# ECSE 307 : Linear Systems and Control.

- Lab course. • Start from the week of 18 Jan.
  Lab assignment posted upfront

- Tutorials : Start next week.

Text Book : Control Sys. Engg. by Nise.

## Grading

Assignments. (≈20%) 10 assignment
due mid night on fridays.
lowest two assignments dropped.
No make assignment.

Labs. (20%) 10 labs. Done individually
lab report due mid night on fridays
lowest two dropped.

Mid term. 20% Closed book timed take home exam.

9:00 am on 24th feb to 5:00 pm of 26th
Wed Frid.

1.5 hrs (1 hr exam)

No class on 24th & 26th.

Final 40%. Compresive final

4 hr. exam (2.5 hr exam)

Available for 3 days.

Closed book.

Impulse resp. $g(t)$

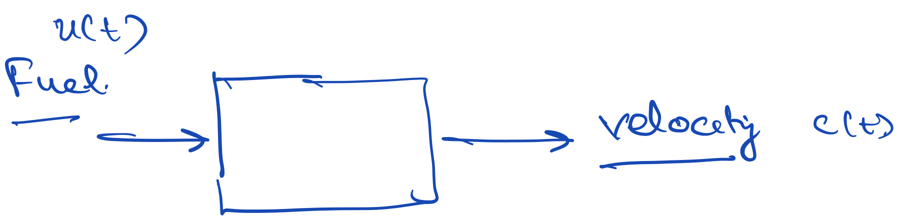

System described const. coeffs linear diff. eqn.

- All analog circuits
- Most mech. sys / Aerospace.
- Many chemical sys.

$$c(t) = r(t) * g(t) \qquad \text{[time domain]}$$

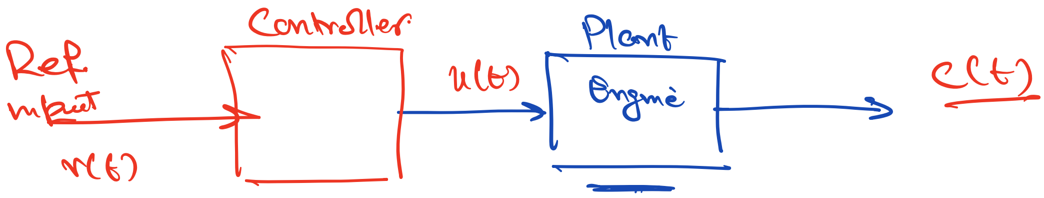
$$C(s) = R(s)\,\underline{G(s)} \qquad \text{[ freq domain]}$$

↪ Transfer fn.




$$\frac{d^2 c(t)}{dt^2} + 2\frac{dc(t)}{dt} + c(t) = \frac{2du(t)}{dt} + u(t)$$

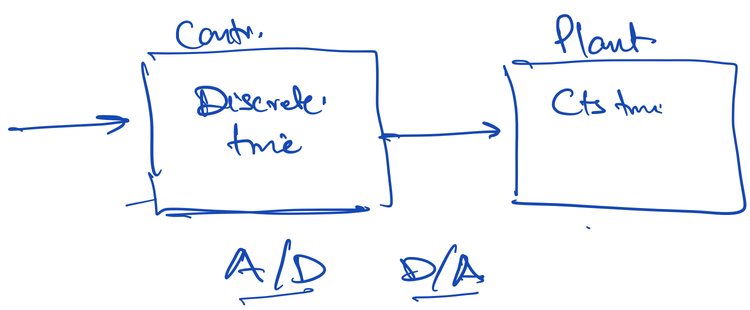
$r(t) = \underline{100}$ km/hr.




- State space design. (Modern control. 1950's)
  Linear Algebra.
  Tedious method
  easily automated.

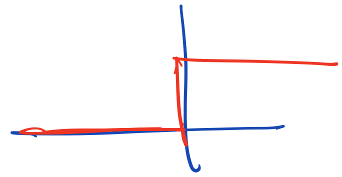
  Accurate design method
  (Computationally expensive
  Complicated controllers)

- Frequency domain design
  Simple — to analyze
  ↳ design
  (Loop shaping controllers)
  (PID controllers.)



# Review of Laplace Transforms

**Notation** : In SS.

$u(t)$ to denote step fn. 

In state space design, $u(t)$ is used to denote control input

I'll use $\mathbb{1}(t)$ to denote step fn.

Laplace Trans — Unilateral LT

Bilateral LT

$$F(s) = \int_{0^-}^{\infty} f(t)\, e^{-st}\, dt \qquad \text{[Unilateral]}$$

$-\infty$ [Bilateral LT]

Inverse LT

$$f(t) = \frac{1}{2\pi j} \int_{\sigma - j\omega}^{\sigma + j\omega} F(s)\, e^{st}\, ds.$$

We will not use formulas, instead use LT Tables.

Sec 2.1 - 2.2 of book

ILT using LT tables $\Rightarrow$ Partial fraction exp.

# THE TRANSFER FN

LDE $\equiv$ LTI.

Const. coeff linear DE.

$$\frac{d^2c(t)}{dt^2} + 2\frac{dc(t)}{dt} + c(t) = \frac{3dr(t)}{dt} + 2r(t)$$

$$\left(\frac{dc(t)}{dt}\right)\left(\frac{d^2c(t)}{dt^2}\right) \Rightarrow \text{Non-linear}$$

Coeff don't depend on time

$\equiv$ LTI.

Rational polynomial

$$G(s) = \frac{3s+2}{s^2+2s+1}$$

Next time : Poles & Zeros

ZSR & ZIR