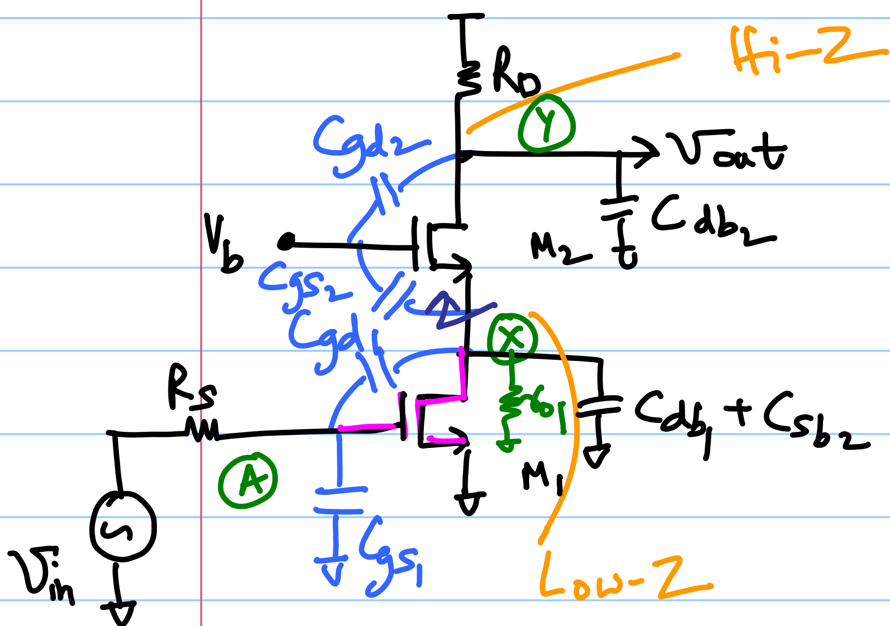
ECE 511 - Lecture 19

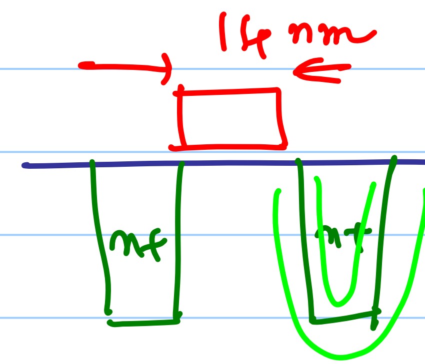
Note Title 3/31/2015

Cascode Amplifier Frequency Response:



$$A_V = -g_{m_1} \cdot R_D \| g_{m_2} r_{o_2} r_{o_1}$$

$$\simeq -g_{m_1} R_D$$



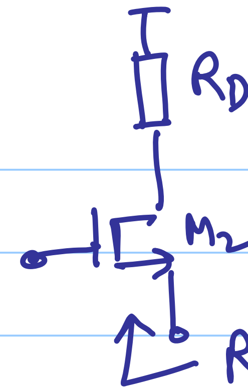
In nano cmos

$C_{gd_1} \rightarrow$ Miller Cap determined by the gain from A to X

$$A_x = -g_{m_1} \cdot R_x = -g_{m_1} \times \left(\frac{1}{g_{m_2} + g_{mb_2}} \| r_{o_1} \right)$$

$$\simeq -\frac{g_{m1}}{g_{m2}+\cancel{g_{m2b}}}$$

$\simeq -1$ if M_1 & M_2 are identical



$R_{up} \simeq \frac{1}{g_{m2}}$

if $R_D \simeq r_o$

$$\omega_{pA} = \frac{1}{R_s\left[C_{gs1} + \left(1+\frac{g_{m1}}{g_{m2}+g_{m2b}}\right)C_{gd1}\right]} \simeq \frac{1}{R_s\left[C_{gs1} + 2C_{gd1}\right]}$$

"Miller Killer"

