EGE UNIVERSITY
ELECTRICAL AND ELECTRONICS ENGINEERING

CONTROL SYSTEMS 1

LAB-6

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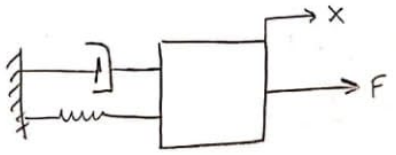
Control Lab - 6



Hareket denk.

$$m\ddot{x}(t) + b\dot{x}(t) + k\,x(t) = f(t)$$

başlangıç koşulları sıfır.

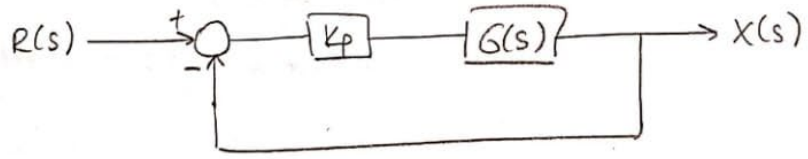
$$ms^2X(s) + bsX(s) + k\,X(s) = F(s)$$

$$\frac{X(s)}{F(s)} = \frac{1}{ms^2 + bs + k} = \frac{1/m}{s^2 + \frac{b}{m}s + \frac{k}{m}}$$

$m = 1\,kg$
$b = 10\,Ns/m$
$k = 20\,N/m$

1- $G(s) = \dfrac{X(s)}{F(s)} = \dfrac{1}{s^2 + 10s + 20}$ ⇒ Transfer func.

2-



3- $\dfrac{X(s)}{R(s)} = \dfrac{K_p \cdot G}{1 + K_p \cdot G} = \dfrac{K_p}{s^2 + 10s + 20 + K_p}$

4- Sönümsüz (Undamped) ⟶ $\zeta = 0$

Az sönümlü (Underdamped) ⟶ $0 < \zeta < 1$

Kritik sönümlü (Critically damped) ⟶ $\zeta = 1$

Aşırı sönümlü (Overdamped) ⟶ $\zeta > 1$

$$Q(s) = s^2 + 10s + 20 + K_p = s^2 + 2\zeta\omega_n s + \omega_n^2$$

$$\omega_n = \sqrt{20 + K_p} \quad , \quad \zeta = \frac{10}{2\omega_n} = \frac{5}{\sqrt{20 + K_p}}$$

Kararlılık

s^2	1	$20 + K_p$
s^1	10	
s^0	$20 + K_p$	

1- $1s^2 + 10s^2 + (20 + K_p)$

$1 > 0$

$10 > 0$

$20 + K_p > 0$

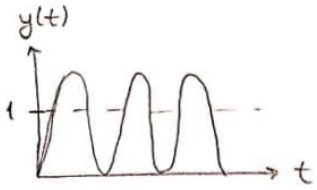
$K_p > -20$

2- $1 > 0 \quad 10 > 0 \quad 20 + K_p > 0$

$-20 < K_p < \infty$

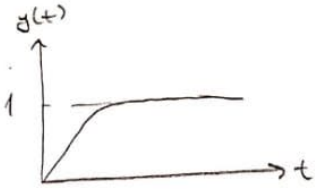
bu durumda sistem kararlı

Undamped $\quad \zeta = 0 \longrightarrow \frac{5}{\sqrt{20+K_p}} = 0 \longrightarrow K_p = \infty$



Underdamped $\quad 0 < \zeta < 1 \longrightarrow 0 < \frac{5}{\sqrt{20+K_p}} < 1 \longrightarrow 5 < K_p < \infty$

Critically damped $\quad \zeta = 1 \quad \frac{5}{\sqrt{20+K_p}} = 1 \longrightarrow K_p = 5$



Overdamped $\quad \zeta > 1 \quad \frac{5}{\sqrt{20+K_p}} > 1 \quad K_p < 5$

MATLAB KODU

```
clc;clear;close all;
m=1;
b=10;
k=20;

% Kp=10^18; %Undamped
% Kp=100;    %Underdamped
% Kp=5;      %Critically damped
% Kp=1;      %Overdamped
%
% Kp=-21;    %Unstable
% Kp=-20;    %Unstable
 Kp=-19;    %Stable

num=1/m;
den=[1 b/m k/m];
G=tf(num,den);

Gcl=feedback(Kp*G,1);

step(Gcl)
```

