```
addpath('lab4files')
addpath('simfiles')
sec3 = load('ThetaData3')
```

```
sec3 = struct with fields:
    Average_Theta: [1×1 struct]
            Theta: [1×1 struct]
```

```
sec4_i = load('Psidotdata4cw')
```

```
sec4_i = struct with fields:
    Average_psi_dot: [1×1 struct]
            psi_dot: [1×1 struct]
```

```
sec4_ii = load('Psidotdata4ccw')
```

```
sec4_ii = struct with fields:
    Average_psi_dot: [1×1 struct]
            psi_dot: [1×1 struct]
```

```
ms =  0.156; mh = 1.326; m = ms+mh; g = 9.81;
x = 0.12; x1 = 19.5/100, x0 = 13.75/100
```

```
x1 = 0.1950
x0 = 0.1375
```

Part i

```
p0 = -0.5185
```

```
p0 = -0.5185
```

```
Rc = ms * (x1 - x)/m
```

```
Rc = 0.0079
```

```
h = Rc / tan(abs(p0))
```

```
h = 0.0138
```

Part ii

```
th3 = sec3.Theta.signals.values;
time_ii = sec3.Theta.time-14.582;
Jshaft = 0.0039;
n = 5
```

```
n = 5
```

```
t_ii = 15.07 % s
```

```
t_ii = 15.0700
```

```
om = 2*pi * n / t_ii % rad/s
```

```
om = 2.0847
```

```
th0 = 0.30833 % rad
```

```
th0 = 0.3083
```

```
o = om/(2*pi*(n-1)) * log(th0/0.082835)
```

```
o = 0.1090
```

```
Jp_prime = m*g*h/ (om^2 + o^2)
```

```
Jp_prime = 0.0462
```

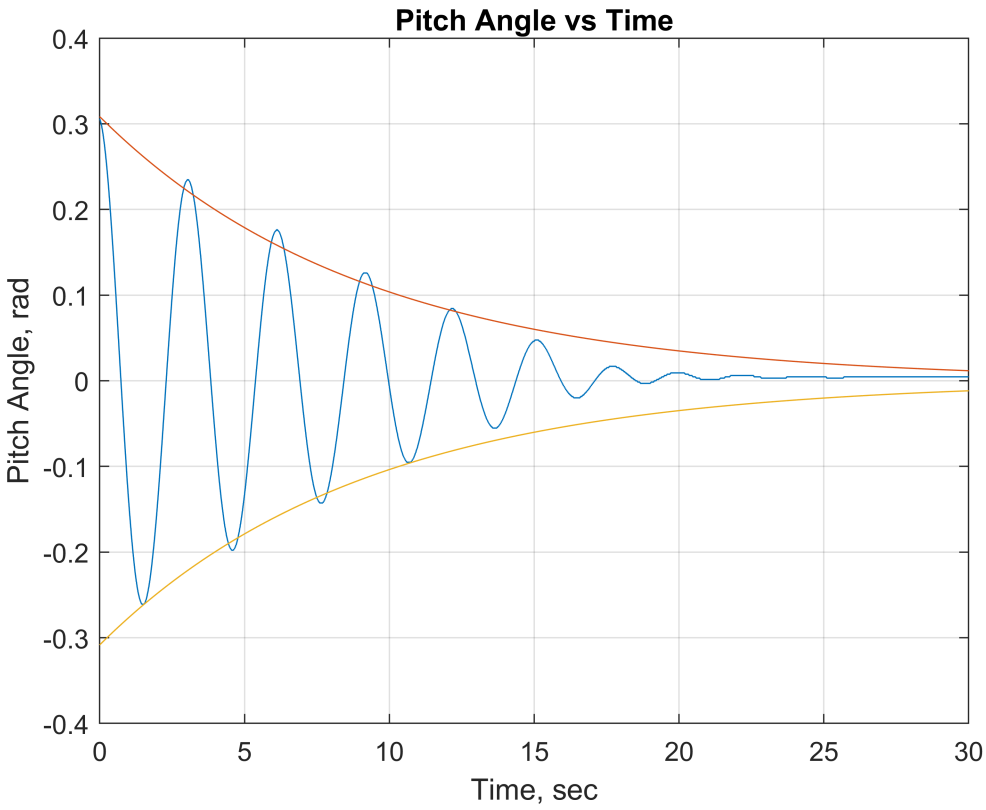
```
Jp = Jp_prime - ms * (x1^2 - x^2)
```

```
Jp = 0.0425
```

