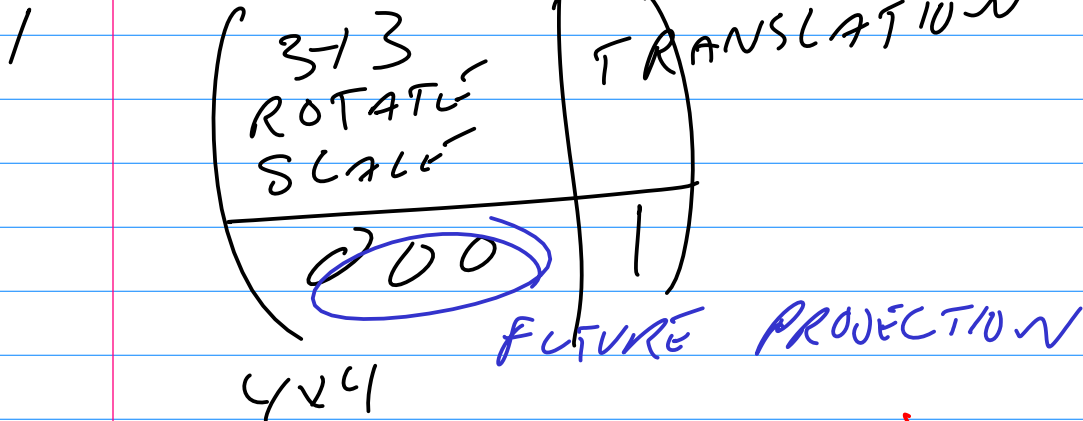


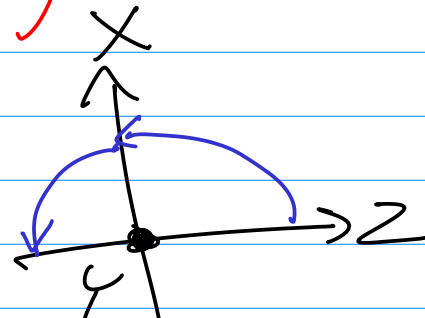
homework 5 solutions



2

$$\begin{pmatrix} 1 \\ 3 \\ 2 \\ 1 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \\ 1 \\ 1 \end{pmatrix}$$

3 90° ROTATIONS



HOW TO FIND MATRIX

- ON EARLIER CLASS NOTES, OR
- TEXT, OR
- PLUS INTO FORMULA

$$a_1 = 0 \quad a_2 = 1 \quad a_3 = 0 \quad \cos 90 = 0 \quad \sin 90 = 1$$

$$M = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ -1 & 0 & 0 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

H4

$$\begin{pmatrix} 2 \\ 3 \\ -1 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 \\ 3 \\ 2 \\ 1 \end{pmatrix}$$

2

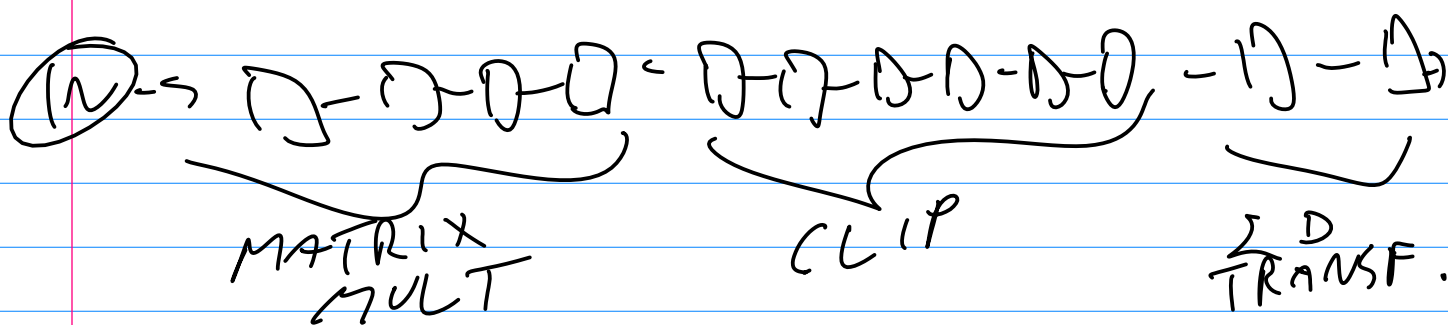
5 - you do w. MATLAB

6 "

7

When every type of transformation is a matrix, then you can combine all the transformations into one transformation by multiplying the matrices. Then you apply that one matrix to all the points. It's faster.

The original SGI graphics pipeline included matrix multiply.



12 COPIES OF SAME CHIP.

8 } IDLE CALLBACK - USE SPARE CYCLES  
 ANIMATION SPEED DEPENDS ON  
 - MACHINE SPEED  
 - OTHER PROCESSES.

TIMER CALLBACK - PREDICTABLE ANIMATION SPEED.

TIMER CALLBACK ROUTINE MUST BE RE-REGISTERED AFTER EACH CALL

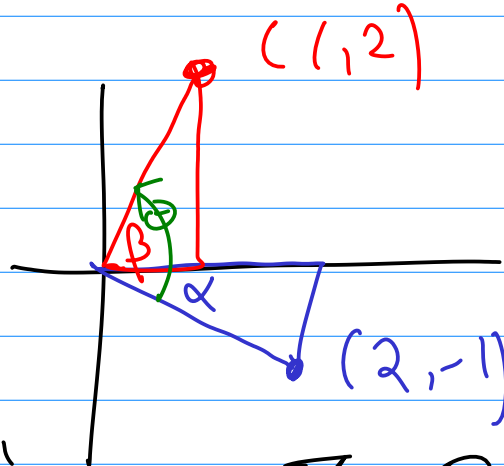
9

OpenGL is a STATE machine. One state variable is the color for future vertices. When you set it, it applies to all future vertices until you set it again to something else.  
Here, the 2nd color replaces the 1st. The vertex is green.  
(After we see LIGHTING, these colors are ignored; the vertex color will be computed. Not on this exam.)

3

10  
11

Also green.



$$\alpha = \arctan 2 \quad \beta = \arctan \frac{1}{2} \quad \theta = \alpha + \beta$$

$$\begin{pmatrix} 1 \\ 2 \end{pmatrix} = \begin{pmatrix} c & -s \\ s & c \end{pmatrix} \begin{pmatrix} 2 \\ -1 \end{pmatrix}$$

$$\left. \begin{array}{l} 1 = 2c + s \\ 2 = 2s - c \end{array} \right\} \begin{array}{l} s = 5s \rightarrow s = 1 \\ \text{END OF HW 5} \end{array}$$

q: when combining matrices, what order?

$$M_2 M_1 \begin{pmatrix} p_1 \\ p_2 \\ p_3 \\ 1 \end{pmatrix}$$

OpenGL trap: It stores matrices internally in COLUMN-MAJOR order.

4

$$\begin{pmatrix} 1 & 5 & 9 & 13 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \\ 4 & 8 & 12 & 16 \end{pmatrix}$$

If you read the modelview matrix, it will be returned in this order.

C is Row-MAJOR.

$$\begin{pmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 9 & 10 & 11 & 12 \\ 13 & 14 & 15 & 16 \end{pmatrix}$$

This midterm will have no quaternions and no homogeneous coordinates. It will have 4x4 matrices, with the bottom row always (0 0 0 1).



