## Import Data

```
clear all;
clc;
data = readtable("step_multiple_15V_75ohm.csv");
data = fillmissing(data,'nearest');
data([1,2],:) = [];
% Step info
step_bot=75;
step_top=80;
```

## Assign Variables

```
% Seperate values
t = table2array(data(:,1))+5;
ADC = round(table2array(data(:,2))/30*1024);
OCR = table2array(data(:,3));
% Match to duty cycle
OCR = round(OCR/5)*(step_top-step_bot)+step_bot;

% Find index before step
idx = find(OCR>75,1,'first')
```

```
idx = 24
```

```


% Trim data with new index
t = t(idx-5:end);
ADC = ADC(idx-5:end);
OCR = OCR(idx-5:end);

% Reset time and find sampling time
t = t-t(1);
T_s=t(2)-t(1)
```

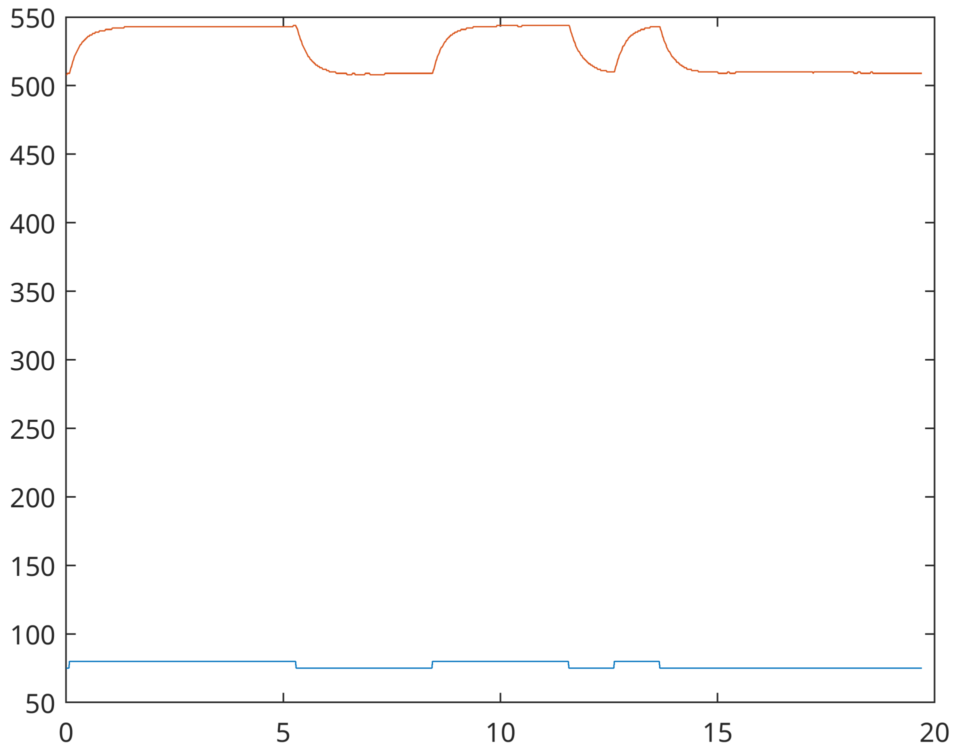
```
T_s = 0.0156
```

## Plot Real Data

```
clf;
plot(t,OCR)
```

```
Warning: MATLAB has disabled some advanced graphics rendering features by switching to software
OpenGL. For more information, click here.
```

