7. (*expires 2/18*) Fit the points $(-1.9, -4.7), (-0.8, 1.2), (0.1, 2.8), (1.4, -1.2), (1.8, -3.5)$ by means of a quadratic function $f(x) = ax^2 + bx + c$, using the least square method. First, do this step by step, as we did in class; then, use the built-in `Maple` command, described in the notes. Check that the two solutions agree.

8. (*expires 2/18*) Fit the set of points

$$(1.02, -4.30), (1.00, -2.12), (0.99, 0.52), (1.03, 2.51), (1.00, 3.34), (1.02, 5.30)$$

with a line, using the least square method we used in class. You will see that this is not a good fit. Think of a better way to do the fit and use `Maple` to do it. Explain in your solution why you think your better way is better.

9. (*expires 2/18*) In this problem we will estimate the charge of the electron: If an electron of energy E is thrown into a magnetic field B, perpendicular to its velocity, its trajectory will be deflected into a circular trajectory of radius r. The relation between these three quantities is:

$$B\,r\,e = \frac{E^2}{m^2c^4}\sqrt{E^2 - m^2c^4}, \tag{1}$$

where e and m are, respectively, the charge and the mass of the electron, and c is the speed of light. The rest mass of the electron is defined as $E_0 = mc^2$, and is about equal to $8.817\,10^{-14}$ Joules. In our experimental set-up the energy of the emitted electrons is set to be $E = 2.511E_0$.
Use `read` to make `Maple` load and execute the commands in the file `electron_data.txt`, which is located in the `Worksheets` directory of the `mat331` account. This defines a list called `electron`. Each element of the list is a pair of the form $[B_i, r_i]$, and these quantities are expressed in Teslas and meters. Use least square fitting to determine the best value for e. [*Hint: Notice that the right hand side of (1) is just a constant—calculate it once and for all and give it a name. Then (1) is a very easy equation, which is linear in the unknown parameter e. To verify your solution:* $e \approx 1.602\,10^{-19}$ Coulomb].
Physical constants courtesy of N.I.S.T.

10. (*expires 2/18*) Prove relation (1), knowing the following physical facts: In relativistic dynamics Newton's law is replaced by

$$F = m\,\frac{d}{dt}\left(\frac{v}{\sqrt{1-\frac{v^2}{c^2}}}\right), \tag{2}$$

where F is the force acting on a particle, m its mass and v, a function of time, its velocity. In the case at hand, the force exerted by a magnetic field B on an electron is $F = e\,v\,B/c$. Recall that in a circular motion the acceleration $a = dv/dt = v^2/r$, r being the radius of the circle. Since (1) is expressed in terms of the energy, rather than the velocity, you also need Einstein's formula,

$$E = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}, \tag{3}$$

which can be solved in terms of v.