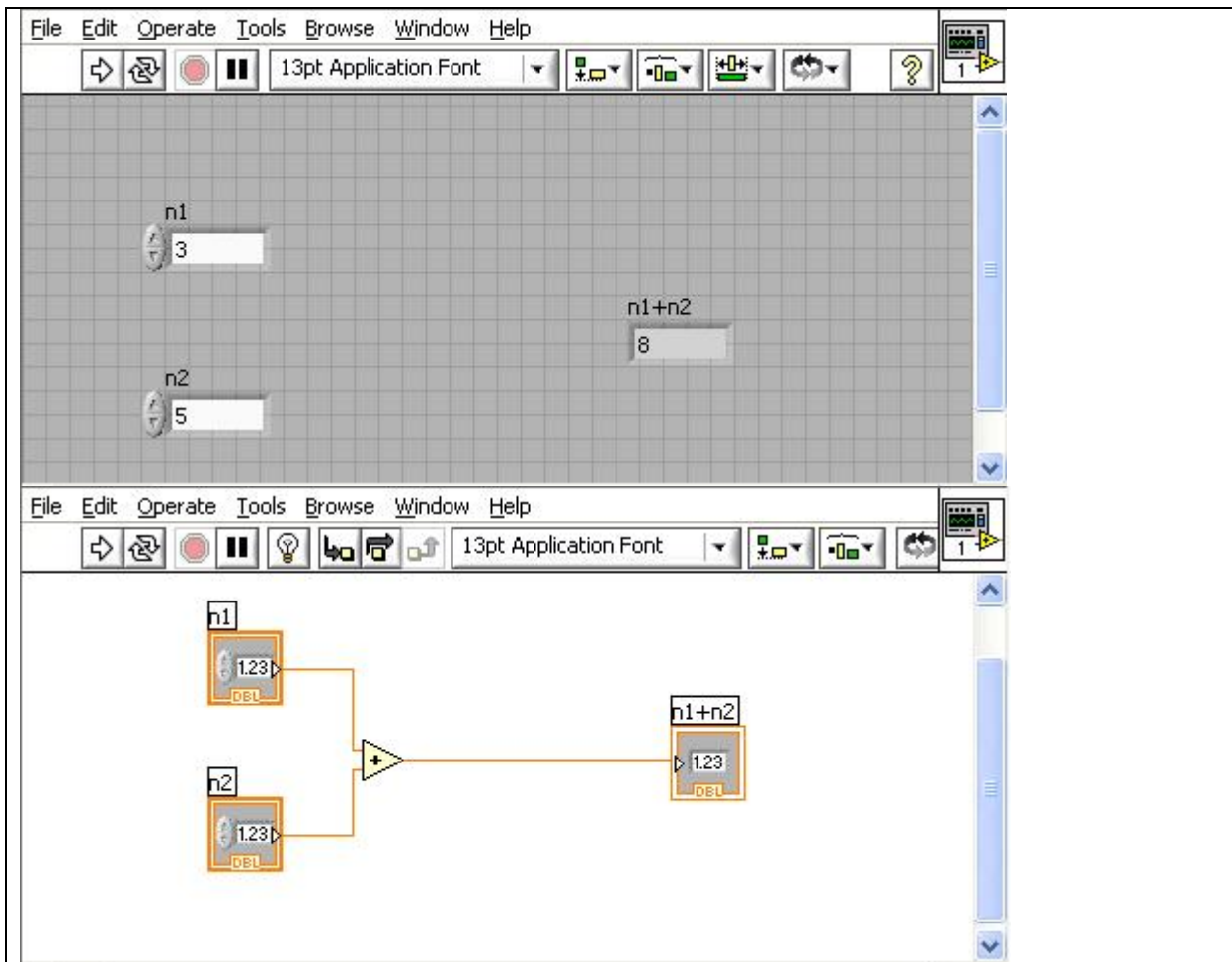
For example where to locate 'Reciprocal'?. This is more of an operation (getting the reciprocal of  $x$  is doing  $1/x$ ). So right-click on the Block Diagram to bring up the Functions palette (F), then select All Functions, then Numeric, and find Reciprocal under button  $1/x$ . So the location for Reciprocal is F/All Functions/Numeric

