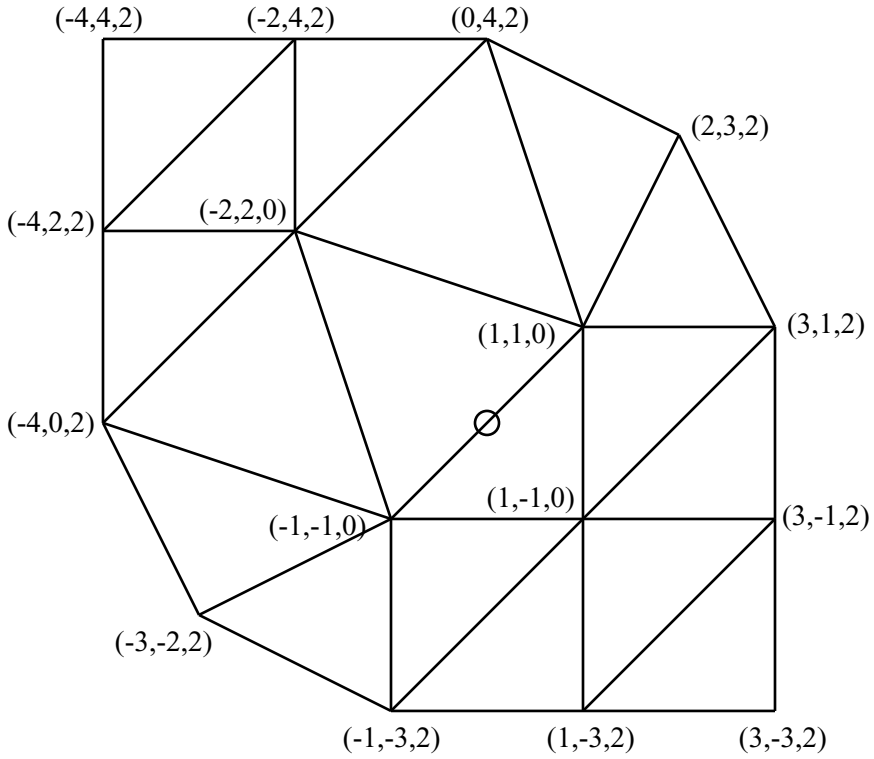
CS 559: Computer Graphics

Homework 7

This homework must be done individually. Submission date is Thursday, December 9, 2004, in class. It will be graded and available before December 15, two days before the final.

Question 1:

You are performing subdivision on the mesh below.

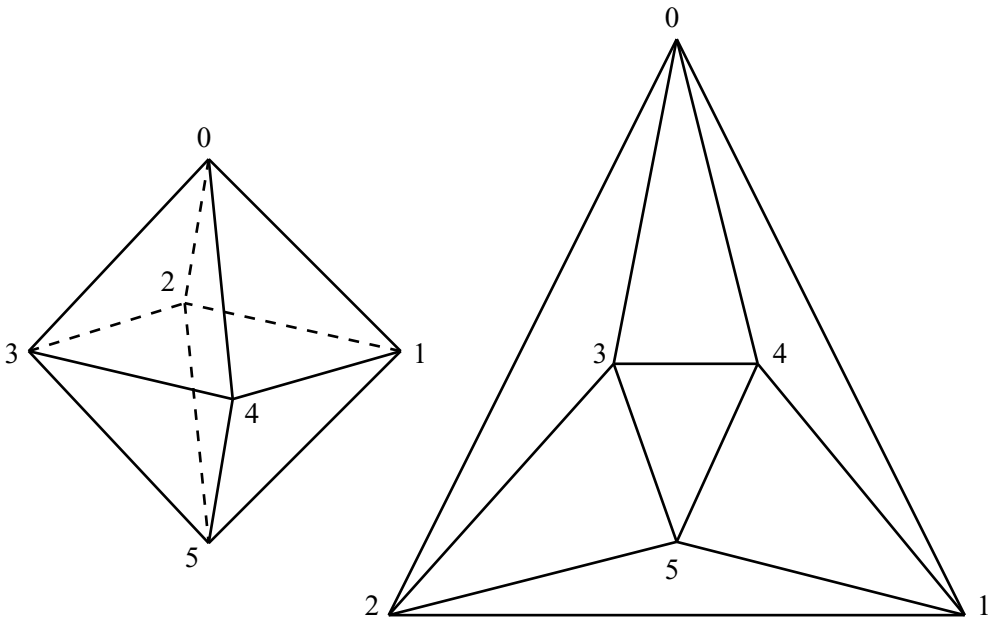


a. What is the 3D location of the new vertex indicated by an open circle for the parameter value $w = \frac{1}{16}$?

b. What is it for parameter $w = 0$?

Question 2:

The following figure on the left shows the octahedron used as the starting shape for sphere subdivision. The center figure shows the mesh "unwrapped" to reveal the connectivity. On the right are the vertex locations.



a. Perform sphere subdivision of the face 3-4-5 (the one using vertices 3, 4 and 5). Give the location of the new vertices 3-4, 4-5 and 3-5 (the vertex for the edge between 3 and 4, etc.).

b. Use the modified subdivision scheme to compute the location of the new vertex 3-4.

Question 3:

A Bezier curve will be used to represent a straight line of length 1. The first control point, $\mathbf{x}_0$, is at (0,0,0).

