Faculty of Engineering

Computer and Systems Engineering Department

CSE 371: Control Systems (1)

Instructor: Prof. Wahied Gharieb Ali

Assignment #1

Time Domain Analysis

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Section: **3**

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Problem (1)

1. Consider the following first order system Transfer function

$$\frac{C(s)}{R(s)} = \frac{1}{s + 0.1}$$

Simulate the time response of the output of this system using MATLAB/SIMULINK in the following cases:

a) R(s) is a unit step function and compute the settling time
b) R(s) is a ramp function and compute the steady state error
c) R(s) is a unit impulse function and compute the system's time constant and its static gain.

Problem formulation

Given a transfer function of 1st order with Gain equals 10 and Time Constant equals 10

Background

Testing the unit step function, ramp function, unit impulse function input response with first order transfer function with general form $G(s) = \frac{K}{\tau S+1}$

Answers

a) For a unit step function the output would be

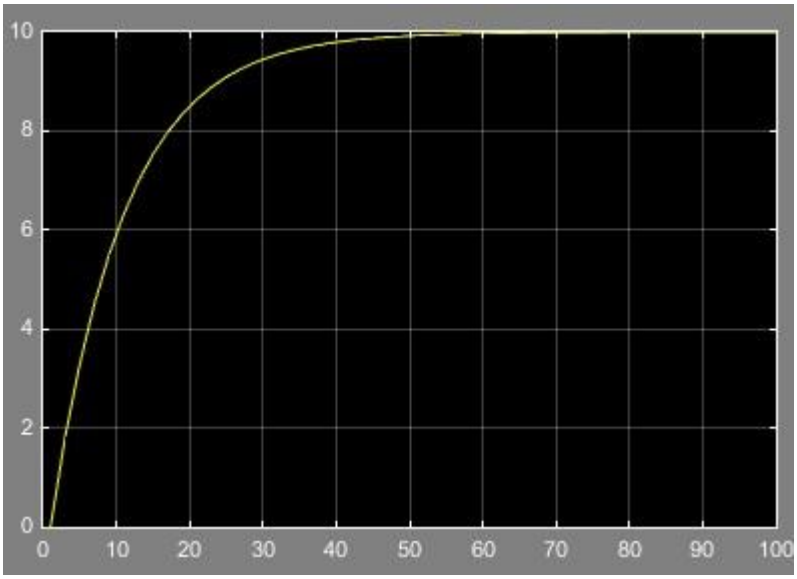

Figure 1: Unit step function response

*Settling time τs = 40 time units

Comment: Since τ = 10 time units and τs = 4τ, therefore τs = 40 time units.

b) For a ramp function the output would be

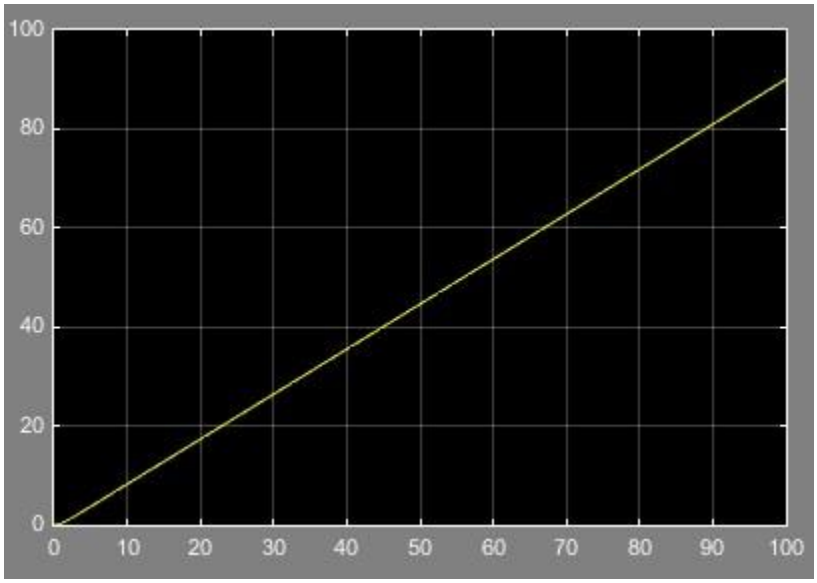

Figure 2: Ramp function response

*Steady State Error (Ess) = ∞ , $Ess = \frac{R}{Kv}$

where Kv = 0

Comment: For Steady State Error to be eliminated, (Kv = $\lim_{s\to 0} sG(s)$) should be equal to infinity. So G(s) must be at least of type 2 zero poles.

