ECE 415
HW1
Pavan Kumar S Naik
(66994062 4)

1.a). Given,

Similarity Transform

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = sR\begin{bmatrix} x \\ y \end{bmatrix} + t$$

wkt, $p' = sRp + t$

where, $s \rightarrow$ Scaling factor

$R \rightarrow$ Rotation matrix

$t \rightarrow$ Translation

$\therefore s = 0.5$

$$R = \begin{bmatrix} \cos 30^\circ & -\sin 30^\circ \\ \sin 30^\circ & \cos 30^\circ \end{bmatrix} = \begin{bmatrix} 1.732 & -0.5 \\ 0.5 & 1.732 \end{bmatrix}$$

$$t = \begin{bmatrix} t_1 \\ t_2 \end{bmatrix} = \begin{bmatrix} 2 \\ 2 \end{bmatrix}$$

1.b). Similarity Transform (Homogenous coordinates)

wkt

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} a & -b & t_1 \\ b & a & t_2 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$\therefore sR = \begin{bmatrix} a & -b \\ b & a \end{bmatrix} = 0.5\begin{bmatrix} 1.732 & -0.5 \\ 0.5 & 1.732 \end{bmatrix} = \begin{bmatrix} 0.866 & -0.25 \\ 0.25 & 0.866 \end{bmatrix}$$

$\therefore a = 0.866$, $b = 0.25$ & $a^2 + b^2 \neq 1$

Homogenous coordinate

$$\boxed{\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 0.866 & -0.25 & 2 \\ 0.25 & 0.866 & 2 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} x \\ y \\ 1 \end{bmatrix}}$$