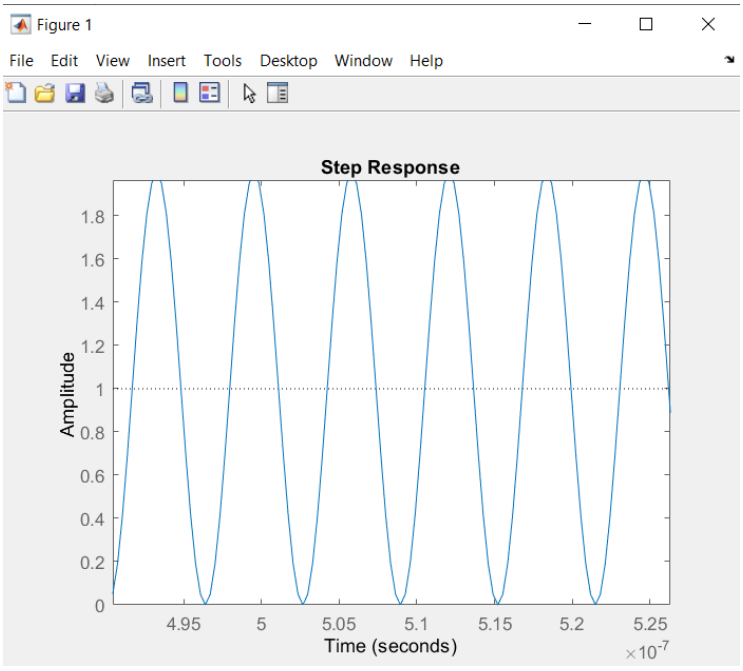


Figure 1 Kp=10^18 yani sonsuz değer için sistem cevabı (Undamped)

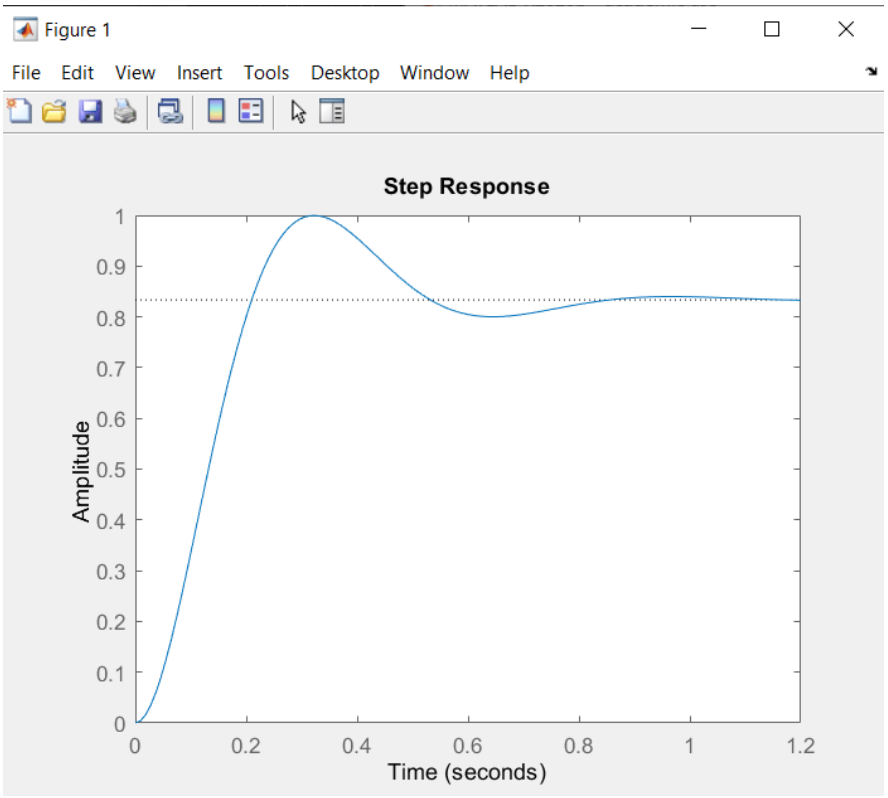


Figure 2 Kp=100 için sistem cevabı (Underdamped)

