Assignment 3: Shape functions
Assigned: 8th February 2019
Due: 22nd February 2019

1. Using the Jupyter notebook for shape function plot the shape functions for linear, quadratic and cubic polynomials with equally spaced nodes. Comment on the suitability of these shape functions for calculating deflection, strain, and curvature.

2. Using the same shape function notebook plot and comment on the suitability of a 5th and a 10th order polynomial shape functions with equally spaced nodes.

3. Using hand calculations compute and plot the standard shape function for the element shown in Figure 1a.

4. Modify the Jupyter notebook for shape function exercise to compute the shape functions for the elements shown in Figure 1. Compare your result from the hand calculation with the solution obtained using the Jupyter notebook for Figure 1a. Please try part (1b) with Jupyter notebooks only. Comment on the degree of displacement and strain that can be modeled using these elements:
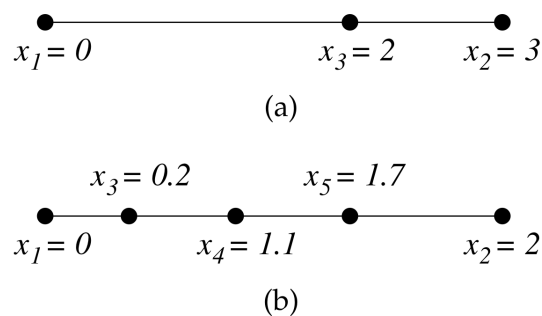
$x_1 = 0$ $x_3 = 2$ $x_2 = 3$

(a)

$x_3 = 0.2$ $x_5 = 1.7$

$x_1 = 0$ $x_4 = 1.1$ $x_2 = 2$

(b)

Figure 1: 1D elements

5. For a linear element with nodes $x_1 = 0$ and $x_2 = l$, compute the 'element mass matrix' $M_e = \int_0^l N^T N dx$. Comment on the mass conservation of the element matrix. The mass matrix derived is called the 'consistent mass matrix'. Could you try to derive the equivalent lumped mass matrix?