ECE 447: Control Systems (Fall 2021)

Prof: Sam Burden TA: Sat Singh

this week: ☐ HW0 assigned → due Fri Oct 8

☐ week 1 lecture material

Prof Burden TODO: ☑ post HW N in week N

☑ post about discussion board

☑ post tutorial notes

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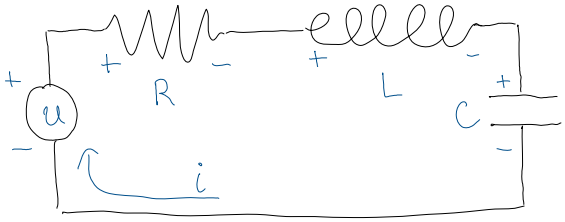
week 1 tutorial

1°. RLC circuit



ECE 233

1'. Kirchoff's voltage law $\sum v_e = 0 = -v_u + v_R + v_L + v_C$

@CCE "lumped element"

voltage / current / charge relationships

$v_u = u$ – voltage source (input) $v_L = L\frac{di}{dt}$ – change in current $\frac{di}{dt}$

$v_R = iR$ – current i $v_C = \frac{1}{C}q$ – charge q

$$i = \frac{dq}{dt} \Rightarrow \frac{di}{dt} = \frac{d^2q}{dt^2}$$

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1². differential equation $L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{1}{C}q = u$

"time domain" $\Leftrightarrow L\ddot{q} + R\dot{q} + \frac{1}{C}q = u$ $\quad \frac{d}{dt}x \equiv \dot{x}$

↳ how do physical quantities interact & change in time?

Laplace xform

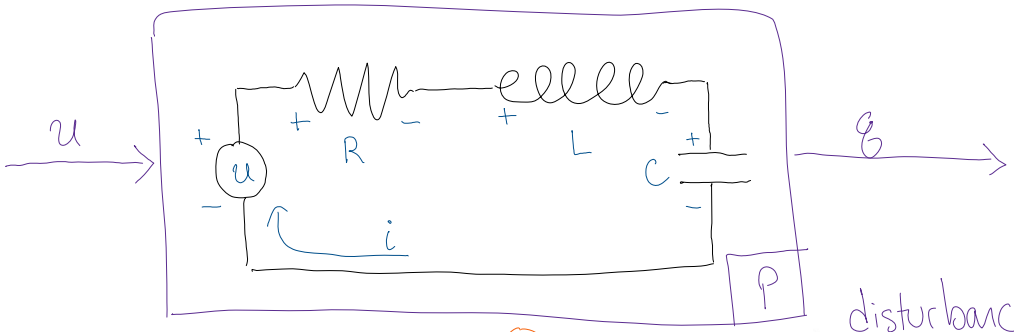
1³. transfer function

"frequency domain" $Ls^2q + Rsq + \frac{1}{C}q = u$

$\Leftrightarrow \left(Ls^2 + Rs + \frac{1}{C}\right)q = u$

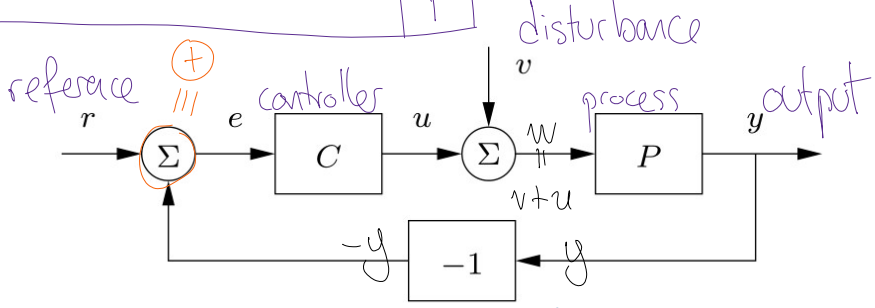
$\Leftrightarrow q = \left(\frac{1}{Ls^2 + Rs + 1/C}\right)u = G(s)u$

↳ how is an input signal transformed through a system?



1⁴. block diagram

1⁵. feedback interconnection



requires P linear

"block diagram algebra": this equation consists only of input & output signals from block diagram

$$y = P(v+u) \overset{*}{=} Pv + PCe$$
$$= Pv + PC(r-y)$$

$$\iff \quad y + PCy = Pv + PCr$$

$$\iff \quad (1 + PC)\, y = Pv + PCr$$

$$\iff \quad y = \frac{P}{1+PC} v + \frac{PC}{1+PC} r$$

these equations are meaningful in both time- and freq-domain, but they're most useful in freq domain

2°. Colab demo — Sympy, Bode plot, simulation