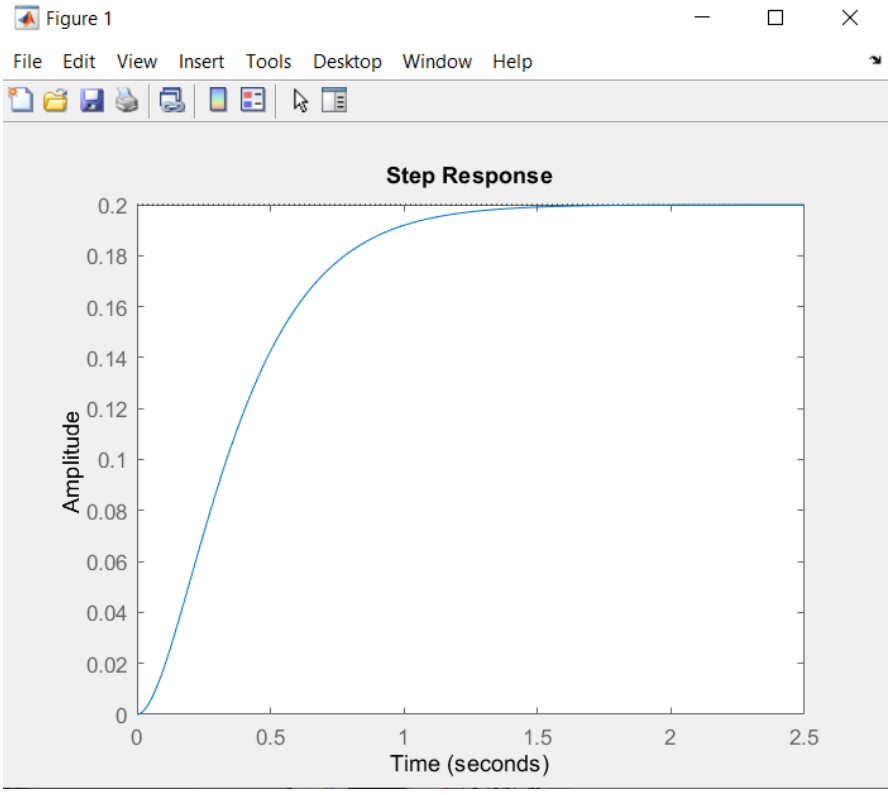


Figure 3 Kp=5 için sistem cevabı (Critically damped)

