# Faculty of Engineering

Computer and Systems Engineering Department

CSE 371: Control Systems (1)

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Micro-Project Report

Submitted by



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## Problem Formulation

Given a closed loop unity feedback system with PID controller and it's required to simulate it for unit step input using MATLAB/SIMULINK, study the effect of a constant disturbance input and compute Gm and Pm for the system.

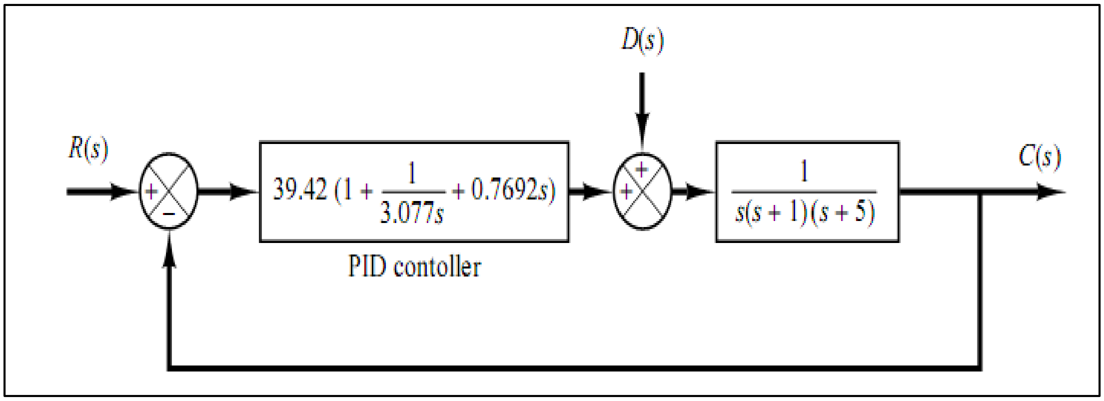


*Figure 1: Closed loop unity feedback system with PID controller*

Where R(s) is the input
D(s) is the disturbance
C(s) is the output
Transfer Function $G(s) = \frac{1}{s^3+6s^2+5s}$
Unity feedback H(s) = 1

## Background

A feedback control system seeks to bring the measured quantity to its required value or set-point, to do so we use a PID controller.

The PID is one of the most popular feedback controller algorithm used. It is a strong easily understood algorithm that can provide excellent control performance despite the varied dynamic characteristics of processes.

The PID controller consists of three controls which abbreviate its name
P for Proportional, I for Integral, D for Derivative.

Generally there are 4 algorithms used in the PID controller

- P (only proportional control)
- PI (proportional and integral controls)

- PD (proportional and derivative controls)
- PID (all the controls together proportional, integral and derivative)

## Simulations

a) Unit step input simulation for closed loop unity feedback system using MATLAB/SIMULINK

