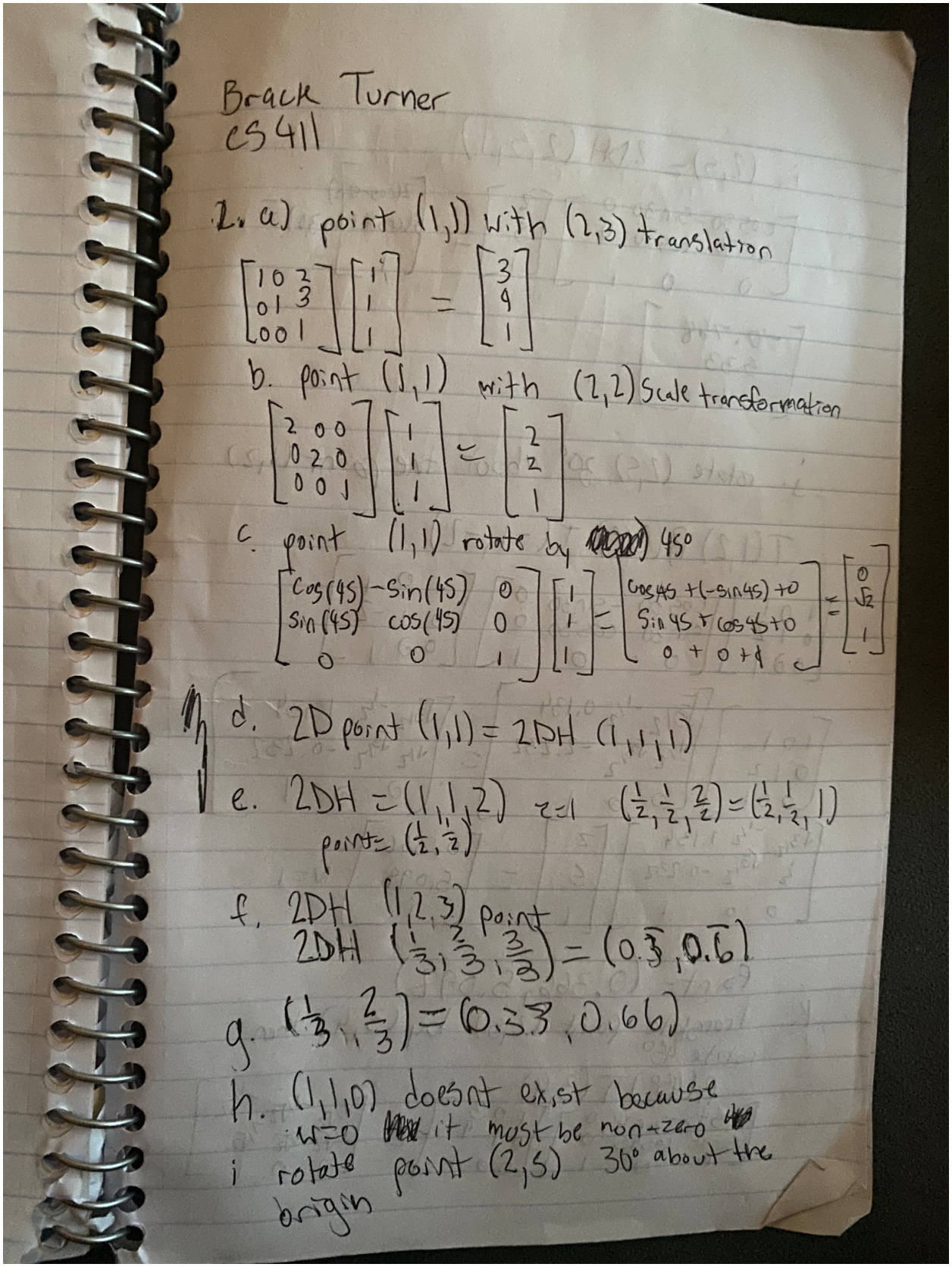


Brack Turner
CS 411

2. a) point (1,1) with (2,3) translation

$$\begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 3 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 3 \\ 4 \\ 1 \end{bmatrix}$$

b. point (1,1) with (2,2) scale transformation

$$\begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ 2 \\ 1 \end{bmatrix}$$

c. point (1,1) rotate by 45°

$$\begin{bmatrix} \cos(45) & -\sin(45) & 0 \\ \sin(45) & \cos(45) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} \cos 45 + (-\sin 45) + 0 \\ \sin 45 + \cos 45 + 0 \\ 0 + 0 + 1 \end{bmatrix} = \begin{bmatrix} 0 \\ \sqrt{2} \\ 1 \end{bmatrix}$$

d. 2D point (1,1) = 2DH (1,1,1)

