Transfer Functions

Electrical Engineering

Output over input in the s domain, and the substitution that gives frequency response.

A transfer function is output over input in the s domain, with initial conditions set to zero.

$H(s) = Y(s)/X(s)$ · $s = j\omega$ gives magnitude and phase

RC low-pass

$1/(1 + sRC)$

One pole.

Its corner

$\omega = 1/RC$

The −3 dB point.

Gain at DC

$H(0) = 1$

Set $s = 0$.

THE COMMON MISTAKE

× Cancelling a pole against a nearby zero

✓ Cancelling only when they match exactly

Near-cancellation leaves a slow mode invisible in the simplified expression that still dominates how long the output takes to settle.

Substituting $s = j\omega$ gives the frequency response, and that substitution is only meaningful for a stable system.