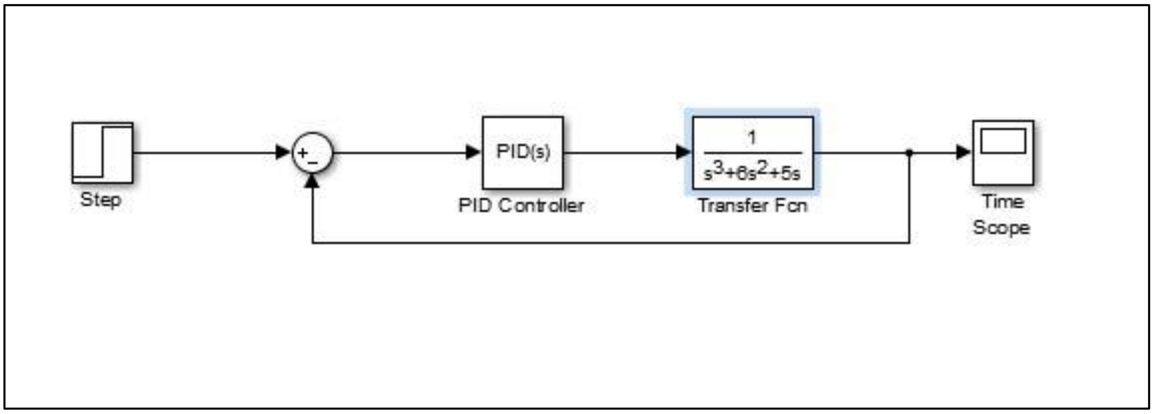


*Figure 2: System representation from MATLAB/SIMULINK*

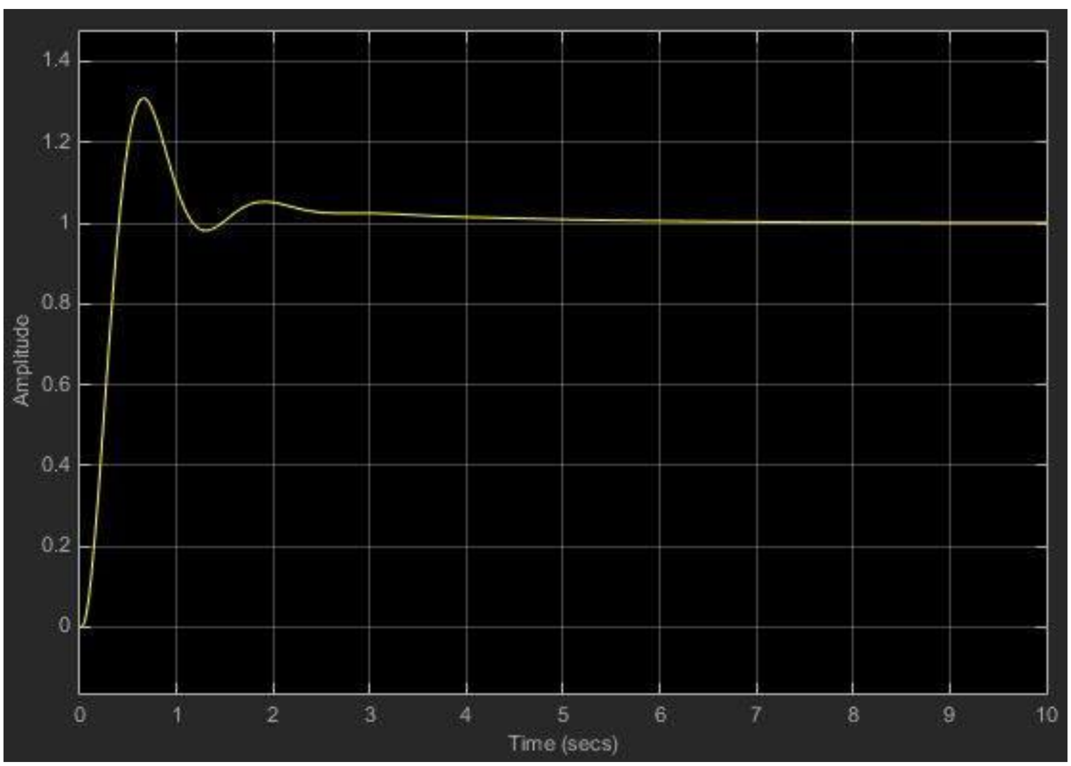


*Figure 3: Unit step response for the system*

b) To decrease the settling time the derivative parameter (Kd) has to be modified in the PID controller block such that it has to be increased.

As the derivative of the process error is calculated by determining the slope of the error over time and multiplying this rate of change by the derivative gain (Kd).

c) To study disturbance effect on the system we should deactivate the input R(s) (using superposition theorem)