ECE415 Computer Vision I
Homework 1
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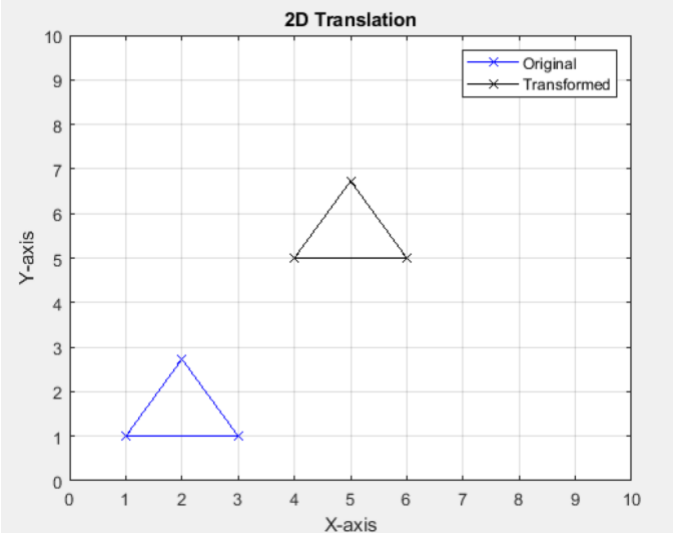
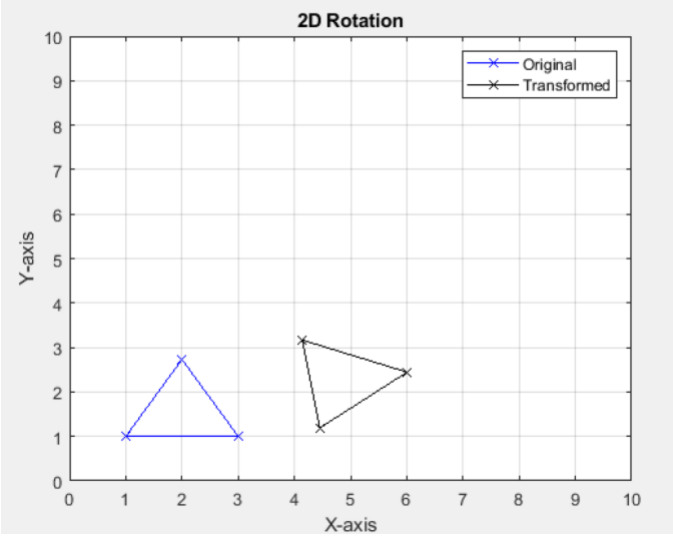
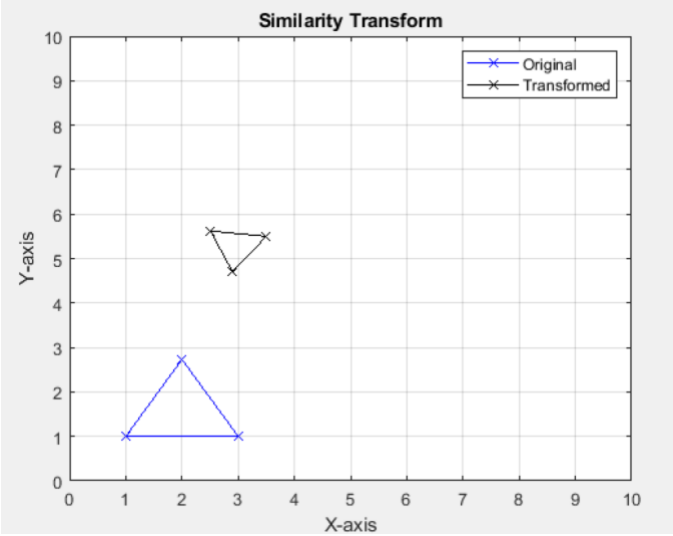
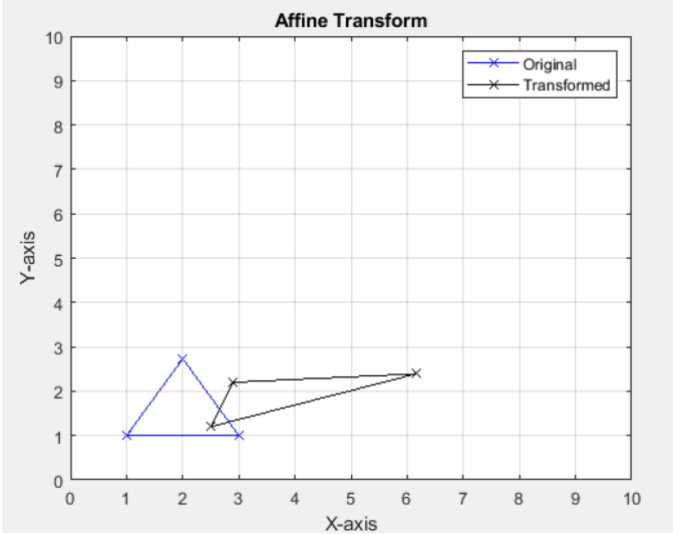
2. a) Plot each input object and its 5 transformed versions. Clearly label axes and give each plot a meaningful title.

Triangle:






