2.2-2 (a,b) In each of the two plane structures shown, rigid blocks are connected by linear springs. Imagine that only horizontal displacements are allowed. In each case, write the structure equilibrium equations $[K]\{D\} = \{R\}$ in terms of spring stiffnesses $k_i$, displacement d.o.f. $u_i$, and applied loads $F_i$.

![Diagram of structures](image)

**Problem 2.2-2**

2.5-4 For the frame shown, write equilibrium equations $[K]\{D\} = \{R\}$ using d.o.f. $\{D\} = [u_1 \quad v_1 \quad \theta_{z1} \quad \theta_{z2}]^T$. Both members are slender and have the same $E, I, A,$ and $L$. Express matrix coefficients in terms of $L, a = AE/L$, and $b = EI/L^3$.

2.6-8 For a given $\{D\}$, why does the form $\{D\}^T[K]\{D\}/2$ represent strain energy in a structure? *Suggestion:* Consider work done by applied loads.

3.3-2 (a) Imagine that, at each end node, a uniform bar element is to have not only axial displacement d.o.f., but axial strain d.o.f. as well, so that $\{d\} = [u_1 \quad \varepsilon_{x1} \quad u_2 \quad \varepsilon_{x2}]^T$. Derive the resulting 4 by 4 element stiffness matrix.

(b) How can this element be used to model a bar that carries concentrated axial loads, or has abrupt changes in elastic modulus or in cross-sectional area?