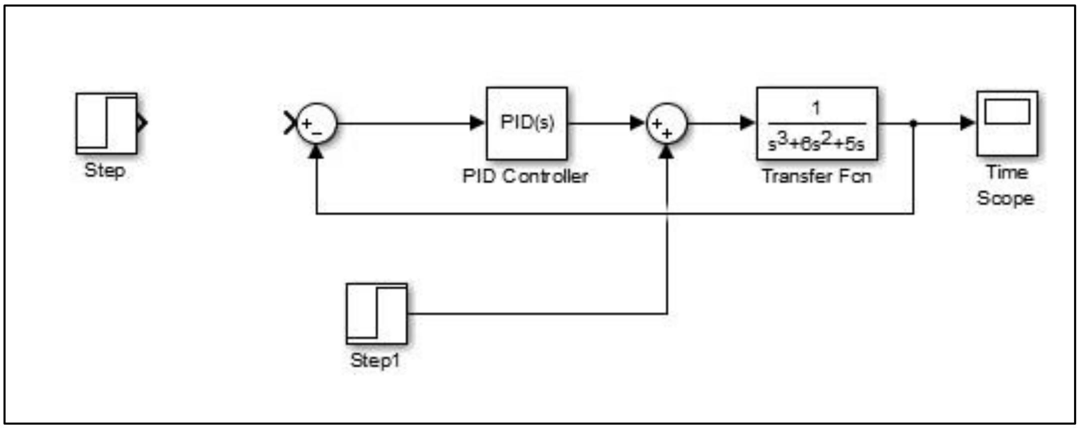


Figure 4: Applying Disturbance on the system

When disturbance = 0.1U(s), the system responses as shown in figure

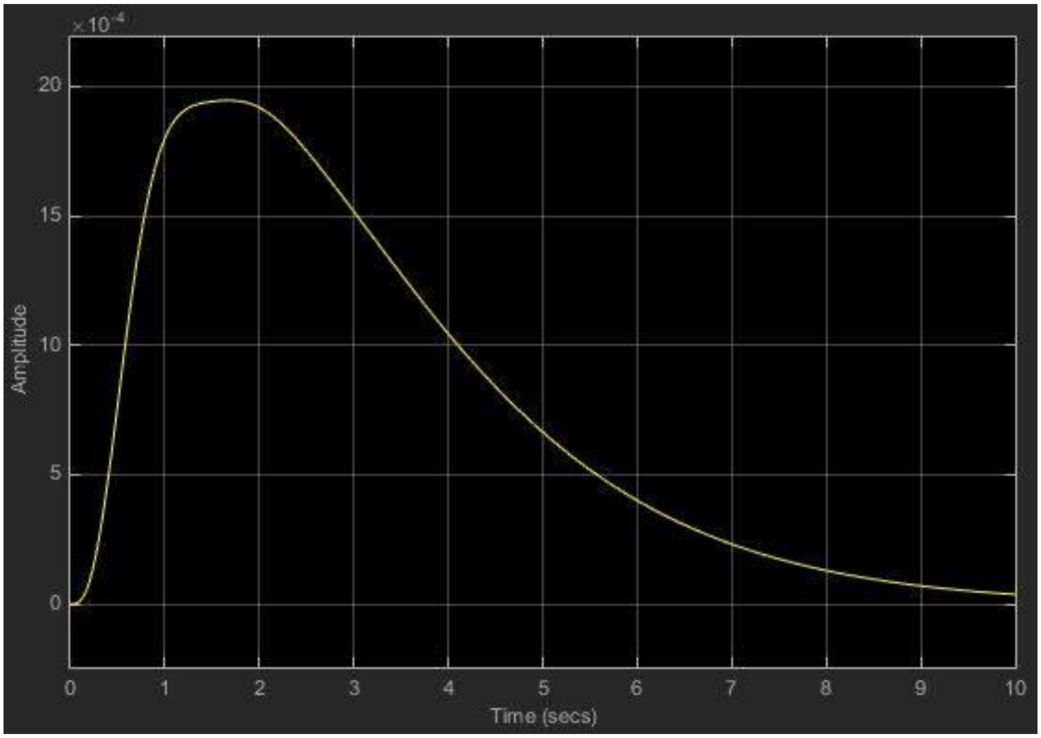


*Figure 5: Disturbance 0.1U(s) response for the system*

When disturbance = -0.1U(s), the system responses as shown in figure

