Numerical Methods
Bachelor in Physics

Practicum 4:
Curve fitting

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1. Consider the following calibration data of a thermocouple

$T(^oC)$	45	50	55	60	70	80	90	100
$V(mV)$	3.49	3.17	2.93	2.73	1.76	1.63	1.41	1.36

   (a) Construct a quadratic least squares model for the data. You can use te command polyfit.

   (b) Plot the fit and the data.

   (c) Approximate $V(T)$ en dV/dT in $T = 66$ and 76.

2. Consider the following data set

```
>> x=.4:.2:1.8;
>> y=[.189 .202 .265.300 .345 .563 .691 1.249];
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   (a) Construct four least squares models for the data: linear, exponential, power function and the rational function $1/(\alpha x + b)$.

   (b) Plot and compare all fits. Use subplot to get all plots on a single figure.

   (c) Which is the best fit? Why? Maybe MATLAB knows the answer. Try ≫ why.

3. Consider following data

x	1.0	1.4	2.1	2.6	3.7	4.6	5.2	6.8
y	-4.71	-3.53	-1.88	-1.31	0.11	0.18	0.97	1.89

Choose two models to fit the data and determine the coefficients (tip: make a y vs. $log(x)$ plot of the data). Plot the results and explain your choices. Which choice seems to be the best one?

3D plots in MATLAB

4. In order to create a 'mesh plot', 'surface plot' or 'contour plot' of a function with two variables $z = f(x, y)$, we have to generate *matrices* X and Y, which contain the x and y values of each grid point. Assume that the x-values are stored in the *vector* x, and the y values in the *vector* y. Each row of matrix X is then equal to the vector x, and each columns of matrix Y is equal to the vector y. The advantage of working with matrices instead of vectors, is that you can now perform very easily element wise operations on the matrices and get the result in each grid point. Creating the X and Y matrices can be done in MATLAB as follows [X,Y] = meshgrid(x,y).

   Plot the function $z = \sin(\sqrt{x^2 + y^2})/(\sqrt{x^2 + y^2})$. Use x and y values from -20 up to 20. Do not use a very fine grid, since this will result in huge memory usage. If you have a matrix Z with the results in each grid point, you can plot the function with mesh(X,Y,Z), surf(X,Y,Z), contour(X,Y,Z) or contourf(X,Y,Z). In order to avoid a devision by zero, you can add eps to $\sqrt{x^2 + y^2}$.

5. Two dimensional interpolation. Assume you have calculated function values of the function $f(x, y)$ in a non-uniform grid and you have the vectors x, y, and z which correspond with the x-, y- and the calculated z-values. If you want to interpolate the data on a homogeneous grid (e.g. to make a good looking plot), you can use the command Z=griddata(x,y,z,X,Y) with X and Y generated with meshgrid. Try to do this with the data given in files dataelectron.dat and datahole.dat. The command load dataelectron.dat puts the data in a matrix with the same number of columns as in the data file (columns are separated by spaces). The first column are the x values, the second column are the y values, and the last column are the corresponding function values. The x values start at zero, and the y values are chosen symmetrically around zero. Interpolate the data on a grid with step size 0.5. Consult help griddata to figure out how to obtain a cubic interpolation. Make a figure with mesh.