Problem 1.

Consider the table of x-y data to the right.

(a) Find the a_i coefficients in a quadratic curve fit of the data. Compute r^2 for your curve fit.
(b) Find the a_i coefficients in a cubic curve fit of the data. Compute r^2 for your curve fit.
(c) Make a plot showing both curve fits along with the data points on the same graph.

for the simplest model, is characterized by a linear force-deformation relationship

$$F = kx,$$

F being the force loading the spring, k the spring constant or stiffness and x the spring deformation. In reality the linear force–deformation relationship is only an approximation, valid for small forces and deformations. A more accurate relationship, valid for larger deformations, is obtained if non–linear terms are taken into account. Suppose a spring model with a quadratic relationship

$$F = k_1 x + k_2 x^2$$

is to be used and that the model parameters, k_1 and k_2, are to be determined from experimental data. Five independent measurements of the force and the corresponding spring deformations are measured and these are presented in Table 1.

Force F [N]	Deformation x [cm]
5	0.001
50	0.011
500	0.13
1000	0.30
2000	0.75

Table 1: Measured force-deformation data for spring.

Problem 2.

Consider the cantilever truss structure shown below. The truss structure consists of 10 rigid links connected by pin joints at 7 nodes. Node 1 is fixed so that no motion can occur in the horizontal or vertical directions. A weight of W=1kN is attached at node 7 as shown. Our objective is to find the truss element loads.

These types of truss structures can be analyzed by summing the forces in the vertical and horizontal directions at each node. For example, the force balance at node 2 is given by:

$$\Sigma F_x = -F_1 + F_2 + F_5 \cos\phi = 0 \quad ; \quad \Sigma F_y = -F_4 - F_5 \sin\phi = 0$$

where F_p is the tensile force in the p^{th} truss member. At node 1, one must include reaction forces R1x and R1y in the horizontal and vertical directions, respectively; at node 4, only a reaction force in the horizontal direction is needed, R4x.

(a) By summing the forces at the other nodes, come up with a linear system of 13 equations in 13 unknowns for the truss structure.

(b) Solve for the tensions and reactions in each element of the truss structure using the Matlab *backslash command*; i.e., if A*x = B, then x = A\B. Use dimensions H = 1 m and L = 2 m.

(c) If the maximum tensile force that any truss member can withstand is 10 kN and the largest compressive load that any truss member can withstand (before buckling) is 5 kN determine if the truss structure can safely hold the 10 kN load. If not, determine which truss member(s) will fail, and determine the maximum load that the truss structure can hold without failure.