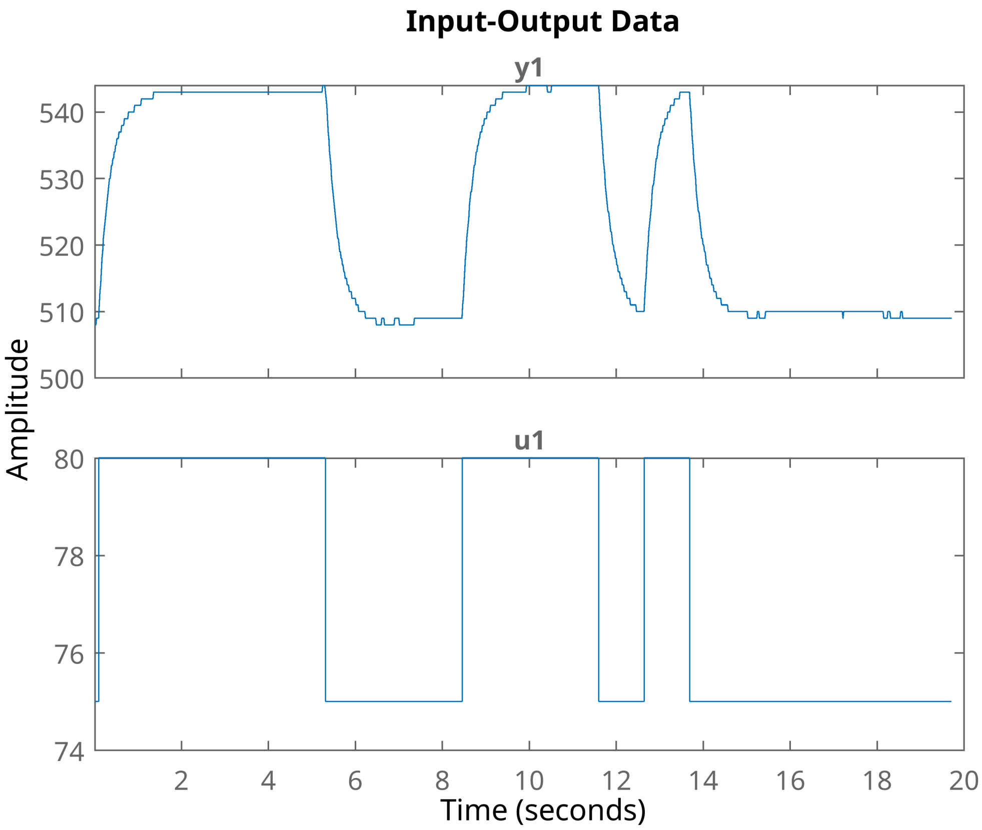
```
hold on
plot(t,ADC)
hold off
```



```
clf
```

## Identify Transfer Functions

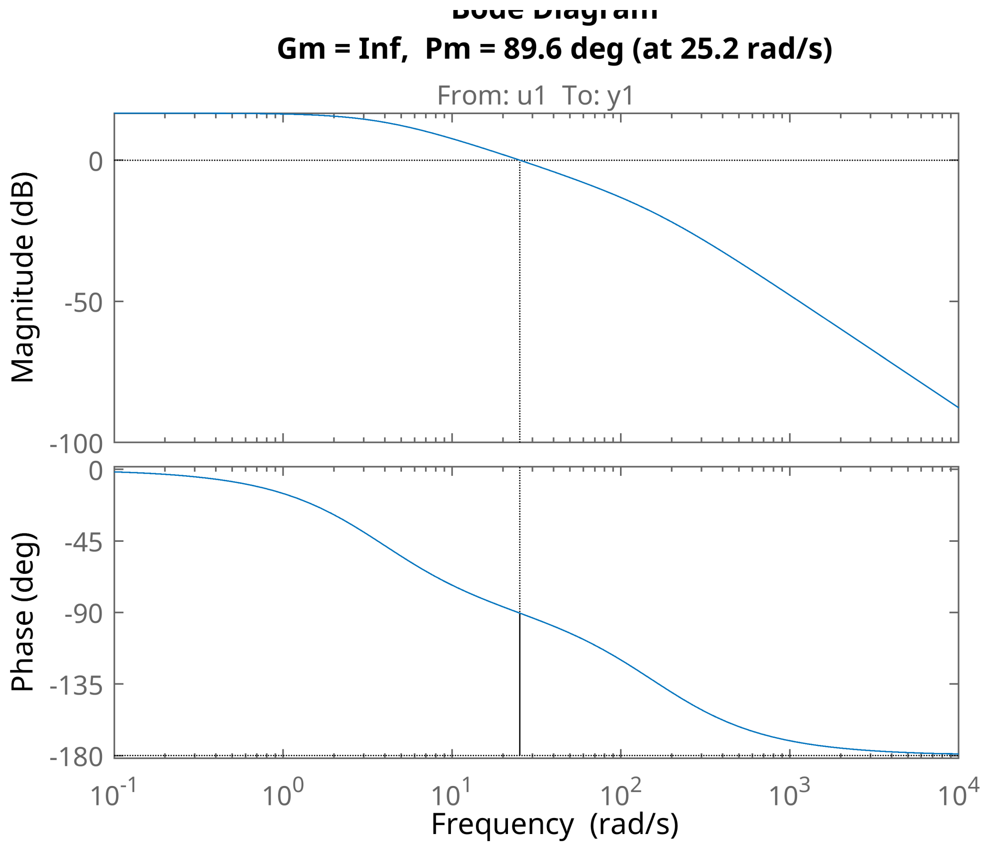
```
idd = iddata(ADC,OCR,T_s);
plot(idd)
```



