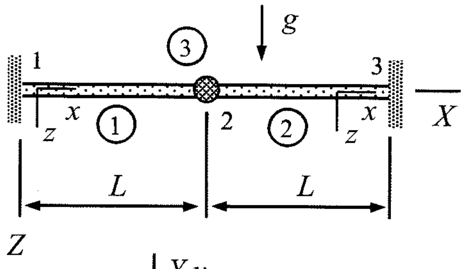
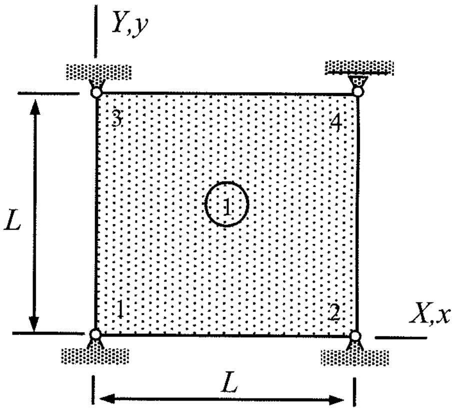
MEC-E8001 Finite Element Analysis, Exam 15.02.2017

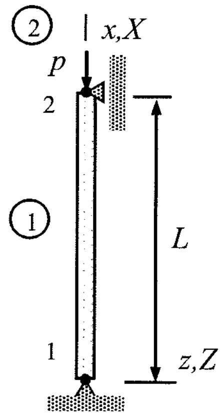
1. The XZ-plane structure shown consists of two massless Bernoulli beams and a homogeneous disk (of mass m) considered as a rigid body. Determine the displacement u_{Z2} and rotation θ_{Y2} at node 2. Young's modulus E of the beam material and the second moment of area I are constants.



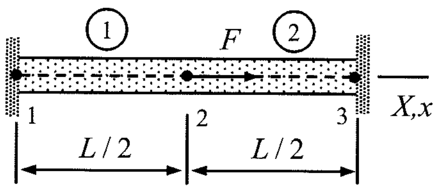
2. Node 4 of a thin rectangular slab (assume plane stress conditions) is allowed to move horizontally and nodes 1, 2, and 3 are fixed. Derive the initial value problem giving as its solution the horizontal displacement $u_{X4}(t)$ of node 4 as function of time, if $u_{X4}(0)=U$ and $\dot{u}_{X4}(0)=0$. Use just one bilinear element. Material parameters E, $\nu=0$, ρ and thickness h of the slab are constants.



3. Determine the buckling force p_{cr} and the buckled shape of the structure shown by using one two-noded Bernoulli beam element. Displacements are confined to the XZ-plane. Parameters E, A, and I are constants.



4. Determine the equilibrium equation of the elastic bar of the figure with the large deformation theory. The active degree of freedom is u_{X2} and the cross-sectional area and length of the bar are A and L without the point force F acting on node 2. Constitutive equation of the material is $S_{xx}=CE_{xx}$, in which C is constant. Use two elements with linear shape functions.



5. Determine the stationary temperature distribution in a thin slab shown. Edge 1-2 is at constant temperature ϑ°, heat flux through the other edges vanishes, and heat generation rate per unit area is s. Use linear triangle elements with ϑ_3 and $\vartheta_4=\vartheta_3$ as the active degrees of freedom and consider $\vartheta_1=\vartheta_2=\vartheta^{\circ}$ as known. Thickness t, thermal conductivity k, and heat production rate per unit area s are constants.