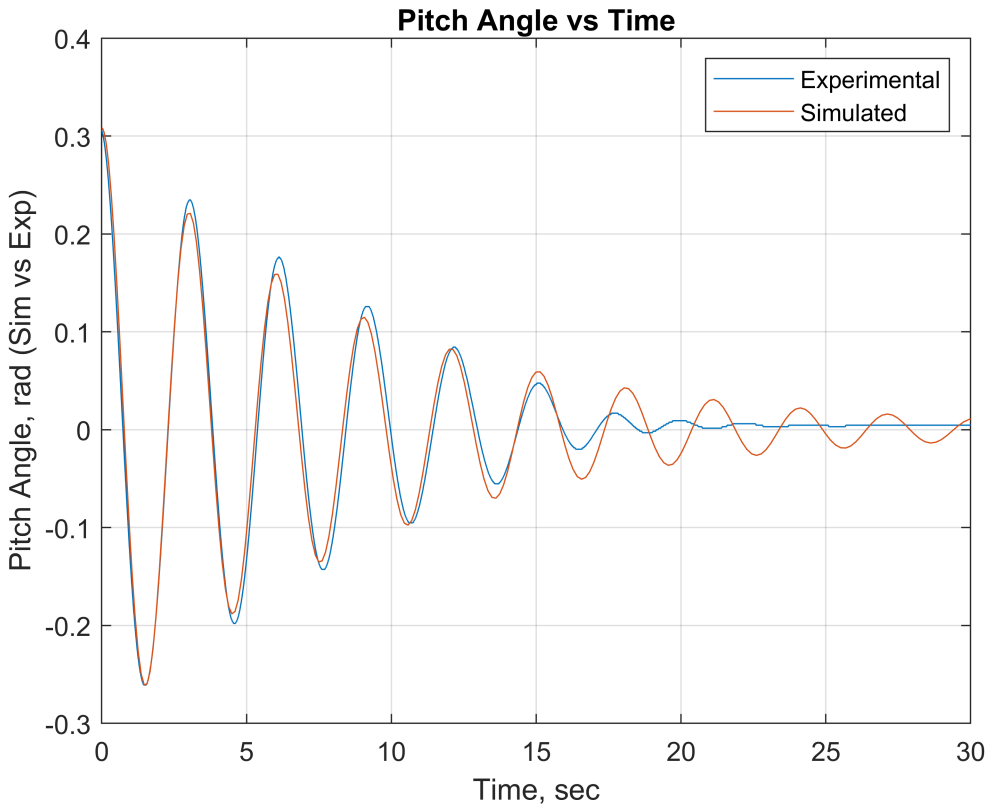
```
cp = 2*o*Jp_prime
```

```
cp = 0.0101
```

```
eeee = th0 * exp(-time_ii * o);
plot(time_ii,th3)
hold on
plot(time_ii,eeee)
plot(time_ii,-eeee)
xlim([0 30])
title('Pitch Angle vs Time')
xlabel('Time, sec')
ylabel('Pitch Angle, rad')
grid on
hold off
```




```
out = sim('part_iisim.slx');
thiisim = out.th.data;
timesim = out.th.time;
plot(time_ii,th3)
hold on
plot(timesim,thiisim)
xlim([0 30])
title('Pitch Angle vs Time')
xlabel('Time, sec')
ylabel('Pitch Angle, rad (Sim vs Exp)')
grid on
legend('Experimental','Simulated')
hold off
```



Part iii)

```
Jy = Jp
```

```
Jy = 0.0425
```

```
yawratecw = sec4_i.Average_psi_dot.signals.values;
exptime = sec4_i.psi_dot.time-5.96;
t = 0:1/1000:45;
y0 = .259466;
cy = o*(Jp + Jshaft)
```

