Computational Mechanics by Isogeometric Analysis
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Exercises 27 February, 2014
B–splines and NURBS: basis functions and curves

1. Determine the properties of the B–splines basis $\{N_{i,p}(\xi)\}_{i=1}^{n}$ (order p, number of basis functions n, and regularity of the basis functions) associated with the following knot vectors:

   a) $\Xi = \{0, 0, 1, 2, 3, 3\}$;

   b) $\Xi = \{0, 0, 0, 1, 2, 3, 3, 3\}$;

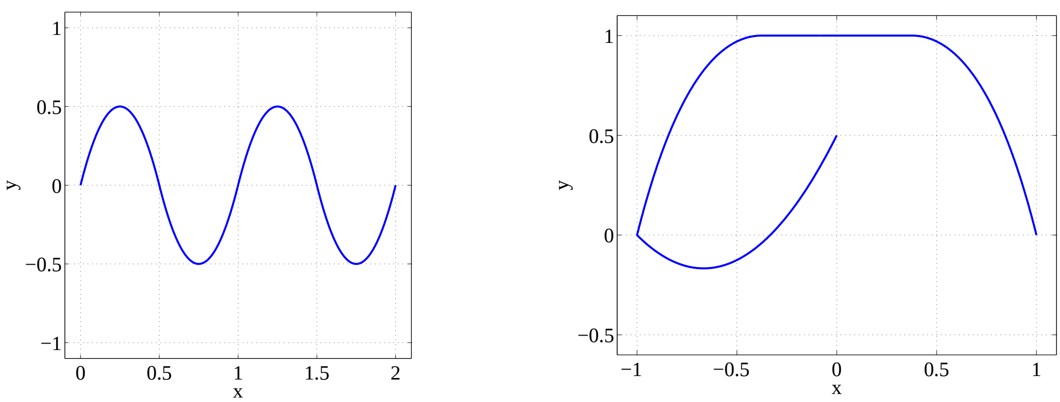
   c) $\Xi = \{0, 0, 0, 1, 2, 3, 3, 4, 4, 4\}$;

   d) $\Xi = \{0, 0, 0, 0, 1, 2, 3, 3, 4, 5, 5, 5, 6, 7, 8, 8, 8, 8\}$.

2. Plot the B–splines basis functions of point 1) by using the MATLAB function `display_univariate_nurbs_basis_functions.m` based on the MATLAB package `nurbs`.

3. Use the Cox–de Boor recursion formula to obtain the explicit expression of the B–splines basis functions corresponding to the knot vectors Ξ of points 1a) and 1b).

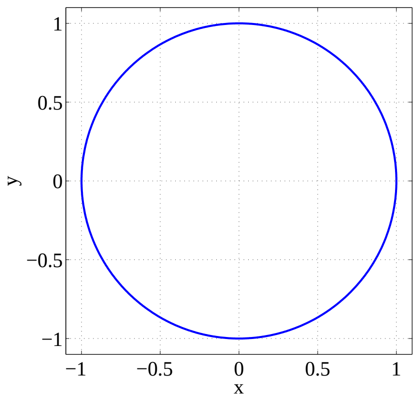
4. Represent the following curves in $\mathbb{R}^2$ as B–splines and plot them by means of the MATLAB function `display_nurbs_curve.m`.



a) b)

5. Plot the NURBS basis functions corresponding to the knot vector Ξ of point 1b) by setting the weight associated to the second basis function, say w_2, firstly equal to 0.1 and then to 10 ($w_i = 1$ for all $i = 1, 3, \ldots, n$).

6. Represent and plot the circle of unitary radius in $\mathbb{R}^2$ by using a NURBS basis of polynomial order 2.



7. Represent and plot a spiral of unitary radius in $\mathbb{R}^3$ by using a NURBS basis of polynomial order 2; the spiral should exhibit at least two loops.