because C_{gd1} sees a gain of -1 not A_v

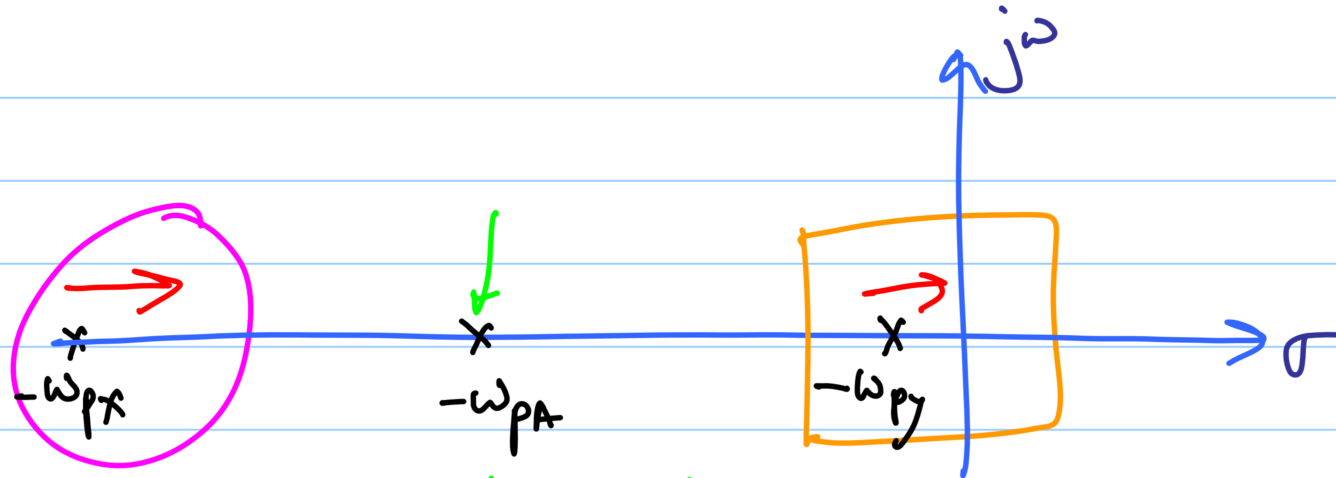
@ node-X

$$C_X = 2C_{gd_1} + C_{db_1} + C_{sb_2} + C_{gs_2}$$

$$\omega_{px} = \frac{1}{\frac{1}{(g_{m_2}+g_{mb_2})} \times C_X} = \frac{g_{m_2}+g_{mb_2}}{C_X}$$

<u>output pole</u>

$$\omega_{py} = \frac{1}{\boxed{R_D}\left(C_{db_2} + C_L + C_{gd_2}\right)}$$



depends upon R_S

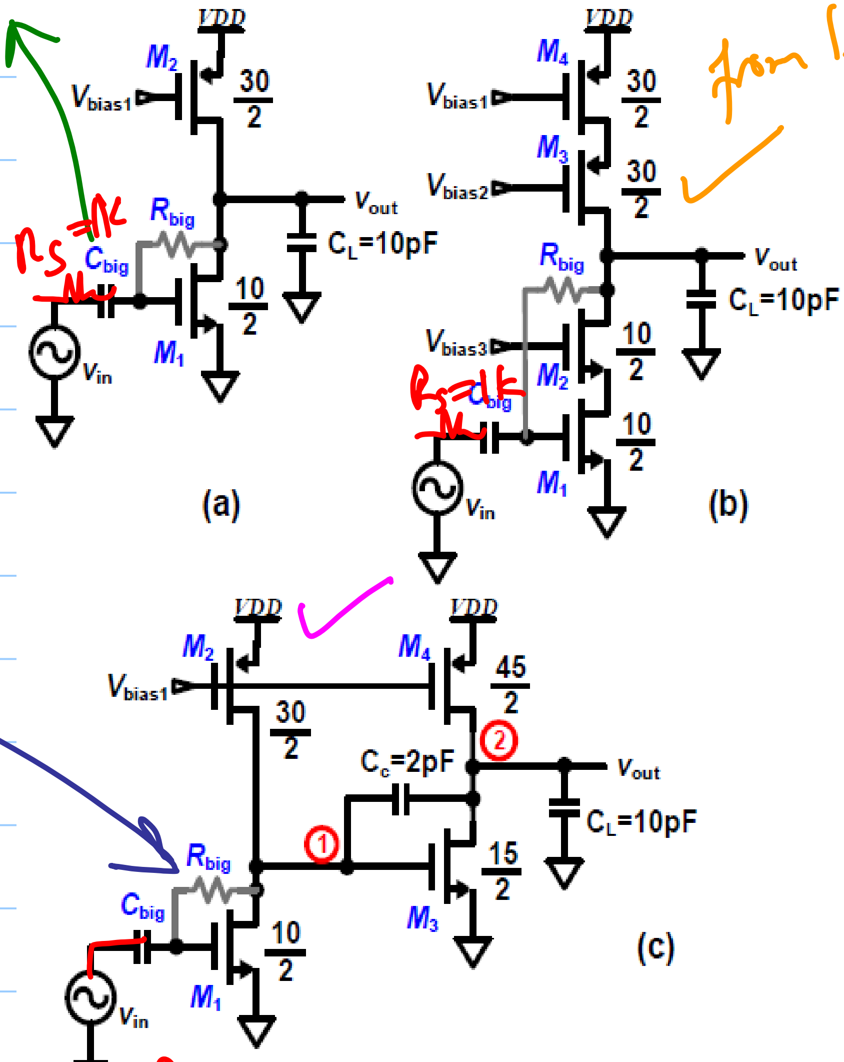
$$\frac{1}{\left(\frac{s}{\omega_p}+1\right)}$$

