CS174A Assignment 3 - Part 1
Written Section

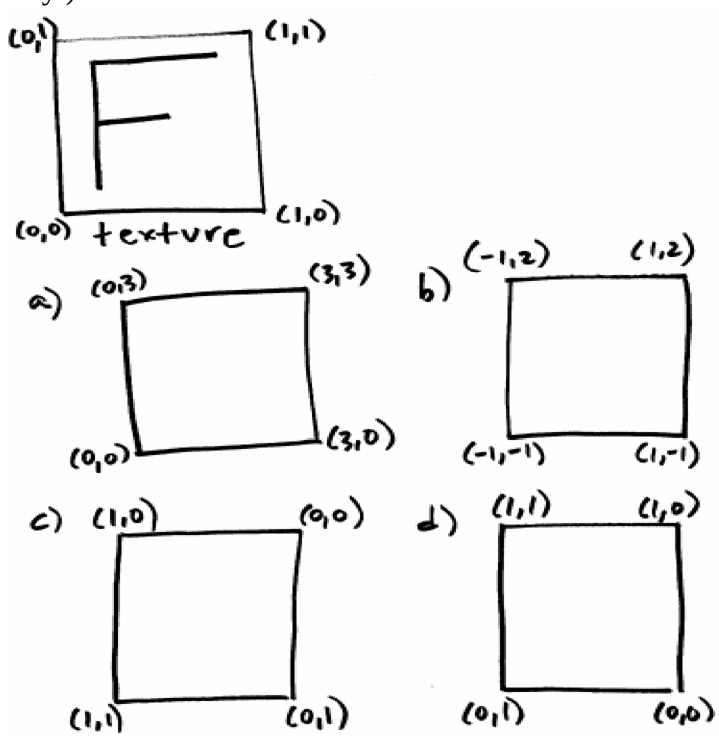
Out: Mon, November 20th, 2017 **Value:** 10% of final grade
Due: Tue, December 5th, 2014 12:00 pm (noon) **Total Points**: 152
Late days may be used until Fri, December 8 12:00 pm (noon)

1. **Clipping** (16 pts)
   Clip the polygon with points A = (0, 3), B = (2, 3), C = (0, -2) against the box (-1,-1), (1,1), (1,1), (-1,1).
   a. Show the full configuration after clipping against the top of the box with a sketch, including any new points you may need to create. If you need to create new points, give them names in alphabetical order (D, E, F, ...). Compute the exact coordinates of any new points that result from intersecting lines. (Provide the final values as decimal numbers.) Show your intermediate work, including outcodes for vertices.
   b. Same as above, after clipping against the bottom edge.
   c. Same as above, after clipping against the right edge.
   d. Same as above, after clipping against the left and final edge of the box.

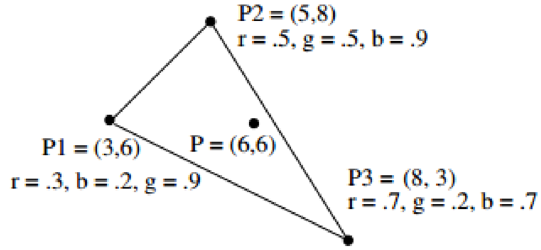
2. **Rasterization / Scan-conversion** (30 pts)
   Give an algorithm for scan-converting a circle with radius *r* and center at (x_o, y_o).
   a. (2 pts) Give the implicit equation of the circle.
   b. (3 pts) Give a naive scan-converting algorithm (ie. naively determines the next (x,y) to be drawn)
   c. (25pts) Give an algorithm for scan converting a circle using a Bresenham approach. (Hint: Work by octants and use symmetry.)

3. **Textures** (16 pts)

   In the following figure, sketch the texture (top) as it would appear in each of the rectangles with the specified texture coordinates.



4. **Interpolation** (4 pts)
Find the barycentric coordinates for P, and use them to interpolate the (r, g, b) color component at that point. Show your work.