c) For unit impulse function

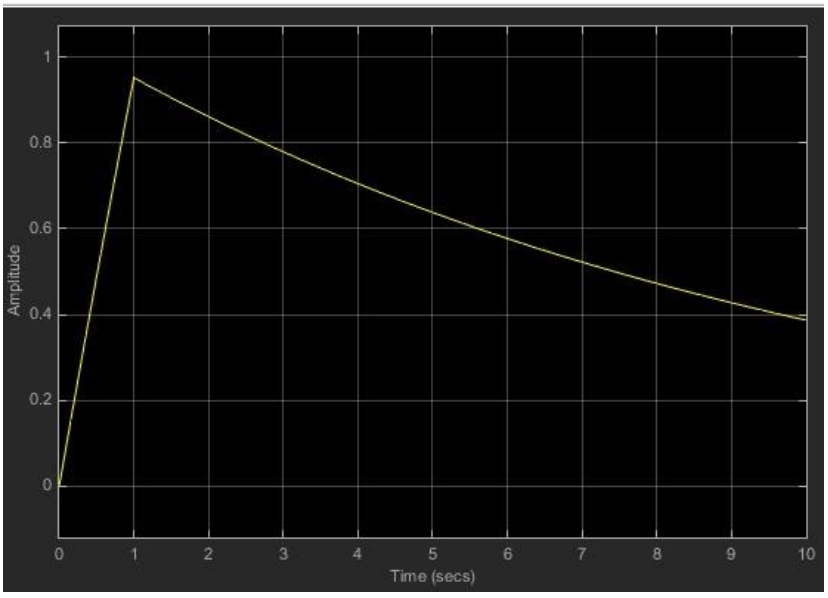

Figure 3: Unit impulse function response

*System Time Constant τc = 10 time units , *System Static Gain = 10

Problem (2)

2. Consider the following second order system Transfer function

$$\frac{C(s)}{R(s)} = \frac{4}{s^2 + 6s + 4}$$

Simulate the system response using MATLAB/SIMULINK for a unit step input. Compute the rise time, maximum overshoot, and settling time.

Problem formulation

Given a transfer function of 2nd order with $\omega n = 2$ & $\xi = 1.5$. Therefore Overdamped system since $\xi > 1$

Background

Testing the unit step function input response with 2nd order transfer function with general form $G(s) = \frac{\omega n^2}{s^2 + 2\xi\omega n s + \omega n^2}$

Answers

For a unit step function, the output would be

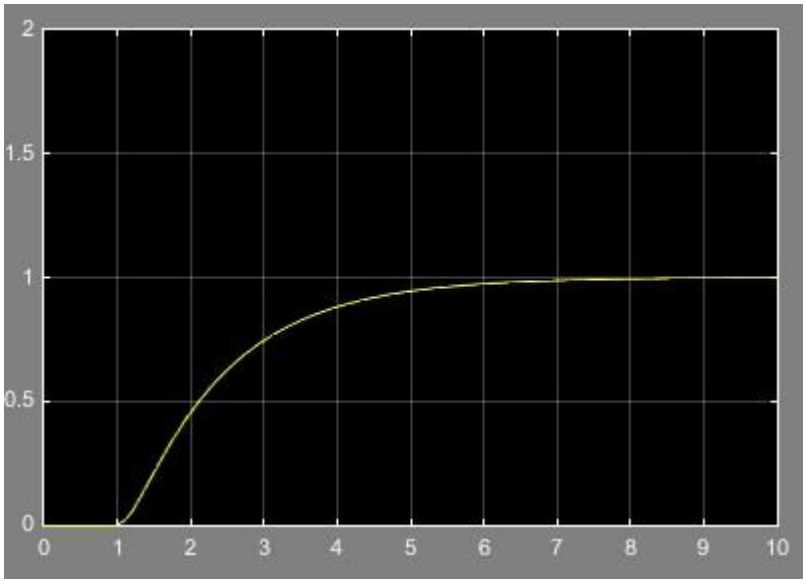

Figure 4: Unit step function response

*Rise time = 2.5 time units (form graph)

*Max overshot = 0 (form graph)

*Settling time = 6 time units (form graph)