## Contents



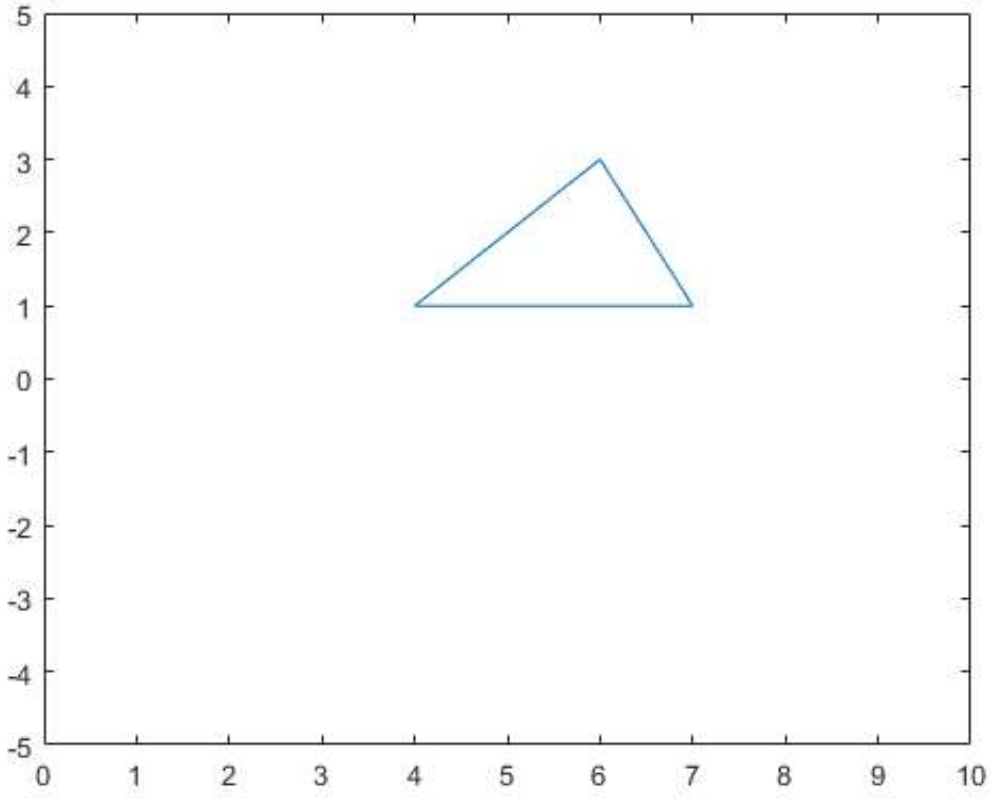
```
% Zain Bhaila
% Math 401
% Homework 2
```

