

TRANSIENT RESPONSE ANALYSIS

Test signals:

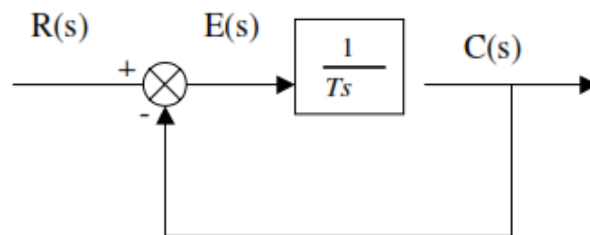
- Impulse
- Step
- Ramp
- Sin and/or cos

Transient Response: for t between 0 and T

Steady-state Response: for $t \rightarrow \infty$

First order systems

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



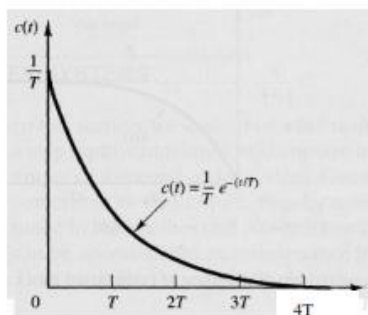
Impulse response:

$$R(s) = 1$$

$$r(t) = \delta(t)$$

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

$$c(t) = \frac{e^{-t/T}}{T} \quad t \geq 0$$



Unit-impulse response of the system

Unit step response:

$$C(s) = \frac{1}{Ts + 1} \cdot \frac{1}{s} = \frac{1}{s} - \frac{T}{sT + 1}$$

$$c(t) = 1 - e^{-t/T} \quad t \geq 0$$

$$e(t) = r(t) - c(t) = e^{-t/T} \quad e(\infty) = 0$$

$$c(T) = 1 - e^{-1} = 0.632$$

$$\left. \frac{dc(t)}{dt} \right|_{t=0} = \frac{1}{T} e^{-t/T} \Big|_{t=0} = \frac{1}{T}$$

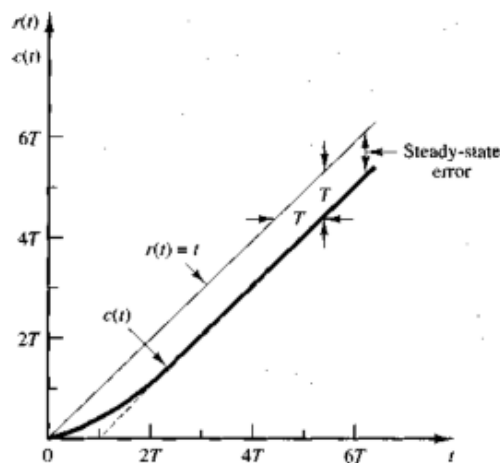
Unit ramp response

$$C(s) = \frac{1}{Ts+1} \cdot \frac{1}{s^2} = \frac{1}{s^2} - \frac{T}{s} + \frac{T^2}{Ts+1}$$

$$c(t) = t - T + Te^{-t/T} \quad t \geq 0$$

$$e(t) = r(t) - c(t) = T \left(1 - e^{-t/T} \right) \quad t \geq 0$$

$$e(\infty) = T$$



Unit-ramp response of the system

<u>Input</u>		<u>Output</u>
Ramp	$r(t) = t \quad t \geq 0$	$c(t) = t - T + Te^{-t/T} \quad t \geq 0$
Step	$r(t) = 1 \quad t \geq 0$	$c(t) = 1 - e^{-t/T} \quad t \geq 0$
Impulse	$r(t) = \delta(t)$	$c(t) = \frac{e^{-t/T}}{T} \quad t \geq 0$