-As a background to changing values on a Numeric Control, we make a simple addition VI. We will need two inputs (Numeric Controls) and one output (Numeric Indicator) in the Front Panel, where the user will input the numbers she/he would like to add, where she/he will read the result, respectively. We should label the inputs as  $n1$  and  $n2$ , and the output as  $n1+n2$ . This is necessary to identify identical elements on the Block Diagram, and as part of the user interface. **Label** can be entered by typing into the blank box that is shown when an element is placed in the Front Panel. The blank box can be brought up by right-click on the element and select '**Show Label**'. To edit labels, select the Text tool, under Tools Palette, then click on the label.

To tell LabVIEW how to produce the output from these inputs, the programmer goes to the Block Diagram to place the addition operation (F/All Functions/Numeric), then wire the inputs  $n1$  and  $n2$  into the left terminals of the addition by selecting the **wiring tool** (under T), click to start, click to end, double-click to finish a wiring. Note that since the addition is commutative,  $n1$  and  $n2$  can be individually connected to either the left upper terminal or the left lower terminal of the addition operator. Should we have a division, the upper terminal is divided by the lower terminal, or the left terminals are different. In a subtraction, the upper terminal is subtracted by the lower one.

If we need to remove any piece of wire, use the **Select tool** (arrow under T) to select that piece, then hit 'backspace' on the keyboard.

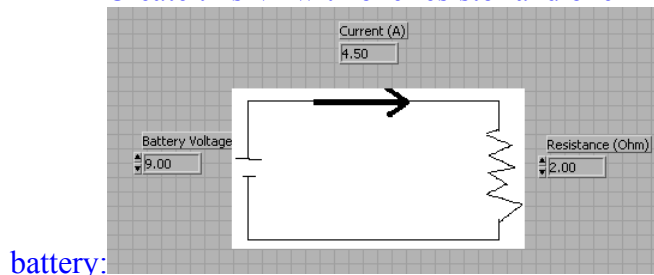
Then it comes to put in values into the Numeric Controls to test our addition VI: using the **Operate Value tool** (finger, under T) and click on the left handles to increase or decrease by an integer unit. To run the VI, click on the **Run button** (right arrow in the upper left corner), the results should show as expected. If we would like to scan through different inputs and outputs without having to hit the Run button every time we change the inputs, then use **Run Continuously** (found to the right of the Run button). Under this mode, the VI should be stopped before any modification can be made.

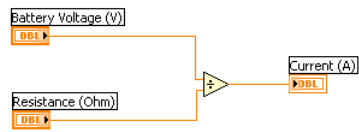


[back](#)

