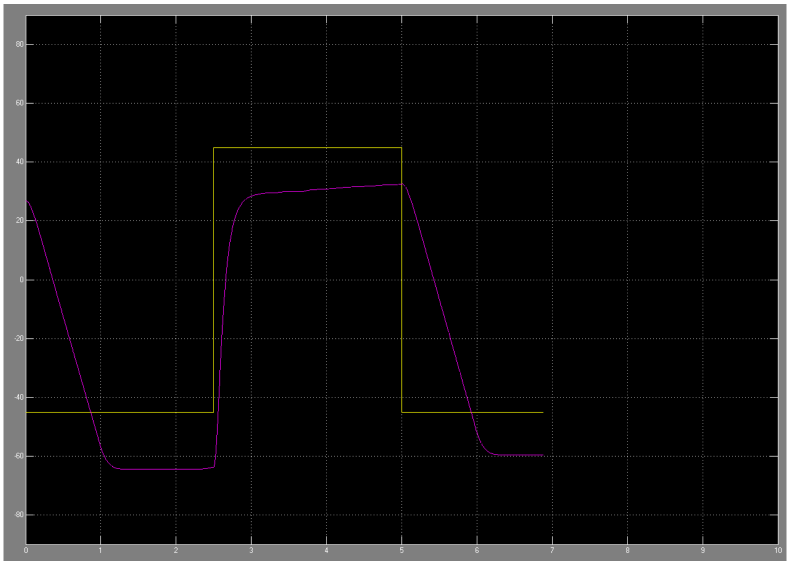
1. Items done in this sessoin:

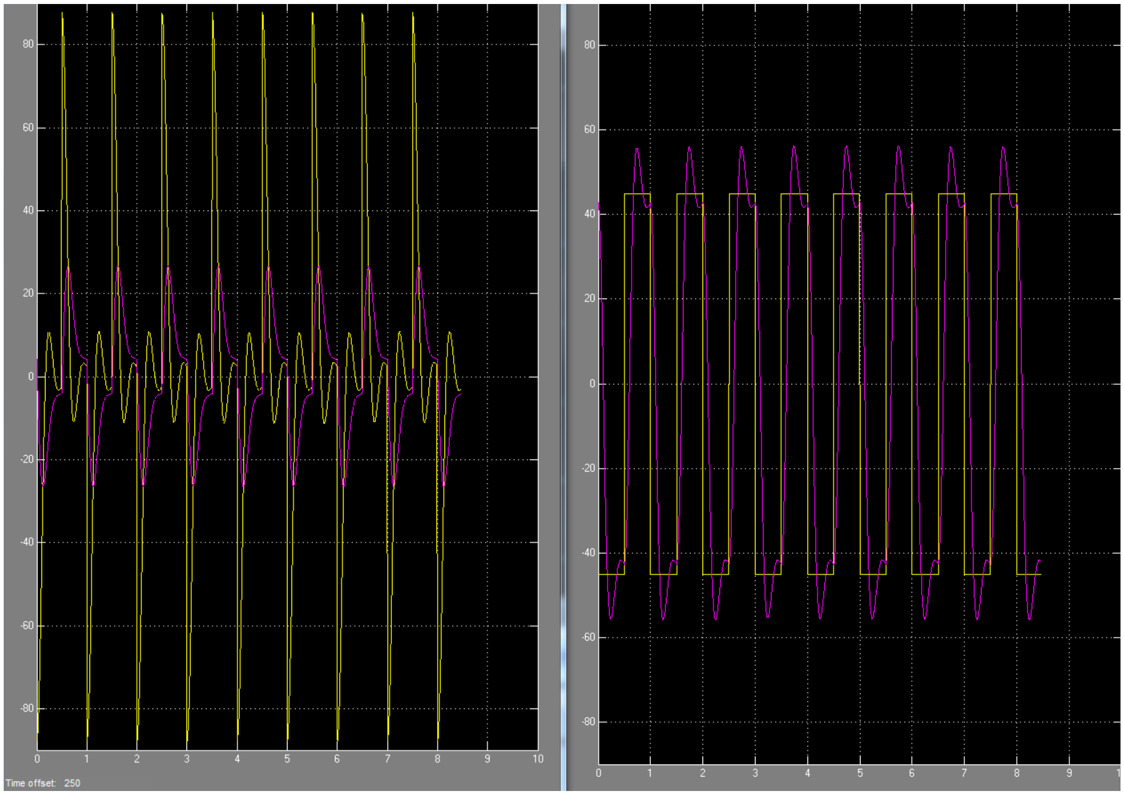
First, we investigate control voltage before and after saturation block. When we set up the asymmetrical saturation values, -10 and 1, the moving shape becomes like the following photo and we can discover the speed constraint by the control voltage. The climbing up slop is faster because of the -10 value, while the descending slope is slower because of the +1 value of the voltage.



