GATE 2021 CH Q52

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Question: A system has a transfer function

$$G(s) = \frac{3e^{-4s}}{12s+1}$$

When a step-change of magnitude M is given to the system input, the final value of the system output is measured to be 120. The value of M is _____. (GATE 2021 CH Q52)

Solution:

Symbol	Value	Description
$x(t)$	$Mu(t)$	Input Signal
$X(s)$	$\frac{M}{s}$	s-domain Input Signal
$y(t)$		Output Signal
$Y(s)$		s-domain Output Signal
$G(s)$	$\frac{3e^{-4s}}{12s+1}$	Transfer Function

TABLE I: Given Parameters

Given, input step-change:

$$x(t) = Mu(t) \tag{1}$$

$$u(t) \xleftrightarrow{\mathcal{L}} \frac{1}{s} \tag{2}$$

$$\implies X(s) = \frac{M}{s} \tag{3}$$

Transfer Function:

$$G(s) = \frac{Y(s)}{X(s)} = \frac{3e^{-4s}}{12s+1} \tag{4}$$

$$\implies Y(s) = \frac{3e^{-4s}}{12s+1}\frac{M}{s} \tag{5}$$

$\therefore$ system output

$$\lim_{s\to 0} sY(s) = 120 \tag{6}$$

$$\implies \lim_{s\to 0}\left(\frac{3e^{-4s}}{12s+1}M\right) = 120 \tag{7}$$

$$\implies 3M = 120 \tag{8}$$

$$\implies M = 40 \tag{9}$$

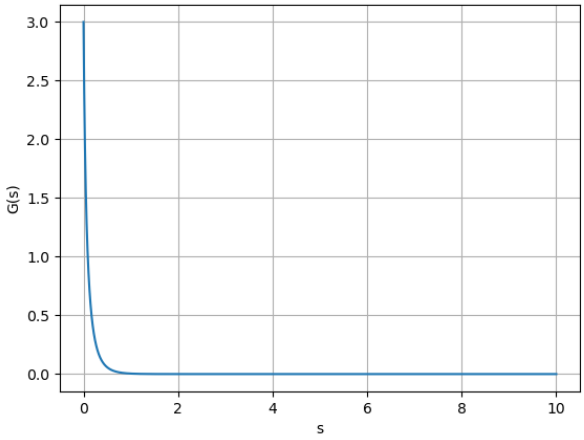

Fig. 1: Plot of $G(s)$ vs s