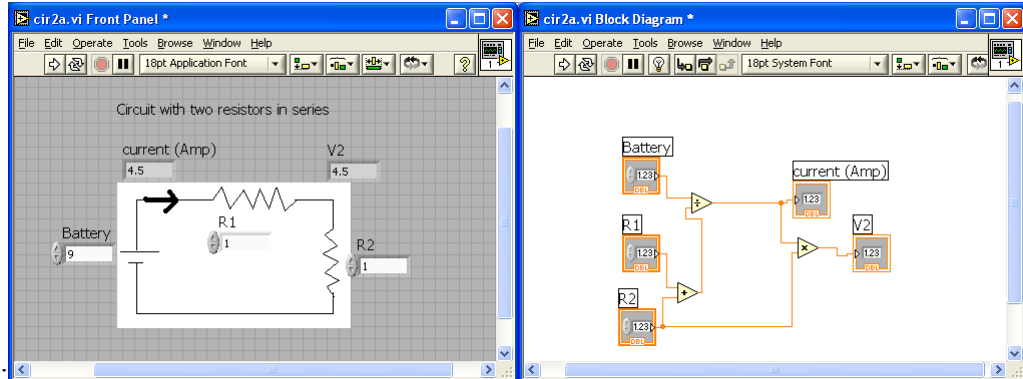
## CW6: Introduction to LabVIEW

a) Create this VI with one resistor and one



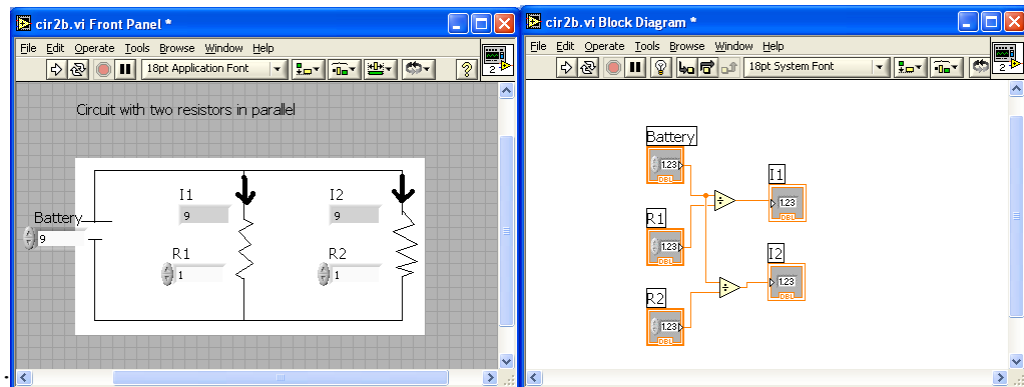


b) Create this VI for two resistors in



series:

c) Create this VI for two resistors in



parallel:

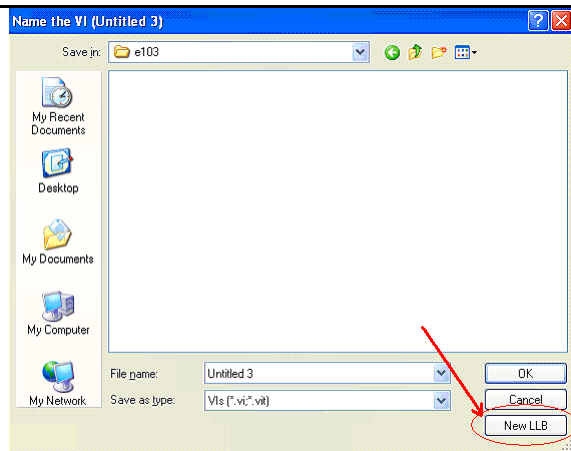
In each team, students working together at a computer numbered between 1 and 10 will submit LabVIEW LLB file cw6\_XX\_a.llb, students working at a computer numbered between 11 and 20 will submit LabVIEW LLB file cw6\_XX\_b.llb, to the *files* folder in the server. Replace **XX** by 01 if team 1, etc. **Include your names within the files.**

Save each VI into a LLB file (LabVIEW library) as follows:

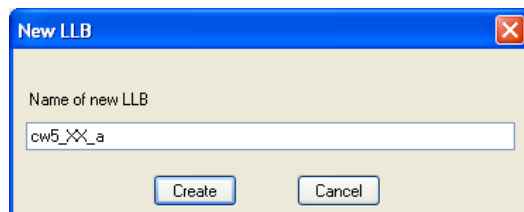
Creating library file cw5\_XX\_a.llb and saving part a) in there.