What if R_D was a cascode PMOS current mirror

(a) & (c) use 2-stage model with Miller Cap

from lecture 19

$$\omega_{p_1} = \frac{1}{g_{m_2} R_2 R_1 C_c}$$



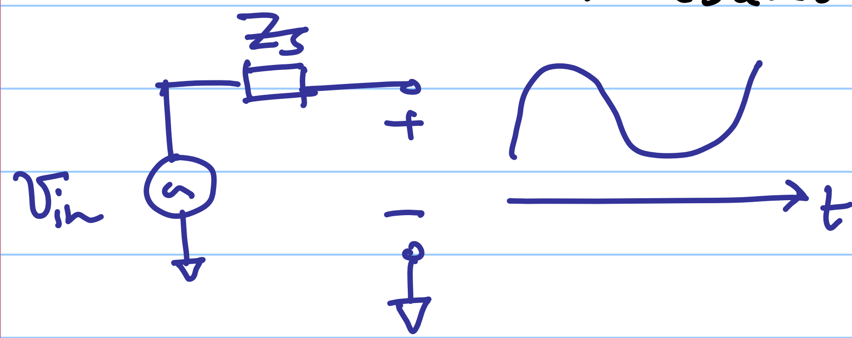
$$\omega_z = \frac{g_{m_2}}{C_c}$$

$$\omega_{um} = \frac{g_{m_1}}{C_c}$$

$R_s = 0$

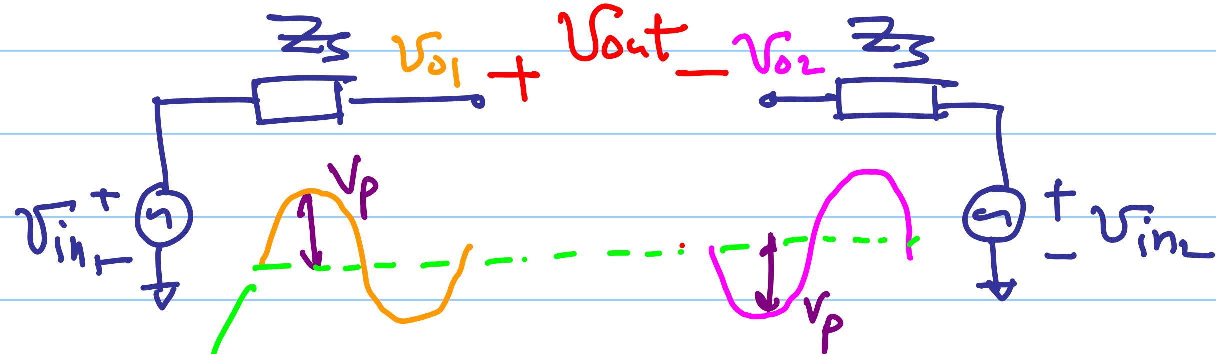
Differential Amplifiers

* Single-ended signal is defined as one that is measured wrt a fixed potential i.e. ground



1-wire

* A differential signal is defined as one measured between two nodes that have equal & opposite signal excursions, around a fixed potential



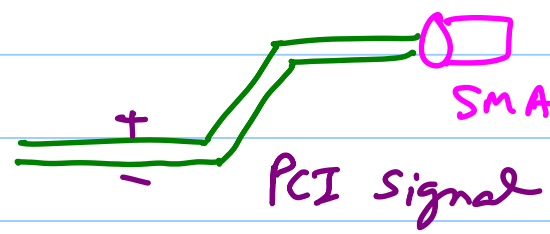
CM-level

(common mode)

