Homework 5:
Least Squares Curve Fitting Exercise

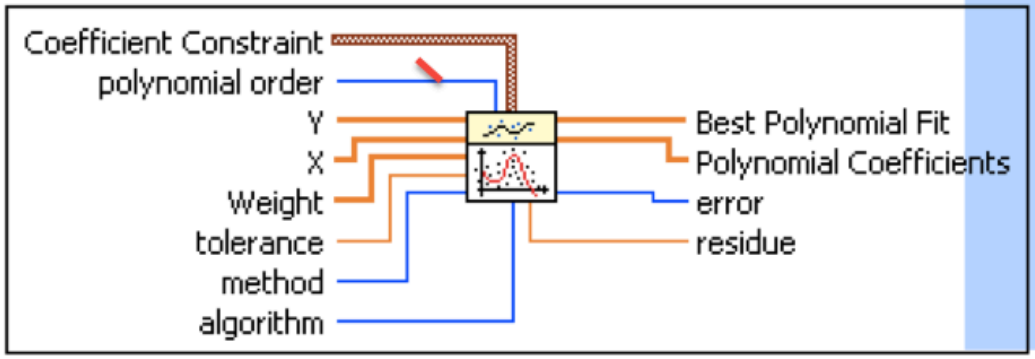
LabVIEW Polynomial Least Squares FIT VI

- In general for an "mth" order fit

$$A = \left[X^T X\right]^{-1} X^T Y$$

- Numerical Methods required for Solution to this system

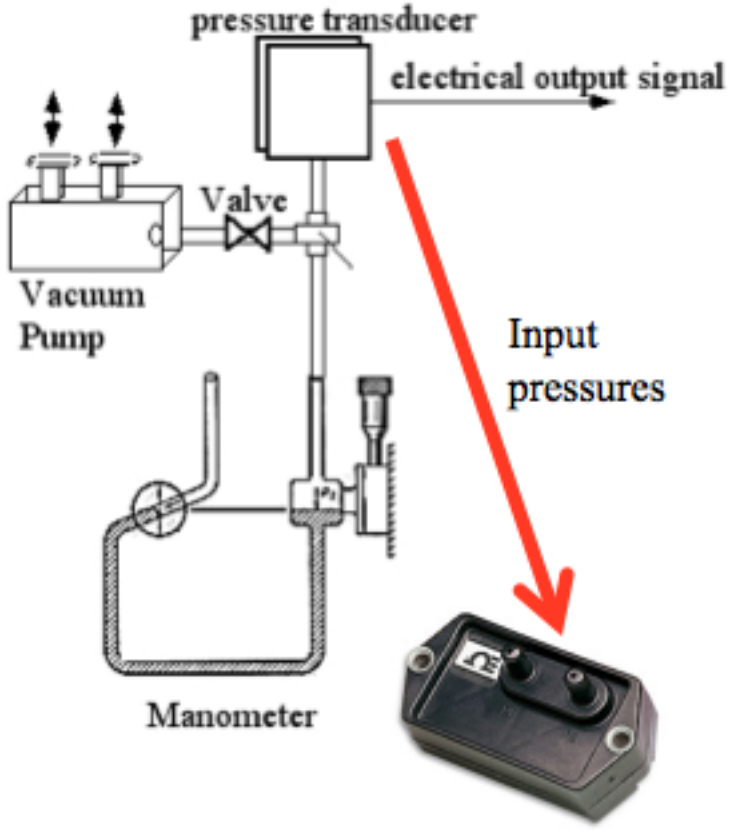
- **LabVIEW polynomial fit VI**



- Solution Algorithms

0	SVD (default)
1	Givens
2	Givens2
3	Householder
4	LU Decomposition
5	Cholesky
6	SVD for Rank Deficient H

Pressure Transducer Calibration Data



- Pressure Transducer Calibration
- Input Known Pressure Value
- Read Output Voltage From Transducer

You are going to curve fit this data with 1st and 2nd order curve fits and statistically assess the fit accuracies

Pressure Transducer Calibration Data

Pressure Transducer
Calibration, Data Table

Data Point	Output Volts	Pressure, kPa
1	1.00	9.21
2	1.33	8.42
3	1.67	21.85
4	2.00	39.83
5	2.33	44.98
6	2.67	65.57
7	3.00	82.49
8	3.33	96.47
9	3.67	113.42
10	4.00	131.55
11	4.33	142.27
12	4.67	153.71
13	5.00	184.25
14	5.33	196.17
15	5.67	216.70
16	6.00	237.92

See template with data loaded Onto MAE 3340 web page

http://www.neng.usu.edu/classes/mae/3340/section3/HW5_VIs.zip

Read Data and Display plots:

1. Raw Data
2. Curve Fits
3. Fit Error Scatter Plots
4. Fit accuracy Estimate based on t-Distribution at 95% confidence level
5. Compare accuracies of 1st and 2nd order fits

