5ELEN018W Robotic Principles-Assignment

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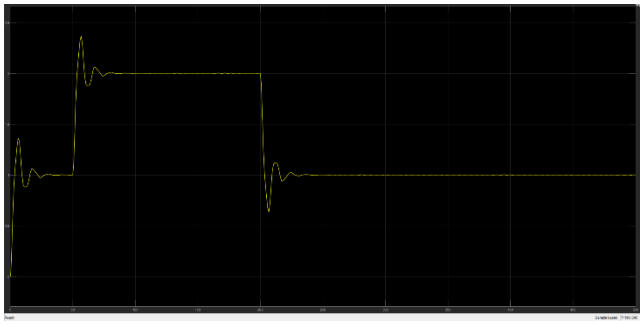
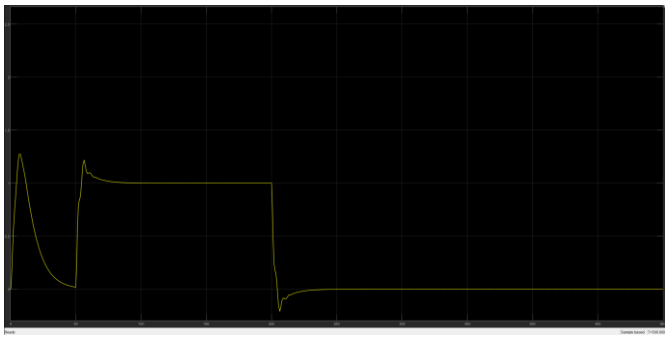
PID Controller

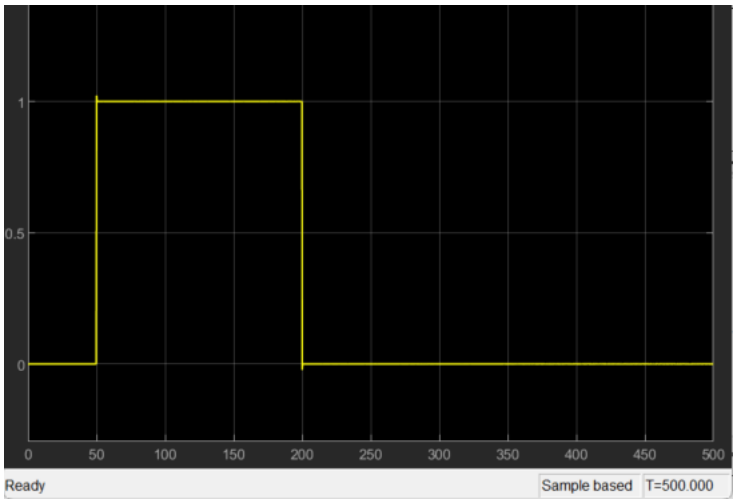
Without PID:



With PID:



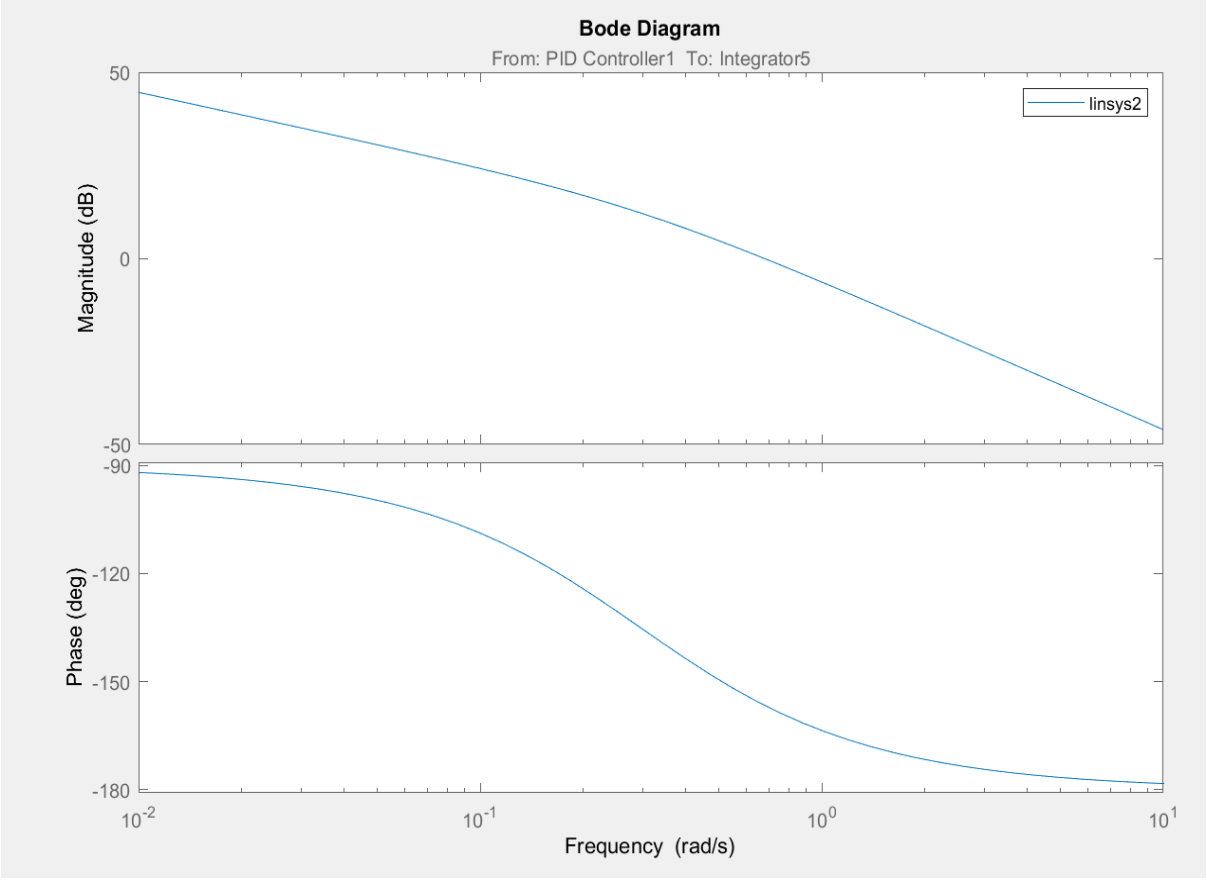
P: 0.662004660677278, **I**: 0.0474334448316438, **D**: 1.4050308795023



