2007 Paper 7 Question 4

Advanced Graphics

(*a*) A NURBS curve is defined by control points $\mathbf{P}_1, \mathbf{P}_2, \ldots, \mathbf{P}_{n+1}$ and knot vector $(t_1, t_2, \ldots, t_{k+(n+1)})$.

(*i*) State the formulæ for deriving the basis functions $N_{i,k}(t)$. [3 marks]

(*ii*) Graph all seven of the linear basis functions, $N_{i,2}(t)$, for the knot vector $(0, 1, 2, 4, 5, 5, 5, 6, 7)$. [3 marks]

(*iii*) Draw seven points, $\mathbf{P}_1, \mathbf{P}_2, \ldots, \mathbf{P}_7$, equi-spaced around a circle and draw the linear NURBS curve defined by those points and the basis functions from part (*ii*). [2 marks]

(*iv*) Derive the formula for and sketch a graph of the basis function $N_{3,3}(t)$ for the knot vector in part (*ii*). [3 marks]

(*b*) Choose *one* of the *Doo–Sabin*, *Catmull–Clark* and *Loop* subdivision schemes. Describe your chosen scheme, including an explanation of how it works in regular regions of the mesh, how it works at and around extraordinary polygons, and how it works at and around extraordinary vertices. [9 marks]