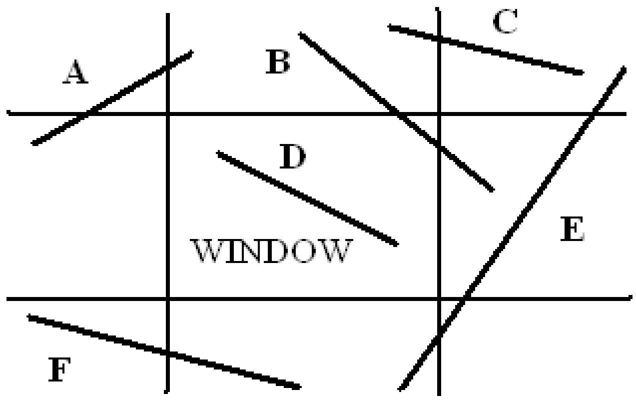
CS 184 Midterm 1 Fall 2004 Prof. Sequin

Problem – Clipping (8 pts.)

For the figure below list all the line segments that can be trivially culled away in the first step based on their "outcodes" in a Cohen-Sutherland line clipping algorithm.



These line segments can be trivially rejected:

____

Problem – Circle the correct answer (12 pts.) (-4 pts. each)

| TRUE | FALSE | In a perspective projection, moving the camera further away from the object to be imaged will cause a uniform scaling of the displayed result.

| TRUE | FALSE | In a perspective projection, changing the size of the window (frustum) specification will cause an affine change of the projected result.

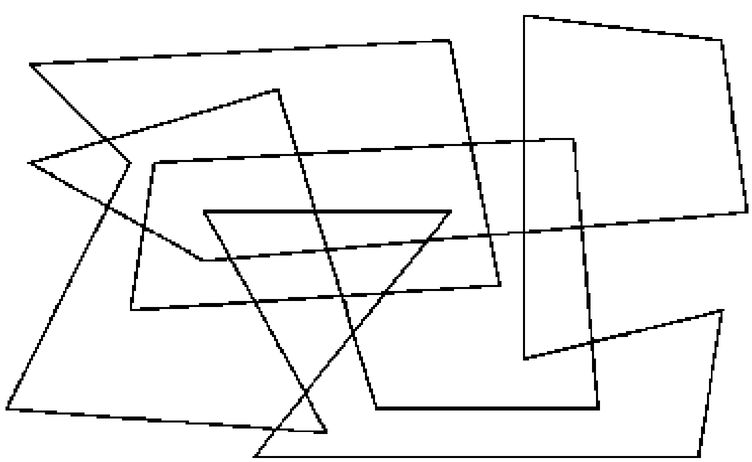
| TRUE | FALSE | Uniform illumination on a flat Lambert surface will always produce uniform apparent brightness for any observer.

| TRUE | FALSE | The Phong lighting model can produce non-uniform apparent brightness even with a single uniform directional light source.

| TRUE | FALSE | The Gouraud shading technique produces a planar {a*x + b*y + c} brightness distribution on flat faces of a polyhedral object.

Problem – Inside/outside Test (12 pts.)

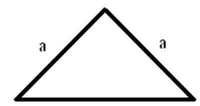
For the self-intersecting polygon below, paint the "inside" areas according to the NON-ZERO WINDING NUMBER MODEL.



Problem – Short Questions (32 pts.)

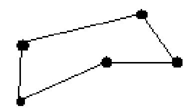
(6) Circle all the 3D transformations that commute with non-uniform scaling in y:
nonuniform scaling in x; translation in y; mirroring in z; rotation around x; rotation around y.

(4) How many degrees of freedom are associated with an isosceles triangle anywhere in R2? ____________



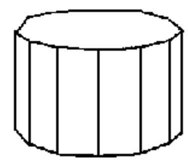
(4) How many degrees of freedom are associated with all possible infinitely long 3-(irregular)-sided prisms in R3? ____________

(4) How many degrees of freedom are associated with all possible free-floating 5-bar ring-linkages with unit-length links in R2 (=chain loops with 5 equal links). ____________



(6) What are the minimum and maximum number of vanishing points that can be obtained in a perspective projection of a regular twelve-sided prism?

