SFWR ENG 3DX4 Summary

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Course: SFWR ENG 3DX4

Math objects made using [MathType](); graphs made using [Winplot]().

Table of Contents

Note: the following summaries may be useful:
- [SFWR ENG 2MX3]()
- [ENGINEER 3N03]()
- [TRON 3TA4]()

I may review to clarify or correct, but mostly I will omit those things.

Introduction to Systems

Systems can be represented by **block diagrams** to make it easier to marginalize the different parts of the systems.

Laplace

Useful for…

Time begins when your signal begins

$$h(t) = \begin{cases} 0, & t < 0 \\ 1, & t \geq 0 \end{cases}$$

Initial conditions:
- $c(0)$

Time domain (t): variables are <u>lower case</u>, e.g. $f(t)$
Frequency domain (s): variables are <u>upper case</u>, e.g. $F(s)$

Transfer function:

When doing the inverse Laplace, it's useful to break your fractions up so that you can

Strictly Stable: it will eventually get back to the initial position
Marginally Stable:
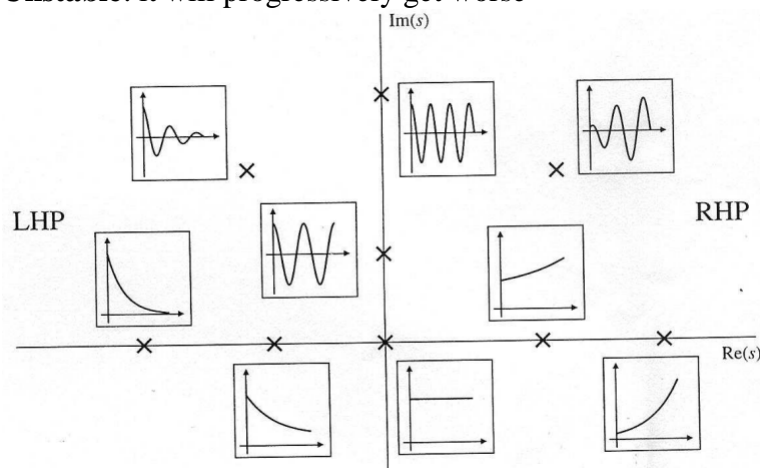**Unstable**: it will progressively get worse

Figure 2.5 from Dorf and Bishop, *Modern Control Systems (10th Edition)*, Prentice-Hall, 2004.
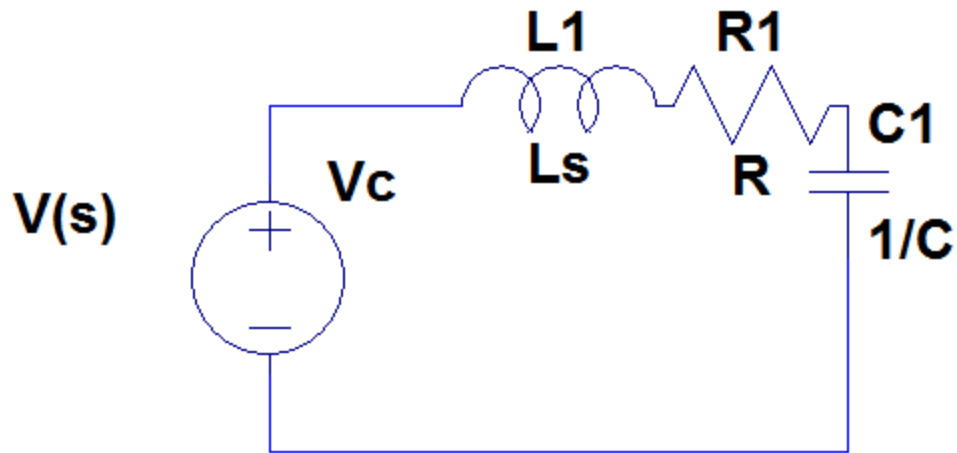
Transfer Functions

Electrical
admittance:
$$Y(s) = \frac{I(s)}{V(s)} = \frac{1}{R} = G$$

$$V_c(s) = I(s)\frac{1}{Cs}$$

$$I(s) = \frac{V(s)}{L_s + R + \frac{1}{Cs}}$$

L1   **R1**

C1

Vc   **Ls**   **R**

V(s)   **1/C**

Cramer's Rule

$$x_1 = \frac{\det(A_1)}{\det(A)}, x_2 = \frac{\det(A_2)}{\det(A)}, \ldots, x_n = \frac{\det(A_n)}{\det(A)}$$

$$V_C(s) = \overbrace{H(s)}^{\text{transfer function}}\frac{1}{Cs}$$

OP-Amps

Mechanical
Translational systems:
Rotational Systems:

Newton's Second Law of Motion: $\Sigma f = Ma$

$$Z_m(s) = \frac{F(s)}{X(x)}$$
$$f(t) = Ma(t)$$
$$= M\frac{d^2x}{dt^2}$$

Translational Systems

Spring
Spring is like a capacitor
Force displacement: $f(t) = Kx(t)$

Viscous Damper
Using viscous fluid to slow something down

Viscous Damper is like a resistor

Force displacement: $f(t) = f_v \dfrac{dx(t)}{dt}$

Mass
Mass is like a inductor

Force displacement: $f(t) = M \dfrac{d^2 x(t)}{dt^2}$

Rotational Systems

Transducer: anything that converts energy to electrical energy
Transmitter: long distances

Unstable systems have ∞ steady state error
Steady-state error [e_∞]:
$$e_\infty = \lim_{t \to \infty} e(t)$$
Percent overshoot: if the phase is longer than the
Settling time: how long it takes to get to the steady state within a small bit
<Insert the graph, with the pieces coloured and labelled all preeety>

Non-/Linear Systems
- Op Amps are linear
- If you don't have enough voltage, your motor magnets won't have enough power to switch poles, so they require a minimum voltage

You can't model non-linear systems, until you linearize it. To do this, we find the slope and approximate the equation of the line, using y=mx+b

Proportional-Integral-Derivative (PID):
If your gears are vibrating, your PID is probably too high

Block Diagrams
A way of representing a system

Summing junction: could be an X or +, but usually an X in this course

Cascade: subsystems in series are multiplied

Parallel: parallel subsystems have a *summing junction* at the end, so you just add everything together

Feedback: positive feedback is bad