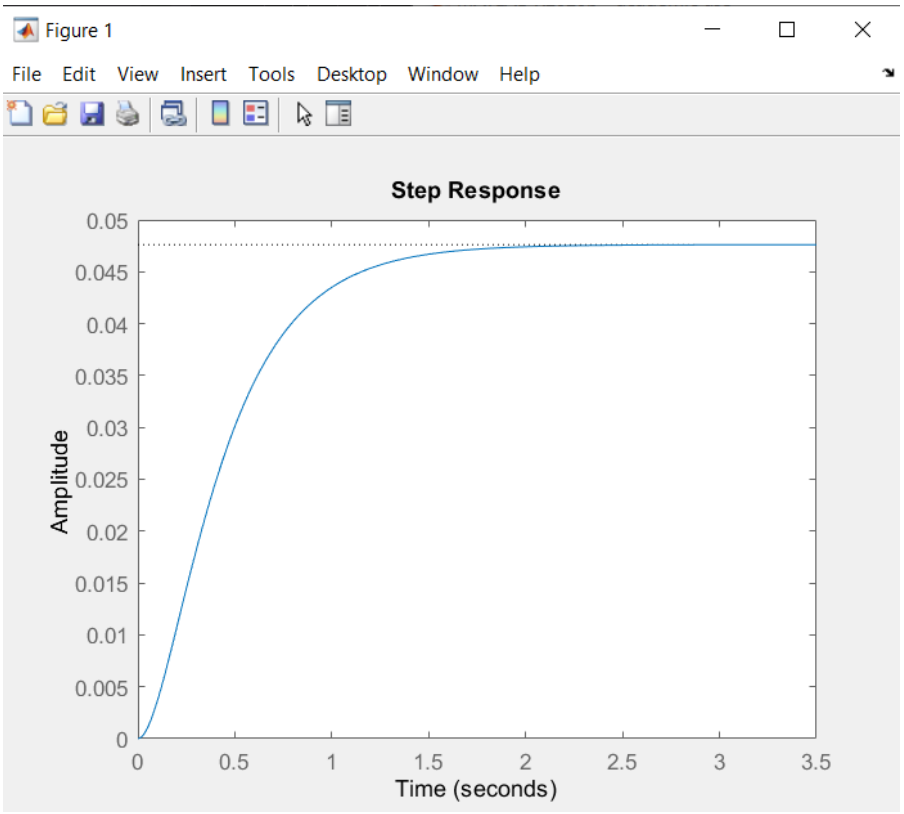


Figure 4 Kp=1 için sistem cevabı (Overdamped)

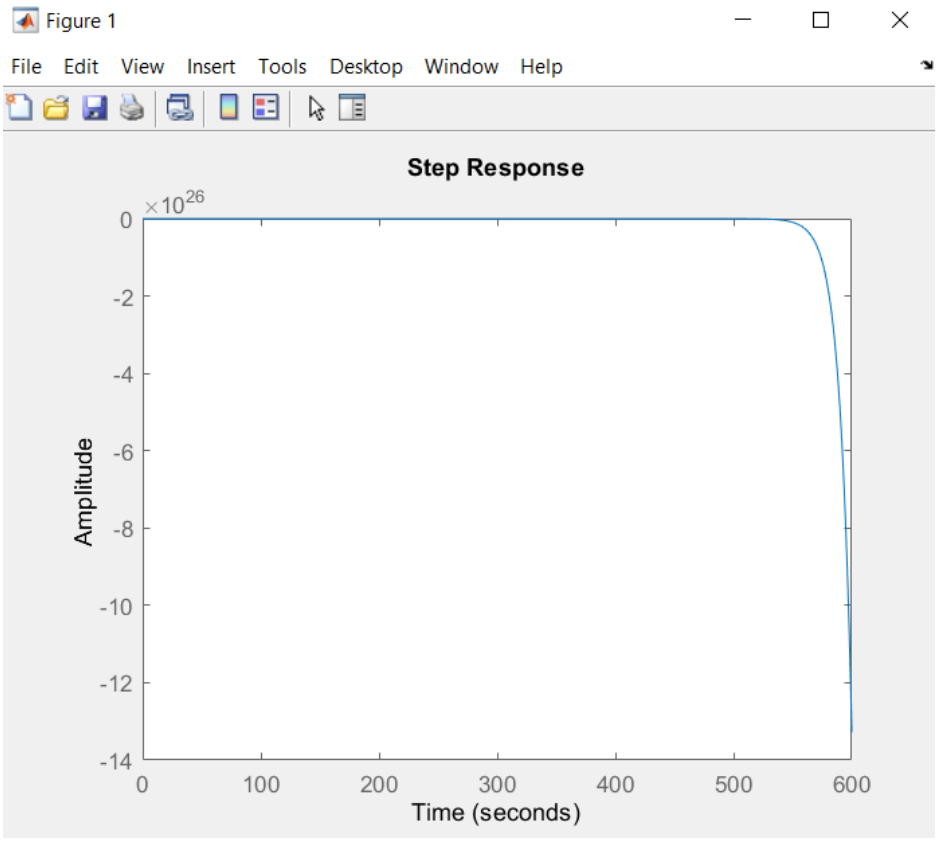


Figure 5 Kp=-21 için sistem cevabı (Unstable)