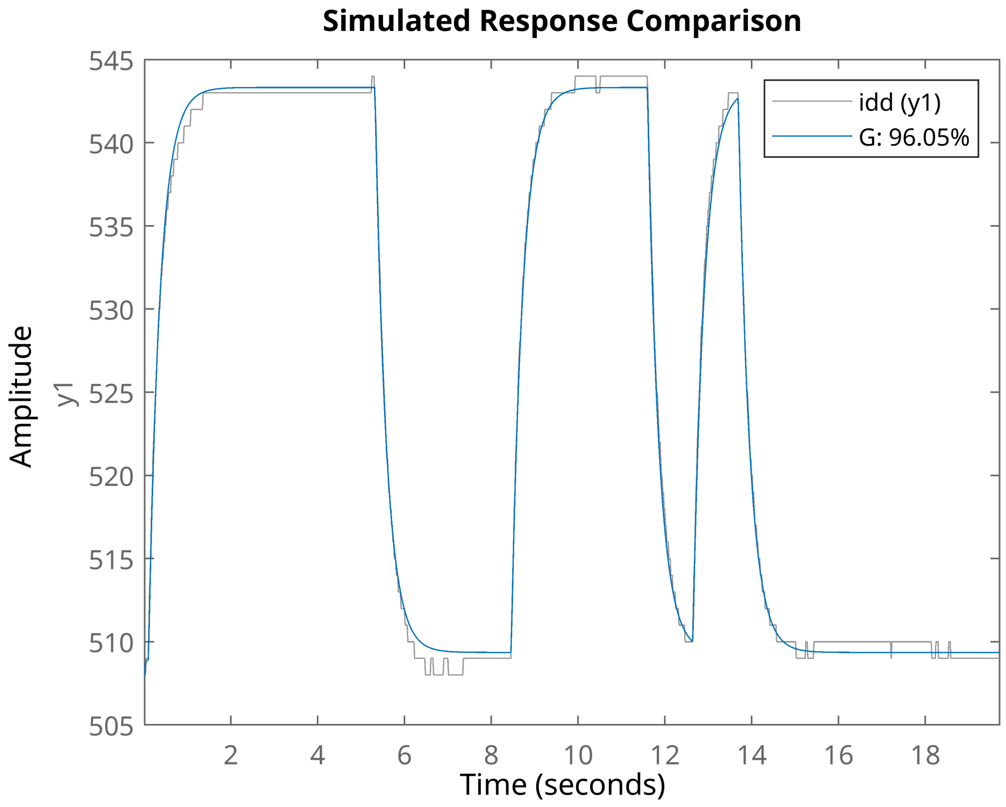
```
G=tfest(idd,2,0)
```

```
G =
 
  From input "u1" to output "y1":
          4122
  ---------------------
  s^2 + 163.7 s + 606.9
 
Continuous-time identified transfer function.

Parameterization:
   Number of poles: 2   Number of zeros: 0
   Number of free coefficients: 3
   Use "tfdata", "getpvec", "getcov" for parameters and their uncertainties.

Status:
Estimated using TFEST on time domain data "idd".
Fit to estimation data: 96.05%
FPE: 0.3826, MSE: 0.3795
```

```
margin(G)
```



```
compare(idd,G)  % Passer meget godt med dataet
```



