Quiz 2: CS CS4640 Name _____

1. Suppose $f = [2, 3, 5]$ and $h = [10, 1, 4]$; i.e., $f(0) = 2$, $f(1) = 3$, $f(2) = 5$, $h(0) = 10$, $h(1) = 1$, $h(2) = 4$. Show in detail (i.e., expand as sum from $-\infty$ to ∞) how to compute

$$g(x) = \int_{-\infty}^{\infty} f(x')h(x - x')dx'$$

in the discrete case for $x = 0$. Also, give $f \circ h$ (called $f * h$ in the text).

a. $g(0) =$

$$g(0) = \sum_{x'=-\infty}^{-1} f(x')h(-x') + f(0)h(0) + \sum_{x'=1}^{\infty} f(x')h(-x')$$

$$= 0 + 2 \cdot 10 + 0$$

$$= 20$$

b. $f \circ h =$

```
0 0  2 3 5   0 2  3 5   2 3  5   2 3 5  0   2 3 5 0  0
4 1 10 0 0   4 1 10 0   4 1 10   0 4 1 10   0 0 4 1 10

  = 20         = 32       = 61      = 17       = 20

foh = [20,32,61,17,20]
```

2. Given the perspective projection equations which capture the camera operation as shown in the figure:

$$x = f\frac{X}{Z}$$

$$y = f\frac{Y}{Z}$$

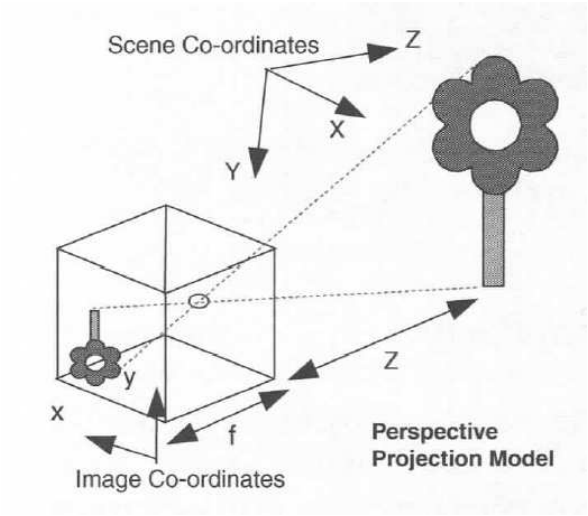

Figure 1: Camera Projection Model (from text).

2a. Explain why a positive X value in the 3D coordinate frame results in a positive x value in the image frame even though it's on the opposite side.

Because the x- and y-axes in the two coordinate frames go in opposite directions.

2b. Give a Matlab function (following class guidelines in function names, header info, etc.) which takes f, X, Y, and Z as inputs and returns x, y, and g as outputs, where g is a reasonable Z-dependent gray level. Make sure it handles potential corner cases ("a corner case (or pathological case) involves a problem or situation that occurs only outside of normal operating parameters" according to Wikipedia).

```
function [x,y,g] = CS4640_perspective(f,X,Y,Z)
% CS4640_perspective - returns perspective project of 3D point to
%                      image plane
% On input:
%     f (float): focal length
%     X (float): 3D x value of point
%     Y (float): 3D y value of point
%     Z (float): 3D z value of point
% On output:
%     x (float): x location in image plane
%     y (float): y location in image plane
%     g (uint8): gray level of point in image plane
% Call:
%     [x,y,g] = CS4640_perspective(1,3,3,3);
% Author:
%     T. Henderson
%     UU
%     Fall 2019
%

x = NaN;
y = NaN;
g = -1;

if f<=0 | Z<1
    return
end

x = f*X/Z;
y = f*Y/Z;
g = uint8(255*exp(-Z/10)/exp(-1/10));
```