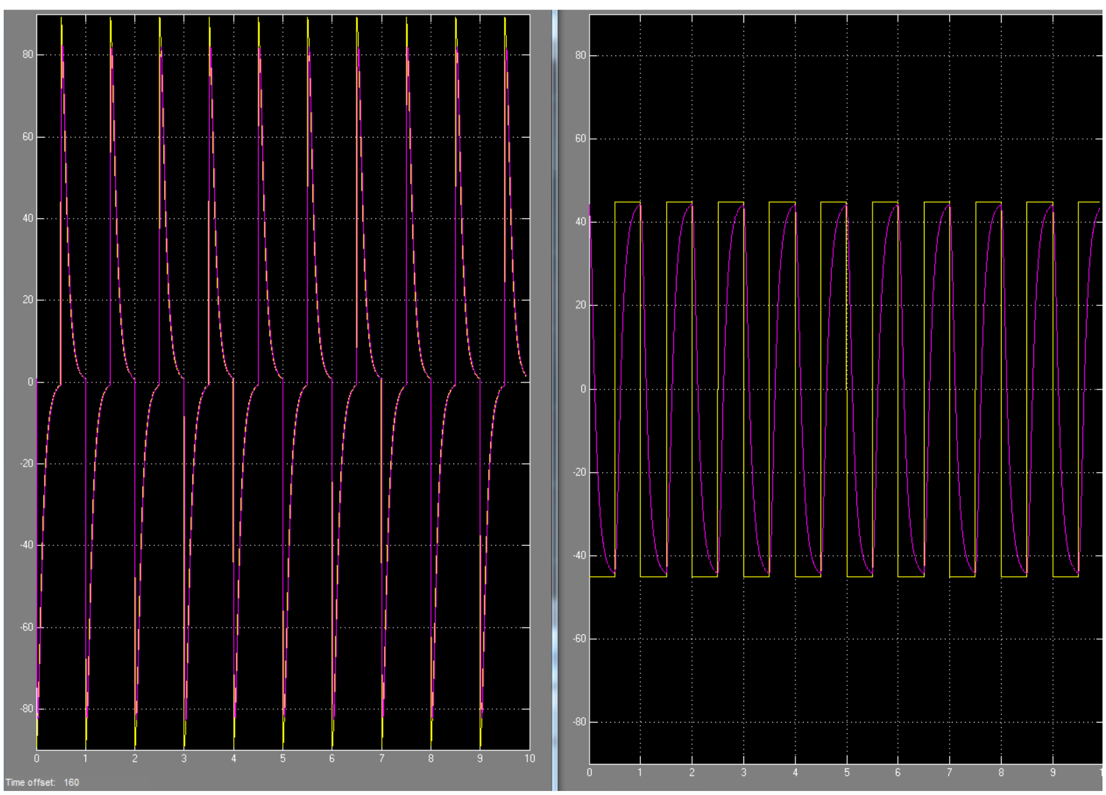
Then we tried different values of Wc (1,5,10,100,200,500) in the low pass filter transfer function block.

The following two pictures are that Wc equal 5 and 100. The left scope is the error signal in degree before (yellow line) and after (purple line) the transfer function. The right scope is the output signals of desired (yellow line) and actual (purple line) in degree .