Saving part b) or c) into cw5\_XX\_a.llb

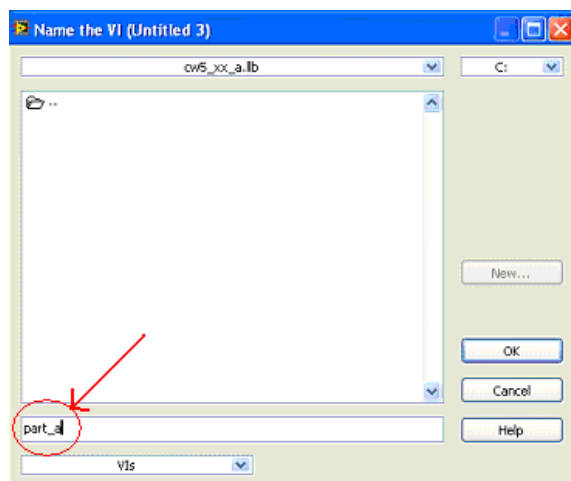




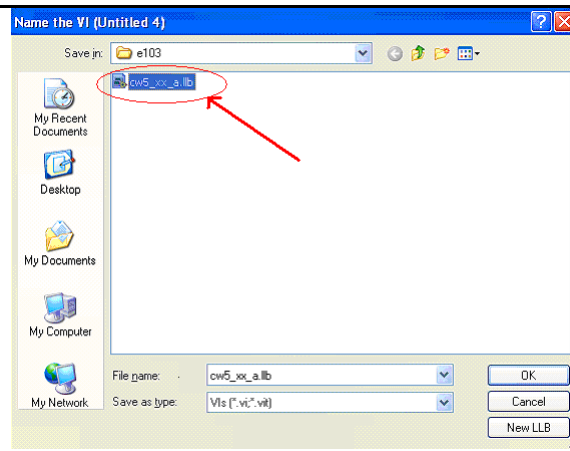
After select Save, click on New LLB



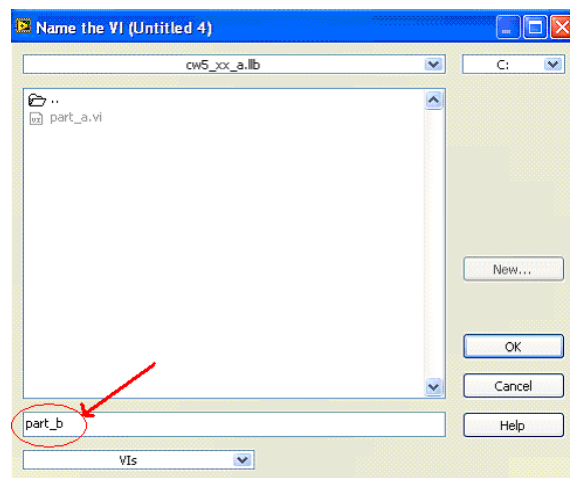
Type in "cw5\_XX\_a", where XX is the two digit team number, and "a" or "b" based on your subgroup within the team. Then click Create.



Type in the file name for the VI: in this case "part\_a". Then click OK



After select Save, double click on the library you created cw5\_XX\_a.llb



Type in the file name for the VI: in this case "part\_b". Then click OK

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**Circuit Analysis with LabVIEW I** (see also link in the e-syllabus).

Example: a VI that solves a simple electrical circuit with one battery and one resistance:

Developing a Virtual Instrument consists of the following steps:

1) Define the problem you want to solve, specify what will be the inputs and the outputs. The inputs are the battery voltage  $V$  (in Volts) and the resistance of the light bulb  $R$  in (in Ohms). The output is the current flowing in the circuit  $I$  (in Amps)

2) Determine the equations or operations needed to produce the outputs from the inputs  
We need an equation that gives  $I$  in terms of  $V$  and  $R$ . It is Ohm's law:  
 $I = V/R$

3) Implement the controls and indicators and graphs in the Control Panel and the operations in the Block Diagram

Control panel: enter a numeric control for  $V$ , another one for  $R$ ; a numeric indicator (without handle on the left side) for the current  $I$

Block Diagram: enter the "divide" operation, then wire  $V$  and  $R$  to this operator, and the output to  $I$

4) Fix any error and implement modifications as needed

If there is a broken wire, that needs to be fixed

If there is no error, the arrow on the upper left corner ("Run") is not broken

5) Test the final results against expected theoretical values.

Enter  $V=9V$ ;  $R=2\text{ Ohm}$ ,  $I$  should read  $4.5\text{ A}$

In circuits with more than one resistor, if the output does not agree with our calculation, the Block Diagram needs to be revised.