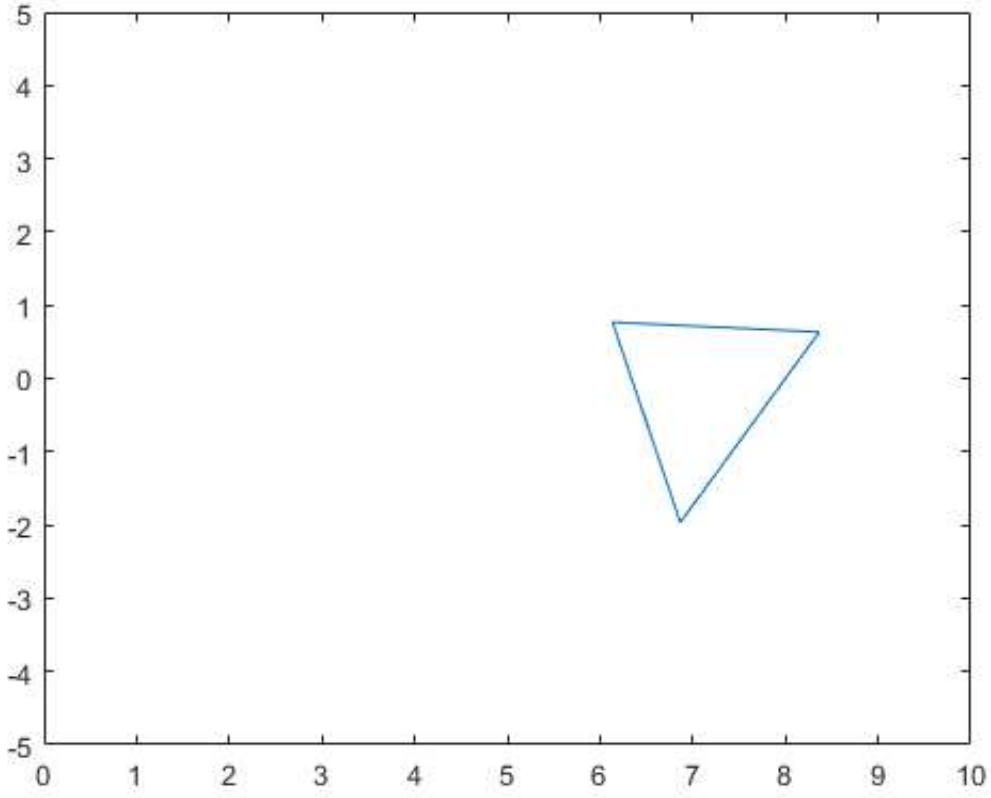
## 3.9

```
p1 = [6 ; 3 ; 1] % initial points
p2 = [4 ; 1 ; 1]
p3 = [7 ; 1 ; 1]
T1 = [ 1 0 -8 ; 0 1 -2 ; 0 0 1] % shift to origin
R = [cos(pi/3) -sin(pi/3) 0 ; sin(pi/3) cos(pi/3) 0; 0 0 1] % rotate
T2 = [ 1 0 8 ; 0 1 2 ; 0 0 1] % shift back
M = T2 * R * T1
p12 = M * p1 % transformed points
p22 = M * p2
p32 = M * p3
plot([6; 4; 7; 6], [3; 1; 1; 3]) % plot original
axis([0 10 -5 5])
figure(2)
plot([p12(1,:) ; p22(1,:) ; p32(1,:) ; p12(1,:)], [p12(2,:) ; p22(2,:) ; p32(2,:) ; p12(2,:)]
) % plot rotated
axis([0 10 -5 5])
```

```
p1 =

     6
     3
     1


p2 =

     4
     1
     1


p3 =

     7
     1
     1
```

```
T1 =

     1     0    -8
     0     1    -2
     0     0     1


R =

    0.5000   -0.8660         0
    0.8660    0.5000         0
         0         0    1.0000


T2 =

     1     0     8
     0     1     2
     0     0     1


M =

    0.5000   -0.8660    5.7321
    0.8660    0.5000   -5.9282
         0         0    1.0000


p12 =

    6.1340
    0.7679
    1.0000


p22 =

    6.8660
   -1.9641
    1.0000


p32 =

    8.3660
    0.6340
    1.0000
```




**3.20**

```
T1 = [ 1 0 0 2 ; 0 1 0 0 ; 0 0 1 -4 ; 0 0 0 1]
RY = [cos(-2*pi/3) 0 sin(-2*pi/3) 0 ; 0 1 0 0 ; -sin(-2*pi/3) 0 cos(-2*pi/3) 0 ; 0 0 0 1]
T2 = [ 1 0 0 -2 ; 0 1 0 0 ; 0 0 1 4 ; 0 0 0 1]
M = T2 * RY * T1 %#ok
```

```
T1 =

     1     0     0     2
     0     1     0     0
     0     0     1    -4
     0     0     0     1


RY =

   -0.5000         0   -0.8660         0
         0    1.0000         0         0
    0.8660         0   -0.5000         0
         0         0         0    1.0000


T2 =

     1     0     0    -2
     0     1     0     0
     0     0     1     4
     0     0     0     1


M =

   -0.5000         0   -0.8660    0.4641
         0    1.0000         0         0
    0.8660         0   -0.5000    7.7321
         0         0         0    1.0000
```