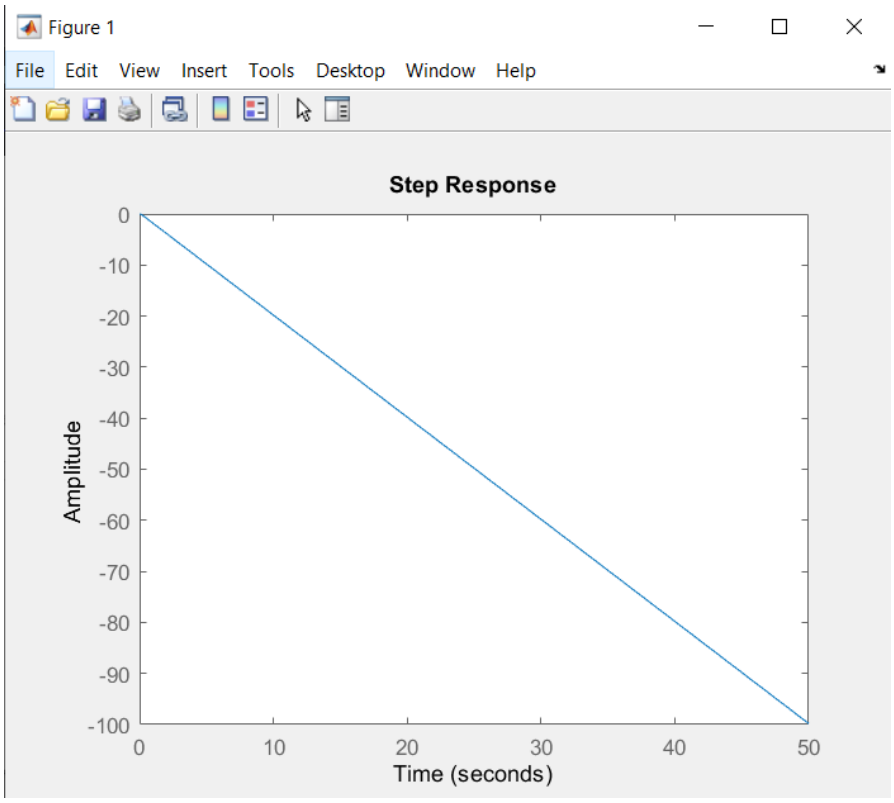


Figure 6 Kp=-20 için sistem cevabı (Unstable)

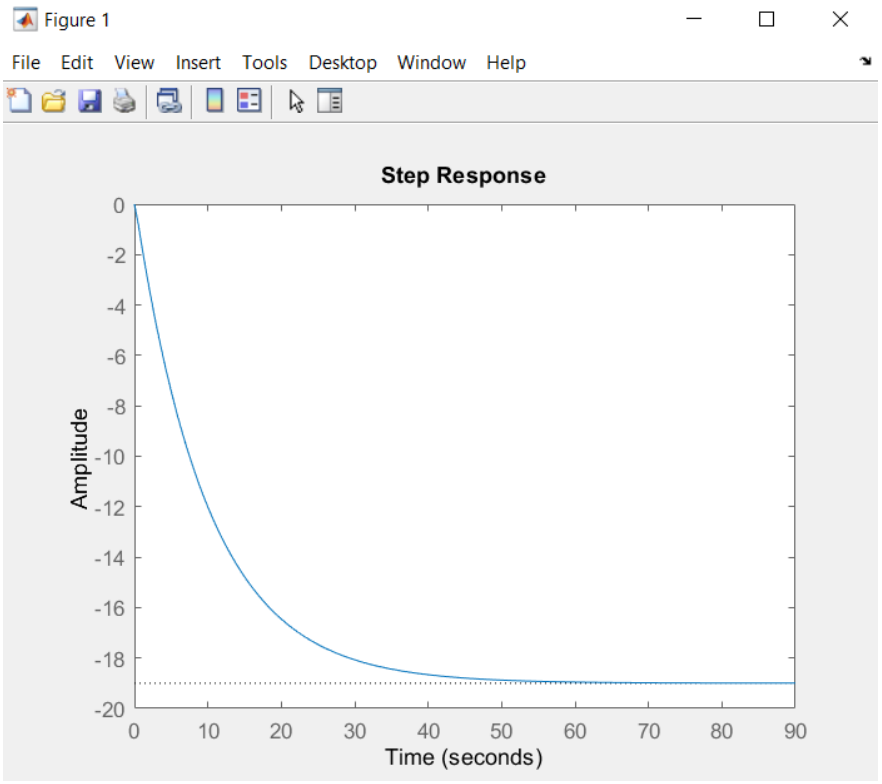


Figure 7 Kp=-20 için sistem cevabı (Stable)

