ME235A Finite Element Analysis
Fall, 2001

Computing Assignment 1
Handed out Oct. 25, Thur.
Due Nov. 7, Wed.

We will be solving the model 1-d bar problem in the text using the finite element method with the Matlab program `BarProblem`. The BVP is:

$$u_{,xx}(x) + f(x) = 0 \quad x \in [0,1]$$
$$u(1) = g$$
$$-u_{,x}(0) = h$$

The domain is divided into 100 elements of equal length, and the distributed load $f(x)$ is a constant. The values of f, g, and h are given in the file `InputParameters`.

1. The given program is missing the subroutines which assemble the element stiffness matrices and load vectors into the global stiffness matrix and load vector. Code the subroutines and execute the program. The function m-files are included, you only need to fill them in.
   Then plot the exact solution to the problem and compare with the finite element solution. (You might try changing the number of elements to a smaller number to see more clearly how the piecewise linear approximation represents the exact solution.)

* Notes
i. In assembling the global load vector, the essential boundary condition contributions to each element are calculated by the subroutine `ElementForce_g`, and you will need to include those in the assembly.
ii. The natural boundary contribution to the global load vector is taken into account separately after the assembly.
iii. The function arguments are specified for your convenience, but you can change them if you want to.

2. Modify the code to include calculation for the stresses (which in this case is exactly the same as $u^h_{,x}$). Plot the results, and comment on the accuracy of the stresses.

3. Modify the code slightly to solve for the same problem, but with the boundary conditions changed. (You don't need to plot the exact solution for this problem)

   a. $u(0) = g, \quad -u_{,x}(1) = h$

   b. $u(0.5) = g, \quad -u_{,x}(0) = h$

* Note that you will have to change the boundary value data in the subroutine `InputBoundaryConditions`, as well as consider the correct location of the natural boundary condition that is added into the global force vector.