## Create PID Controller

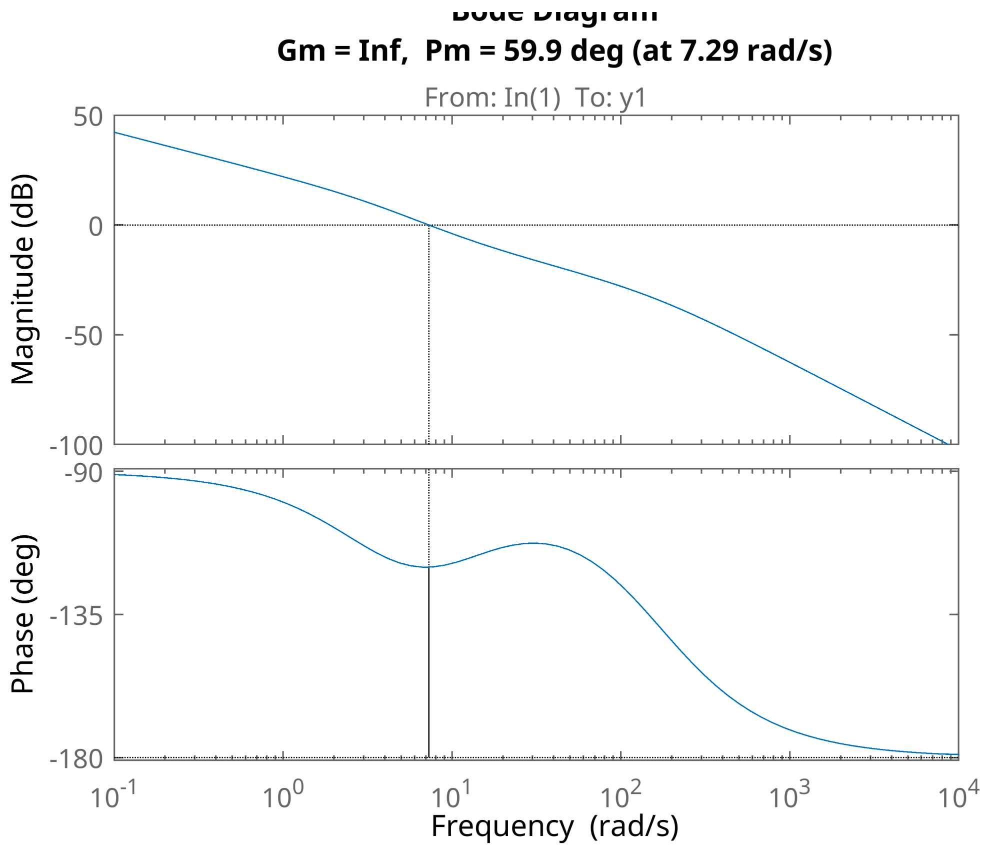
```
format long
abs(pole(G))
```

```
ans = 2×1
10^2 ×
   1.599132933691860
   0.037953676139054
```

```
gm = 60; Ni=0.7; alpha=1;
% First PID Controller
[wc, Kp, taui,taud, ok] = findpid(G, gm, Ni,alpha)
```

```
ans = 
'Found 1 valid solution(s) out of 1 phase crossing(s)'
wc = 
   7.287339268059741
Kp = 
   0.182988032300996
taui = 
   0.096057007125781
taud = 
   0.137224295893973
ok = 
     1
```

```
s=tf('s');
Cpid=minreal(Kp*(taui*s+1)/(taui*s)*(taud*s+1)/(alpha*taud*s+1));
Gol=minreal(G*Cpid);
margin(Gol);
```