MIN: ____________ MAX: ____________

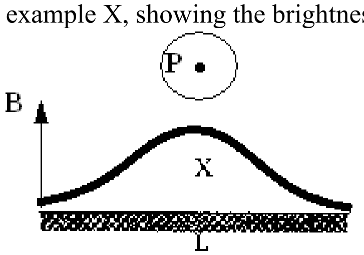


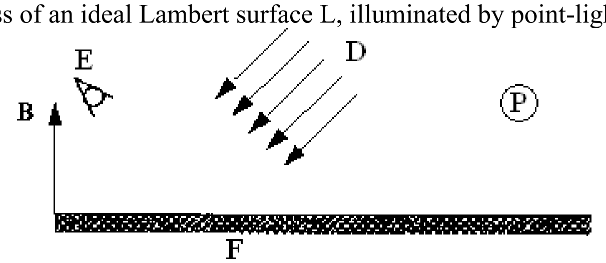
(4) Which of the four directional vector diagrams below describes most appropriately the brightness distribution of a PHONE specular component for $N_{Phong} = 20$?

(4) In what direction does the +X-axis point after a +90 degree rotation around the Y-axis (right-handed coordinate system)? ____________

Problem – Illumination (12 pts.)

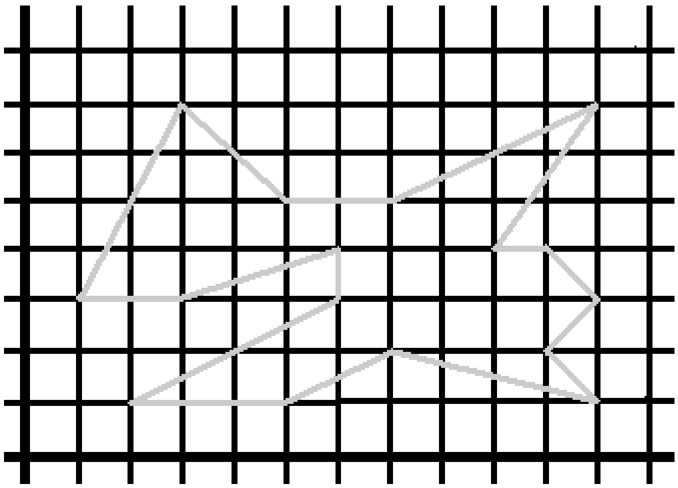
(A) Sketch apparent brightness B, as seen from eye E, along real face F (Phong model, $K_{amb} = K_{diff} = K_{spec} = 0.5$, $N_{phong} = 50$), illuminated by directional light D and point-light P. Follow example X, showing the brightness of an ideal Lambert surface L, illuminated by point-light P.





Problem – Rasterization (12 pts.)

Assuming the lower-left pixel-corner sampling paradigm, draw for the polygon below all boundary elements that belong to it: enhance its edges and circle all its sample points that fall on the boundary. (Apparent coincidences are meant to be exact coincidences). No need to fill in pixels.



Problem – Camera Specification (12 pts.)

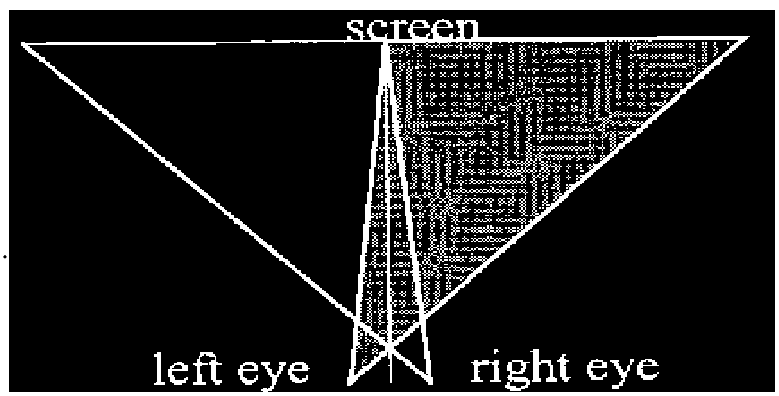
Use SLIDE statements (i.e., fill in the template below) to define the view frustum for the left-eye camera in an ideal stereo set-up with the following constraints: Eye separation 6cm. Distance to screen 100cm. Screen-area available for the two side-by-side viewports 40cm wide by 20cm high. Front clipping: 10cm in front of the eyes. Back clipping plane: 1km from the eyes.
(Default unit length in the WORLD = 1 cm).

camera id

projection SLF_P………………….

frustum (…………………….) (……………

endcamera



Problem – Perspective Warp (8 pts.)

