Lab Sheet 4 – ANSWER SHEET

Investigating PID Control

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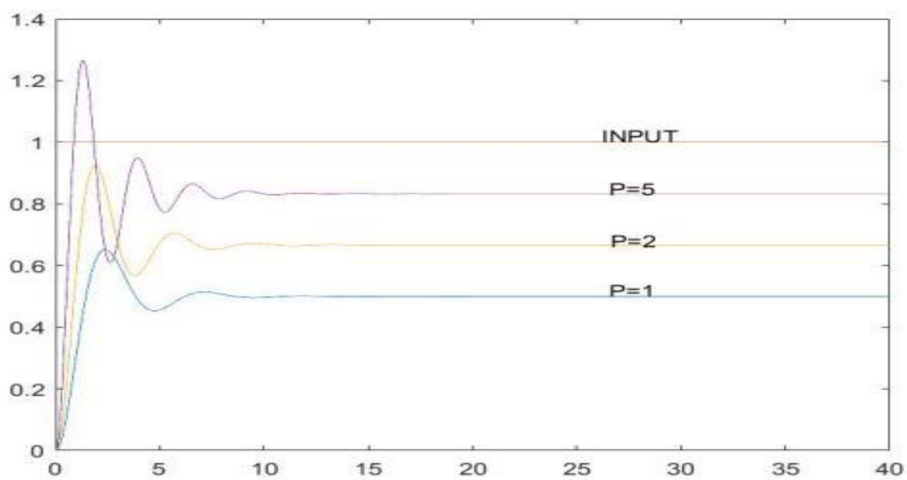
Ex.1: PID Controller for the Mass-Spring-Damper (Bicycle) System

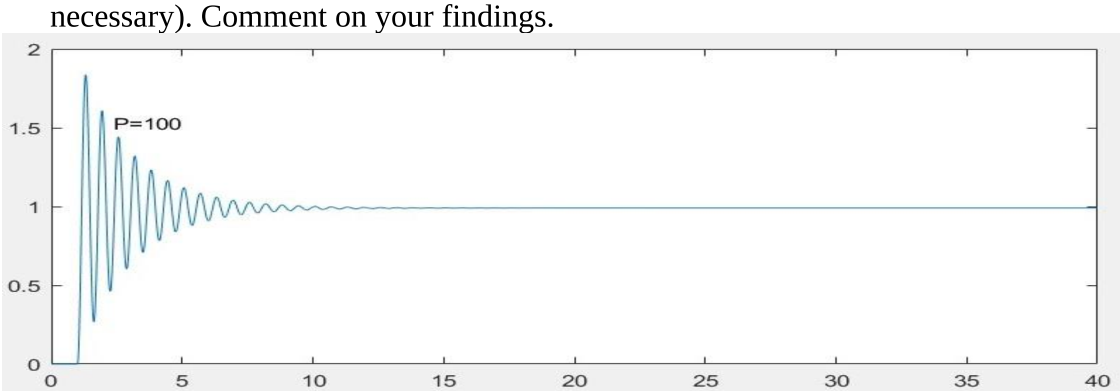
The effect of changing parameter P (proportional control):

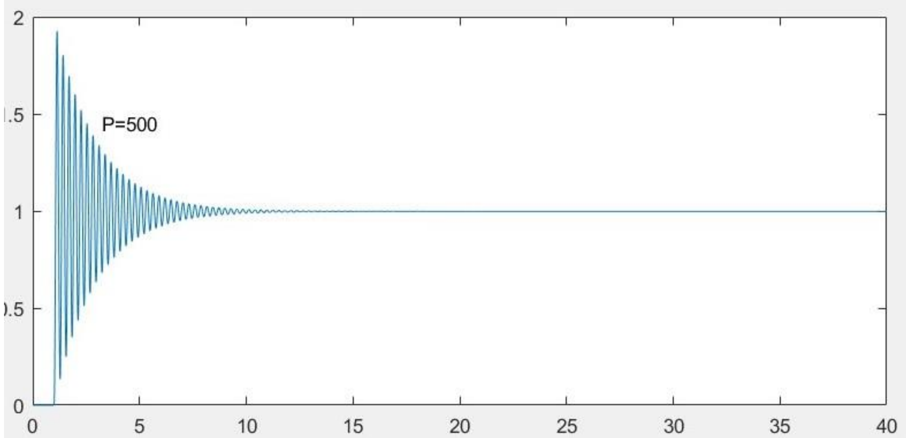
- Set I = 0 and D = 0. Now simulate the system for 40s for P values of 1, 2 and 5. Record all three graphs on the same figure. Include the input also. Comment on your results, i.e. what happens as P increases?



