Student #:
Name:

Write down answers in-between questions. Please answer using short sentences. The given spaces should be more than enough.

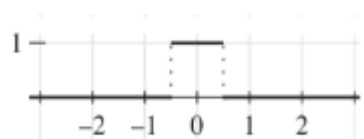
1. Given an input signal [0,0,0,0,0,1,1,1,1,1] and a kernel [-1, 2, -1], calculate the filtered signal assuming that the filtered signal has the same resolution as the input signal, and the “copy edge” extrapolation method is used where the filter window falls off the edge of the input signal.

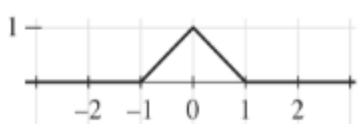
2. If we use each of the following 1D reconstruction filters to reconstruct a continuous function $g(x)$ from a sequence of samples $f[i]$ using continuous-discontinuous convolution, for which filters will $g(x)$be C^0 continuous?

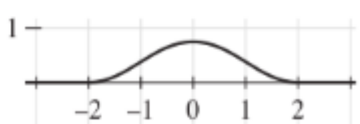
For which filters will $g(x)$ be C^1?

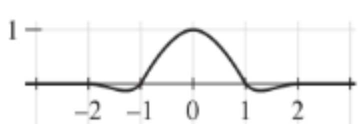
For which filters will $g(x)$ interpolate $f[i]$?

(The reconstructed function $g(x)$ is defined as $g(x) = \sum f\,[i]a(x-i)$ for an arbitrary sequence of samples $f[i]$ when each of the followings is $a(x)$.)

1.


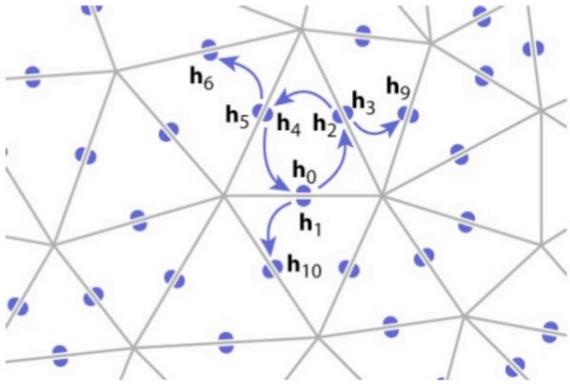
2.


3.


4.


3. EdgesOfVertex is a function that iterates through the list of half edges adjacent to vertex v. Fill in the blanks (???).

```
EdgesOfVertex(v) {
h = v.h;
do {
        h = ??? ;
    } while (h != v.h);
}
```

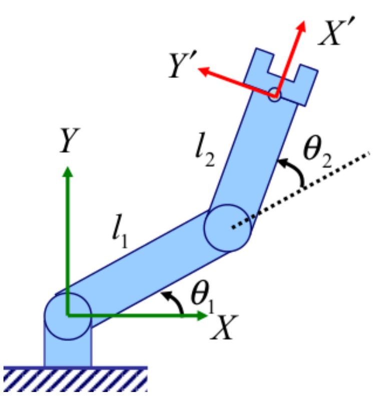


	pair	next
hedge[0]	1	2
hedge[1]	0	10
hedge[2]	3	4
hedge[3]	2	9
hedge[4]	5	0
hedge[5]	4	6
	⋮	

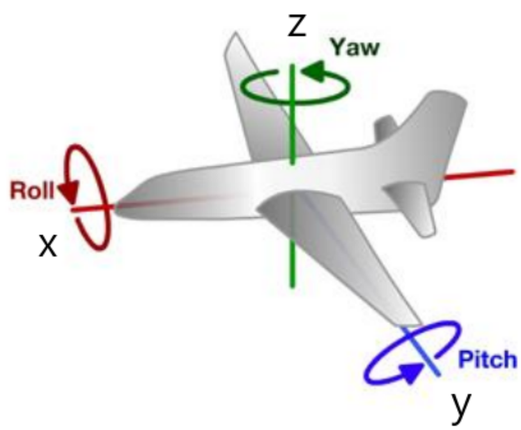
```
HEdge {
HEdge pair, next;
Vertex v;
Face f;
}
```

4. Derive the average storage requirement (bytes per vertex) of the indexed triangles representation assuming that a vertex contains a position, a 2D texture coordinate and a normal (all 4byte float variables).

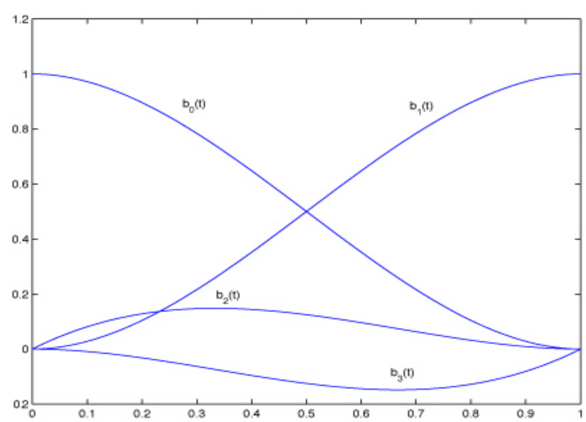
5. Write down the transformation matrix T of the tool (at X', Y') in terms of 2D rotation matrix R_θ and 2D translation matrix $T_{(tx,ty)}$.