SIMULİNK

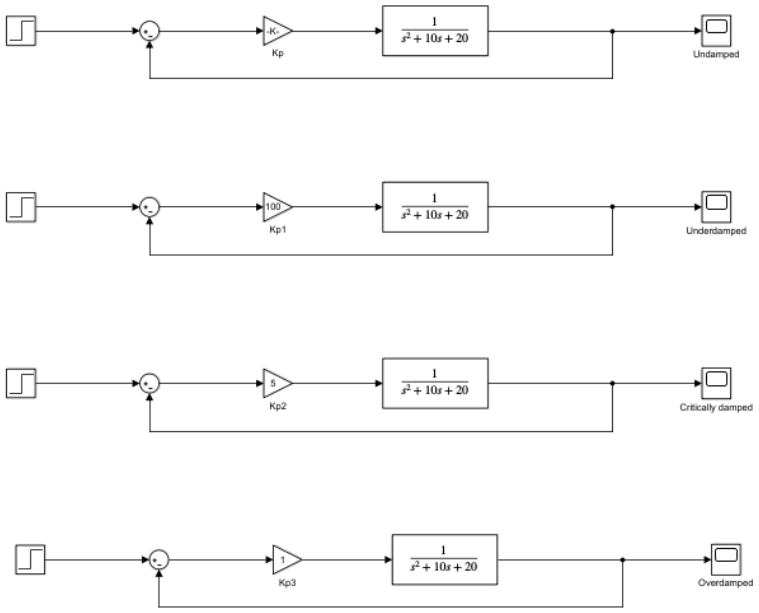


Figure 8 Transfer fonsiyonların farklı Kp değerleri için simulink simülasyonu

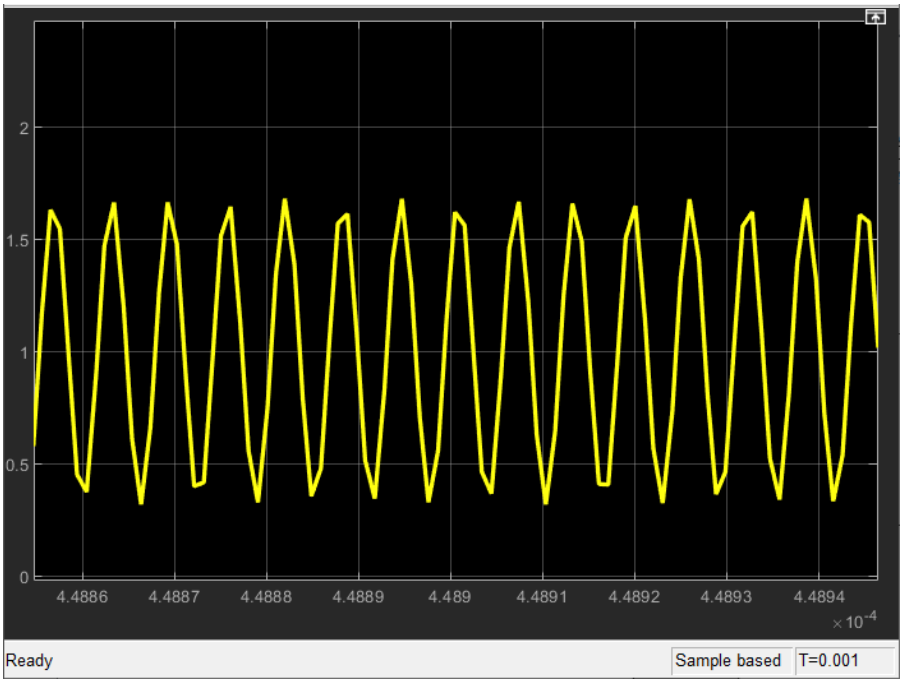


Figure 9 Kp=10^18 yani sonsuz değer için sistem cevabı (Undamped)

