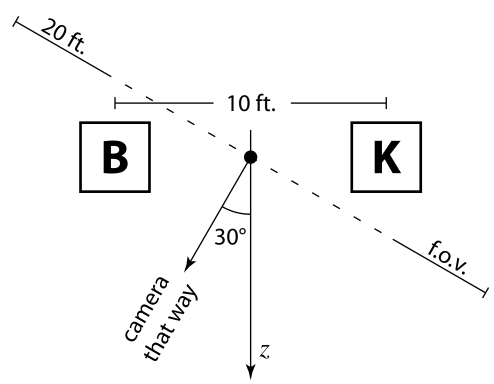
CS 465 Prelim 2

Tuesday 2 November 2004—Special election day editon

Problem 1: Viewing (45 pts)

It has been decided that there will be a last-minute fourth presidential debate tonight, before the polls close on the West coast, and you are the TV producer in charge. One of the conditions the two campaigns agreed upon was that the camera would be placed so that the candidates appear the same height on the screen. The two podiums are set up on the stage of an auditorium, separated from one another by 10 feet. President Bush is 6 feet tall and is standing at the left (from the camera's point of view); Senator Kerry is 6 feet 4 inches tall and is standing on the right:



1. The director wants the camera's view direction to be at an angle of 30 degrees to the center line of the auditorium. Assume the camera is pointed exactly at the midpoint of the line between the podiums, and the view direction is level (not looking up or down). How far away from that point does the camera need to be? Round to the nearest 2 feet.

2. To fit both candidates nicely in the frame, you want about a 20-foot-wide field of view (measured perpendicular to the view direction at the distance of the midpoint). The video camera you are using has a sensor that measures 10mm wide by 7.5mm high, and you have lenses with focal lengths 12, 25, 50, 75, and 100 millimeters. Which focal length should you choose?

One of the TV networks wants to use computer graphics to make a fancy "Decision 2004" banner that flies around the podiums in 3D as the candidates arrive. They commissioned a modeler who built a 3D model of the auditorium and the podiums. The model is in feet, and the origin is on the stage floor at the midpoint between the podiums. The podiums are on the x axis; the y axis points straight up, and the z axis points toward the audience. The camera is at eye level: 5.5 feet above the plane of the stage foor.

3. Your 3D rendering system wants the camera pose given by eye and target points and an up vector, and the view volume specified by left, right, bottom, top, near, and far coordinates. What input should you give the renderer so that it will match the view of the camera in the auditorium? Use 5 feet for the near-plane distance and about twice the distance to the candidates (round to the nearest 50 ft) for the far plane.

All three parts are asking about the same camera setup—so for each part use the results from the previous parts. Just in case you forget, $\sin 30° = \frac{1}{2}$ and $\cos 30° = \frac{\sqrt{3}}{2}$. If it's convenient to leave a square root in some of your answers, go ahead.

Problem 2: Pipeline (30 pts)

Consider the following types of rendering being done using a programmable graphics pipeline. For each rendering mode, answer (a) what attributes would be interpolated by the rasterizer, and which may safely be interpolated in screen space (without perspective correction); (b) what operations would be done by the vertex processor to compute those attributes (including transformations from one coordinate space to another); (c) what operations would be done by the fragment processor to compute a color and depth for the framebuffer.

1. Rendering with no lighting, just a color that comes straight from a texture map.
2. A white Phong highlight on top of a Gouraud shaded, untextured diffuse component. That is, the diffuse shading is computed per vertex but the specular shading is computed per fragment.
3. Phong lighting with a texture-mapped diffuse component and a highlight color that varies slowly across the surface.

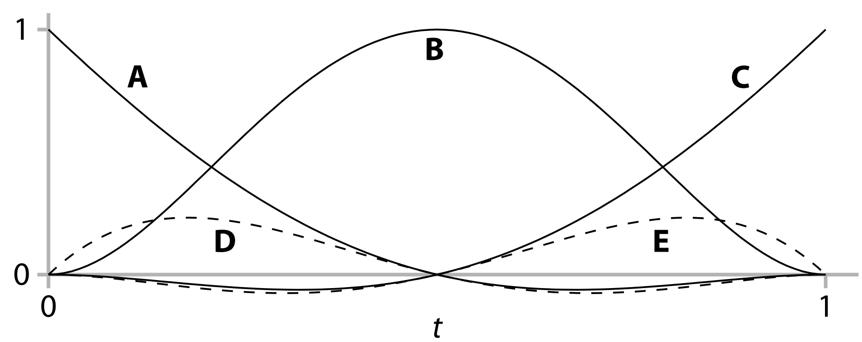
Problem 3: Splines (25 pts)

Your next assignment is to optimize the code for drawing the 50-state red/blue map (since the map changes so fast!). The boundaries of the states are drawn using spline curves, but you're not sure which kind is being used.

1. You start by considering the kinds of splines you know about. Write out a matrix that looks like this and fill in yes or no in each space to indicate which type of spline has which properties.

	C^1	C^2	stays in convex hull of control points	interpolates control points
Hermite				
Cubic Bézier				
Cubic B-Spline				
Catmull-Rom				

2. When you look at the existing spline code, you see that it is using a sequence of segments, each defined by a quartic (fourth degree) spline with an unfamiliar spline matrix. You plot the basis functions and you see the following curves:



(a) Which of the five control points (arbitrarily labeled A through E in the plot) will the curve pass through, and for what values of t?

(b) Which control points affect the tangent to the curve at $t = 0$? At $t = 0.5$? At $t = 1$?

(c) Does this spline have the convex hull property? How did you tell?