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1/(1+z_{min}) & -z_{min}/(1+z_{min}) \\ 0 & 0 & -1 & 0 \end{bmatrix}$$

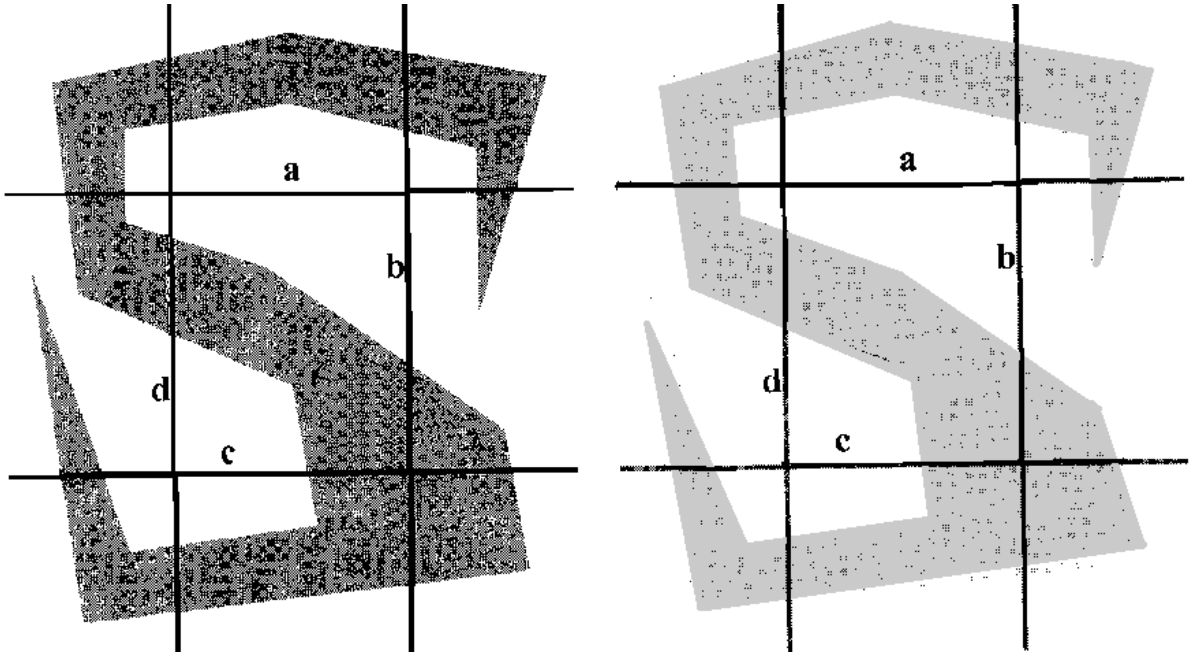
What are the two equations of the transformed planes in 3-space after a perspective transform of the canonical perspective viewing volume? (At left is the homogeneous perspective transformation matrix).

1.) for the plane y=z : …………………………….

2.) for the plane x=y : ……………………………..

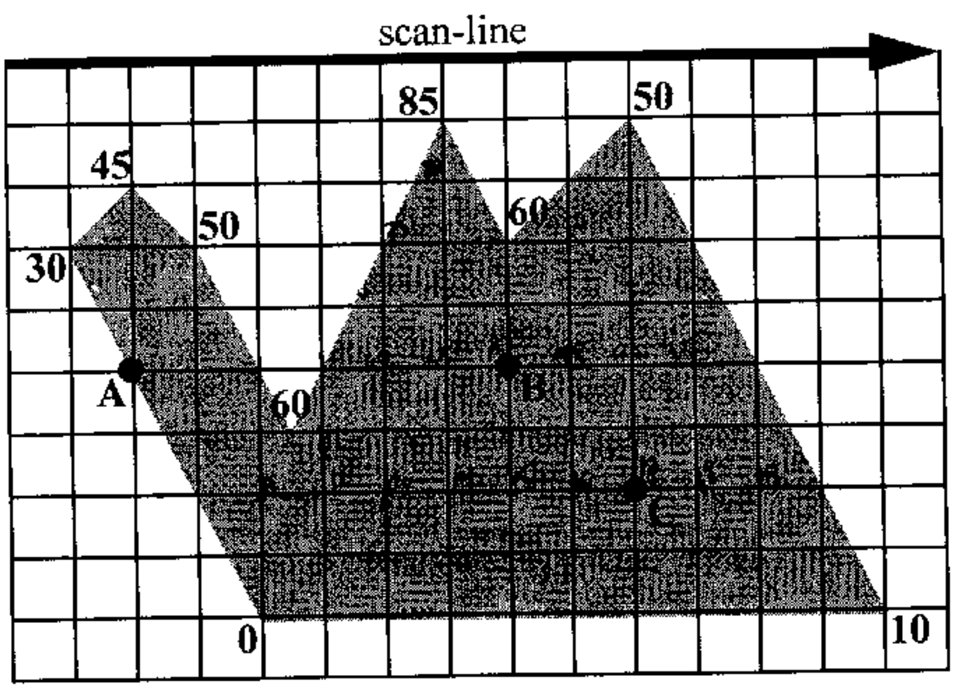
Problem – Clipping (8 points)

Show the polygon contour(s) that will be output from the Sutherland-Hodgman polygon clipping algorithm for the polygons shown below. Assume that the clipping sequence is : a, b, c, d. Show the final result in the right figure by strongly tracing out all output line segments.