## 3.23

```
A = [0 ; 1; sqrt(3)]
r = acos(1/sqrt(3)) % theta of A from y axis
RX1 = [1 0 0 0 ; 0 cos(r) -sin(r) 0 ; 0 sin(r) cos(r) 0 ; 0 0 0 1] % rotate A to z-axis
RZ = [cos(pi/3) -sin(pi/3) 0 0 ; sin(pi/3) cos(pi/3) 0 0; 0 0 1 0 ; 0 0 0 1] % rotate around
A
RX2 = [1 0 0 0 ; 0 cos(-r) -sin(-r) 0 ; 0 sin(-r) cos(-r) 0 ; 0 0 0 1] % rotate A back to ori
ginal
M = RX2 * RZ * RX1 %#ok final rotation matrix
```

```
A =

         0
    1.0000
```

```
    1.7321


r =

    0.9553


RX1 =

    1.0000         0         0         0
         0    0.5774   -0.8165         0
         0    0.8165    0.5774         0
         0         0         0    1.0000


RZ =

    0.5000   -0.8660         0         0
    0.8660    0.5000         0         0
         0         0    1.0000         0
         0         0         0    1.0000


RX2 =

    1.0000         0         0         0
         0    0.5774    0.8165         0
         0   -0.8165    0.5774         0
         0         0         0    1.0000


M =

    0.5000   -0.5000    0.7071         0
    0.5000    0.8333    0.2357         0
   -0.7071    0.2357    0.6667         0
         0         0         0    1.0000
```

### 3.25

```
% part a
RX1 = [1 0 0 0 ; 0 cos(pi/2) -sin(pi/2) 0 ; 0 sin(pi/2) cos(pi/2) 0 ; 0 0 0 1] % rotate aroun
d x
P = [1 0 0 0 ; 0 1 0 0 ; 0 0 0 0 ; 0 0 (-1/10) 1] % project from x=10
RX2 = [1 0 0 0 ; 0 cos(-pi/2) -sin(-pi/2) 0 ; 0 sin(-pi/2) cos(-pi/2) 0 ; 0 0 0 1] % rotate b
ack around x
M = RX2 * P * RX1

% part b
p1 = [1 ; 2 ; 3; 1] % (1,2,3)
p2 = [4 ; -1 ; 0; 1] % (4,-1,0)
p3 = [5 ; 2 ; 3 ; 1] % (5,2,3)
p1t = M * p1 * 10/8 % p1 projected
p2t = M * p2 * 10/11 % p2 projected
```

```
p3t = M * p3 * 10/8 % p3 projected
```

```
RX1 =

    1.0000         0         0         0
         0    0.0000   -1.0000         0
         0    1.0000    0.0000         0
         0         0         0    1.0000


P =

    1.0000         0         0         0
         0    1.0000         0         0
         0         0         0         0
         0         0   -0.1000    1.0000


RX2 =

    1.0000         0         0         0
         0    0.0000    1.0000         0
         0   -1.0000    0.0000         0
         0         0         0    1.0000


M =

    1.0000         0         0         0
         0    0.0000   -0.0000         0
         0   -0.0000    1.0000         0
         0   -0.1000   -0.0000    1.0000


p1 =

     1
     2
     3
     1


p2 =

     4
    -1
     0
     1


p3 =

     5
     2
     3
```

```
     1
```

```
p1t =

    1.2500
   -0.0000
    3.7500
    1.0000
```

```
p2t =

    3.6364
   -0.0000
    0.0000
    1.0000
```

```
p3t =

    6.2500
   -0.0000
    3.7500
    1.0000
```

## 3.28

```
% part a
P = [1 0 0 0 ; 0 1 0 0 ; 0 0 0 0 ; 0 0 -1/d 1] % projection matrix
PI = limit(P, d, inf) % limit as d approaches infinity

% part b
syms x y z;
p = PI * [x ; y ; z ; 1]
% the projection is just original x and y values
% this makes sense because from infinitely far away you would be
% looking directly down over the entire xy plane, thus seeing only
% the top of any object without any "horizontal" perspective
```

```
P =

[ 1, 0,    0, 0]
[ 0, 1,    0, 0]
[ 0, 0,    0, 0]
[ 0, 0, -1/d, 1]
```

```
PI =

[ 1, 0, 0, 0]
[ 0, 1, 0, 0]
```

```
[ 0, 0, 0, 0]
[ 0, 0, 0, 1]


p =

  x
  y
  0
  1
```

---

*Published with MATLAB® R2017b*