Similarity Transform
Original
Transformed
Y-axis
X-axis
0
1
2
3
4
5
6
7
8
9
10


Affine Transform
Original
Transformed
Y-axis
X-axis
0
1
2
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7
8
9
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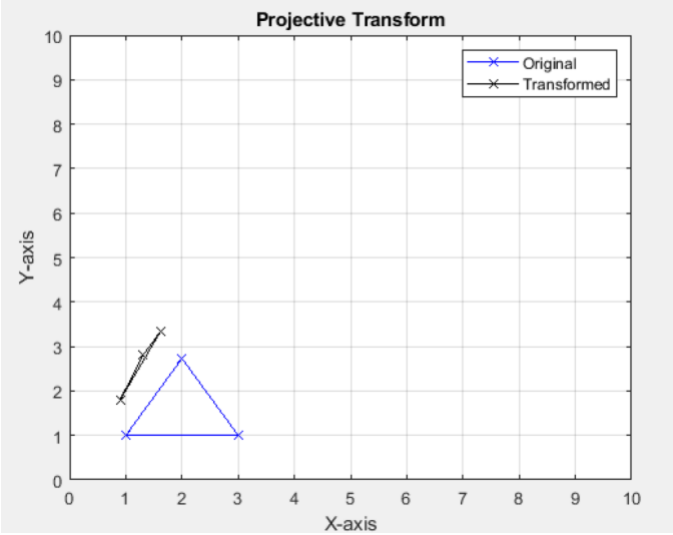
Projective Transform
Original
Transformed
Y-axis
X-axis
0
1
2
3
4
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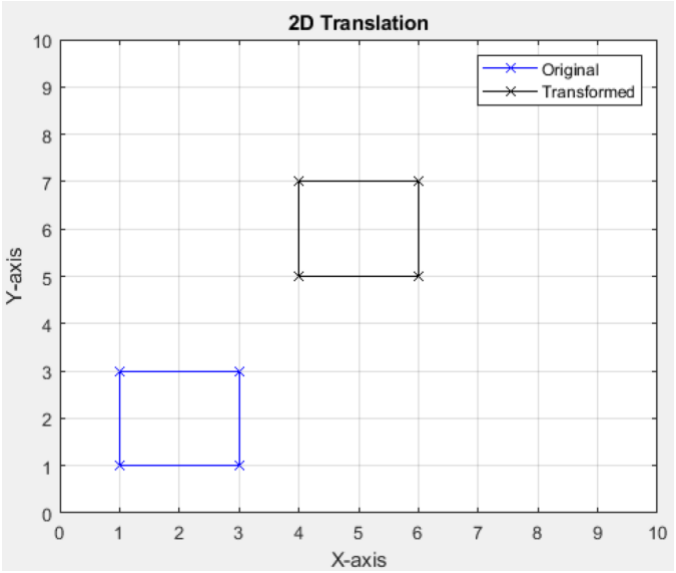
9
10

Square:


2D Translation
Original
Transformed
Y-axis
X-axis
0
1
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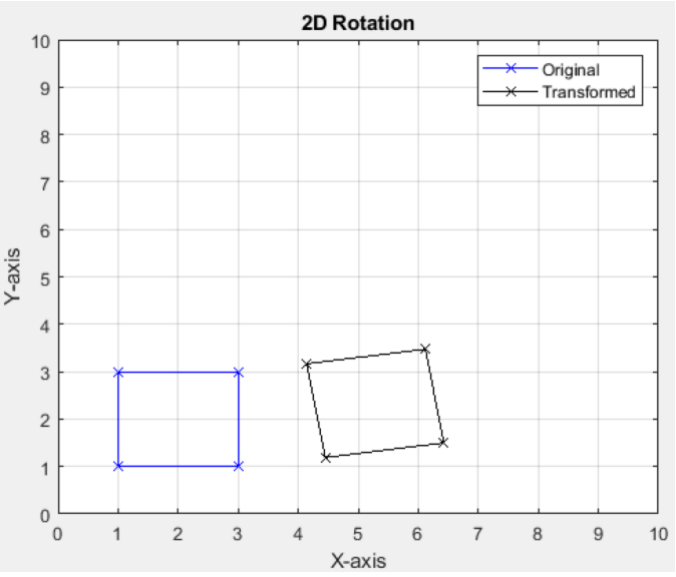
2D Rotation
Original
Transformed
Y-axis
X-axis
0
1
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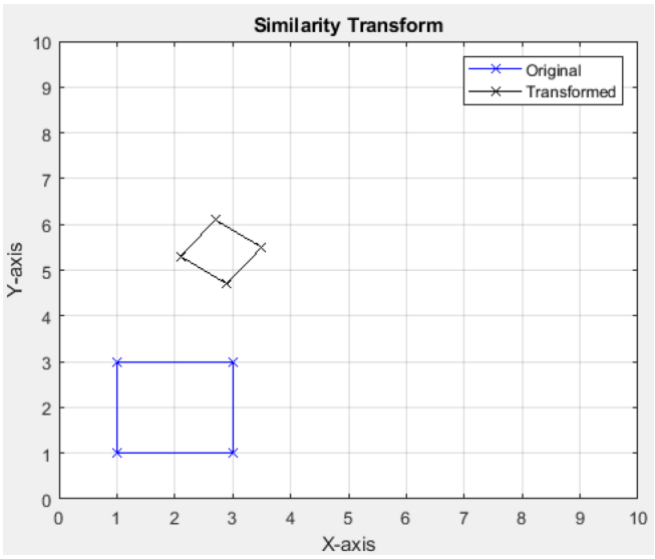
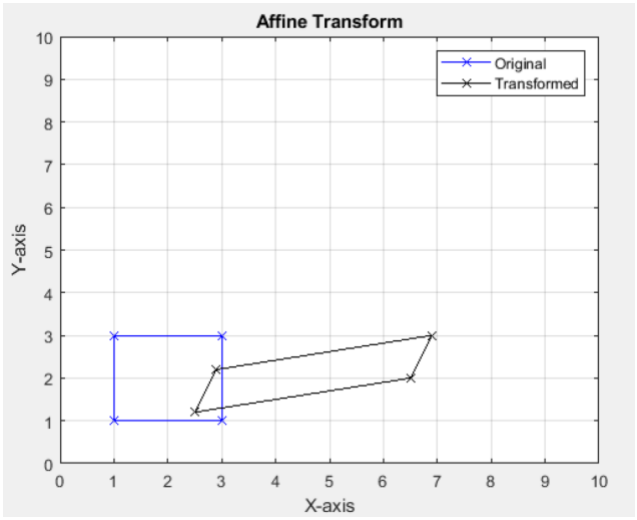
5
6
7
8
9
10


