CS 431 Homework 3

Soham Karanjikar

1 ANSWERS

1. a) i)Increasing Kp increases the amount of oscillations before stabilization.

ii)Increasing Kd hugely reduces time before balance and also reduces the number of oscillations.

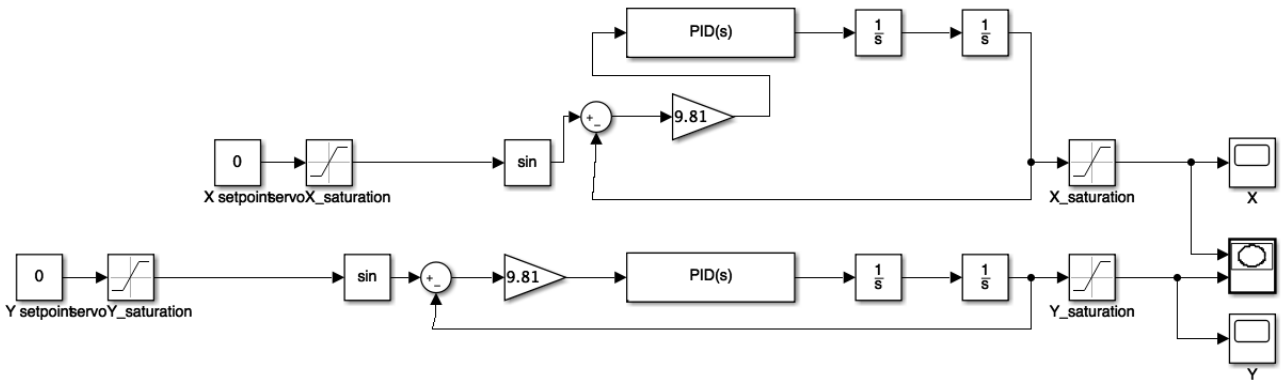
iii)Increasing Ki also slightly increases oscillations and increases the amount of time it takes to stabilize. If you increase it a lot the system goes out of balance and oscillates from 1 to -1.

iv)If Kp is set to 0 then the system never oscillates and balances.

v)If Kd (while Kp is set to 1.5) is set to 0 then the system oscillates forever and never stabilizes.

vi) Setting either of them to negative causes the system to go out of balance and diverge.

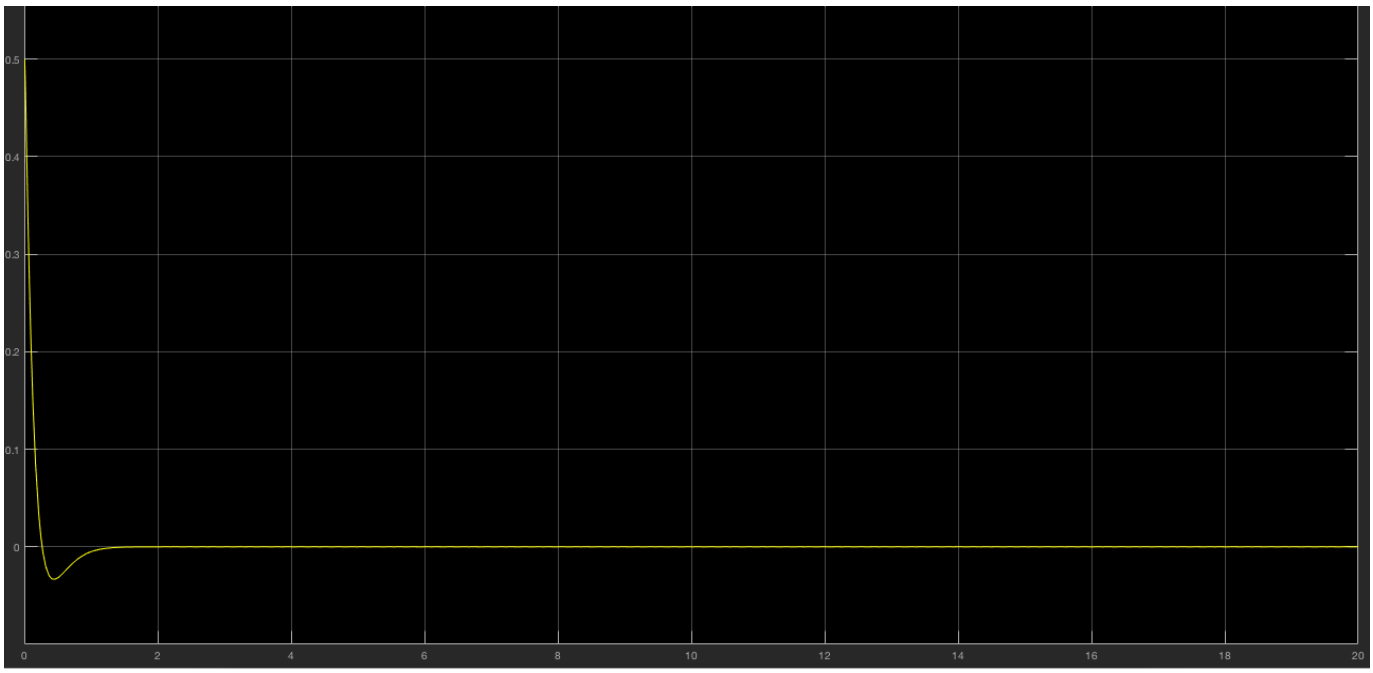
b) The best values were Kp = 0, Kd = 1, Ki = 0. This gives no oscillations and directly converges to 0, balancing the board.



