

Impulse & Step Response

Electrical Engineering

The two responses that characterise a system, and the calculus linking them.

The impulse response fully describes an LTI system, and every other response follows from it.

$$y(t) = x(t) * h(t) \cdot h(t) = d/dt \text{ of the step response}$$

RC low-pass $h(t)$

For $t \geq 0$.

$$(1/RC) \exp(-t/RC)$$

Its step response

Integral of h .

$$1 - \exp(-t/RC)$$

Pure delay T

Shift, no shaping.

$$h(t) = \delta(t - T)$$

THE COMMON MISTAKE

✗ Reading the 10–90% rise time as the time constant

✓ Rise time $\approx 2.2 \tau$ for one pole

One time constant only reaches 63% of the final value, so the measured rise time is more than twice τ .

Rise time and bandwidth are the same fact twice: for a first-order system their product is about 0.35.