Similarity Transform
Original
Transformed
Y-axis
X-axis
0
1
2
3
4
5
6
7
8
9
10


Affine Transform
Original
Transformed
Y-axis
X-axis
0
1
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7
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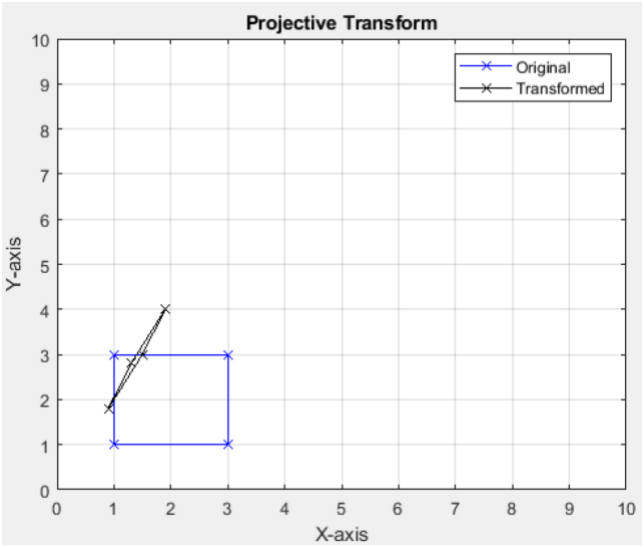
Projective Transform
Original
Transformed
Y-axis
X-axis
0
1
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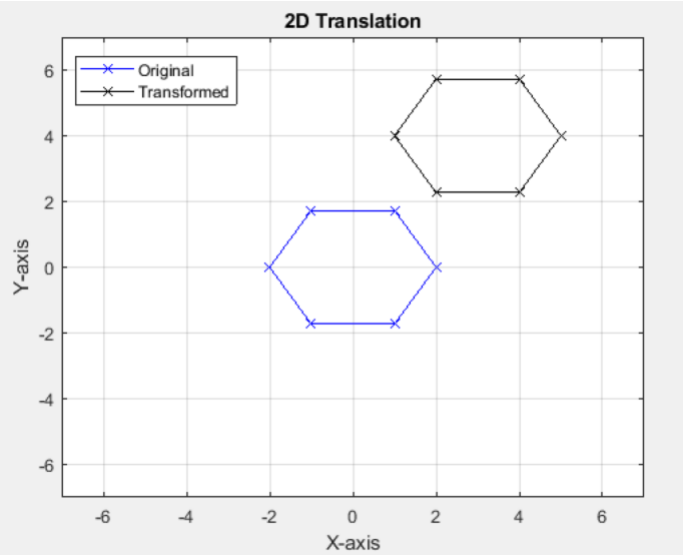
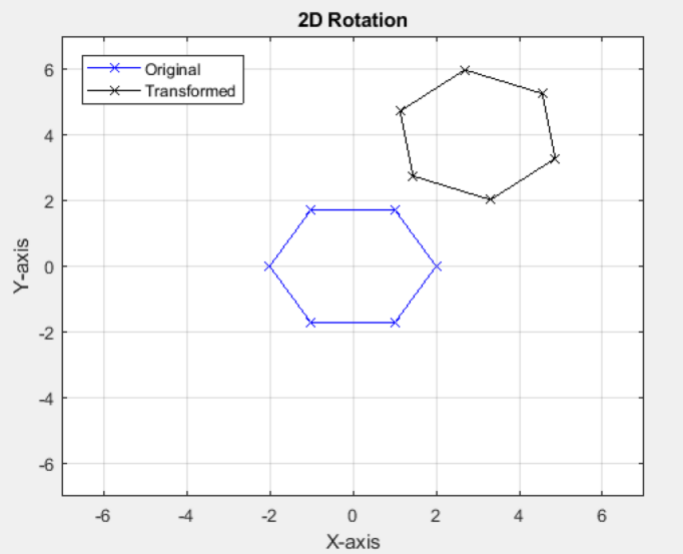
Hexagon:


2D Translation
Original
Transformed
Y-axis
X-axis
6
4
2
0
-2
-4
-6
-6
-4
-2
0
2
4
6


2D Rotation
Original
Transformed
Y-axis
X-axis
6
4
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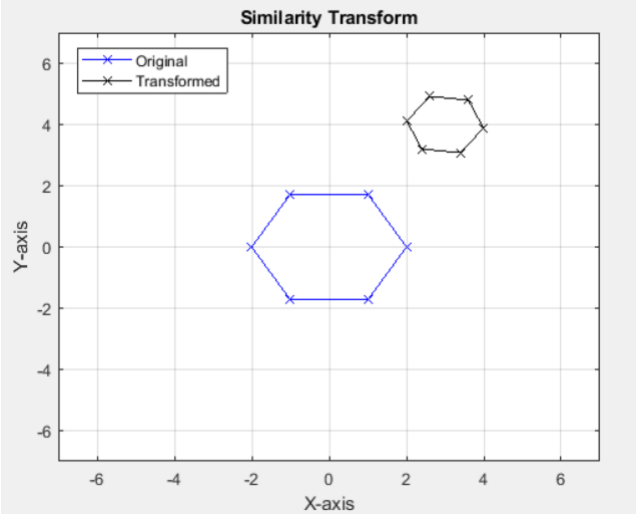
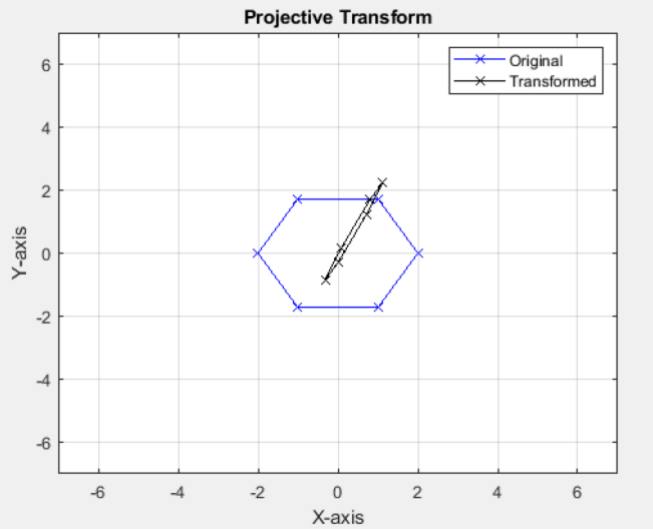
0
-2
-4
-6
-6
-4
-2
0
2
4
6