You are going to curve fit this data with 1st and 2nd order curve fits and statistically assess the fit accuracies

Example Front Panel Solution

Pressure Transducer
Calibration, Data Table

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Curve fit order: 2

0

Fit Coefficients: -28.5974, 27.9292, 2.73038, 0

Mean Fit Error, kPa: -7.9825E-14

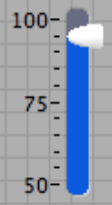
RMS Fit Error, kPa: 4.04829

t-Value for DOF: 13

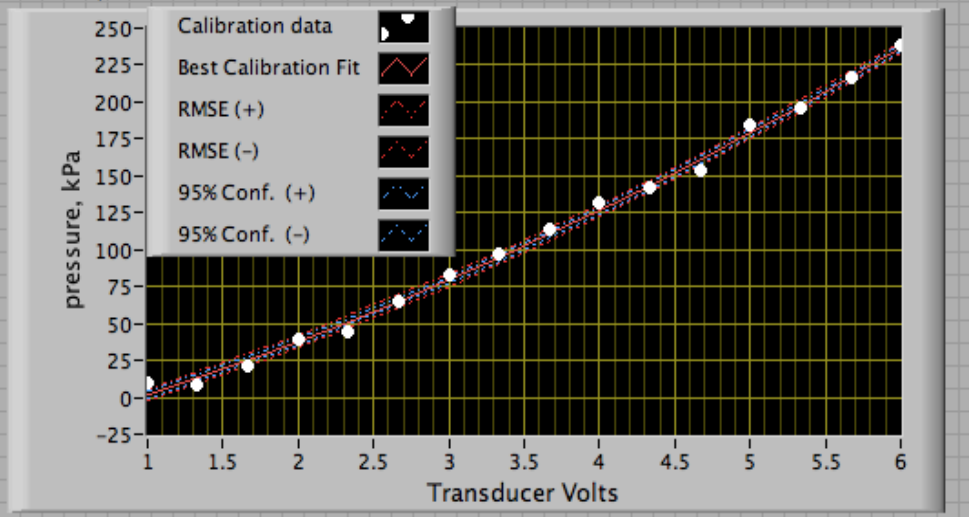
t-Value for confidence level: 2.15887

t-Value Confidence Interval: 2.18493

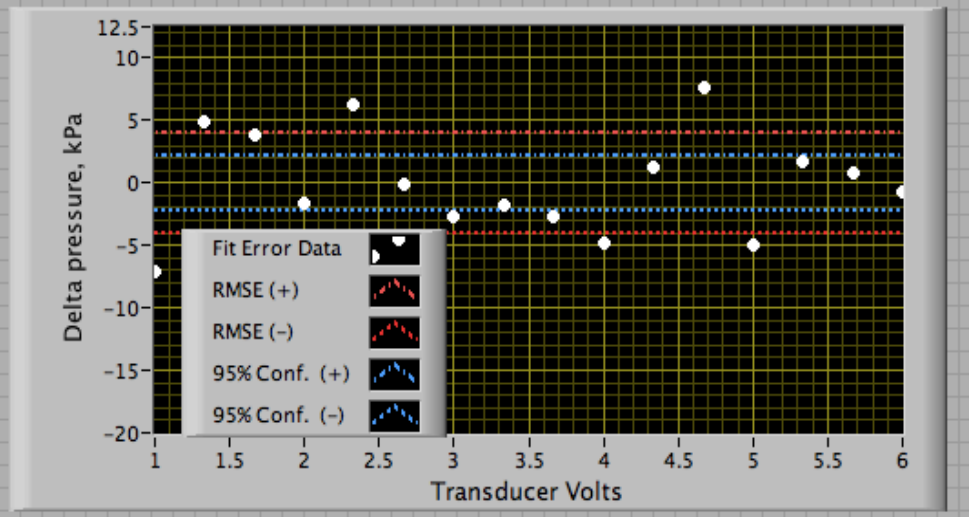
Desired Confidence
Level % for Error Bounds: 95



Pressure, Volts Calibration



Fit Scattrer Plot



Report Format:

Required:

Front Panel Screen Shots for both first and second order curve fits (can be separate shots)

- Raw data vs. Best fit
- Scatter plot of fit error
- RMSE error boundaries
- 95% Confidence-level student t-error boundaries

Error Analysis Discussion

- RMS Error calculations
- 95% Confidence level student-t error boundaries
- … How did you derive these values, how do they compare
- Tabulate Compare fit errors and fit coefficients for 1^{st}, 2^{nd}, and 3^{rd} order curve fits
- Look at the fit coefficient carefully … based on these results … what can you conclude about the pressure transducer linearity ?

Tutorial Videos:

Tutorial for Programming HW 5 Solution in Labview (March 1 2015)

Part 1: 26 minutes https://connect.usu.edu/p3dl04wukqb/

Part 2: 38 minutes ...https://connect.usu.edu/p1b57guw1zh/