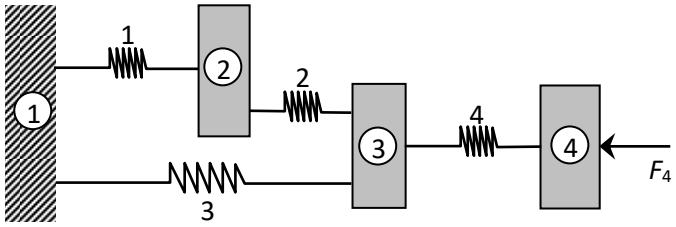
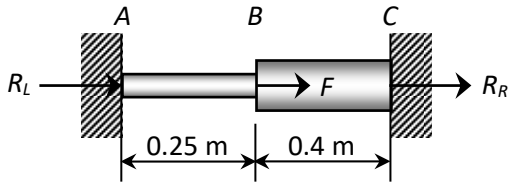
Homework 1

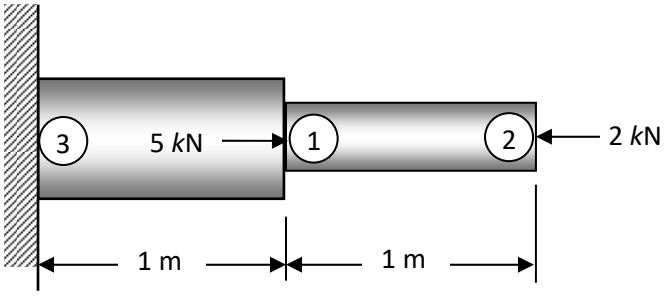
1. Three rigid bodies, 2, 3 and 4, are connected by four springs as shown in the figure. A horizontal force of 1,000 N is applied on Body 4 as shown in the figure. Find the displacements of the three bodies and the forces (tensile/compressive) in the springs. What is the reaction at the wall? Assume the bodies can undergo only translation in the horizontal direction. The spring constants (N/mm) are $r_1 = 400$, $r_2 = 500$, $r_3 = 500$, and $r_4 = 300$.



2. Use FEM to determine the axial force P in each portion, AB and BC, of the uniaxial bar. What are the support reactions? Assume: E = 100 GPa, area of cross sections of the two portions AB and BC are, respectively, 10^{-4} m^2 and 2×10^{-4} m^2 and F = 10,000 N. The force F is applied at the cross section at B.



3. A stepped bar is clamped at one end, and subjected to concentrated forces as shown. **Note: the node numbers are not in usual order!**



Assume: E=100 GPa, Small area of cross section =1 cm^2, Large area of cross section =2 cm^2

(a) Write the element stiffness matrices of Elements 1 and 2 showing the row addresses:

(b) Assemble the above element stiffness matrices to obtain the following structural level equations in the form of $[\mathbf{K}_s]\{\mathbf{Q}_s\} = \{\mathbf{F}_s\}$.

(c) Delete the rows and columns corresponding to zero DOF to obtain the global equations in the form of $[\mathbf{K}]\{\mathbf{Q}\} = \{\mathbf{F}\}$.

(d) Determine the displacements and element forces.