Similarity Transform
Original
Transformed
Y-axis
X-axis
6
4
2
0
-2
-4
-6
-6
-4
-2
0
2
4
6


Affine Transform
Original
Transformed
Y-axis
X-axis
6
4
2
0
-2
-4
-6
-6
-4
-2
0
2
4
6


Projective Transform
Original
Transformed
Y-axis
X-axis
6
4
2
0
-2
-4
-6
-6
-4
-2
0
2
4
6

2. b) Comment on what characteristics of the shape have been preserved by each of the transformations.

Transformations	Preserved	Not Preserved
Translation	• Orientation • Length of sides • Angles between sides	• Position
Rotation	• Length of sides • Angles between sides	• Orientation
Similarity Transform	• Angles between sides	• Orientation • Length of sides
Affine Transform	• Only the parallelism of the lines	• Orientation • Length of sides • Angles between sides
Projective Transform	• Straight lines remain. straight	All the other properties

2. c) Print out transformation matrices.

(For Triangle, Square and Hexagon)

i. Translation

It1 =

1	**0**	**3**
0	**1**	**4**
0	**0**	**1**

ii. Rotation *(assuming angle = 30 degrees)*

Rt =

0.1543	**0.9880**	**3.0000**
-0.9880	**0.1543**	**4.0000**
0	**0**	**1.0000**

iii. Similarity Transform *(assuming a = 0.3 and b = 0.4)*

SRt =

0.3000	**-0.4000**	**3.0000**
0.4000	**0.3000**	**4.0000**
0	**0**	**1.0000**

iv. Affine Transform

A =

0.2000	**2.0000**	**0.3000**
0.5000	**0.4000**	**0.3000**

v. Projective Transform

H =

0.2000	**0.3000**	**0.4000**
0.5000	**0.6000**	**0.7000**
0.8000	**0.9000**	**1.0000**

2. d) Print out in homogeneous & Cartesian coordinates vertices for each input object and each of the transformed objects.

Assuming z = 3 for Homogenous Coordinates in all cases.

Triangle:

i. Translation

Cartesian

4.0000	5.0000	6.0000	4.0000
5.0000	6.7300	5.0000	5.0000
1.0000	1.0000	1.0000	1.0000

Homogenous

12.0000	15.0000	18.0000	12.0000
15.0000	20.1900	15.0000	15.0000
3.0000	3.0000	3.0000	3.0000

ii. Rotation *(assuming angle = 30 degrees)*

Cartesian

4.1423	6.0058	4.4508	4.1423
3.1662	2.4450	1.1902	3.1662
1.0000	1.0000	1.0000	1.0000

Homogenous

12.4268	18.0175	13.3524	12.4268
9.4987	7.3351	3.5705	9.4987
3.0000	3.0000	3.0000	3.0000

iii. Similarity Transform *(assuming a = 0.3 and b = 0.4)*

Cartesian

2.9000	2.5080	3.5000	2.9000
4.7000	5.6190	5.5000	4.7000
1.0000	1.0000	1.0000	1.0000

Homogenous

8.7000	7.5240	10.5000	8.7000
14.1000	16.8570	16.5000	14.1000
3.0000	3.0000	3.0000	3.0000

iv. Affine Transform

Cartesian

2.5000	6.1600	2.9000	2.5000
1.2000	2.3920	2.2000	1.2000

Homogenous

7.5000	18.4800	8.7000	7.5000
3.6000	7.1760	6.6000	3.6000

v. Projective Transform

Cartesian

0.3333	0.3202	0.3023	0.3333
0.6667	0.6601	0.6512	0.6667
1.0000	1.0000	1.0000	1.0000

Homogenous

0.9000	1.6190	1.3000	0.9000
1.8000	3.3380	2.8000	1.8000
2.7000	5.0570	4.3000	2.7000