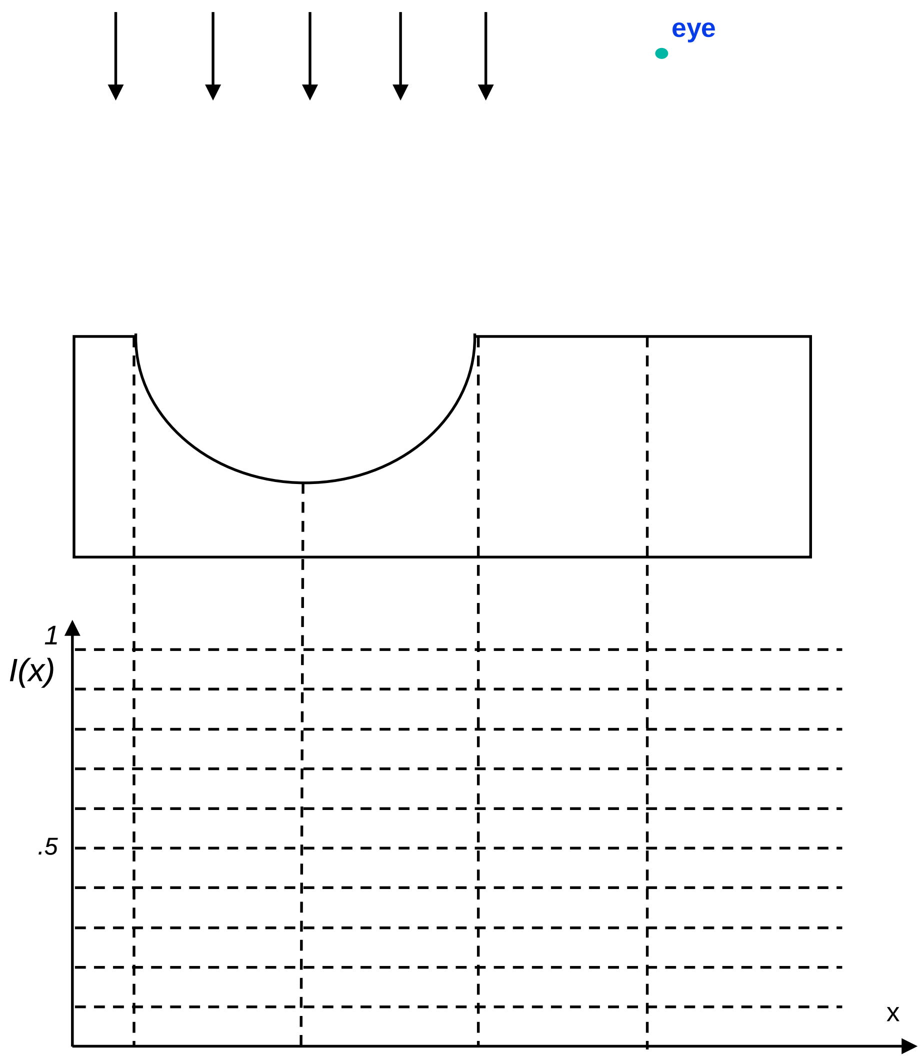


5. **Local Illumination** (18 pts)

a) (16 pts) Sketch the illumination that would be computed for the above scene using the Phong illumination model. The scene is lit from above using a directional light source that is coming directly from above. Use 4 sketches: one for ambient, one for diffuse, one for specular and one for the total illumination. The Phong illumination model is given by:

$$I = I_d k_d (\mathbf{n} \cdot \mathbf{l}) + I_s k_s (\mathbf{r} \cdot \mathbf{v})^n + I_a k_a$$