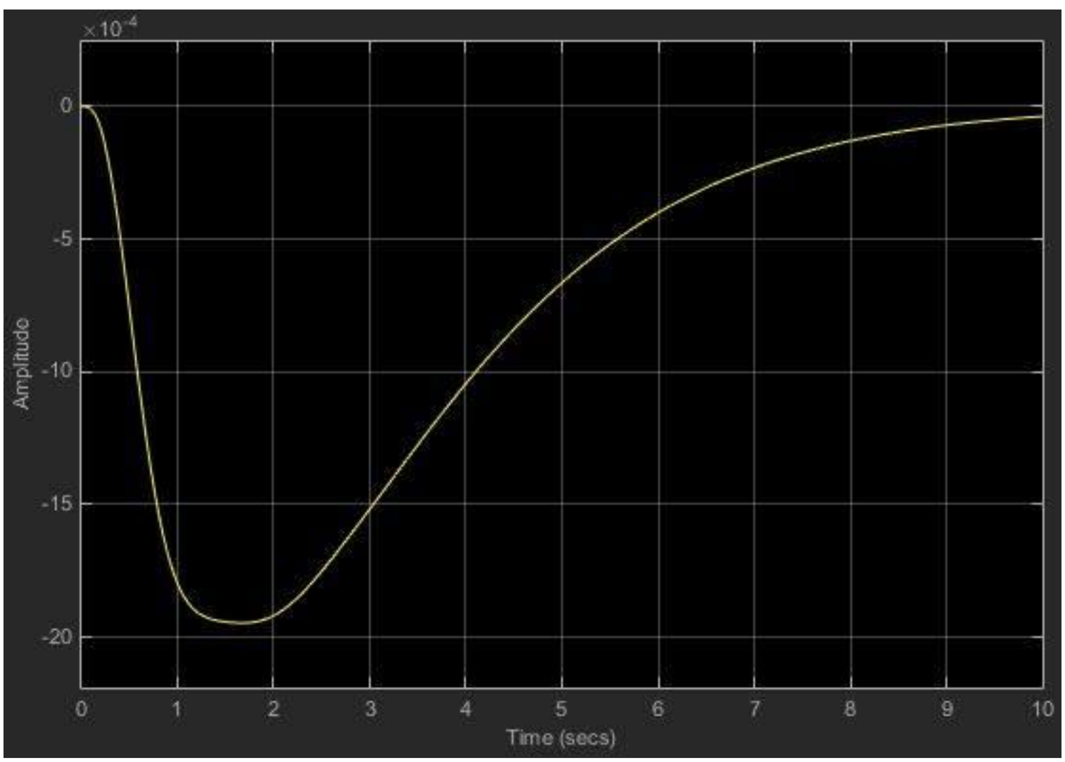


*Figure 6: Disturbance -0.1U(s) response for the system*

d) Gain Margin and Phase Margin for the open loop system without PID controller

```
>> num = [1];
>> den = [1 6 5 0];
>> sys= tf(num,den);
>> margin(sys)
```

