Problem #1 – 10pts

2.3-2 (a,b) The plane structures shown consist of rigid weightless bars connected by linear springs, each of stiffness $k$. Degrees of freedom are horizontal translations $u_i$ and small rotations $\theta_i$ for $i = 1,2$, as shown. Vertical motion and out-of-plane displacements are not allowed. In each case determine the 4 by 4 structure stiffness matrix in terms of $k$ and $b$.

![Diagram](image1)

**Problem 2.3-2**

Problem #2 – 5pts:

2.3-4 To elevate the end of a cantilever beam without rotating it, as shown, force and moment are required. From the information shown, fill in as many numerical values as you can in an element stiffness matrix that operates on nodal d.o.f. \[
\{d\} = \begin{bmatrix} v_1 & \theta_1 & v_2 & \theta_2 \end{bmatrix}^T,
\]
where $v_1$ and $v_2$ are measured in millimeters. Do not use beam deflection formulas or Eq. 2.3-5. Instead rely on the given data, physical argument, statics, and the symmetry of $[k]$. Ignore transverse shear deformation.
Problem #3 – 5pts:

2.5-5 For the plane frame of Fig. 2.3-3(a), assume that members are slender and have the same $EI_y$, and that axial deformations are negligible in comparison with bending deformations. Let loads and deformations be confined to the plane of the frame. Write the structure stiffness matrix that operates on “active” d.o.f. 

$$[D] = \begin{bmatrix} u_B & \theta_{zB} & \theta_{zC} \end{bmatrix}^T.$$ 

(Hint: Do not consider axial stretch for any of the members)

Problem #4 – 15pts: Consider the following configuration for a two beam element structure with axial stretches included in the analysis. Assume $EI = EA = 1$.

a) Create a proper coordinate transformation matrix first to relate local coordinate system of a beam element arbitrarily oriented at an angle $\theta$.

b) Find the global stiffness matrix of the structure based on the transformation found in part a.

c) Find vertical displacement of the joint.