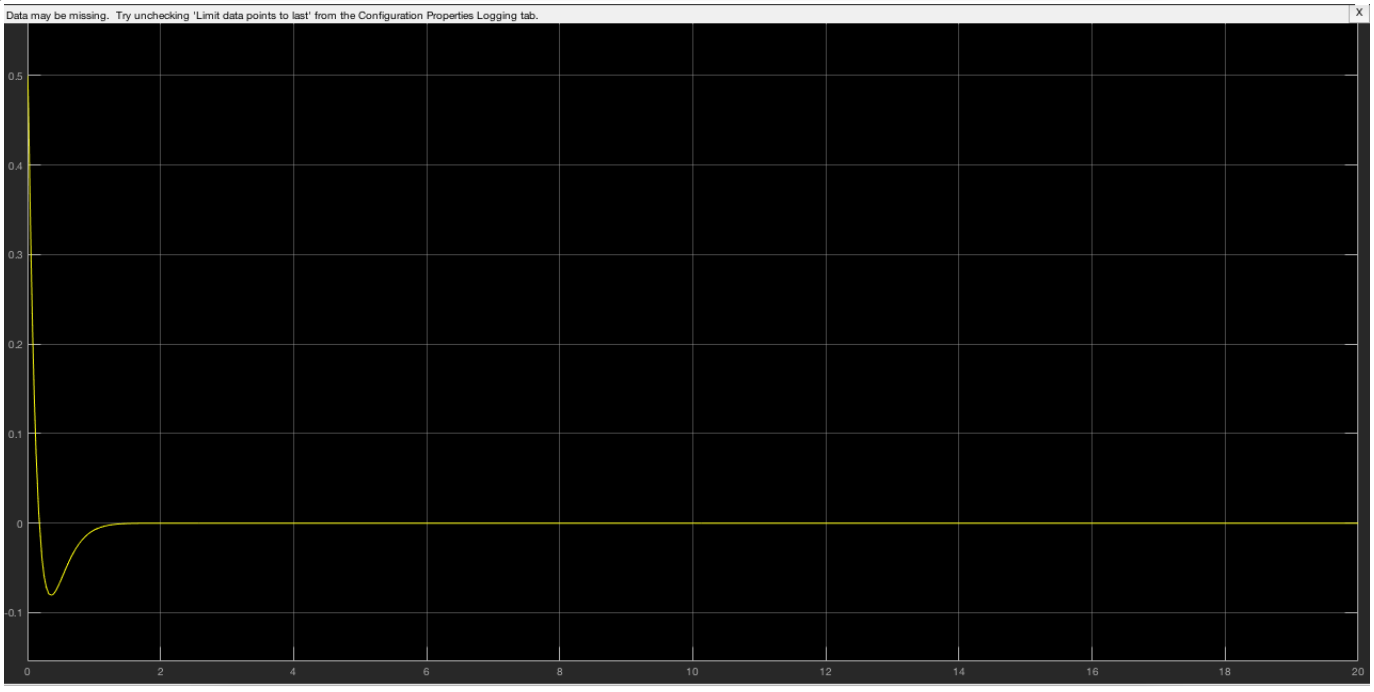
Model:

