PHY 381, Homework #1 , Due September 17, 2019

14.11 Determine an equation to predict metabolism rate as a function of mass based on the following data. Use it to predict the metabolism rate of a 200-kg tiger.

Animal	Mass (kg)	Metabolism (watts)
Cow	400	270
Human	70	82
Sheep	45	50
Hen	2	4.8
Rat	0.3	1.45
Dove	0.16	0.97

14.13 Fit an exponential model to

x	0.4	0.8	1.2	1.6	2	2.3
y	800	985	1490	1950	2850	3600

Plot the data and the equation on both standard and semi-logarithmic graphs with the MATLAB `subplot` function.

15.3 Fit a cubic polynomial to the following data:

x	3	4	5	7	8	9	11	12
y	1.6	3.6	4.4	3.4	2.2	2.8	3.8	4.6

Along with the coefficients, determine r^2 and $s_{y/x}$.

15.6 Use multiple linear regression to derive a predictive equation for dissolved oxygen concentration as a function of temperature and chloride based on the data from Table P15.5. Use the equation to estimate the concentration of dissolved oxygen for a chloride concentration of 15 g/L at $T = 12$ °C. Note that the true value is 9.09 mg/L. Compute the percent relative error for your prediction. Explain possible causes for the discrepancy.

TABLE P15.5 Dissolved oxygen concentration in water as a function of temperature (°C) and chloride concentration (g/L).

	Dissolved Oxygen (mg/L) for Temperature (°C) and Concentration of Chloride (g/L)		
***T*, °C**	***c* = 0 g/L**	***c* = 10 g/L**	***c* = 20 g/L**
0	14.6	12.9	11.4
5	12.8	11.3	10.3
10	11.3	10.1	8.96
15	10.1	9.03	8.08
20	9.09	8.17	7.35
25	8.26	7.46	6.73
30	7.56	6.85	6.20

17.12 Ohm's law states that the voltage drop V across an ideal resistor is linearly proportional to the current i flowing through the resister as in $V = iR$, where R is the resistance. However, real resistors may not always obey Ohm's law. Suppose that you performed some very precise experiments to measure the voltage drop and corresponding current for a resistor. The following results suggest a curvilinear relationship rather than the straight line represented by Ohm's law:

i	−1	−0.5	−0.25	0.25	0.5	1
V	−637	−96.5	−20.5	20.5	96.5	637

To quantify this relationship, a curve must be fit to the data. Because of measurement error, regression would typically be the preferred method of curve fitting for analyzing such experimental data. However, the smoothness of the relationship, as well as the precision of the experimental methods, suggests that interpolation might be appropriate. Use a fifth-order interpolating polynomial to fit the data and compute V for $i = 0.10$.

17.19 The acceleration due to gravity at an altitude y above the surface of the earth is given by

y, m	0	30,000	60,000	90,000	120,000
g, m/s^2	9.8100	9.7487	9.6879	9.6278	9.5682

Compute g at $y = 55{,}000$ m.

18.6 Develop an M-file to compute a cubic spline fit with natural end conditions. Test your code by using it to duplicate Example 18.3.

18.3 The following is the built-in `humps` function that MATLAB uses to demonstrate some of its numerical capabilities:

$$f(x) = \frac{1}{(x-0.3)^2 + 0.01} + \frac{1}{(x-0.9)^2 + 0.04} - 6$$

The `humps` function exhibits both flat and steep regions over a relatively short x range. Here are some values that have been generated at intervals of 0.1 over the range from $x = 0$ to 1:

x	0	0.1	0.2	0.3	0.4	0.5
$f(x)$	5.176	15.471	45.887	96.500	47.448	19.000
x	0.6	0.7	0.8	0.9	1	
$f(x)$	11.692	12.382	17.846	21.703	16.000	

Fit these data with a **(a)** cubic spline with not-a-knot end conditions and **(b)** piecewise cubic Hermite interpolation. In both cases, create a plot comparing the fit with the exact `humps` function.

18.9 The following data define the sea-level concentration of dissolved oxygen for fresh water as a function of temperature:

T, °C	0	8	16	24	32	40
o, mg/L	14.621	11.843	9.870	8.418	7.305	6.413

Use MATLAB to fit the data with **(a)** piecewise linear interpolation, **(b)** a fifth-order polynomial, and **(c)** a spline. Display the results graphically and use each approach to estimate $o(27)$. Note that the exact result is 7.986 mg/L.