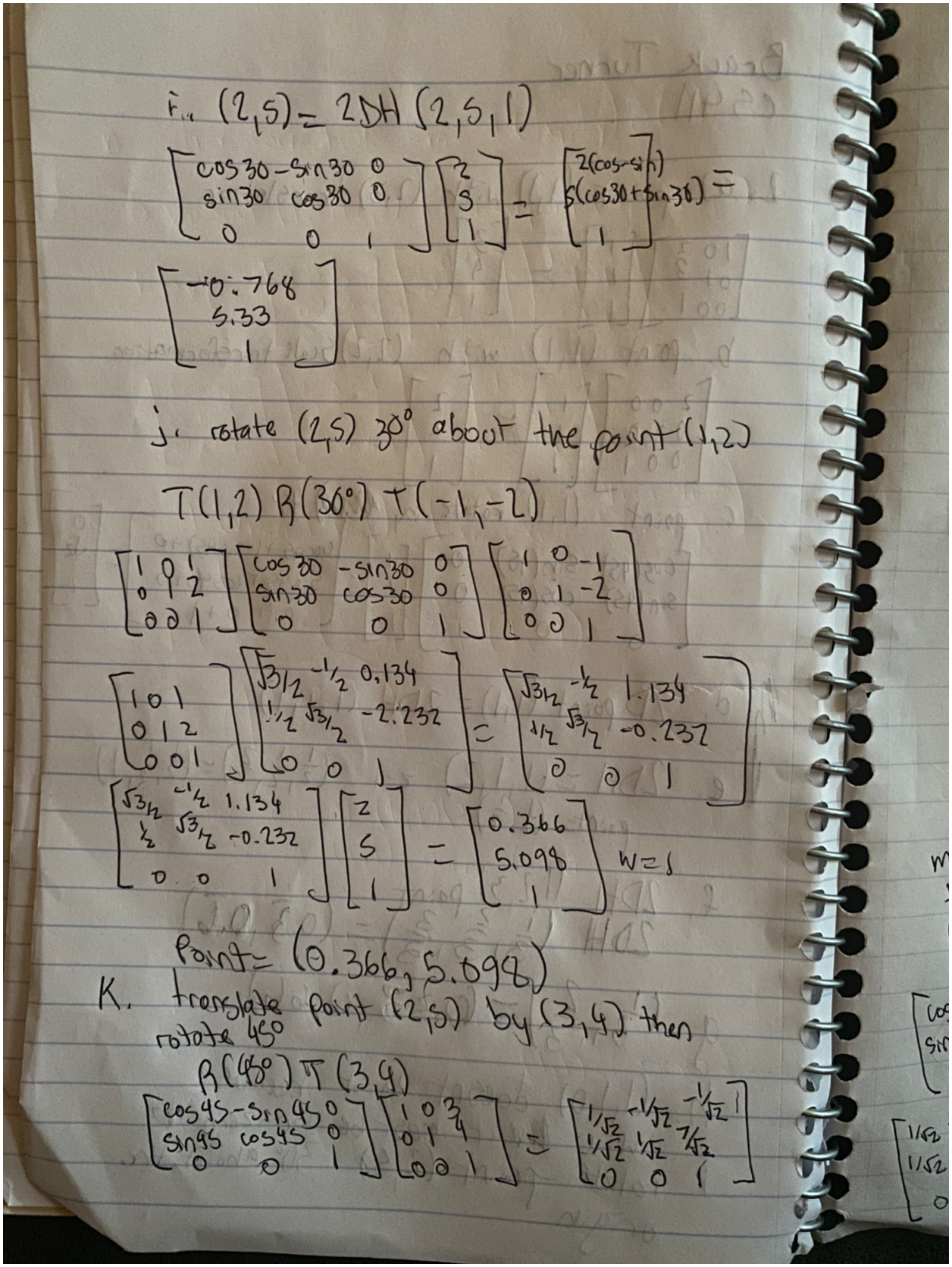
e. 2DH = (1,1,2) $z=1$ $\left(\frac{1}{2}, \frac{1}{2}, \frac{2}{2}\right) = \left(\frac{1}{2}, \frac{1}{2}, 1\right)$
point = $\left(\frac{1}{2}, \frac{1}{2}\right)$

