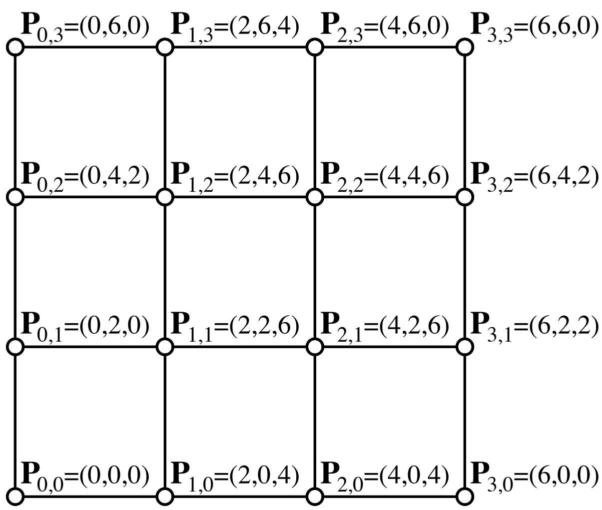

Figure 1: Surface Control Grid

1. Take the control grid in Figure 1 to be for a bicubic Bézier surface patch, $\mathbf{P}(s,t)$.
   a. Find the Cartesian coordinates for $\mathbf{P}(0,0)$, $\mathbf{P}(\frac{1}{2},0)$, and $\mathbf{P}(\frac{1}{2},\frac{1}{2})$.
   b. Find the normal vector at $\mathbf{P}(0,0)$, $\mathbf{P}(\frac{1}{2},0)$, and $\mathbf{P}(\frac{1}{2},\frac{1}{2})$.
   c. If we want to tessellate this patch using the fewest number of triangles such that the approximation error $\epsilon \leq .001$, how many rows and columns of triangles will we need? (See Section 15.4.2 in the notes.)

2. This problem asks you to go through, by hand, the first curve intersection example for Project 5 in the file `proj5.dat`. For the curve $\mathbf{P}(s)$ with control points

$$\mathbf{P}_0 = (0,0), \quad \mathbf{P}_1 = (2,4) \quad \mathbf{P}_2 = (4,-4) \quad \mathbf{P}_3 = (6,0)$$

   and weights are all 1,
   a. What is the implicitization matrix M? That is, what are the 9 elements $ax + by + cw$ for the 3×3 matrix whose determinant is the implicit equation of this curve?
   b. The curve $\mathbf{Q}(t)$ is a degree-one polynomials Bézier curve with control points

$$\mathbf{Q}_0 = (3,-1), \quad \mathbf{Q}_1 = (3,5).$$

   If you substitute the parametric equations for $\mathbf{Q}(t)$ into each element of M, what is the resulting matrix? (Each element should be a linear polynomial in t.)
   c. What is the inversion equation for $\mathbf{P}(s)$? Use the inversion equation to compute the parameter value s for the point $(3,0)$.