

3.20 Step Response

Consider the following transfer function:

$$G(s) = \frac{20e^{-s}}{0.5s + 1}$$

Plot the step response of this system. Identify anything unusual or different in the response and report the reason for this behaviour.

Solution:

The step response of the given system can be interpreted as the step response of the transfer function $G(s) = \frac{20}{0.5s+1}$, followed by the application of the effect of e^{-s} , which shifts the response by 1 second.

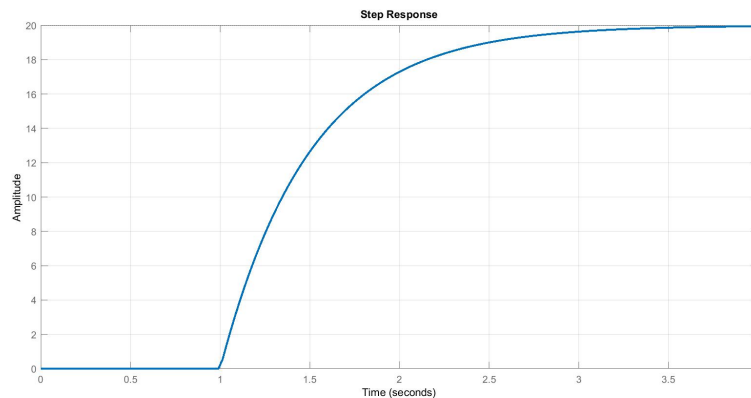


Figure 4: Step response of $G(s)$

GPT Answer :

The step response of the system shows a typical response curve with an exponential rise towards a steady state. However, when incorporating the effect of the time delay represented by e^{-s} , we notice a delayed response. This delay shifts the entire response curve to the right by a unit time (in this case, 1 second), indicating that the system's output takes an additional second to start responding to the input. This behavior is unusual compared to systems without time delays and is directly attributable to the exponential term e^{-s} in the transfer function, which represents a pure time delay in the system. Such delays can significantly affect the performance and stability of control systems, making timely response and feedback control more challenging.

Confidence Level: 95

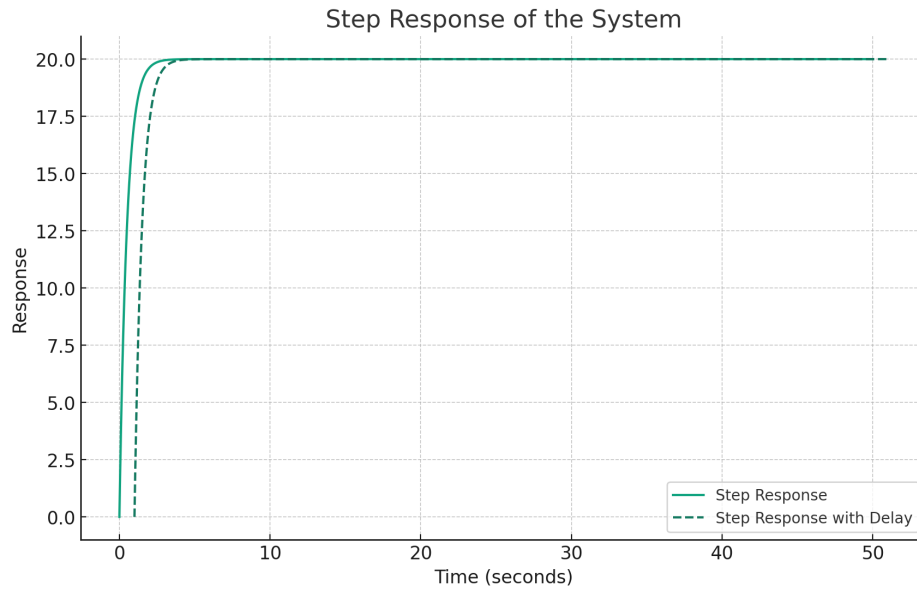


Figure 5: Step response using GPT 4

Confidence Level: 90%

Correct

Claude Answer :

The step response of the given transfer function $G(s) = \frac{20e^{-s}}{0.5s+1}$ will exhibit a time delay due to the presence of the exponential term e^{-s} in the numerator. This delay represents a dead time in the system's response to a step input.

When plotting the step response, you will observe the following characteristics:

The response will initially remain at zero for a duration equal to the time delay (in this case, 1 second). After the time delay, the response will begin to rise and exhibit a first-order exponential behavior, similar to the response of a system without a time delay. The steady-state value of the response will be determined by the DC gain of the system (in this case, 20). The presence of the time delay alters the system's response, introducing a dead time before the system begins to react to the input. This behavior is different from a typical first-order system without a delay, where the response would start rising immediately after the step input is applied.

Confidence level: 95%

Correct. Despite the absence of a plot from Claude 3, the description provided is precise and accurately captures the essence of the plot.