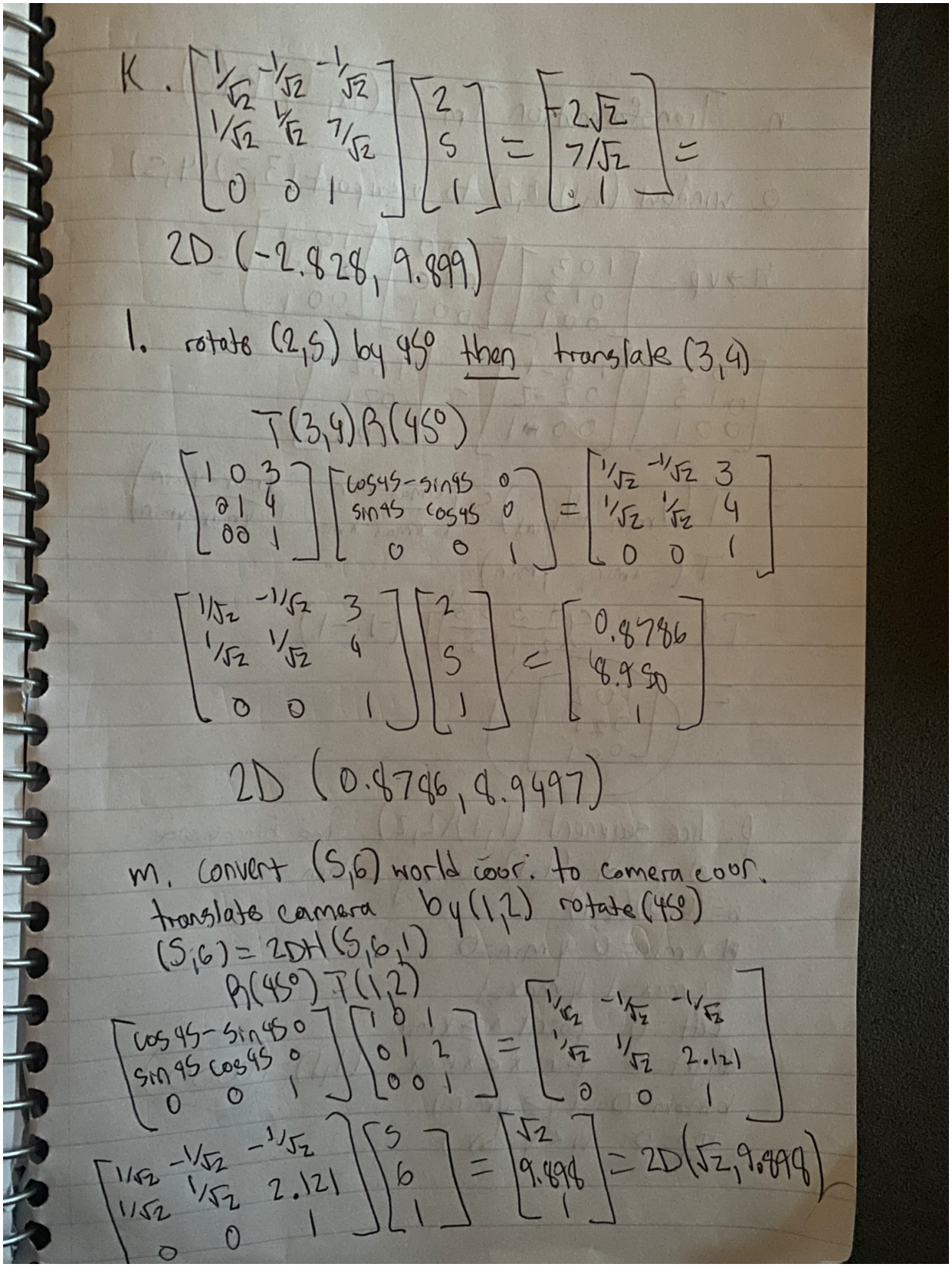
f. 2DH (1,2,3) point
2DH $\left(\frac{1}{3}, \frac{2}{3}, \frac{3}{3}\right) = (0.\overline{3}, 0.6)$

