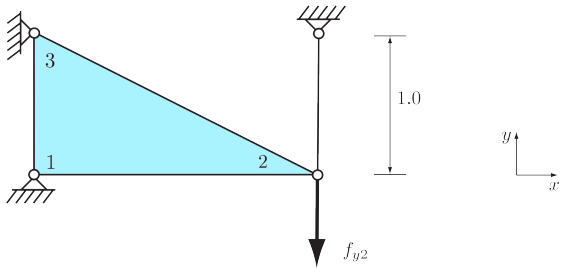
Assignment 3: FEM Structural analysis
Assigned: 14th February 2019
Due: 1st March 2019

1. Consider the following structural system consisting of a three-noded triangle and a cable element (i.e. two-noded one-dimensional element). The triangle element is fixed at the (local) nodes 1 and 3 and its stiffness matrix for the unconstrained degrees of freedom at node 2 is

$$\mathbf{K} = 10^9 \begin{bmatrix} 1.97 & 0 \\ 0 & 0.66 \end{bmatrix} \begin{matrix} u^e_{x2} \\ u^e_{y2} \end{matrix}$$

For the cable, the product of the Young's modulus and cross-sectional area is $EA = 1.0 \cdot 10^9$. Further, the system is loaded with a nodal force of $f_{y2} = -10000$.



- Determine the displacements u_{x2} and u_{y2} of node 2.
- Determine the force in the cable.

2. Using the Jupyter notebook for elastic-bar-linear.ipynb compute and plot the displacement profiles for the following loading conditions using linear elements for FE discretization.

- A uniformly distributed load of 1.
- A uniformly varying load with 1 at the fixed end, and 0 at the free end.
- A sinusoidal load described as $f(x) = \sin(x^2)$

(a) Calculate the error in displacement, using a reference solution as the FE solution with 100 elements.

(b) Use at least 5 different discretizations and plot how the error changes with the number of elements.

(c) Based on the errors computed above, determine the number of linear elements required for the FE analysis for the three loading conditions shown above.