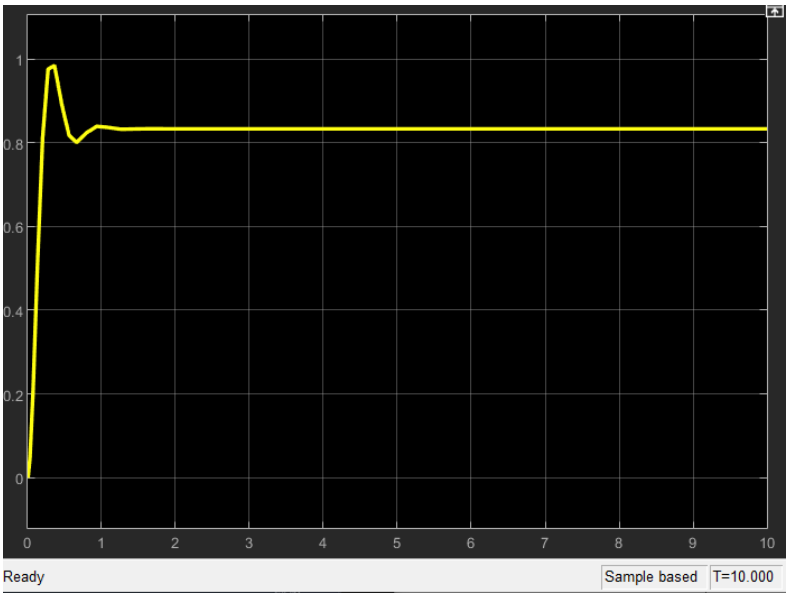


Figure 10 Kp=100 için sistem cevabı (Underdamped)

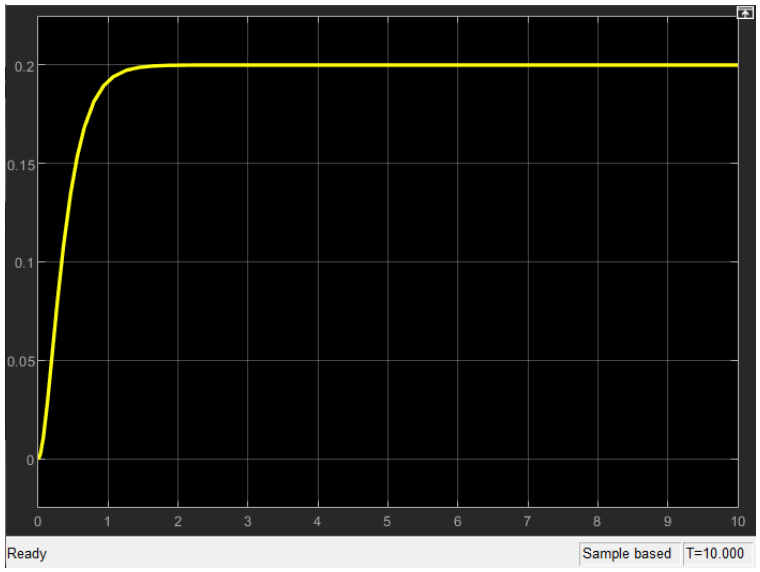


Figure 11 Kp=5 için sistem cevabı (Critically damped)

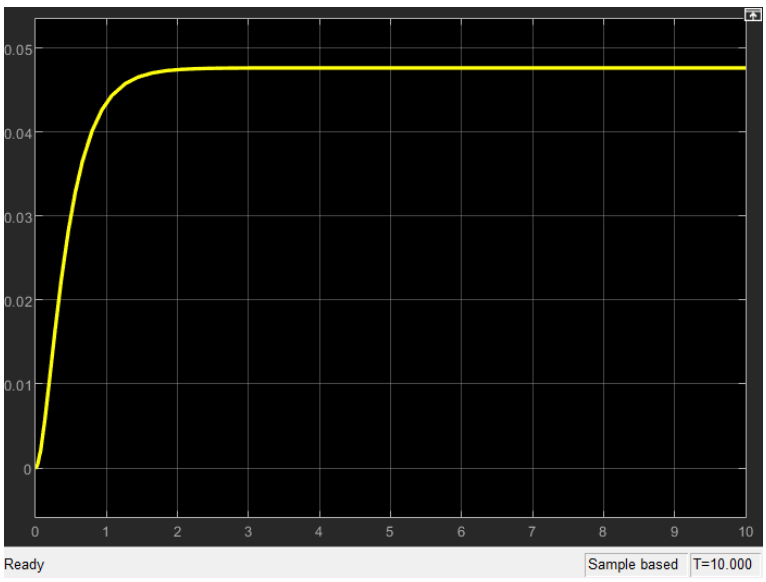


Figure 12 Kp=1 için sistem cevabı (Overdamped)