Insert a text box by clicking on "A" (Edit Text) in the tool palette

Insert a circuit diagram made in Paint by selecting (using the dotted rectangle in Paint left menu), then Edit/Copy; then in the Front Panel of LabVIEW, Edit/Paste

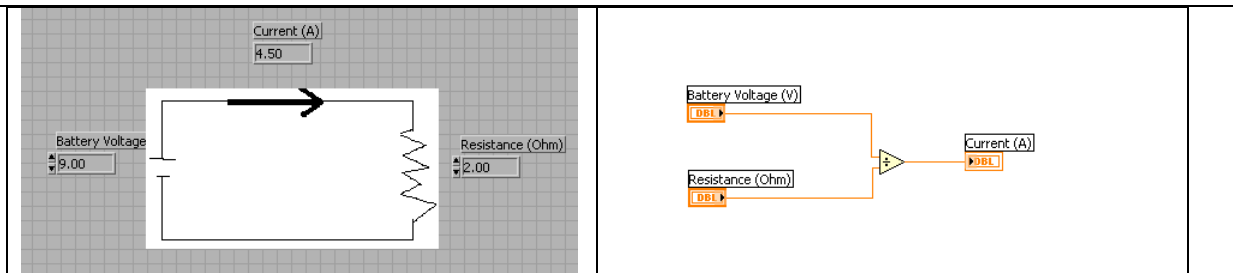
Front Panel: enter two numeric controls, label them as  $V$  and  $R$ ; enter one numeric indicator, label it as  $I$

Block Diagram: enter the "Divide" operator from Arith/Compare/Numeric

Group  $V$  and  $R$  together with the "Divide" on the left side of the Block Diagram, and the  $I$  on the right.

Check if the "Run" button is continuous

Enter values in the Numeric Controls  $V$  and  $R$  boxes and check the result at the numeric indicator  $I$  box after clicking on the "Run" button.



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## Circuit Analysis with LabVIEW II (see also link in e-syllabus)

Example: a VI that solves a simple electrical circuit with one battery and two resistors in series.

1) Define inputs: V; R1; R2

Define outputs: V2 (voltage across R2); and I (current for this circuit of 2 resistances in series)

2) Equations:  $I = V / (R1 + R2)$ ;  $V2 = I * R2$

3) Front Panel: Circuit diagram using Paint; then enter three numeric controls for V, R1, and R2; two numeric indicators for V2 and I

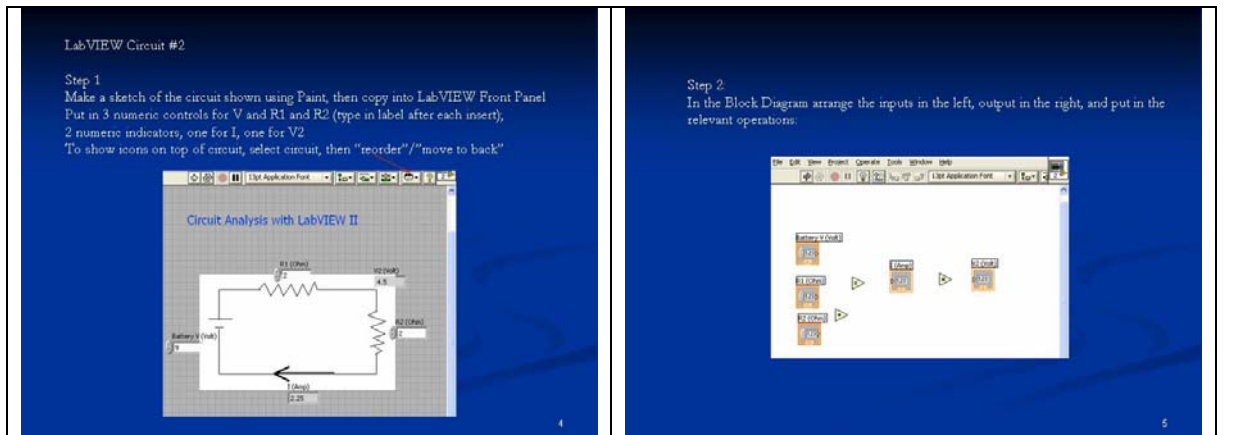
Block Diagram: order elements for least number of cross wires (to facilitate the debugging process), group V, R1, R2 on the left, I and V2 on the right

Enter an “add” operator, a division (both for producing I from V, R1 and R2 using the given equation), and a “multiply” to produce V2 from I and R2.