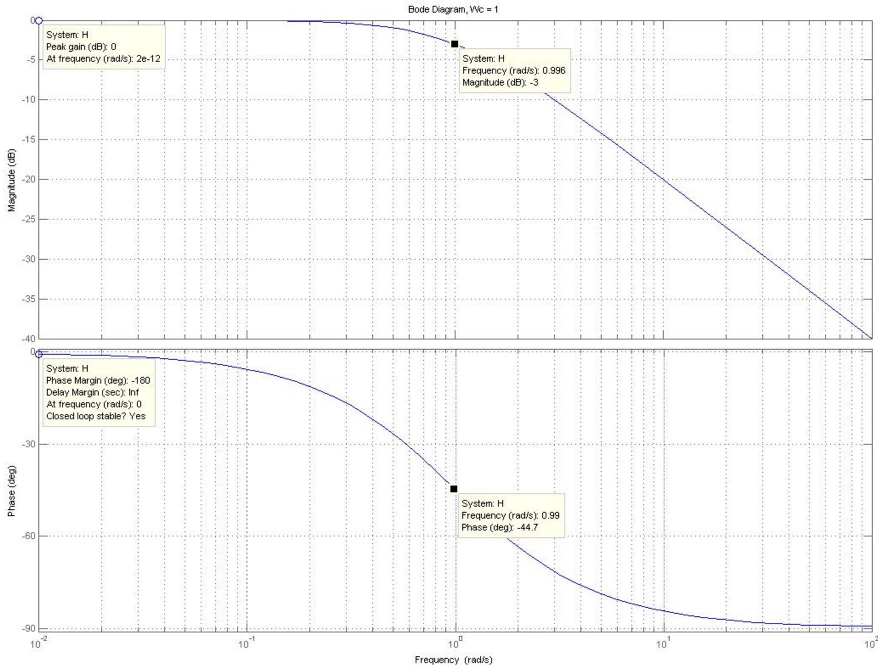
Wc = 5: In the left scope we can easily discover that the low-pass filter eradicate majority of the high amplitude, and in the right has overshooting since the filter over-restrain the contribution from the Derivative.



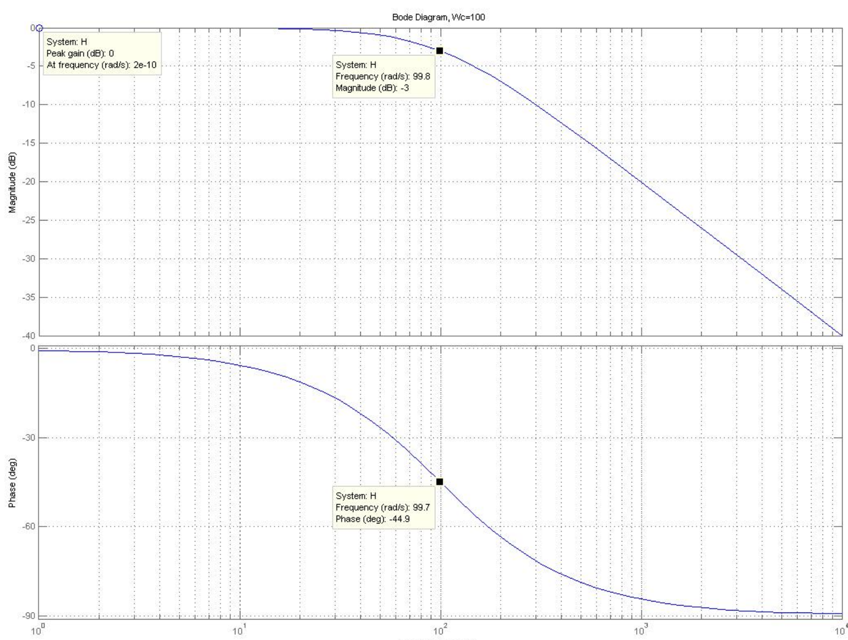
Wc = 100: In the left scope, the low-pass filter let the majority of the the error signal pass. In the right scope of desired and actual output signal, more support of the Derivative contribution comes in to the control system and stabilize the overshooting.



