Eigenvector : $\vec{x}$ where $A\vec{x} = \lambda \vec{x}$

eigenvalue : λ

in upper triangular form: λs are the pivots

to find: $(a-\lambda)(d-\lambda) - bc = 0$

Steady state:

$A\vec{x} = 1\vec{x}$

$(A-I)\vec{x} = \vec{0}$

Cols should also sum to 1

Free variables; find in terms of other variable

Richard Zhu

<u>Determinant</u>

$$\det\left(\begin{bmatrix} a & b \\ c & d \end{bmatrix}\right) = ad - bc$$

<u>Norm</u>

$$\|x_n\|^2 = \sqrt{x^2 + y^2 + z^2 + \ldots}$$

$$\vec{v}^T\vec{v} = \|\vec{v}\|^2$$

<u>Linear dependence</u>

$$\sum_{i=1}^{k} \alpha_i \vec{v}_i = \vec{0} \qquad A\sum_{i=1}^{k} \alpha_i \vec{v}_i = \sum_{i=1}^{k} \alpha_i (A\vec{v}_i)$$

any set of αs

<u>Null Space / Column Space</u>

$Null(A) =$ set of $\vec{x}$s where $A\vec{x} = 0$

$Col(A) =$ Span of column vectors of A

Rank: Max (independent row vectors, independent col vecs)

<u>Projection</u> (LS in 2d)

projection of $\vec{b}$ onto $\vec{a}$

$$x_1 \vec{a} \text{ where } x_1 = \frac{\langle \vec{b}, \vec{a} \rangle}{\langle \vec{a}_n, \vec{a}_n \rangle} = \frac{\langle \vec{b}, \vec{a} \rangle}{\|\vec{a}\|^2}$$

<u>Least Squares</u>

$$A\vec{x} \approx \vec{b}$$

$$\vec{x} = (A^T A)^{-1} A^T \vec{b}$$

<u>Orthonormal</u> Matrix w/ columns $\vec{a}_i$

Orthogonal: $\langle \vec{a}_i, \vec{a}_j \rangle = 0$ $\quad A^T A = I$

Normal: $\langle \vec{a}_i, \vec{a}_i \rangle = 1$

$$A^T = A^{-1}$$

<u>Cross Corr</u>

$corr(x, y) = z[n]$

$corr(y, x) = z[-n]$ * be careful of $n = 0$

OMP

$M\vec{x} \approx \vec{y}$ where M is fat

① Initialize $\vec{e}$ to $\vec{y}$, j to 1, k to sparsity lvl k, $A = [\ ]$

② while $j \leq k$

i. Compute inner product for each vector in the set, $\vec{m}_i$, with $\vec{e}$: $c_i = \langle \vec{m}_i, \vec{e} \rangle$

ii. Column concatenate A with col vector that had max inner product with $\vec{e}$: $A = [A \mid \vec{m}_i]$

iii. Use LS to compute $\vec{x}$ given this iterations A: $\vec{x} = (A^T A)^{-1} A^T \vec{y}$

iv. Update error vector: $\vec{e} = \vec{y} - A\vec{x}$

v. $j = j + 1$

Op Amps

Xuse NVA

IDEAL: Golden Rules: Assume Ideal Op Amp ~~Amplifyer~~ unless otherwise specified

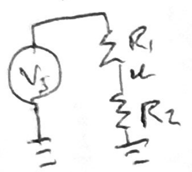
$I^+ \,\&\, I^- = 0$

$u_+ = u_-$

Negative Feedback: golden rules apply

Circuits

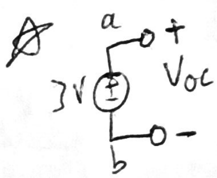
Voltage divider



$u = \frac{R_2 V_s}{R_1 + R_2}$

Passive Sign Convention

i flows into +



$V_{OC} = a - b = 3V$

Superposition

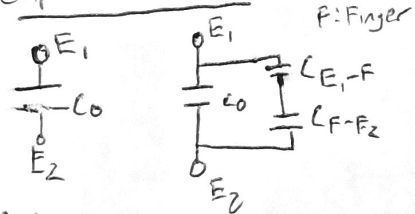
turn off $I_s \rightarrow$ open circuit

turn off $V_s \rightarrow$ short wire

compute Voltages/Currents and sum ~~them~~ each one (source)