Problem – Gouraud Shading (12 pts.)

Below is a polygon that is rendered with a scan-line based algorithm using Gouraud shading. The rendering intensities at its vertices are indicated. Write out the intensities at the labeled points.



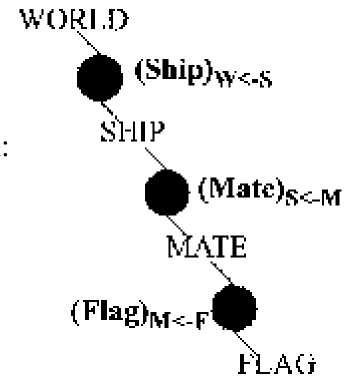
A = ______

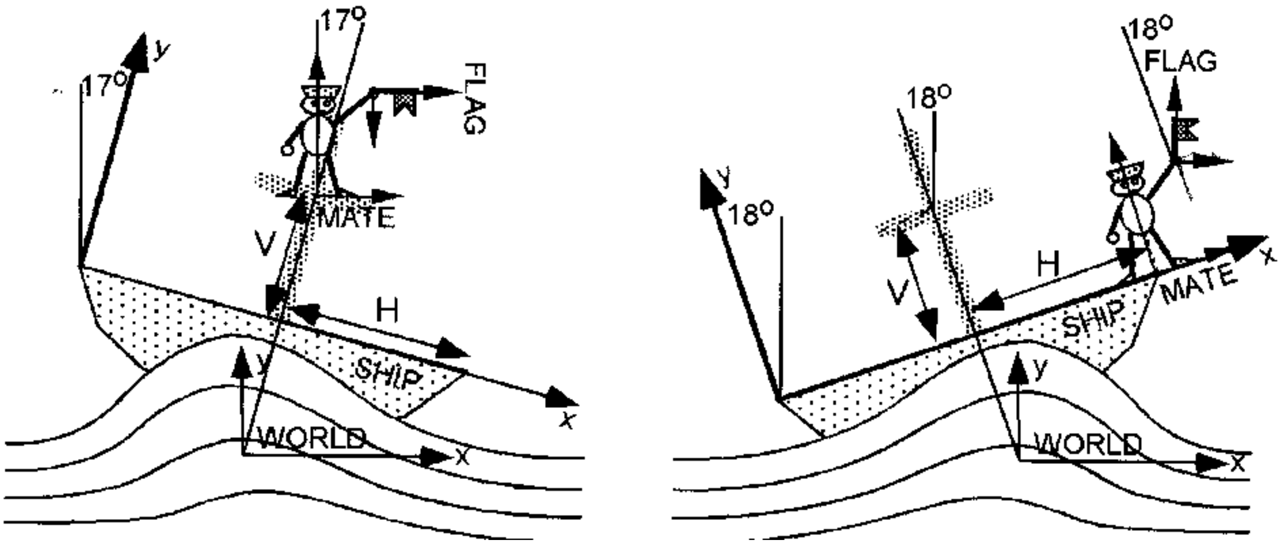
B = ______

C = ______

Problem – Scene Modification (15 points)

The two-dimensional scene below has the hierarchical strucdture shown by the diagram on the right, wher circles indicate the respective transformation matrices at each instance call. Thus the placement of FLAG in WORLD coordinates is given by the compound transformation:
$FLAG_W = (S)_{W<-S} * (M)_{S<-M} * (F)_{M<-F} * FLAG_F$ (eqn_1)
Assuming the use of homogeneous COLUMN coordinate triples. The current values of these matrices describe the state shown on the left below.





Now we want to describe the scene shown on the right by inserting a few extra matrices into the string of matrices in (eqn_1). Write down a suitably modified string of transformations for the new $FLAG_{WORLD}$; using the CS184 shorthand notation { T(dx, dy), S(sx, sy), R(_) }.
Use only the dimensions and angles explicitly indicated in the scenes above.

$new\_FLAG_W = \ldots\ldots\ldots(S)_{W<-S}\ldots\ldots\ldots(M)_{S<-M}\ldots\ldots\ldots(F)_{M<-F}\ldots\ldots\ldots FLAG_F$

Problem – Parametric Representation (7 pts.)

Give a parametric representation of a ray r(t) that starts at point P, passes through point Q, and then goes off to infinity.

r(t) = . . .