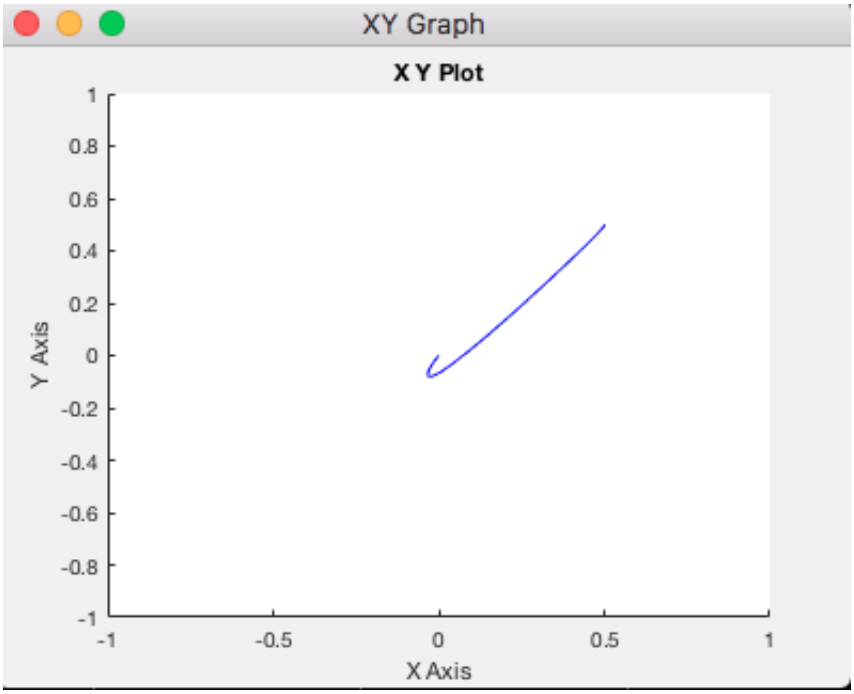
Graphs:

X:


0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
14
16
18
20

Y:


Data may be missing. Try unchecking 'Limit data points to last' from the Configuration Properties Logging tab.
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
2
4
6
8
10
12
14
16
18
20

XY: 

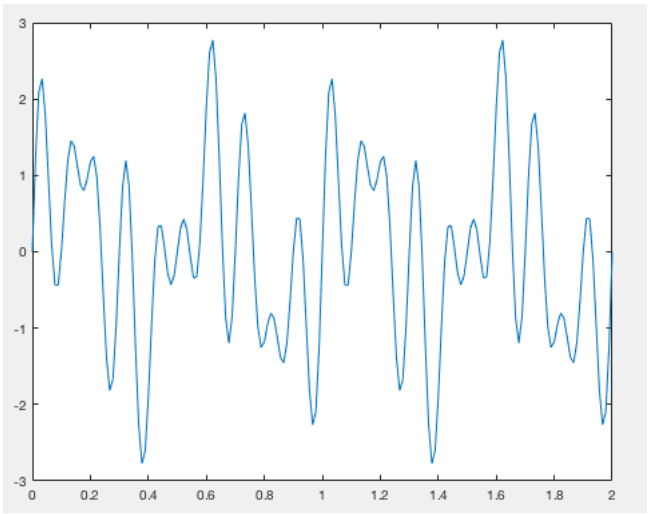
c) Yes with values like Kp = 10, Kd = 5, the system balances almost instantly.

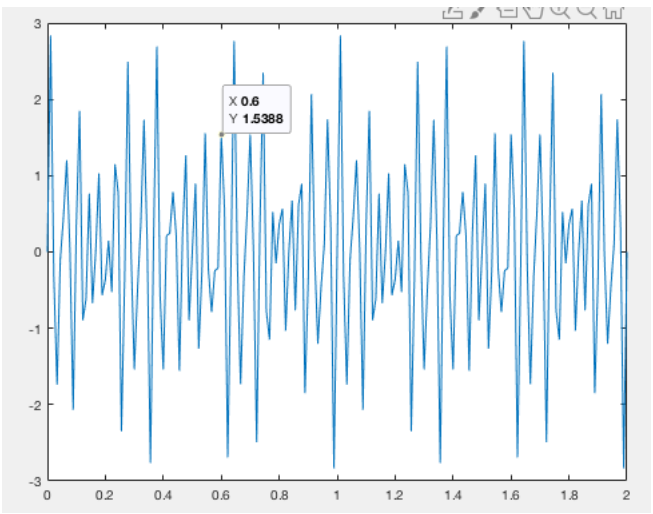
d) These values cannot be realistically achieved because the sensing will take some time and jerking the servos so fast will put the ball out of balance.

e) There is no friction modeled in the simulink example given to us, everything is perfect.