Bode Plot of low-pass filter transfer function with Wc=1:



Bode Plot of low-pass filter transfer function with Wc=100



2. Items for next session:

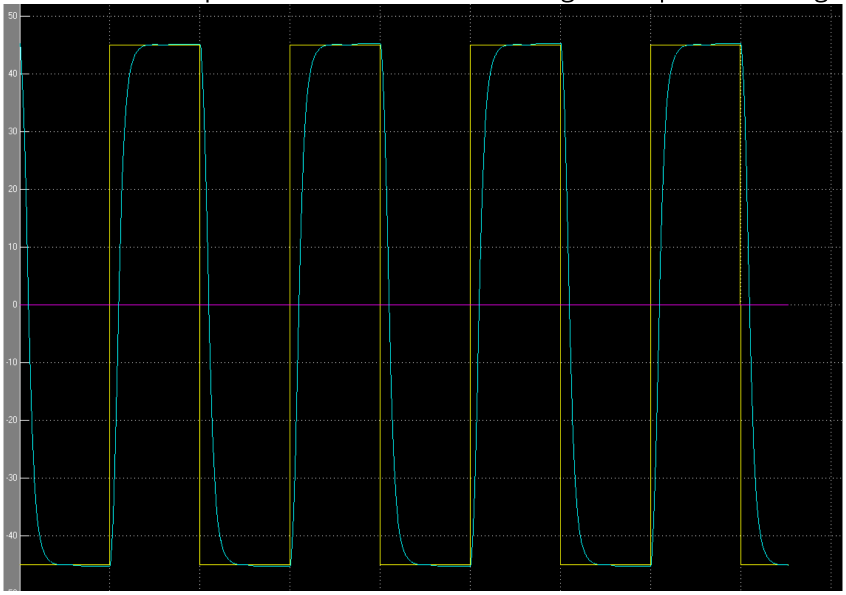
- Progress to next Lab assignment.

3. Questions:

- Could you use this system as a position control device?
The system can be a control device. When we move the link to a certain angle, holding the position for a second and

release it, the link will move back to the desired trajectory as possible as it can. So the system can be a position control device since it is resistant to stay on the desired path.

- What is the shape of the motion when looking at the position using the scope?



The shape looks like an imperfect square-wave with very deep slope, since it takes time for link to move from one side to the other side.

- Can you control the shape of the motion while oscillating?
The shape can be changed through changing the desired input signal.

- What can you say about the speed of the link throughout the entire oscillating region? (Think about this in terms of the amount of energy being delivered to the motor.)
The speed of the link is highly depends on how much voltage put into the motor. And the position control system with PID controller utilize the difference between desired position and actual position to determine how much voltage should be put into the motor.

- Can you predict the shape of the motion if the SRV-02 unit would be tipped on its side?
The general behavior that tipping on one side on the link can be predictable. It would stock for a while and once remove the hands, it goes back to the original desired path. But the exact position still depends on how you tipped the link.

- Does this controller have any predictive nature?
It could be predicted, in a disturbance-free environment, through all parameters such as the frequency of desired trajectory, system, the filter of Derivative, gain of each of PID portion and the control voltage saturation value.

- What is the primary affect of “P” in the transient region when the system is subjected to a step input?
P contributes decreasing the raising time, while the settling time would slightly increase and the stability worsen. When P is small, the controller is insensitive, in the contrast, when P is large, it will begin overshooting and oscillating when P further increase.

- What is the primary affect of “P” in the steady state region when the system is subjected to a step input?
P in the steady state would contribute little output to the system when the steady state error is small or zero.

- What is the primary affect of “I” in the transient region when the system is subjected to a step input?
Integral would consider all the summation of the past error and multiply it with its gain. It can accelerate the settling time, but too large Integral would cause overshooting.

- What is the primary affect of “I” in the steady state region when the system is subjected to a step input?
Integral in the steady state can highly reduce steady error in contrast to those in pure proportional.

- What is the primary affect of “D” in the transient region when the system is subjected to a step input?
Derivative can improve settling time and the stability of the system, and slightly reduce raising time. Higher D can increase the response time to the system.

- What is the primary affect of “D” in the steady state region when the system is subjected to a step

input?
D in the steady state has not much effect on steady state error, while can contribute better stability.