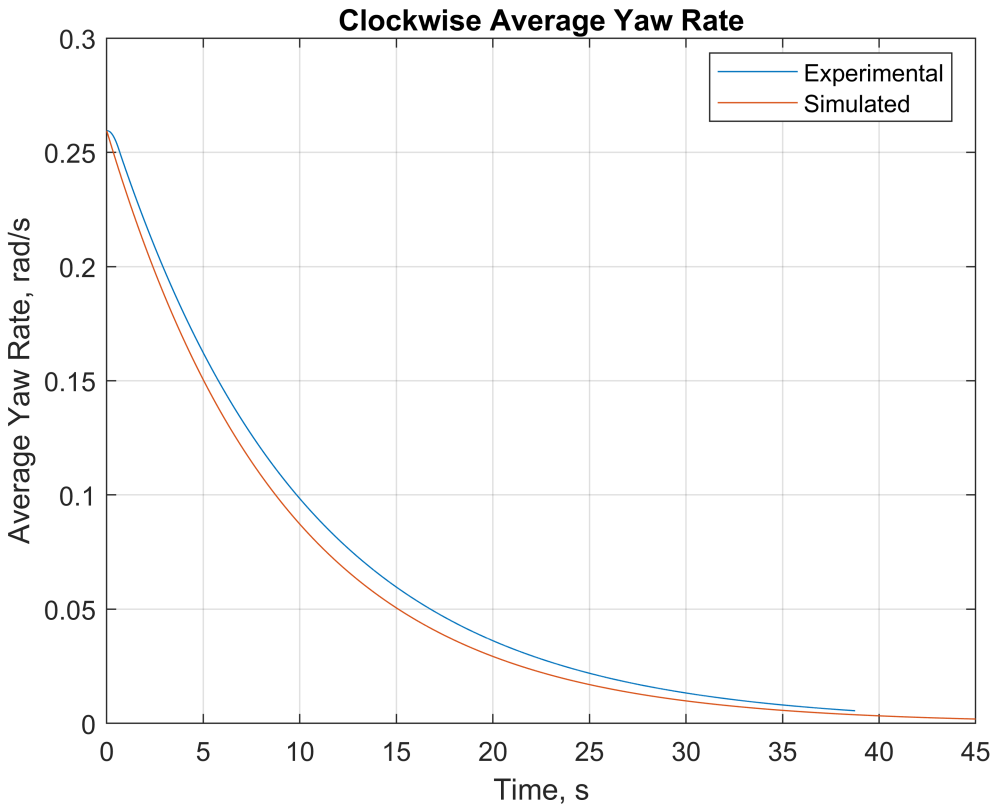
```
cy = 0.0051
```

```
simyawrate = y0 * exp(-o*t)
```

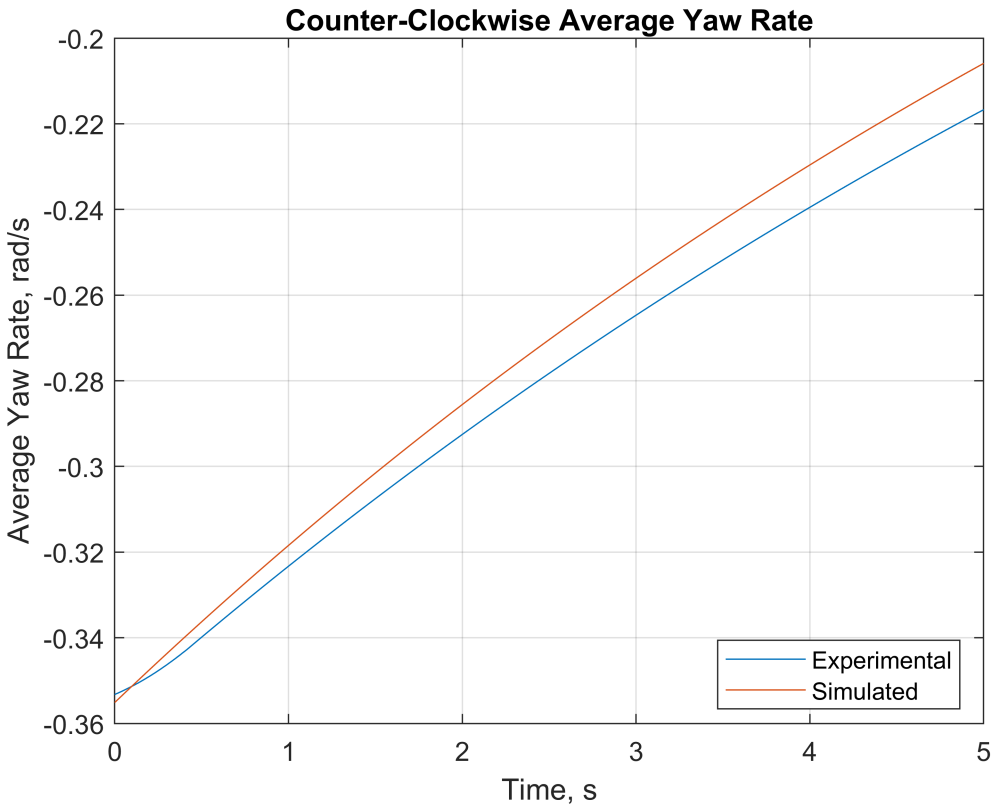
```
simyawrate = 1×45001
    0.2595    0.2594    0.2594    0.2594    0.2594    0.2593    0.2593    0.2593 ···
```

```
plot(exptime,yawratecw)
xlim([0 45])
hold on
grid on
title('Clockwise Average Yaw Rate')
ylabel('Average Yaw Rate, rad/s')
xlabel('Time, s')
plot(t,simyawrate)
legend('Experimental','Simulated','Location',"best")
```

```
hold off
```




```
yawrateccw = sec4_ii.Average_psi_dot.signals.values;
exptime = sec4_ii.psi_dot.time-9.3480;
plot(exptime,yawrateccw)
xlim([0 5])
hold on
y0 = -.355121;
simyawrate = y0 * exp(-o*t);
grid on
title('Counter-Clockwise Average Yaw Rate')
ylabel('Average Yaw Rate, rad/s')
xlabel('Time, s')
plot(t,simyawrate)
legend('Experimental','Simulated','Location',"best")
hold off
```