g. $\left(\frac{1}{3}, \frac{2}{3}\right) = (0.33, 0.66)$

h. (1,1,0) doesn't exist because $w=0$ it must be non-zero

i rotate point (2,5) 30° about the origin


i. (2,5) = 2DH (2,5,1)
[cos30 -sin30 0; sin30 cos30 0; 0 0 1] [2; 5; 1] = [2(cos-sin); 5(cos30+sin30); 1] =
[-0.768; 5.33; 1]
j. rotate (2,5) 30° about the point (1,2)
T(1,2) R(30°) T(-1,-2)
[1 0 1; 0 1 2; 0 0 1] [cos30 -sin30 0; sin30 cos30 0; 0 0 1] [1 0 -1; 0 1 -2; 0 0 1]
[1 0 1; 0 1 2; 0 0 1] [√3/2 -1/2 0.134; 1/2 √3/2 -2.232; 0 0 1] = [√3/2 -1/2 1.134; 1/2 √3/2 -0.232; 0 0 1]
[√3/2 -1/2 1.134; 1/2 √3/2 -0.232; 0 0 1] [2; 5; 1] = [0.366; 5.098; 1] w=1
Point = (0.366, 5.098)
K. translate point (2,5) by (3,4) then rotate 45°
R(45°) T(3,4)
[cos45 -sin45 0; sin45 cos45 0; 0 0 1] [1 0 3; 0 1 4; 0 0 1] = [1/√2 -1/√2 -1/√2; 1/√2 1/√2 7/√2; 0 0 1]



K.
$$\begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & -1/\sqrt{2} \\ 1/\sqrt{2} & 1/\sqrt{2} & 7/\sqrt{2} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 5 \\ 1 \end{bmatrix} = \begin{bmatrix} -2\sqrt{2} \\ 7/\sqrt{2} \\ 1 \end{bmatrix} =$$

2D $(-2.828, 9.899)$

1. rotate $(2,5)$ by $45°$ then translate $(3,4)$

$$T(3,4)R(45°)$$

$$\begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & 4 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ \sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 3 \\ 1/\sqrt{2} & 1/\sqrt{2} & 4 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 3 \\ 1/\sqrt{2} & 1/\sqrt{2} & 4 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 5 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.8786 \\ 8.9497 \\ 1 \end{bmatrix}$$