P: 16345.124844267, **I**: 53209.8337437093, **D**: 1115.5924167861

Since there were many overshoots, the derivative had to be increased. Furthermore, to reduce steady-state error, the integral value had to be increased; however, the proportion was low. There was much oscillation, so the proportion value had to increase. In addition, there is a slight overshoot at the time of 50s and 200s, where it goes over one and since we are under the assumption that the toe-bar force is proportional to its deformation xc − xt, where xc and xt are the displacements of the car and the trailer respectively when the car comes to a stop the signal goes slightly below zero, not precisely the desired results but very close.

Response Diagram



Determine Stability from the Bode Plots

Gain Margin:

The gain margin cannot be calculated as it goes off the diagram; however, according to the plot properties, the limit is -181, so there is a frequency corresponding to -180. This means the gain margin would be very large, about 50.

Phase Margin:

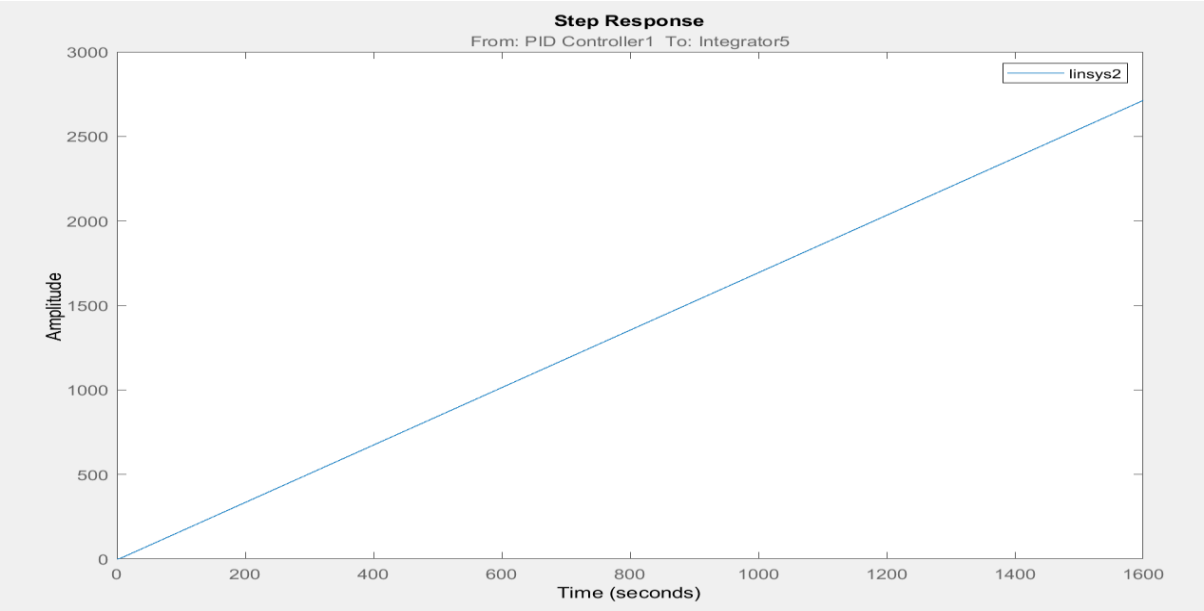
Phase = -150

Phase Margin = -150—180=-150+180=30

Determining Stability

The system is stable because it has a significant positive gain margin, so it has more ‘margin’ before going to instability. It also has a positive phase margin. However, it is not that close to 45 degrees; it is close enough.

Step Response



This shows the constant speed between 50 seconds to 200 seconds when the car engine applies force making it move ahead and pulling the trailer. Since there is no bump and it is a straight line it shows the speed is constant. This shown when it has an open-loop output.