*Figure 7: MATLAB commands of margins of stability without PID*

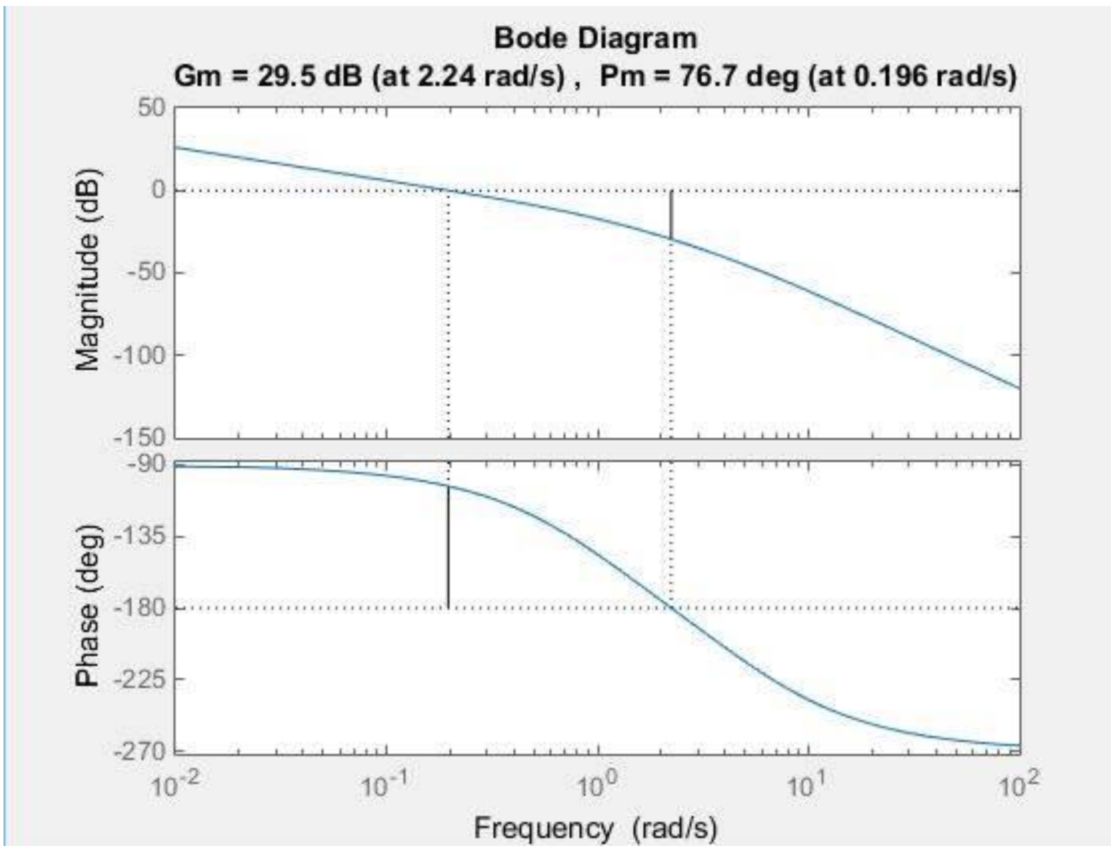


*Figure 8: Bode Diagram representation with Gm and Pm*

Gain Margin and Phase Margin for the closed loop system with PID controller

```
>> Kp = 39.42;
>> Ki =  1/3.077;
>> Kd= 0.7692;
>> C =pid(Kp,Ki,Kd);
>> margin(sys*C)
```

*Figure 9: MATLAB commands of margins of stability with PID*

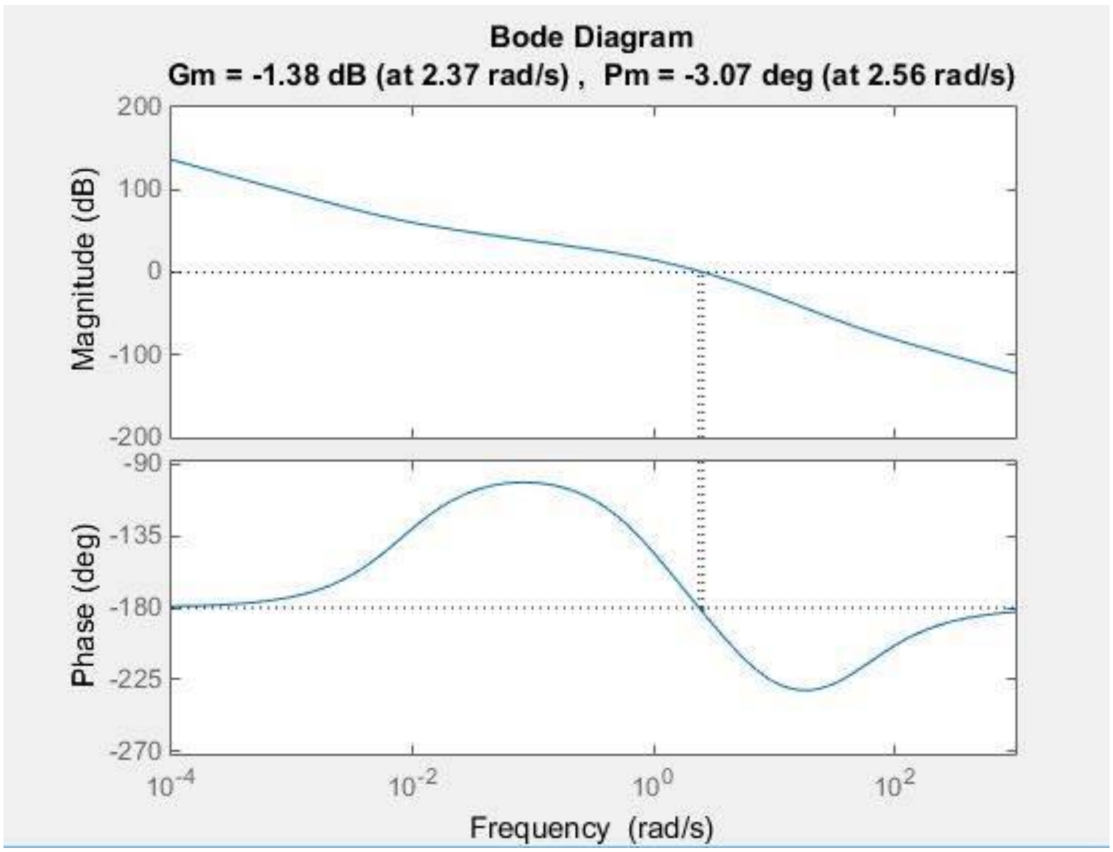


*Figure 10: Bode Diagram representation with Gm and Pm*