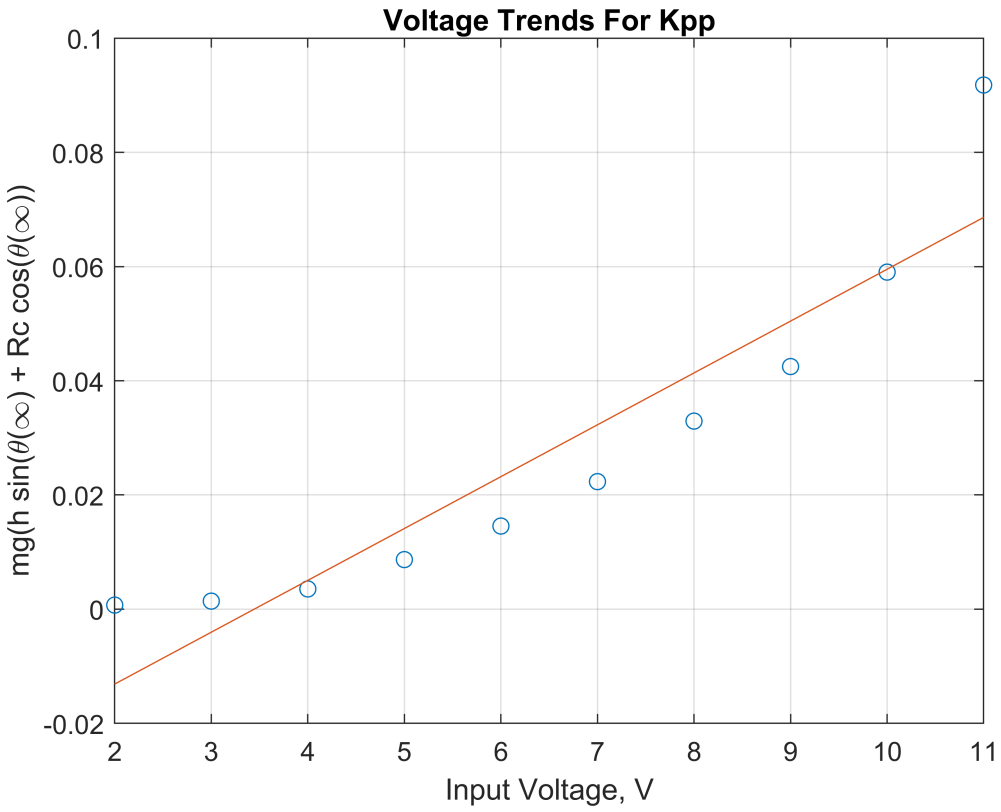


Part iv:

```
pitchvolt = [2 3 4 5 6 7 8 9 10 11]; pitchangle = [-0.5154 -.5124 -.5032 -.481 -.4556 -
yawvolt = [2 3 4 5 6 7 8 9 10 11 12]; yawangle = [-.51 -.5 -.49 -.47 -.46 -.44 -.415 -.
l = 0.184;
pitcheqn = m*g*(h*sin(pitchangle) + Rc*cos(pitchangle));
coef = polyfit(pitchvolt,pitcheqn,1);
xp = linspace(pitchvolt(1), pitchvolt(end),2^12); yp = polyval(coef,xp);
kpp = (yp(2)-yp(1))/(xp(2)-xp(1))/l
```

```
kpp = 0.0493
```