Use “Connect Wire” in the tools palette to connect the elements

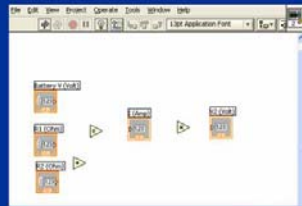
4) Check for errors.

5) Testing: enter V=9 V; R1=2 Ohm; R2=2 Ohm; I should read  $9/4=2.25$  Amp; and V2 should read  $2.25*2=4.5V$



Step 2.

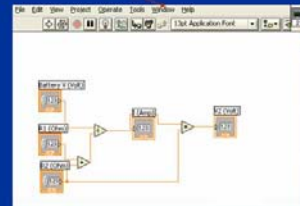
In the Block Diagram arrange the inputs in the left, output in the right, and put in the relevant operations:



5

Step 3.

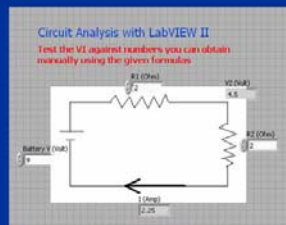
To complete the VI, use the Wiring Tool (in Tools Palette Window or View/Show Tools Palette) to connect the icons



6

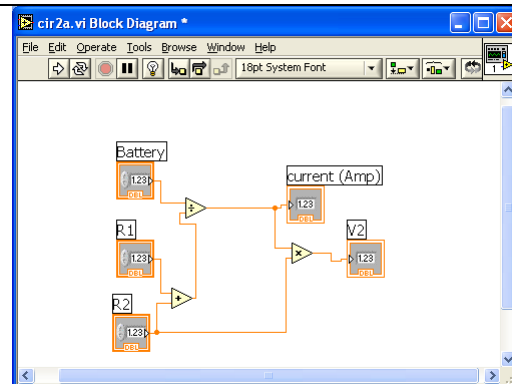
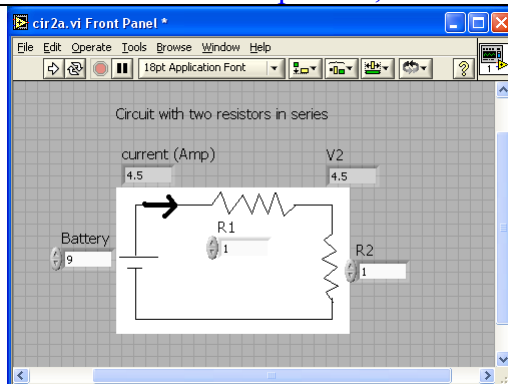
Step 4.

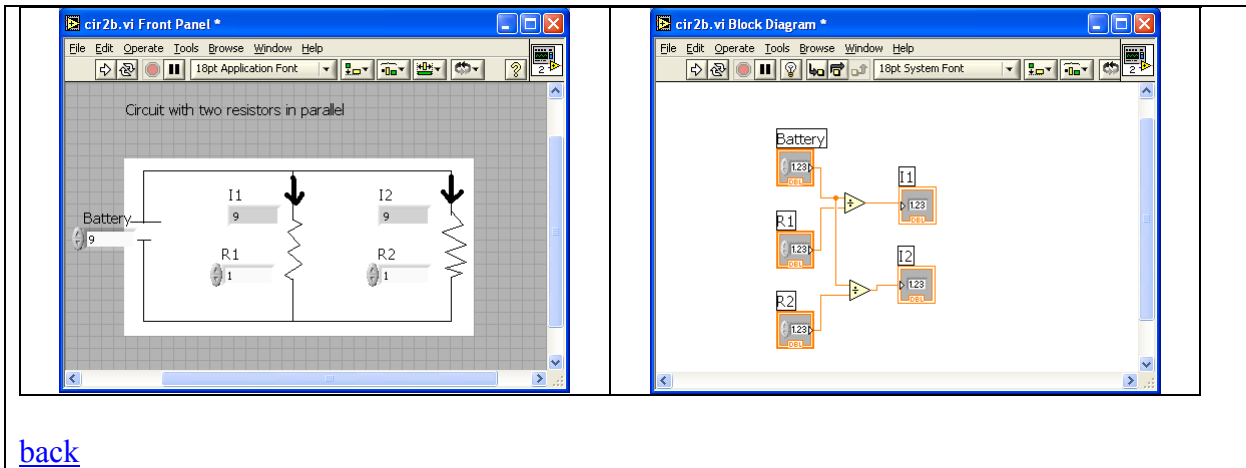
Check the VI's results against numbers you can obtain from the formulas and using "easy numbers" such as  $V=9V$ ,  $R1=1\text{ Ohm}$ ,  $R2=3\text{ Ohm}$ , then  $I=V/(R1+R2)=2.25A$  and  $V1=I \cdot R2=6.75V$ . This may be trivial here, but it is very important to do this check when we work with a larger circuit!



