Exercise 2.5: The two-element truss shown in Fig. 2.6 is made of elastic bars. The dimensions of the structure are specified by the initial distances a=9, b=4 and c=0. Assume AE=10.

a) Write the following functions assuming that a total Lagrangian formulation will be used

1) bar3ge.m: Calculating the stiffness matrix.
2) bar3gs.m: Calculating Green's strain and the corresponding normal force.
3) bar3gf.m: Calculating the internal force vector.

b) Write the script file containing the Newton-Raphson algorithm using the total Lagrangian formulation, use the sequence in Table 1.1, cf. also Table 2.1

c) Take advantage of Example 2.1 to estimate to load level and apply loading P_1 according to Fig. 2.6. Introduce a boundary condition such that $u_2=0$. Plot P_1 versus u_1. Explain the obtained behavior.

d) Introduce a linear spring, with spring stiffness k, directed along u_1. In analogy with Exercise 1.5 define the actual force transmitted to the bars as $P_{eff}=P_1-ku_1$. Show that the complete load curve can be found. Plot P_{eff} versus u_1. For this purpose write the functions

1) bar1e.m: Calculating the element stiffness for a linear spring.
2) bar1f.m: Calculating the internal force vector.

e) Remove the boundary condition $u_2=0$. Instead introduce the spring shown in Fig.2.6. Assume k=0.3 and c=0.01. Use the command plot3 and plot u_1, u_2 and P_{eff}. Explain what happens.

f) Introduce an imperfection by assuming that the initial lengths of the trusses differ. This can be obtained by moving the point where the trusses are connected by a distance 0.01 in direction 3, which is perpendicular to the 1 and 2 directions. Assume c=0. Plot u_1, u_2 and u_3 using the command plot3. In the same plot show the result obtained in d) and e).

g) Consider now the updated Lagrangian formulation. Introduce the necessary functions and write the corresponding Newton-Raphson script file and recalculate d).