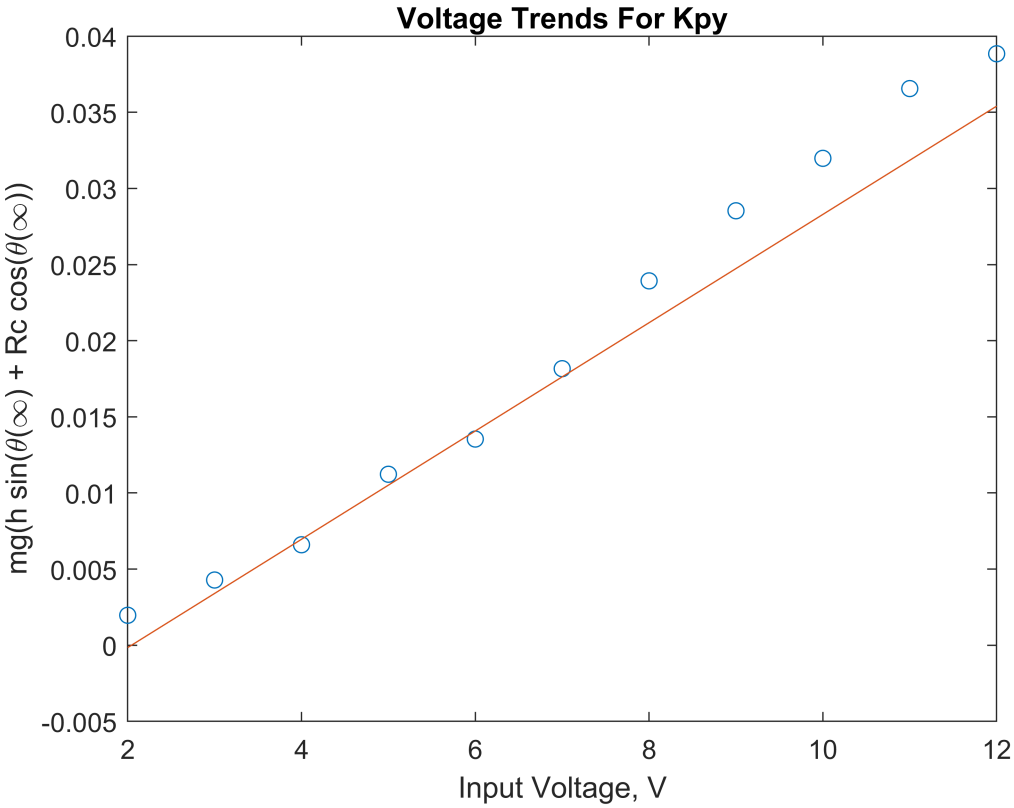
```
plot(pitchvolt,pitcheqn,'o')
hold on
plot(xp,yp)
grid on
xlabel('Input Voltage, V')
ylabel('mg(h sin(\theta(\infty) + Rc cos(\theta(\infty))')
title('Voltage Trends For Kpp')
hold off
```




```
yaweqn = m*g*(h*sin(yawangle) + Rc*cos(yawangle));
coef = polyfit(yawvolt,yaweqn,1);
xy = linspace(yawvolt(1),yawvolt(end),2^12); yy = polyval(coef,xp);
kpy = (yy(2)-yy(1))/(xy(2)-xy(1))
```

```
kpy = 0.0036
```

```
plot(yawvolt,yaweqn,'o')
hold on
plot(xy,yy)
xlabel('Input Voltage, V')
ylabel('mg(h sin(\theta(\infty) + Rc cos(\theta(\infty))')
title('Voltage Trends For Kpy')
hold off
```


Voltage Trends For Kpy
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
-0.005
2
4
6
8
10
12
mg(h sin(θ(∞) + Rc cos(θ(∞))
Input Voltage, V