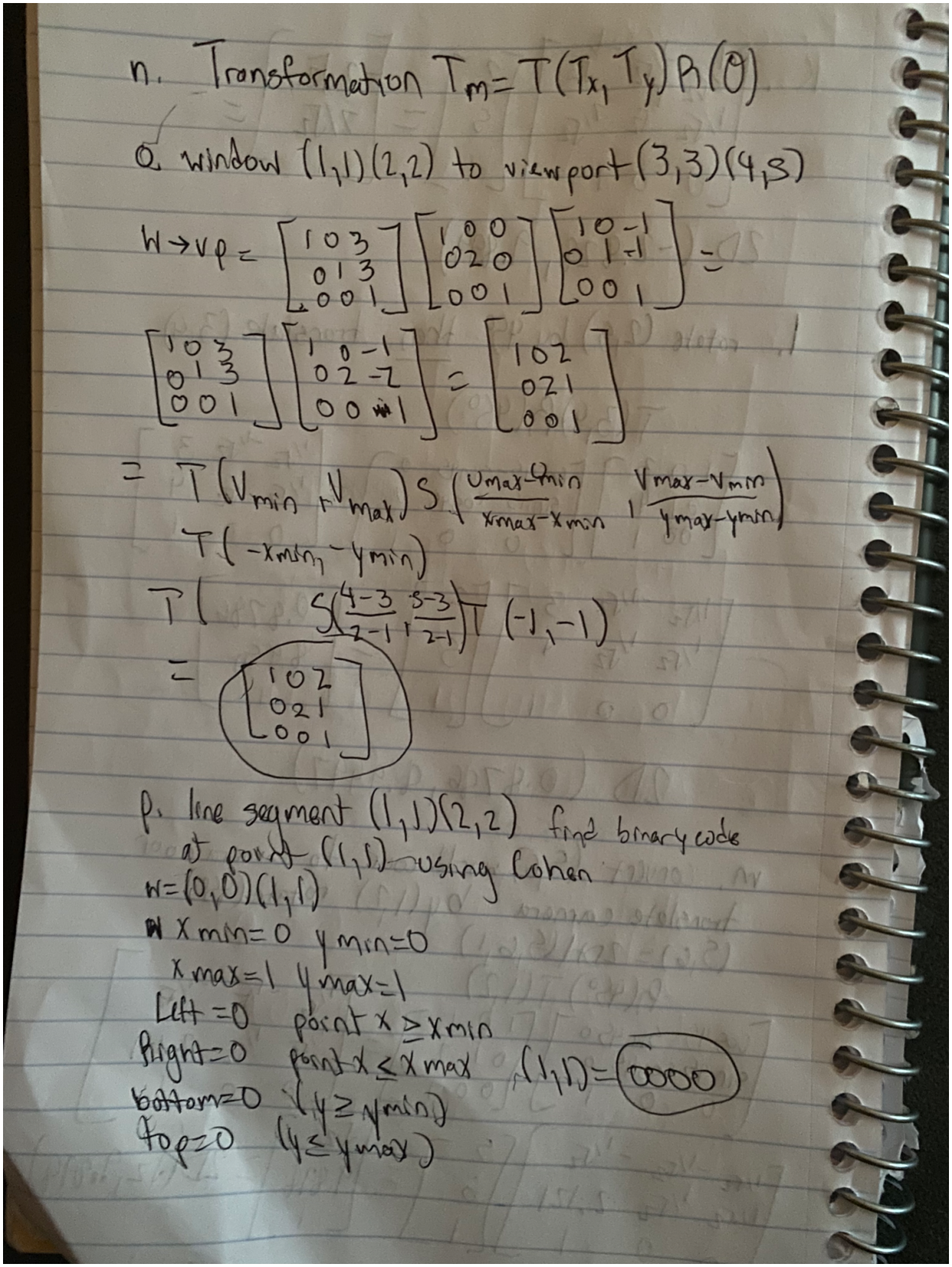
2D $(0.8786, 8.9497)$

m. convert $(5,6)$ world coor. to camera coor.
translate camera by $(1,2)$ rotate $(45°)$
$(5,6) = 2DH(5,6,1)$

$$R(45°)T(1,2)$$

$$\begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ \sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & -1/\sqrt{2} \\ 1/\sqrt{2} & 1/\sqrt{2} & 2.121 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & -1/\sqrt{2} \\ 1/\sqrt{2} & 1/\sqrt{2} & 2.121 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 5 \\ 6 \\ 1 \end{bmatrix} = \begin{bmatrix} \sqrt{2} \\ 9.898 \\ 1 \end{bmatrix} = 2D(\sqrt{2}, 9.898)$$



n. Transformation $T_m = T(T_x, T_y) R(\theta)$

Q. window (1,1)(2,2) to viewport (3,3)(4,5)

$$W \to vp = \begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & 3 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{bmatrix} =$$

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

$$= T(V_{min}, V_{max}) S\left(\frac{U_{max} - U_{min}}{x_{max} - x_{min}}, \frac{V_{max} - V_{min}}{y_{max} - y_{min}}\right)$$

$$T(-x_{min}, -y_{min})$$

$$T\left(S\left(\frac{4-3}{2-1}, \frac{5-3}{2-1}\right) T(-1,-1) \right)$$

$$= \begin{bmatrix} 1 & 0 & 2 \\ 0 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$$

p. line segment (1,1)(2,2) find binary code at point (1,1) using Cohen

w = (0,0)(1,1)

