[**You may use one side of an 8.5 $\times$ 11 inch sheet of paper.**] Show all of your work clearly in the space provided or on the additional page at the end of the exam. If the additional page is used, clearly identify to which exam question it is related. Be sure to **read each problem carefully**. You should answer all 6 questions. Note that the exam is double sided.

1. Consider a grayscale raster system with a resolution of 640×480 that is refreshed at a rate of $60Hz$. For the following parts, just provide the equation required to produce the answer. You do not need to evaluate the equation.
(a) (10 points) How many pixels must the video controller be able to access each second?

(b) (5 points) What is the access time per pixel?

(c) (5 points) How are the answers to parts **(a)** and **(b)** affected if the the system is a true color (24-bits per pixel) system instead of a grayscale system?

2.

(a) (5 points) Give the UNIX command you use to edit a file called `shape.cpp`.

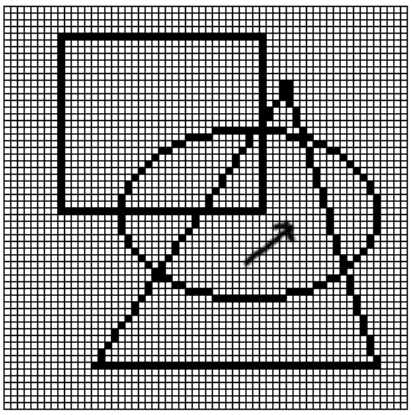
(b) (5 points) Give the UNIX command used to edit all of the files in the current directory that have the extention `.cpp`.

3. (15 points) What is the purpose for declaring many of the member functions in the shape class as `virtual` member functions?

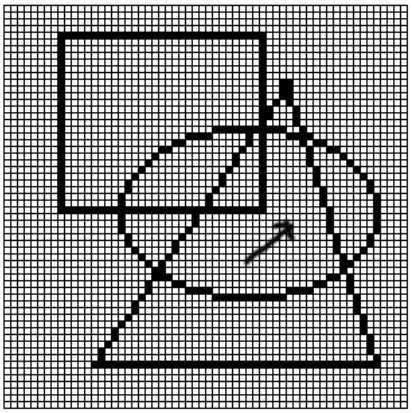
4. (10 points) An efficient algorithm for drawing circles was discussed in class and in the text. Discuss the key design choices of the algorithm that made it efficient.

5. An area fill algorithm like the one described in the text and in lecture could be used to determine the fill areas for the following figures. Indicate which regions of the image are within the fill area if the fill begins at the location signified by the arrow and

(a) (10 points) A 4-connected pattern is used.



(b) (10 points) An 8-connected pattern is used.



(c) (10 points) Does the area fill algorithm use the non-zero winding rule or the even-odd rule for filling?

6. (15 points) What will the following transformation matrix do?

$$\vec{\mathbf{T}} = \begin{bmatrix} \cos(30) & -\sin(30) & 0 \\ 0 & 1 & 3 \\ 0 & 0 & 1 \end{bmatrix}$$

Show all your work.

Additional work area for any problem. Clearly identify to which problem the work on this page is related.