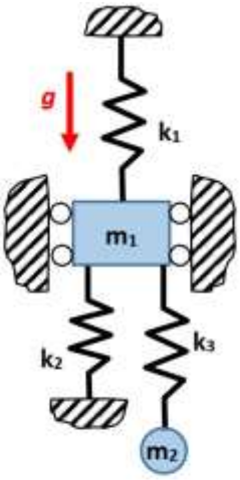
Finite Element Method 1 – Homework training/part 1 Problems:

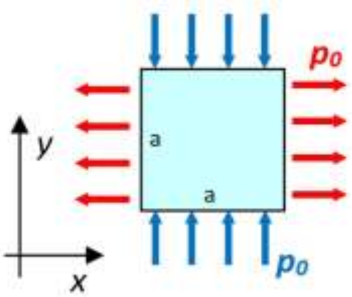
1. Build a FE model of the system of masses and springs in a gravitational field (statics). Find the global stiffness matrix and the load vector. Consider boundary conditions and find the displacements and reactions.

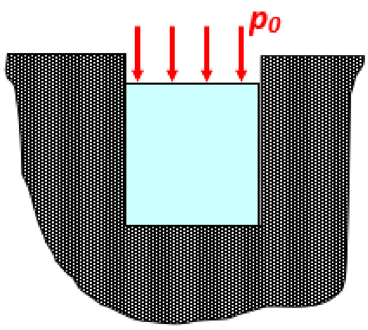


2. Find the components of strain and stress vectors and the elastic strain energy of a sample with a square area and unit thickness. Assume plane stress conditions. Material data: $E = 2{\cdot}10^5$ MPa, $\nu = 0.3$, $a = 10$ mm, $t = 1$ mm, $p_0 = 80$ MPa.

   a) sample loaded with self-balanced pressure loads p_0,

   b) sample supported without friction in a non-deformable groove.



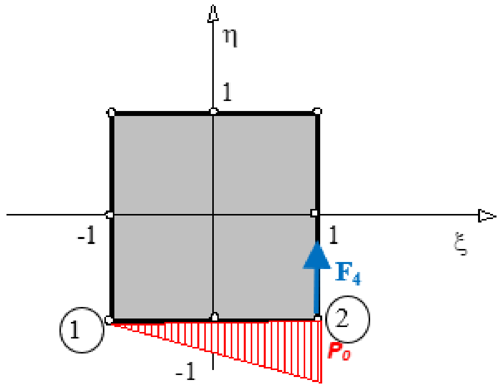


3. Calculate the equivalent nodal forces for the CST element:

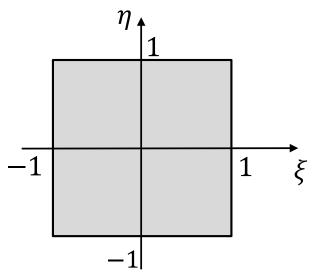
   a) loaded by pressure load p = const,

   b) loaded with a mass load X=const.

4. An 8-node isoparametric element is loaded on its lower side with a linearly varying pressure. Calculate the equivalent nodal force F_4.



5. Perform the Gauss quadrature integration of the function f over a square area using different integration schemes (n = 1, 2 and 3 points). Compare results with the exact solution.

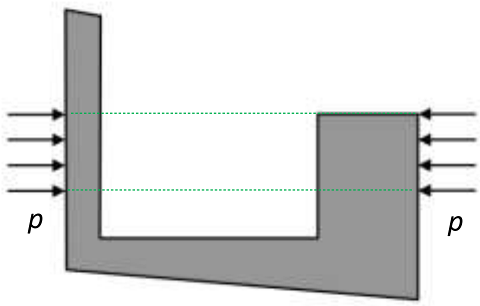


$$F(\xi, \eta) = 3(\xi^2 - 1) + 2\eta$$

Theory:

1. What does the principle of minimum total potential energy state?

2. Suggest the correct support conditions for a plane model loaded by the self-balanced surface load. Why are such conditions necessary?



3. What are the features of a local stiffness matrix of each finite element?

4. What quantities are continuous and what are discontinuous at the boundaries between finite elements in the plane problem of the theory of elasticity?

5. What are the differences and similarities between a plane stress state and a plane strain state in terms of FE analysis?