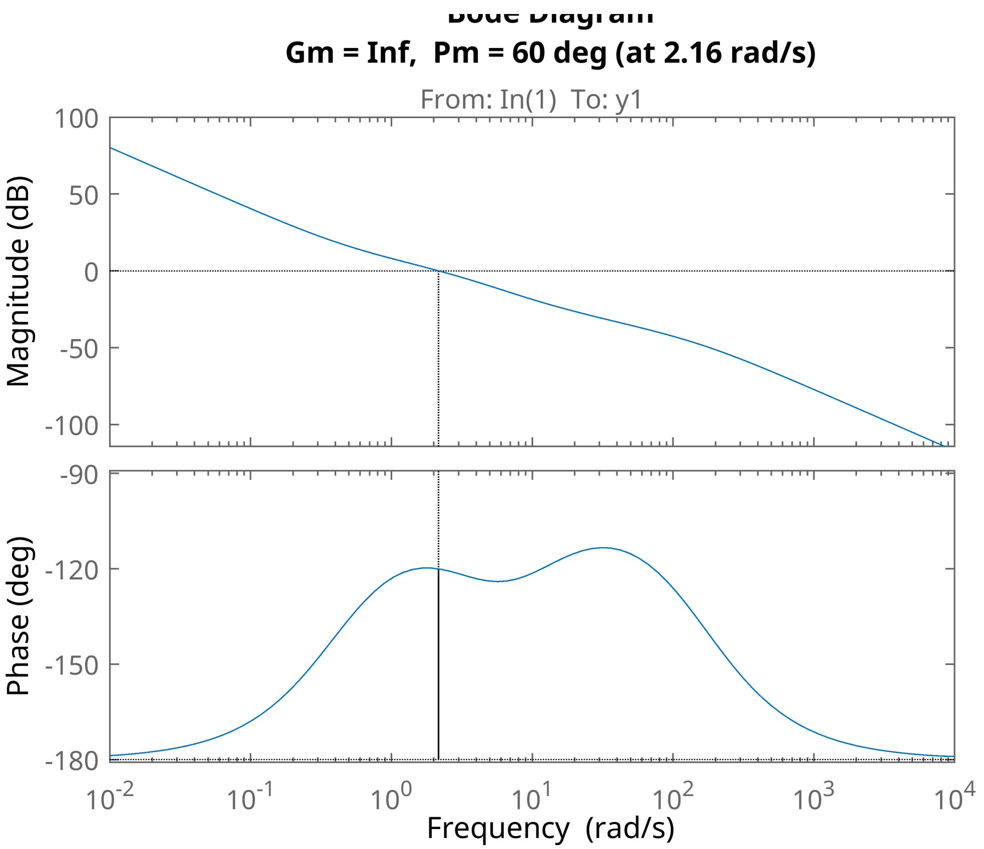
```
Ni = 5
```

```
Ni =
     5
```

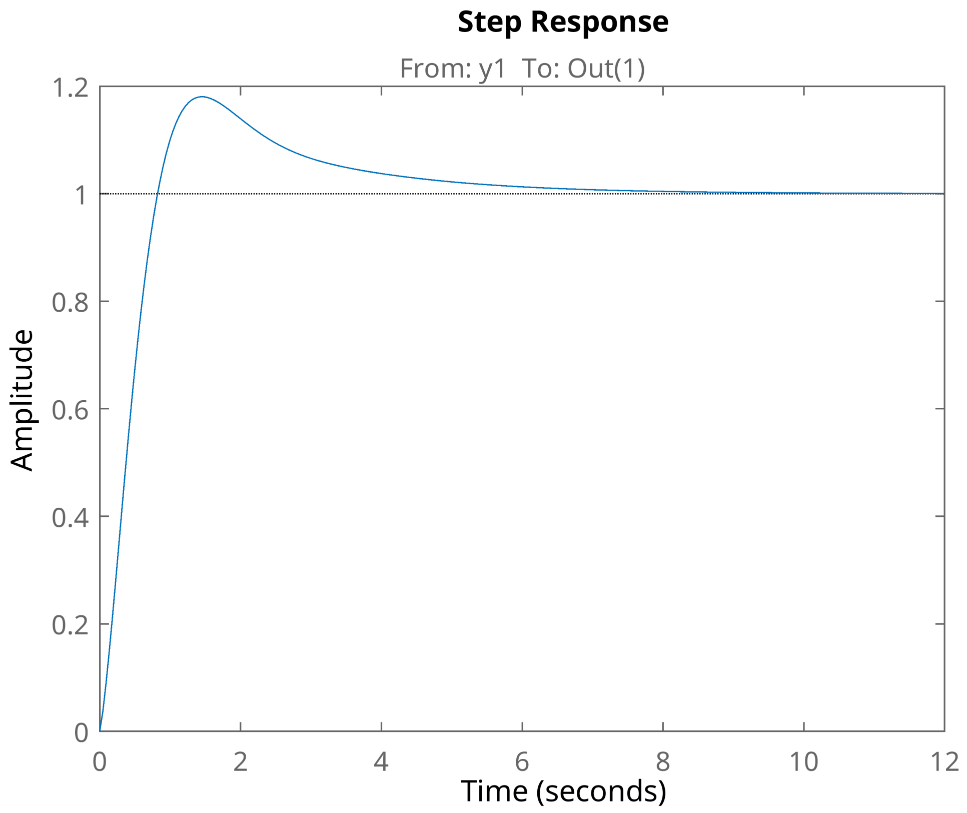
```
% Create extra integrator
[wc2, Kp2, taui2, ok] = findpi(Gol, gm, Ni)
```

```
ans =
'Found 1 valid solution(s) out of 1 phase crossing(s)'
wc2 =
   2.162866991425549
Kp2 =
   0.184751085924124
taui2 =
   2.311746408735237
ok =
     1
```

```
Cpi2=minreal(Kp2*(taui2*s+1)/(taui2*s));
Gol2=minreal(Gol*Cpi2);
margin(Gol2)
```



```
Gcl=minreal(Gol2/(1+Gol2));
step(1*Gcl);
```



## Z-Transform and Output

```
Controller=minreal(Cpid*Cpi2)
```

```
Controller =

  0.03381 s^2 + 0.3666 s + 0.1522
  -------------------------------
               s^2

Continuous-time transfer function.
```

```
format long
Gz=c2d(Cpid,1/10e3,'tustin');
Gz.Variable= 'z^-1'
```

```
Gz =

  0.1831 - 0.1829 z^-1
  --------------------
        1 - z^-1

Sample time: 0.0001 seconds
Discrete-time transfer function.
```

```
[num, den] = tfdata(Gz, 'v');

format long
% Open the file for writing
fileID = fopen('../Code/PID Controller/lib/Controllers/Data.h', 'w');
```

```
% Write the array declaration to the file
fprintf(fileID, 'double num[%d] = {',length(num));

% Write each element of the array to the file
for i = 1:length(num)
    fprintf(fileID, '%0.16f', num(i));

    % Add a comma after each element except the last one
    if i < length(num)
        fprintf(fileID, ', ');
    end
end

% Complete the array declaration
fprintf(fileID, '};\n');

% Write the array declaration to the file
fprintf(fileID, 'double den[%d] = {',length(den));

% Write each element of the array to the file
for i = 1:length(num)
    fprintf(fileID, '%0.16f', den(i));

    % Add a comma after each element except the last one
    if i < length(den)
        fprintf(fileID, ', ');
    end
end

% Complete the array declaration
fprintf(fileID, '};\n');

% Close the file
fclose(fileID);
```