With the increase of P value, the output of the system increases and the amplitude of oscillation increases.

- Investigate values of P = 100 and 500. Find the exact steady state value (use zoom if necessary). Comment on your findings.

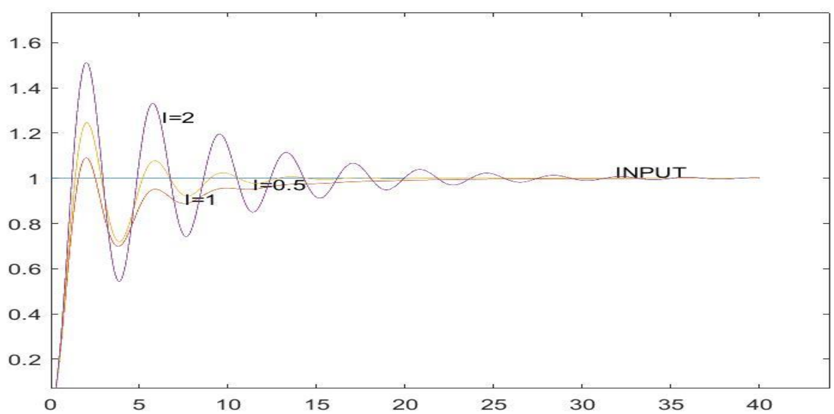




When P=100 and P=500, the exact steady-state value is 1.But the number of oscillations at P=100 is less than P=500.

The effect of changing parameter I (integral action):

- Set P = 2 and D = 0. Now simulate the system for 40s for I values of 0.5, 1 and 2. Record all three graphs on the same figure. Include the input also.



- What impact does the inclusion of I have on the final output (hint – compare your graphs with the previous set for P)? This is the reason why we use integral action in controllers!

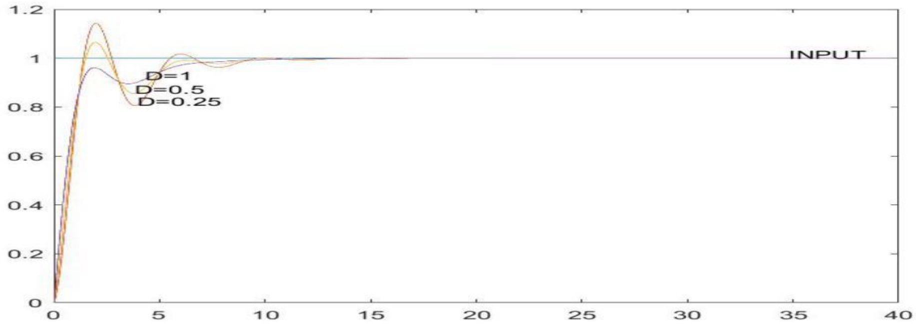
  Changing the integral can reduce the output error and make the output closer to the desired value. But the increase in integral will also lead to an increase in oscillation.

- Secondly, how does increasing I affect the response of the system?

  Obtain the accumulated value of error over time by integrating the error function, and then reduce the error by changing the input of the integral constant, so that the output of the system matches the desired output.

The effect of changing parameter D (derivative action):

- Set P = 2 and I = 1. Now simulate the system for D values of 0.25, 0.5 and 1. Record all three graphs on the same figure. Include the input also.



- What impact does the inclusion of D have on the final response?

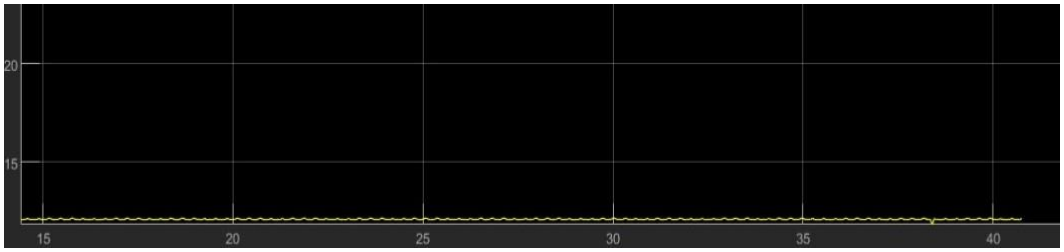
D can slow down the respond speed of the system when the error rate of change increases, so that the system tends to be stable.

