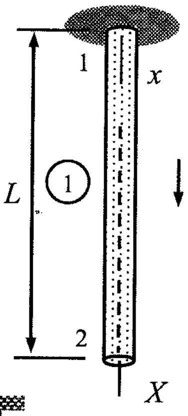
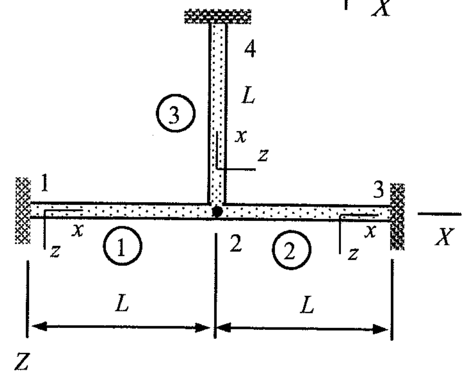
MEC-E8001 Finite Element Analysis, Exam 19.02.2020

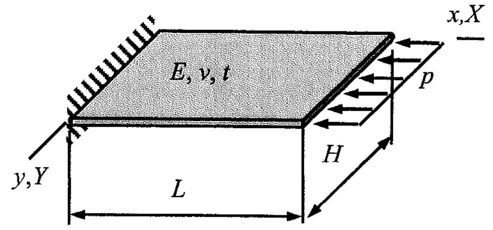
1. Consider a bar of length L loaded by its own weight (figure). Determine the displacement u_{X2} at the free end. Start with the virtual work density expression $\delta w_{\Omega} = -(d\delta u / dx)EA(du / dx) + \delta u f_x$ and approximation $u = (1 - x / L)u_{x1} + (x / L)u_{x2}$. Cross-sectional area A, acceleration by gravity g, and material properties E and ρ are constants.



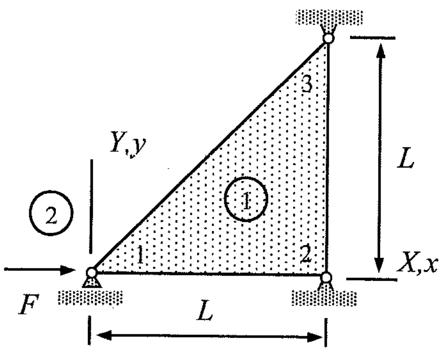
2. The XZ-plane structure shown consists of three beams of equal properties. Assuming that the beams are inextensible in the axial directions, derive the angular speed of free vibrations. Young's modulus E and density ρ of the beam material and the second moment of area I are constants. Assume that the inertia term due to rotation of cross-sections is negligible.



3. The clamping of the plate shown allows displacement in y-direction. At the free edge, the plate is loaded by distributed force p. Determine the critical value p_{cr} of the distributed force making the plate to buckle. Use the approximation $w(x,y) = a_0(x / L)^2$ and assume that $N_{xx} = -p$ and $N_{yy} = N_{xy} = 0$. Material parameters E, ν and thickness of the plate t are constants.



4. A thin triangular slab (assume plane stress conditions) loaded by a horizontal force is allowed to move horizontally at node 1 and nodes 2 and 3 are fixed. Derive the equilibrium equation for the structure according to the large displacement theory. Material parameters C, ν and thickness t at the initial geometry of the slab are constants.



5. Determine the static displacements $u_{Z2} = -u_{Z3}$ of nodes 2 and 3 due to the temperature increase $\Delta\vartheta$ at nodes 2 and 3 (actually in the wall). The material constants are E and α. The cross-sectional area of bar 1 and 3 is A and that of bar 2 is $\sqrt{2}A$. The initial temperature is ϑ°.