$x_{min} = 0$ $y_{min} = 0$

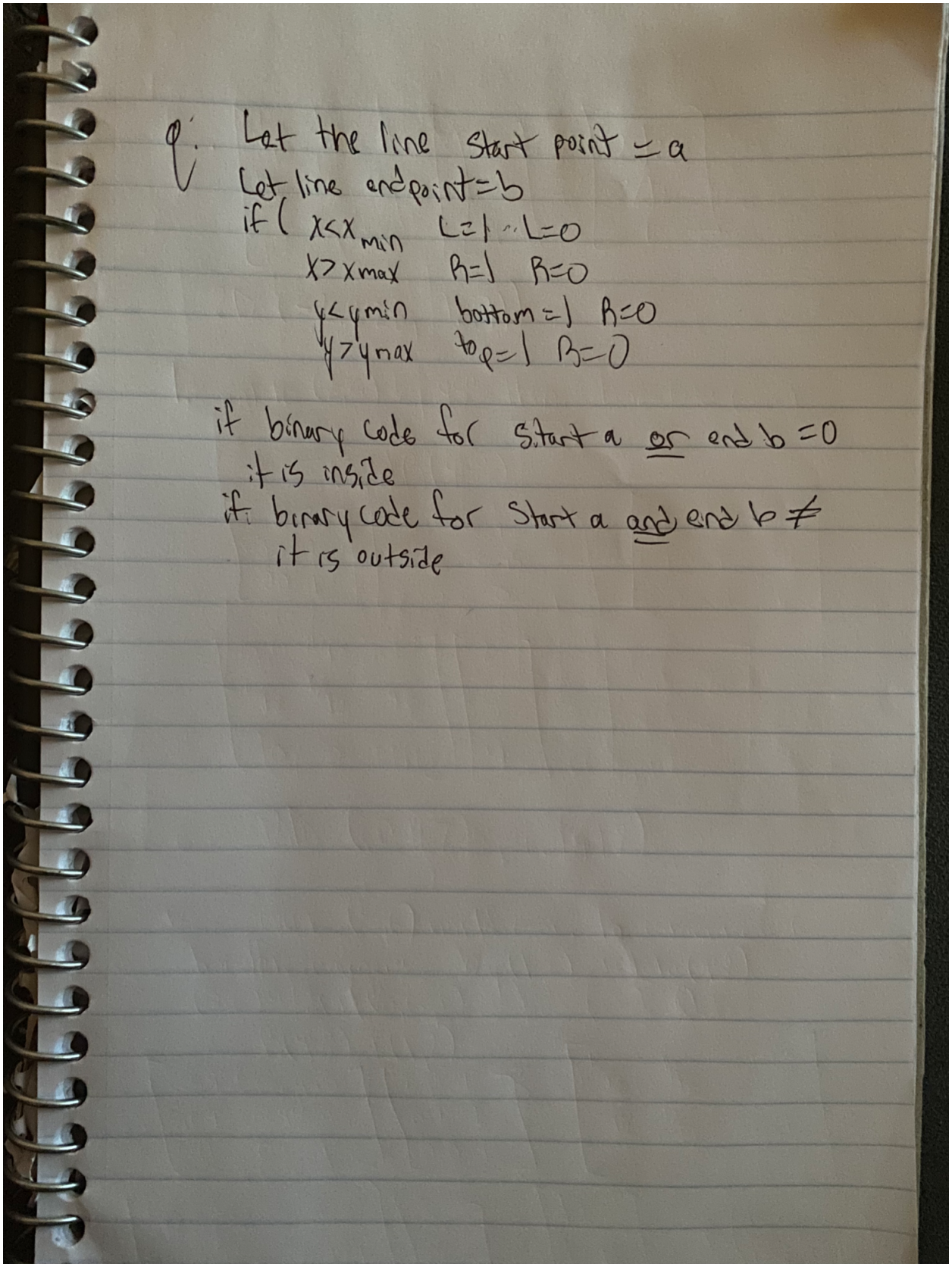
$x_{max} = 1$ $y_{max} = 1$

Left = 0 point $x \geq x_{min}$

Right = 0 point $x \leq x_{max}$ (1,1) = 0000

~~bottom~~ = 0 $(y \geq y_{min})$

top = 0 $(y \leq y_{max})$



Q: Let the line start point = a
Let line endpoint = b
if ($x < x_{min}$ L=1 ∴ L=0
$x > x_{max}$ R=1 R=0
$y < y_{min}$ bottom = 1 R=0
$y > y_{max}$ top = 1 R=0

if binary code for start a or end b = 0
it is inside
if binary code for start a and end b ≠
it is outside

CS411 COMPUTER GRAPHICS FALL 2021 BRACK TURNER

Understanding the library and skeleton code was very straightforward. Getting the initial triangle to move and rotate with the current rotating angle params was fairly easy. The difficulty began understanding the toggling of regular rotation and rotation normal. Also getting the logic right so the buttons could work properly and not interfere with each other took some time. I had to switch to an else if statement so the normal rotate button could be on simultaneously to the regular rotation button and not crash the animation. Adding the zoom in/out features was also easy as well.