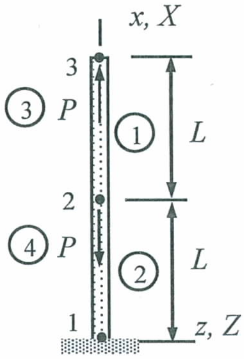
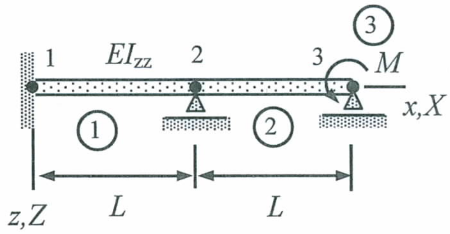
Kul-49.3300 Finite element method I, midterm 1, 07.03.2013

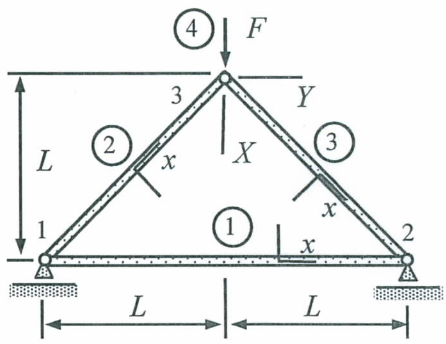
1. The bar structure shown is loaded by point forces (3), (4) of equal magnitude P but opposite directions. Determine the nodal displacements $u_{X2} = a_1$ and $u_{X3} = a_2$. Cross-sectional area A and Young's modulus E are constants. Use two bar elements and two force elements as indicated in the figure.



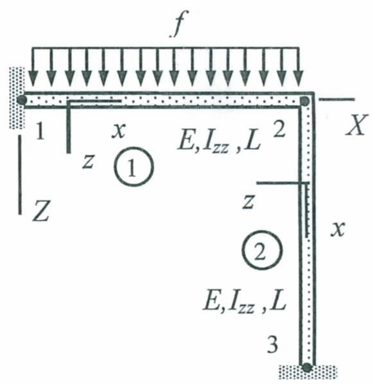
2. Consider the beam of the figure loaded by moment M acting at node 3. Determine rotations $\theta_{Y2} = a_1$ and $\theta_{Y3} = a_2$. Use two beam elements and one moment element. Young's modulus E and the second moment of area I_{zz} are constants.



3. Determine the nodal displacements of the bar structure consisting of bar elements (1), (2) and (3) and force element (4). Assume that $u_{Y2} = -u_{Y1} = a_1$, $u_{Y3} = 0$, and $u_{X3} = a_2$. Cross-sectional area A and Young's modulus E are same for all the bars.



4. Determine the rotation $\theta_{Y2} = a_1$ at node 2 of the structure. Use two Bernoulli beam elements of equal length. Assume that the beams are rigid in the axial directions. Young's modulus of the material E and the second moment of area and I_{zz} are constants.



5. Consider the torsion bar (1) of the figure loaded by torque M (2) acting on the free end. Determine the rotation $\theta_{x2} = a_1$ at the free end if I_{rr} is constant and shear modulus G varies linearly so that the values at the nodes are G_1 and G_2. Start with the virtual work density $\delta w^{\text{int}} = -\delta\phi_{,x} G I_{rr} \phi_{,x}$ and use linear approximation to rotation (a linear two-node element).