

$$\frac{d}{dx} [f(x) + g(x)] = f'(x) + g'(x)$$

$$\frac{d}{dx} [f(x)g(x)] \neq f'(x)g'(x)$$
$$= f(x)g'(x) + g(x)f'(x)$$

$$\mathcal{L}\{f(x)g(x)\} \neq \mathcal{L}\{f(x)\}\mathcal{L}\{g(x)\}$$

$$\mathcal{L}\{f(x) \overset{?}{*} g(x)\} = \mathcal{L}\{f(x)\}\mathcal{L}\{g(x)\}$$

$$\Rightarrow \int_0^x f(x-\tau)g(\tau)d\tau = F(s)G(s)$$

$$ay'' + by' + cy = g(t) \quad y(0) = c_1, y'(0) = c_2$$

$$a(s^2Y(s) - sc_1 - c_2) + b(sY(s) - c_1) + cY(s) = G(s)$$

$$(as^2 + bs + c)Y(s) - asc_1 - ac_2 - bc_1 = G(s)$$

$$(as^2 + bs + c)Y(s) = (as + b)c_1 + ac_2 + G(s)$$

$$Y(s) = \underbrace{\frac{(as + b)c_1 + ac_2}{as^2 + bs + c}}_{\Phi(s)} + \underbrace{\frac{G(s)}{as^2 + bs + c}}_{\Psi(s)}$$

$$y(t) = \phi(t) + \psi(t) \quad + \underbrace{\frac{1}{as^2 + bs + c}}_{H(s)} \cdot G(s)$$

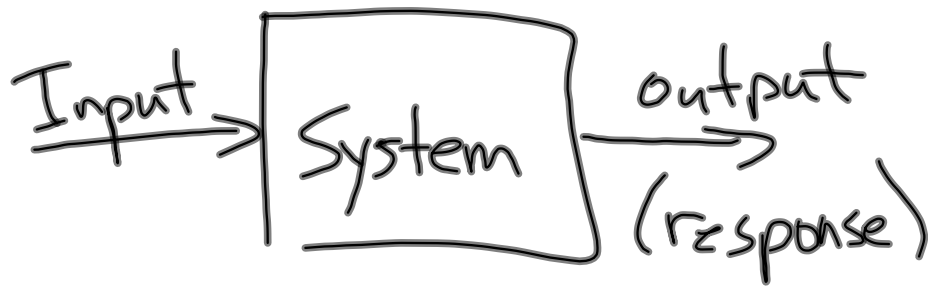
$$\psi(t) = h(t) * g(t) \quad \swarrow \quad H(s) \text{ transfer function}$$

$$ay'' + by' + cy = \delta(t) \quad y(0) = 0, y'(0) = 0$$

$$as^2Y(s) + bsY(s) + cY(s) = 1$$

$$Y(s) = \frac{1}{as^2 + bs + c} = H(s) \text{ transfer function}$$

$h(t)$  is the impulse response of the system.



If  $g(t)$  goes in, what comes out?

How to answer:

Send in  $\delta(t)$ , look at what comes out. It is  $h(t)$ .

Answer:

$$\int_0^t \underbrace{h(t-\tau)}_{\text{measured}} \underbrace{g(\tau)}_{\text{known}} d\tau$$

Done numerically