Square:

i. Translation

Cartesian

4	4	6	6	4
5	7	7	5	5
1	1	1	1	1

Homogenous

12	12	18	18	12
15	21	21	15	15
3	3	3	3	3

ii. Rotation *(assuming angle = 30 degrees)*

Cartesian

4.1423	6.1183	6.4268	4.4508	4.1423
3.1662	3.4747	1.4987	1.1902	3.1662
1.0000	1.0000	1.0000	1.0000	1.0000

Homogenous

12.4268	18.3550	19.2805	13.3524	12.4268
9.4987	10.4242	4.4960	3.5705	9.4987
3.0000	3.0000	3.0000	3.0000	3.0000

iii. Similarity Transform *(assuming a = 0.3 and b = 0.4)*

Cartesian

2.9000	2.1000	2.7000	3.5000	2.9000
4.7000	5.3000	6.1000	5.5000	4.7000
1.0000	1.0000	1.0000	1.0000	1.0000

Homogenous

8.7000	6.3000	8.1000	10.5000	8.7000
14.1000	15.9000	18.3000	16.5000	14.1000
3.0000	3.0000	3.0000	3.0000	3.0000

iv. Affine Transform

Cartesian

2.5000	6.5000	6.9000	2.9000	2.5000
1.2000	2.0000	3.0000	2.2000	1.2000

Homogenous

7.5000	19.5000	20.7000	8.7000	7.5000
3.6000	6.0000	9.0000	6.6000	3.6000

v. Projective Transform

Cartesian

0.3333	0.3333	0.3115	0.3023
0.6667	0.6667	0.6557	0.6512
1.0000	1.0000	1.0000	1.0000

Homogenous

0.9000	1.5000	1.9000	1.3000	0.9000
1.8000	3.0000	4.0000	2.8000	1.8000
2.7000	4.5000	6.1000	4.3000	2.7000

Hexagon:

i. Translation

Cartesian

1.0000	2.0000	4.0000	5.0000	4.0000	2.0000	1.0000
4.0000	5.7300	5.7300	4.0000	2.2700	2.2700	4.0000
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Homogenous

3.0000	6.0000	12.0000	15.0000	12.0000	6.0000	3.0000
12.0000	17.1900	17.1900	12.0000	6.8100	6.8100	12.0000
3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000

ii. Rotation *(assuming angle = 30 degrees)*

Cartesian

2.6915	4.5550	4.8635	3.3085	1.4450	1.1365	2.6915
5.9761	5.2549	3.2788	2.0239	2.7451	4.7212	5.9761
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Homogenous

8.0745	13.6651	14.5906	9.9255	4.3349	3.4094	8.0745
17.9282	15.7647	9.8365	6.0718	8.2353	14.1635	17.9282
3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000

iii. Similarity Transform *(assuming a = 0.3 and b = 0.4)*

Cartesian

2.4000	2.0080	2.6080	3.6000	3.9920	3.3920	2.4000
3.2000	4.1190	4.9190	4.8000	3.8810	3.0810	3.2000
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Homogenous

7.2000	6.0240	7.8240	10.8000	11.9760	10.1760	7.2000
9.6000	12.3570	14.7570	14.4000	11.6430	9.2430	9.6000
3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000

iv. Affine Transform

Cartesian

-0.1000	3.5600	3.9600	0.7000	-2.9600	-3.3600	-0.1000
-0.7000	0.4920	1.4920	1.3000	0.1080	-0.8920	-0.7000

Homogenous

-0.3000	10.6800	11.8800	2.1000	-8.8800	-10.0800	-0.3000
-2.1000	1.4760	4.4760	3.9000	0.3240	-2.6760	-2.1000

v. Projective Transform

Cartesian

0	0.4092	0.3333	0.3077
0.5000	0.7046	0.6667	0.6538
1.0000	1.0000	1.0000	1.0000

Homogenous

0	0.7190	1.1190	0.8000	0.0810	-0.3190	0
-0.3000	1.2380	2.2380	1.7000	0.1620	-0.8380	-0.3000
-0.6000	1.7570	3.3570	2.6000	0.2430	-1.3570	-0.6000