

3.7 Unit Step Response

The output in response to a unit step function input for a particular continuous control system is

$$c(t) = 1 - e^{-t}.$$

What is the delay time T_d ?

Solution :

The output is given as a function of time. The final value of the output is $\lim_{t \rightarrow \infty} c(t) = 1$. Hence T_d (at 50% of the final value) is the solution of

$$0.5 = 1 - e^{-T_d},$$

and is equal to $\log_e(2)$, or 0.693.

GPT Answer:

The delay time T_d in a control system is defined as the time required for the system's response to reach 50

$$c(t) = 1 - e^{-t},$$

we set $c(t) = 0.5$ to find the delay time. This corresponds to the system's response reaching 50

$$0.5 = 1 - e^{-t} \Rightarrow e^{-t} = 0.5 \Rightarrow -t = \ln(0.5) \Rightarrow t = -\ln(0.5).$$

Thus, the delay time T_d is given by $T_d = -\ln(0.5)$.

Confidence Level: 95%

Correct

Claude Answer:

To find the delay time T_p for this system, let's follow these steps:

1. The delay time is defined as the time required for the output to reach 50% of its final value in response to a unit step input.
2. We know the final value of the output is 1, so we need to find the time at which the output reaches 0.5.
3. We can set up an equation:

$$c(T_p) = 0.5 = 1 - e^{-T_p}$$

4. Solve for T_p :

$$\begin{aligned} 0.5 &= 1 - e^{-T_p} \\ e^{-T_p} &= 0.5 \\ -T_p &= \ln(0.5) \\ T_p &= -\ln(0.5) = \ln(2) \approx 0.693 \end{aligned}$$

Therefore, the delay time T_p for this system is approximately 0.693 time units.

Confidence Level: 95%

Correct