6. (Euler angles) A plane leaving the airport is making a left turn while going up. Specifically, an airplane traveling westward is currently heading up at an angle of 10 degrees, and tilting at 15 degrees to the left. Write a rotation matrix that expresses the current orientation of the airplane. (Assume that the world x axis points north. You can use Rx(angle), Ry(angle), and Rz(angle) functions to generate a axis-rotation matrix.)



7. An existing spline code is using a sequence of segments, each defined by a cubic spline with an unfamiliar spline matrix. You plot the basis functions and you see the following curves:

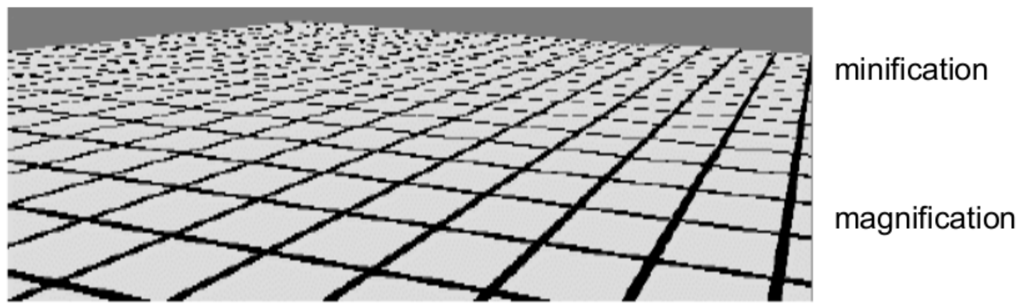


(a) Which of the four control points (arbitrarily labeled 0 through 3 in the plot) will the curve pass through, and for what values of t?

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

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

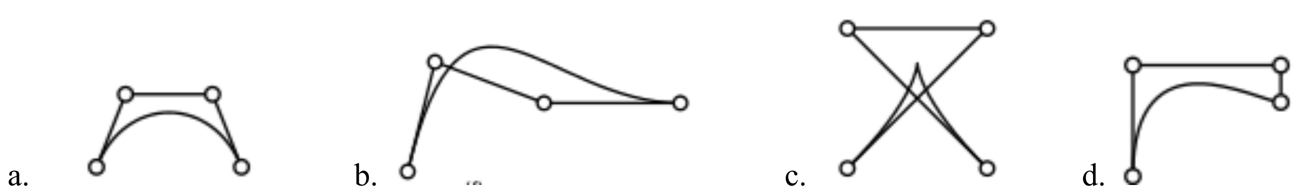
8. List algorithms to reduce the artifacts caused by the minification (at least one algorithm) and magnification (at least one algorithm) of textures. The total number of listed algorithms should be more than two.



9. Construct a summed area table from the texture below, and explain how you can calculate the average value of the lower half of the texture using the summed area table.

1	6	8	3
0	0	3	7
4	7	8	8
5	0	9	9

10. Below are four curves and their “control points/polygon.” Two of the control polygons are the Bezier control polygon for the curve drawn with it; the other four are not. Indicate which of the control polygons are Bezier control polygons for the corresponding curve and which are not. Justify your answer for the control polygons that are not Bezier control polygons. You may assume that none of the control points overlap or are repeated.



11. (a) If we use the following 1D reconstruction filter $a(x)$ to reconstruct a continuous function $g(x)$from a sequence of samples $f[i]$using continuous-discontinuous convolution, how will the resulting function look like? (Draw $g(x)$)

$a(x)$: $g(x)$?

f : [2,3,1,2,3]

(b) Draw a filter that will generate a C^1continuous function interpolating $f[i]$.

12. Given two matrices cow2wld and wld2cam, a cow can be transformed to the camera space using wld2cam * cow2wld.
Here, cow2wld transforms a cow from the object coordinates to the world coordinates, and wld2cam transforms a cow from the world coordinates to the camera coordinates. You can use a.R and a.T to denote the rotation and translation part of the matrix, that is, a=a.T * a.R. Rx is the rotation matrix along X-axis. All rotations needs to happen about the center of the cow (the origin of the object space). Each answer can be written as a transformation matrix that is a slight variation of (wld2cam * cow2wld).

a) describe how to rotate a cow along X-axis in the object space

b) describe how to rotate the cow along the X-axis of the world space.

c) describe how to rotate the cow along the X-axis of the camera space.

13. To compute the damping force between two particles, we need to know the closing speed of the two particles, or the speed at which they are approaching each other. Express the closing speed in terms of the positions r_1, r_2 and the velocity v_1, v_2 of the particles in 3D space.

(Hint: use the direction vector $e = \frac{r_1 - r_2}{|r_1 - r_2|}$, and the dot-product operator.)