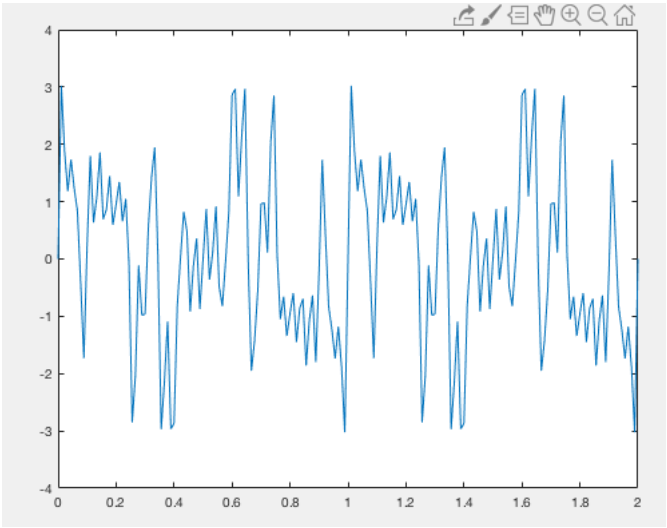
2) a) You can do (iii) all the above. b) i) At least 60Hz. ii) Around 90Hz would be practical.

c) Graphs:

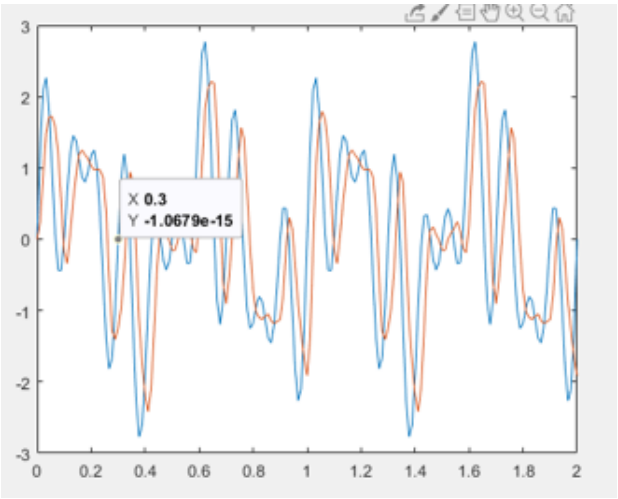
X: 

Y: 

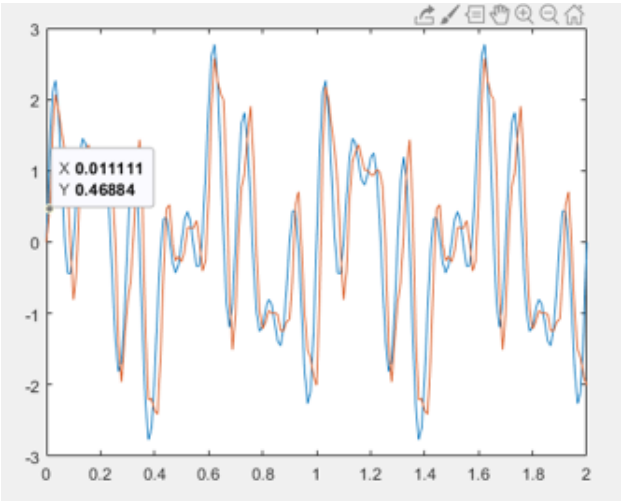
Z:



X and Sampled X (cutoff 10Hz, N = 2):



With cutoff 15hz, N = 3(initial values):



d)Fixed Order i) Increasing the cutoff frequency causes the signal amplitude to: increase

ii) Decreasing the cutoff frequency causes the noise amplitude to: Decrease

e)Fixed Freq i)Increasing the order of filter causes the signal amplitude to: Increase

ii) Decreasing the order of filter causes the phase delay (zf with respect to x) to: Decrease

iii) Advantage is that it matches the signal better so your calculations will be correct. Disadvantage is that it causes a delay in receiving the signal and causes a phase shift which is harmful to calculations.