AE4527 Nonlinear Structural Modeling
Homework Assignment 1

1.1 Geometric Nonlinearity – A Shallow Truss Problem

The shallow truss system of figure 1.1 is loaded with a force **P** such that it will undergo large displacements and large rotations, but small strains. The geometrically nonlinear deformation behavior shall be analysed with a finite element solution implemented in Matlab.

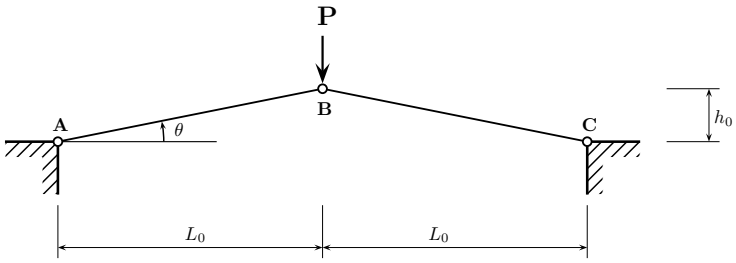

Figure 1.1: Plane shallow truss structure

Solve the problem using the following steps:

1. choose reasonable values for the geometry, the linear elastic material properties and the loading.
2. develop a solution scheme for the nonlinear FE analysis of the given structure. A numerical solution must cover the equilibrium path of the nonlinear problem until the first limit point is reached. Show the solution steps of the applied solution method in algorithmic form in a flowchart.
3. implement the nonlinear truss element, the truss model and the solution algorithm with Matlab and verify your implementation with an analytic solution from literature. Show the following results for a reasonable number of load steps: total applied load, deflection of node B and the reaction forces at A and C.
4. study the influence of a different angle θ that leads to a steep truss structure and show the load-displacement path of your fem solution for both models, shallow and steep truss structure, in a diagram. A proper representation of both results in one diagram might require a suitable normalization of the results.

1.2 Observed Properties

1. Comment on the influence of the angle θ on the deformation of the structure.
2. Is the assumption of small strains justified? Comment on this assumption based on your analysis results.