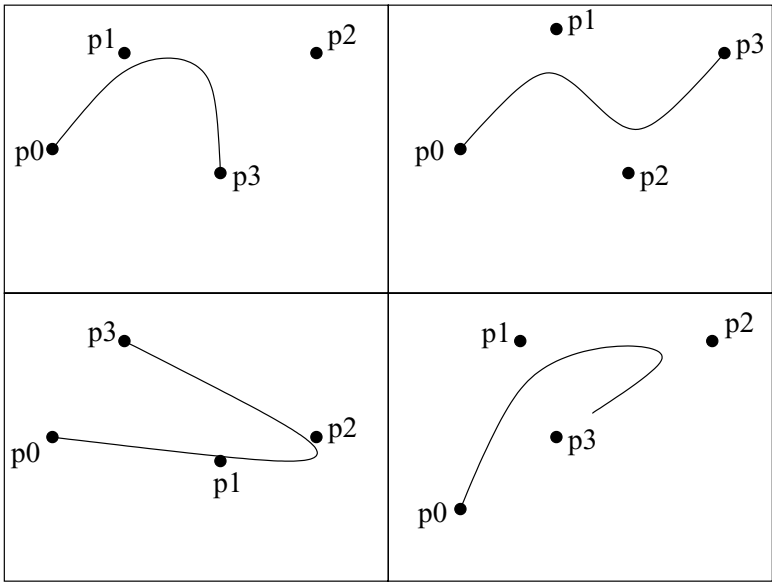
a. The line is to point along the y-axis. Where should the final control point, $\mathbf{x}_3$, be located?

b. Say we want the magnitude of the parametric derivative of the curve to equal 1 at both the start and end of the curve. Where should we place the other two control points, $\mathbf{x}_1$ and $\mathbf{x}_2$?

c. Show that the magnitude of the parametric derivative is always 1 for the curve you have created.

Question 4:

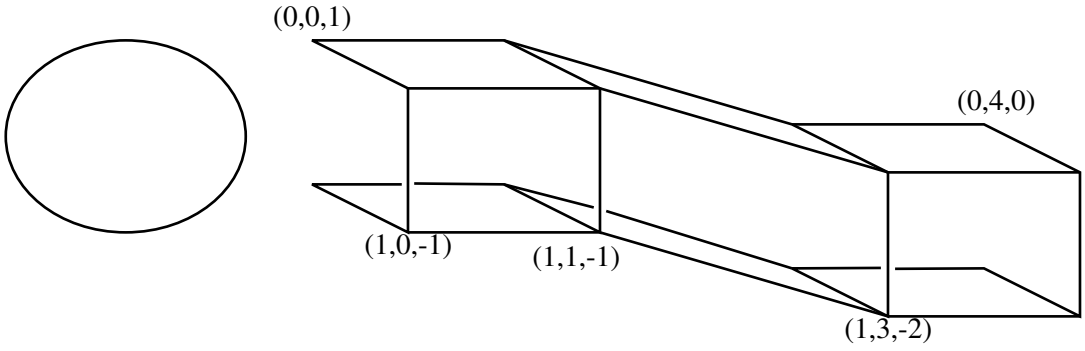
Which of the following must **not** be cubic Bezier curves, and why not?



Question 5:

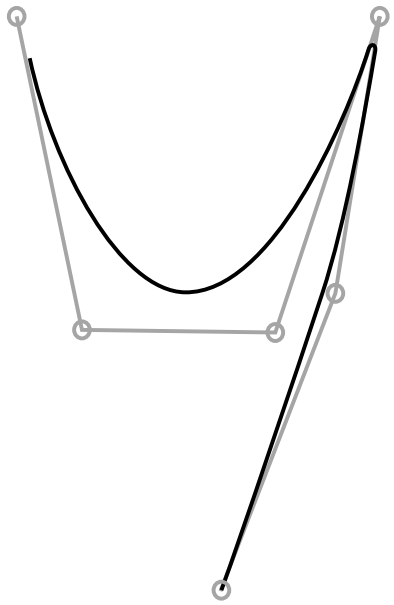
You are required to design a slightly curved pipe using two Bezier patches. The cross section of the pipe is shown on the left, with the control mesh *for one half* of the pipe on the right. Some of the control point locations have been specified already.

Fill in the rest of the control point coordinates (in 3D) for the half of the pipe given. You must take into account the continuity conditions for the join with the other half, even though it isn't shown. You must also ensure that the curves around the openings of the pipe are planar. Otherwise, you are free to assign coordinates as you like.



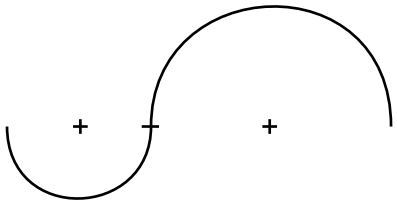
Question 6:

B-spline curves can be forced to be tangent with their control polygons or interpolate vertices by repeating control vertices multiple times. The figure below shows a B-spline curve and its control polygon. Label each vertex of the control polygon (in gray) with the number of times that vertex is being repeated.



Question 7:

The figure below shows two pieces of circular arcs, joined at the point indicated by the small horizontal bar. The center of each circle is also marked, and the centers lie on a straight line through the join point.



a. Each arc is uniformly parameterized such that $t = 0$ is at the left-most point on the arc, $t = 0.5$ is at the midpoint of each arc, and $t = 1$ is at the right-most point. Do the arcs join with C^1 continuity?

b. Do the arcs join with G^1 continuity?