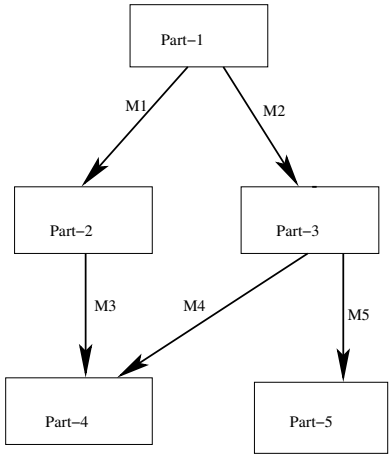
test 2 practice problems

1. Using the half-edge notation ($v.h$ for a half-edge out of a vertex v, $h.n$,$h.p$, $h.o$ for the next, previous and opposite half-edge for a half-edge h) give a pseudocode of a procedure that computes the degree of a vertex v in a manifold mesh. Degree of a vertex is defined as the number of its incident edges.

2. Assuming that procedures `draw-part-i` are given for $i = 1, 2, 3, 4, 5$ and the procedure `MultMatrix(M)` multiplies the modelview matrix on the right (in the standard opengl order) convert the scene graph below to opengl pseudocode.



3. Environment mapping does not look well if applied to a triangle that occupies a large portion of the window. Why? Describe where the colors that are applied to the rectangle come from. You can assume that we look at the rectangle from far away, so that the eye rays reaching it can be approximated with parallel rays.

4. One of numerous variants of the shadow volume algorithm, called 'zfail' (as opposed to 'zpass', which is essentially the one covered in class), counts the number of intersections (number of exits minus number of entries, to be more precise) with shadow polygons that happen *beyond* the closest intersection point using the stencil buffer. It can be implemented by reversing the depth test for stages 2 and 3 (i.e. making it pass if the new depth value is *greater* than the depth value stored at a pixel). In this question, you can disregard clipping issues, i.e. assume that we actually do no clipping at all.

(a) Explain (concisely) why the zfail algorithm is it going to work, i.e. why this count provides a way of distinguishing lit pixels from the ones in shadow. For this part, assume the viewpoint is *not* between the light source and the screen, i.e. the ray starting at the light source and passing through the viewpoint doesn't hit the screen.

(b) Explain the importance of the assumption made in (a).

(c) How would you make the algorithm work without the assumption of (a)?

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5. Using the deCasteljau algorithm, express $B_{P_0P_1P_2P_3}(t)$ as a weighted average of the control points where $t \in [0,1]$ and P_i (i=0, 1, 2, 3) are (arbitrary) control points.

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6. Using the usual half-edge notation, write a pseudocode that:

1. lists all faces incident upon an edge

2. lists all faces adjacent to a given face

3. for a vertex, lists all adjacent vertices

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7. To do spherical environment mapping, we used a photograph of a reflective sphere as the texture. Is it possible to use a photograph of a reflective cube instead? Explain why.

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8. Let $P_0 = (0,0)$, $P_1 = (0,1)$, $P_2 = (1,1)$, $P_3(1,0)$. What is $B_{P_0P_1P_2P_3}(.5)$?

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9. Consider two Bezier curves in the plane:

Curve A: having control points (7,7), (0,2), (0,0), (-7,-7)

Curve B: having control points (3,-3), (1,1), (1,2), (-3,3)

(a) What can one say about these curves based on the Convex hull property for Bezier curves? (drawing is OK if... it's correct)

(b) Using properties of Bezier curves, explain why curves A and B have to intersect. State the properties your argument is based on.

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10. Can a manifold mesh with no boundary edges have 2005 triangles? If a manifold mesh has 7 handles and 2000 triangles, how many edges and vertices does it have?

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11. What is the volume and surface area of the tetrahedron with vertices $(0,0,0)$, $(1,0,0)$, $(0,1,0)$, $(0,2,2)$?