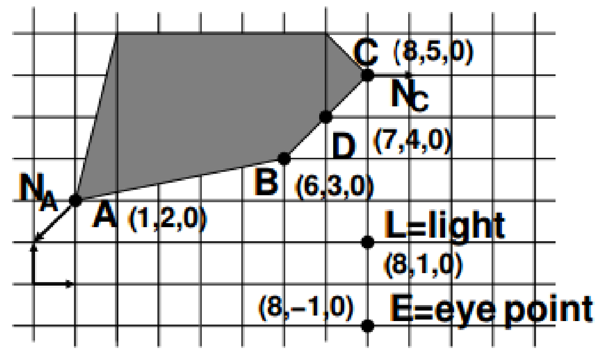
where $I_d = I_a = I_s = 1.0$, $k_a = 0.2$, $k_d = 0.8$, $k_s = 0.7$, $n = 100$.



b) (2 pts) Where are the local illumination models evaluated in the graphics pipeline? Why?

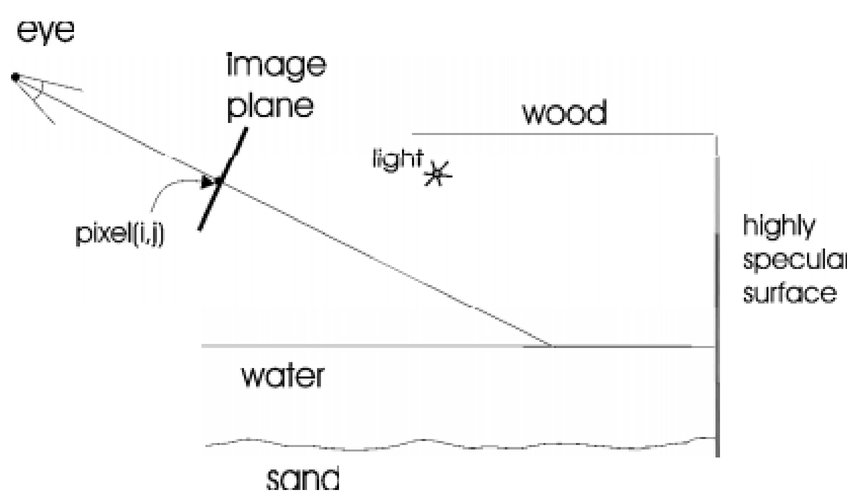
6. **Lighting and Shading** (50 pts)
   For the following questions refer to the figure and parameters below. Remember to normalize!

   - ambient light color I_a is (.1,.2,.1)
   - light color I_L is (1.0, 1.0, .9)
   - diffuse material color k_d is (.3, .8, .9)
   - ambient material color k_a is (.1, .1, .1)
   - specular material color k_s is (1, 1, 1)
   - shininess exponent is 20



   a) (2 pts) Compute the normal at point B
      using per-vertex normals, interpolating between the provided normals for point A and point C.
   b) (16 pts) Compute the ambient, diffuse, specular, and total illumination at points B, C, and D using the Blinn-Phong lighting model with the halfway vector, and the flat shading model.
   c) (16 pts) Do those computations using the Gouraud shading model.
   d) (16 pts) Do those computations using the Phong shading model.

7. **Ray-Tracing** (6 pts)



   a. (3 pts) For the following scene, sketch all the ray paths and shadow rays that would be generated by a raytracer in order to compute the color for the given pixel, (i,j).

   b. (3 pts) Draw the ray tree corresponding to the above ray paths. Draw the reflected paths to the right and the transmitted paths to the left. Also indicate where the shadows rays are generated. Add labels (eq. A, B, C, ...) to both your ray tree diagram and the ray segments sketched in part (a) so that the correspondences can be seen.

8. **Parametric Curves** (12 pts)
In this problem you will determine the basis matrix for a parametric cubic curve defined by the following geometric constraints $P_0=P(0)$, $T_0=P'(0)$, $A_0=P''(0)$, $P_1=P(1)$. Do not bother with numerically inverting any matrices.

a) (4 pts) Give the polynomial representation for a parametric cubic curve.
b) (4 pts) Compute the first and second derivative representation
c) (4 pts) Determine the basis matrix for the parametric cubic curve