7

To compare how much current is flowing through each resistor when they are connected in series or in parallel, we can set up the two Virtual Instruments below:





## Project 1 Progress Report (due today)

**Project 1 leaders: please copy this document and fill in your team response below. Then save as a web page: name “p1pr.html” and upload to your *files* folder.**

### Section 1 (9:30AM)

Team #	Leader (first and last)	a) Describe what system your team is building b) What input X and output Y you will use to test the predictability?	c) In what units (cm, in, s, etc.) will you measure X and Y? d) What instrument will you use to measure X and Y (rulers, stop watch, etc.) e) What will be the range for X? (Note the range needs to allow for at least 10 distinctive values for X)	Assign a grade on communication in your team in this project: 4 –members always communicate how they are doing on their part 3 – members sometimes communicate how they are doing on their part 2- some member does not reply emails or phone calls 1 – members show no interest in participating
1 Section 1				
2 Section 1				
3 Section 1		a)	b)	
4 Section 1				
5 Section 1		a)	b)	
6 Section 1				
7 Section 1				
8 Section 1				
9 Section 1				
10 Section 1				

### Section 2 (2:00PM)

Team #	Leader (first and last)	a) Describe what system your team is building b) What input X and output Y you will use to test the predictability?	c) In what units (cm, in, s, etc.) will you measure X and Y? d) What instrument will you	Assign a grade on communication in your team in this project: 4 –members always
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			use to measure X and Y (rulers, stop watch, etc.) e) What will be the range for X? (Note the range needs to allow for at least 10 distinctive values for X)	communicate how they are doing on their part 3 – members sometimes communicate how they are doing on their part 2- some member does not reply emails or phone calls 1 – members show no interest in participating
<a href="#">1</a> Section 2				
<a href="#">2</a> Section 2				
<a href="#">3</a> Section 2			a)	
<a href="#">4</a> Section 2				
<a href="#">5</a> Section 2		A.)	B.)	
<a href="#">6</a> Section 2		a)	b)	
<a href="#">7</a> Section 2				
<a href="#">8</a> Section 2				
<a href="#">9</a> Section 2				
<a href="#">10</a> Section 2				

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### **LOGBOOK: [example of a logbook page](#)**

**-Use a quadrille notebook; number all pages; date all entries**

**-Write your notes for all activities, thoughts, problems and solutions, and learning conclusions related to Engin 103. You should write down progress, outcomes, and conclusions on projects and teamwork; conclusions from class work (including LabVIEW) and homework.**

**-In addition you should answer in the logbook all questions listed in these notes in blue, as shown below:**

**21) Insert the three tables shown in CW4 with values of the polynomial coefficients and s parameters in the logbook. Describe the differences in the graphs of the three tables in CW4.**

**22) Calculate the constant acceleration of gravity  $g$  (in  $m/s^2$ ) using the quadratic coefficient A from your table #3 of CW4 using the formula provided above; show the calculations and the final result in your logbook**

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