Capacitative Touchscreen

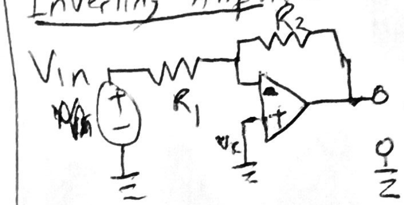
F: Finger



Thevenin

1. Measure voltage across the OC + SC This is V_{th}
2. Zero out independent sources and ~~apply test voltage/current, find corresponding I/V, and plug into $R = \frac{V}{I}$ to get R_{th}~~ find voltage equation for R_{th} from point A to b

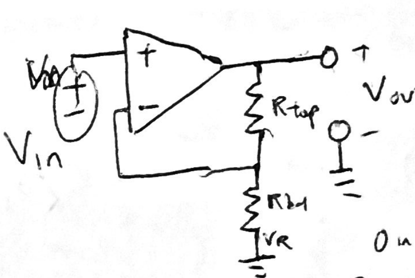
Inverting Amplifier



0 in this case

$V_{out} = -\frac{R_2}{R_1} V_{in} + V_R\left(\frac{R_2}{R_1} + 1\right)$

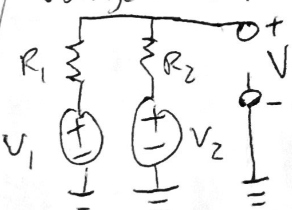
Non-Inverting Amplifier



0 in this case

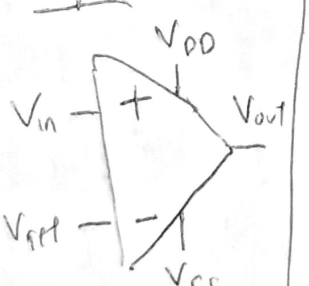
$V_{out} = \left(1 + \frac{R_{top}}{R_{bot}}\right) V_{in} - V_R\left(\frac{R_{top}}{R_{bot}}\right)$

Voltage Summer



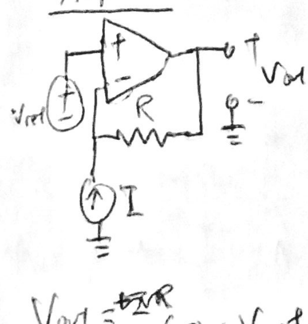
$V_{out} = V_1\left(\frac{R_2}{R_1 + R_2}\right) + V_2\left(\frac{R_1}{R_1 + R_2}\right)$

Comparator



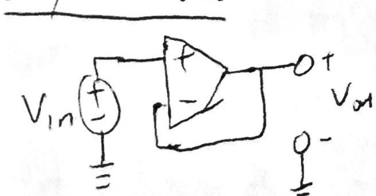
if $V_{in} > V_{ref}$
$V_{out} = V_{DD}$
else $V_{in} < V_{ref}$
$V_{out} = V_{SS}$

Transresistance Amplifier



$V_{out} = \cancel{IR}\ I(-R) + V_{ref}$

Unity Gain Buffer



$V_{out} = V_{in}$

$Q = CV$ $\quad R = \frac{\rho L}{A}$ $\quad C = \frac{\varepsilon A}{d}$

$V = IR$ $\quad I = \frac{Q}{t}$

$P = IV$

Actual ~~types~~ tips!

Look @ what they give you
!
*Read the ENTIRE problem desc - give what they ask for! FOLLOW INSTRUCTIONS

- pay attention to units/determine how to solve problems
- If you don't know what to; just do algebra → * take some liberties w/ communitive/distributive property
  - use asymptotes/denoms, etc for proofs

☆ - Get Partial Credit!!!

- when they say in terms of x, y, z, not all have to be used
- be careful of matrix dimensions

Algebra

for matrix & scalars
!

$(A^2+B^2)\vec{v} = A^2\vec{v} + B^2\vec{v}$

$A^2\vec{x} = \lambda^2\vec{x}$ if $A\vec{x}=\lambda\vec{x}$

Problems

Beacons where we have to sacrifice one as a "reference"

- can create n-1 equations with n beacons
- not linear though
- can create n-2 linear equations w/ n beacons
  - by subtracting 1 equation to linearize

square signals → slope thing → ~~torpator~~ comparator

LSLR/OMP work for square systems

Orthonormal: ~~multiply~~ $\vec{x}^T\vec{x} = \alpha_1\vec{x}$

- find the manipulation where all the $\vec{a}_i\vec{a}_j^T \to 0$

only $\vec{a}_i\vec{a}_i^T \to 1$ remains