Assignment

EE23BTECH11001 - Aashna Sahu

Q:A process has a transfer function $G(s) = \frac{Y(s)}{X(s)} = \frac{20}{90000s^2+240s+1}$.
Initially the process is at steady state with $x(t = 0) = 0.4$ and $y(t = 0) = 100$. If a step change in x is given from 0.4 to 0.5, the maximum value of y that will be observed before it reaches the new steady state is _____(round off to 1 decimal place).

Solution:

Parameter	Description	Value
$G(s)$	Transfer function	$G(s) = \frac{Y(s)}{X(s)} = \frac{20}{90000s^2+240s+1}$
$x(t = 0)$	Input signal	0.4
$y(t = 0)$	Output	100

TABLE 0: Input Parameters

For a step change of $0.5 - 0.4 = 0.1$ magnitude

$$Y(s) = \frac{20}{90000s^2 + 240s + 1} \times \frac{0.1}{s} \tag{1}$$

Final value of this system

$$\lim_{s\to 0} sY(s) = \frac{2}{90000s^2 + 240s + 1} \times \frac{s}{s} = 2 \tag{2}$$

From Table 0

$$t^2 = 90000 \implies t = 300 \tag{3}$$

$$2t\rho = 240 \implies \rho = 0.4 \tag{4}$$

$$\text{Overshoot} = \frac{a}{b} = exp\left[\frac{-\pi\rho}{\sqrt{1-\rho^2}}\right] \tag{5}$$

$$a = y_{max} - 102 \tag{6}$$

$$b = 102 - 100 \tag{7}$$

On solving,

$$\frac{y_{max} - 102}{102 - 100} = exp\left[\frac{-\pi(0.4)}{\sqrt{1-(0.4)^2}}\right] \tag{8}$$

$$\frac{y_{max} - 102}{2} = exp\left[\frac{-1.2568}{0.9165}\right] \tag{9}$$

$$\frac{y_{max} - 102}{2} = 0.253 \tag{10}$$

$$\implies y_{max} = 102.5077 \tag{11}$$