Ex.2: Controlling an actual practical system: a ball-in-a-tube system that requires a ball to be maintained at a certain height (output) using a fan (input)
(*These values may need to be slightly varied depending on your actual hardware system!)

- In the PID block set P = 0.6*, I = 0 and D = 0. Switch on the bench power supply, run the Simulink model and see what happens. Repeat for different values of P.

When the P value is higher, the output value of the system is smaller and the vibration is smaller. Increase the value of P, the output value of the system will become larger, and the vibration will increase accordingly.

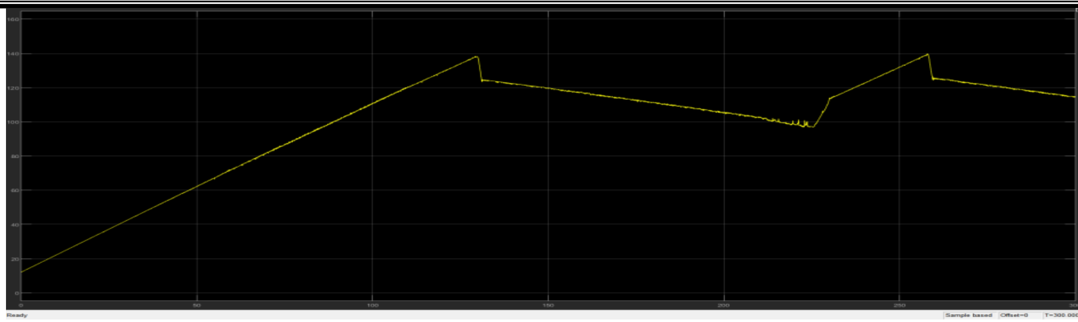
- Click on the Scopes in the model and monitor the signals obtained.



- Comment on your results – i.e. what effect does P have on achieving the desired outcome for this system? You do not need to plot your results in this case.

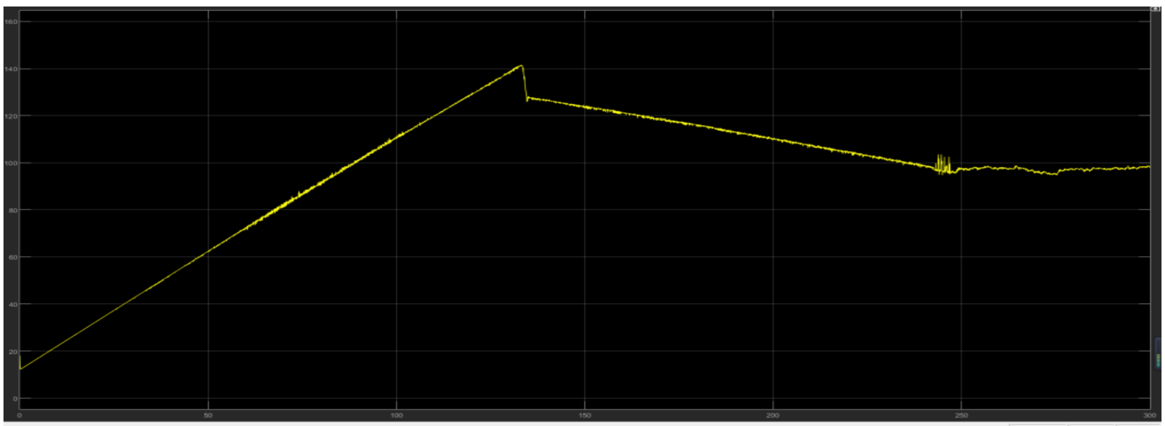
As the P value increases, the system gradually tends to the desired output, but the stability difference increases accordingly.

- Now update the PID block and set the parameters P = 0.6*, I = 0.05* and D = 0 and rerun the simulation. Plot the error response in Matlab. Comment on the effect of including I in the control system.



The cumulative value of the error over time is obtained by integrating the error function, and then the error is reduced by changing the input of the integral constant so that the output of the system matches the expected output.

- Change D to 0.015*and rerun the simulation once again. Plot the new error response on top of the previous one (remember to use the Hold On command in Matlab).



- By comparing the responses, comment on the effect of using D on the system output.

When the error rate increases, the response speed of the system becomes slower and the system tends to be stable.

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