2-wire signalling

differential signal

$$V_d = V_{o_1} - V_{o_2}$$

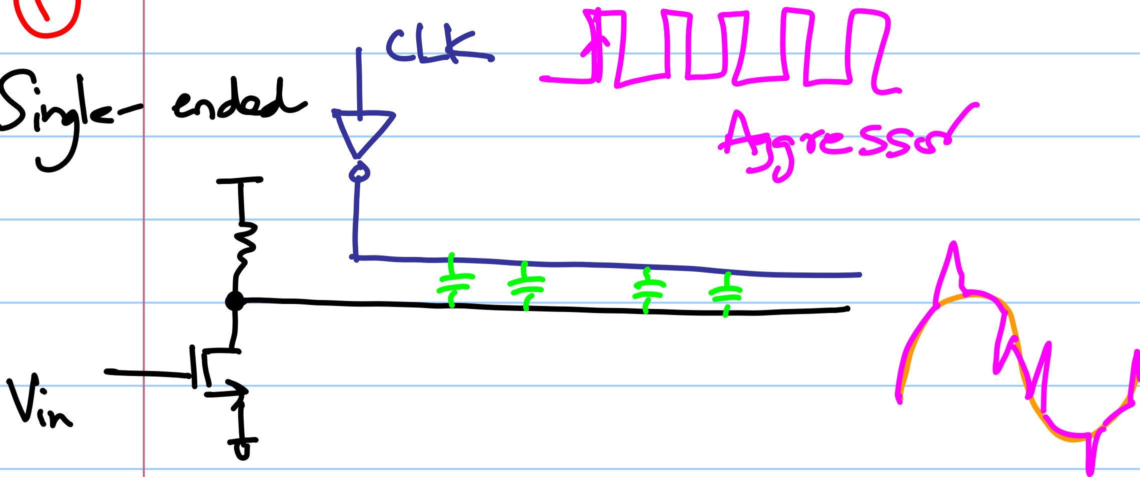


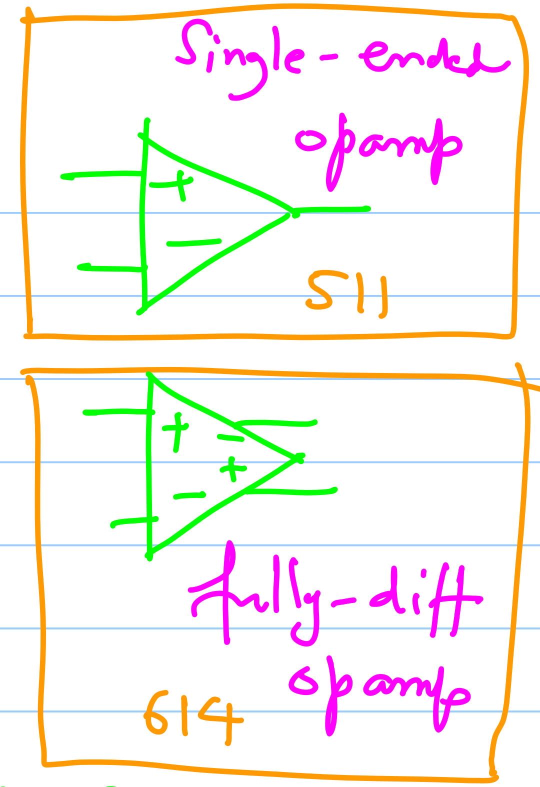
$$V_{CM} = \frac{(V_{o_1} + V_{o_2})}{2}$$ ← average of V_{o_1} & V_{o_2}

ideally a fixed DC value

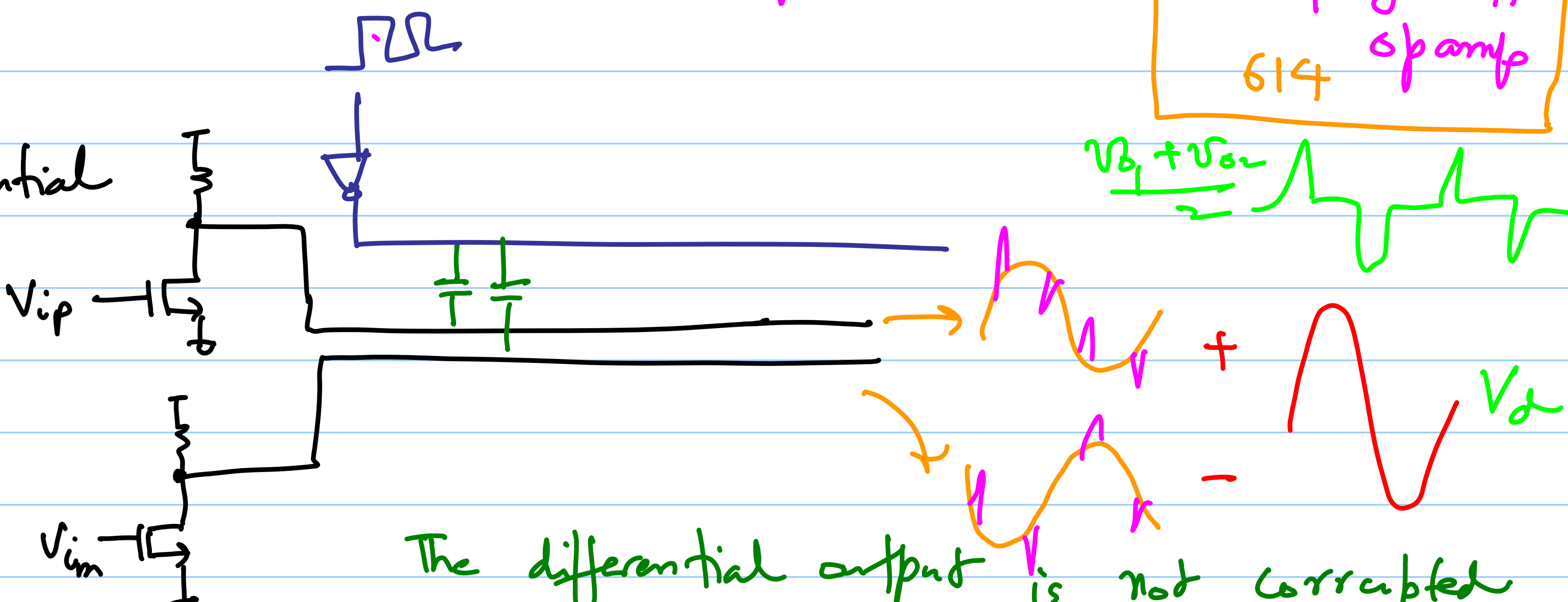
Advantages:

① Single-ended





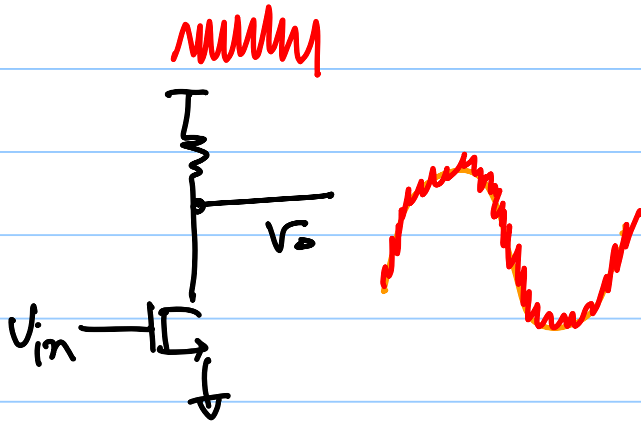
Differential



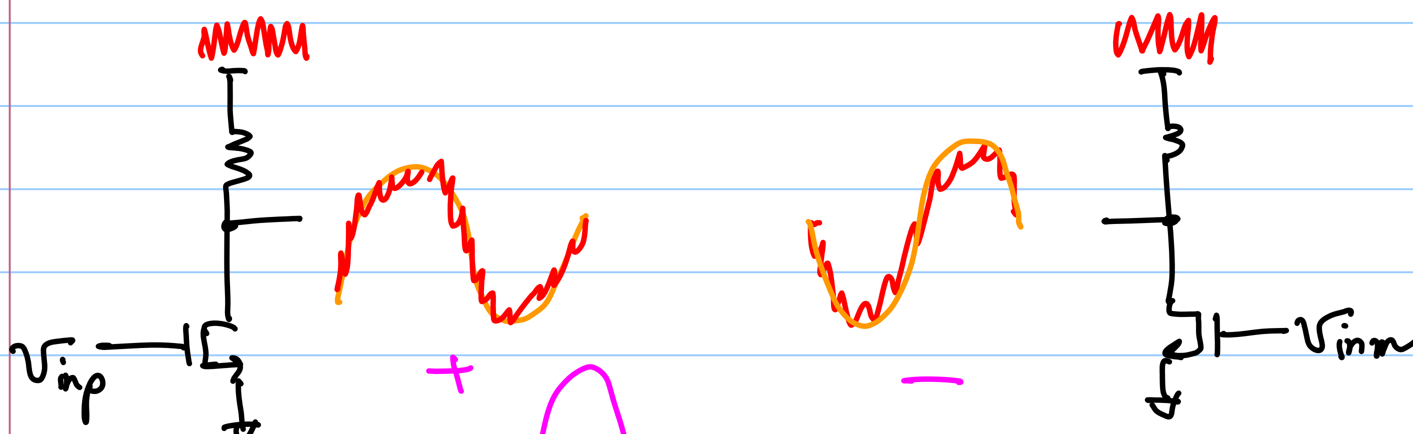
The differential output is not corrupted

↳ CM-level is disturbed

This arrangement rejects any CM disturbance

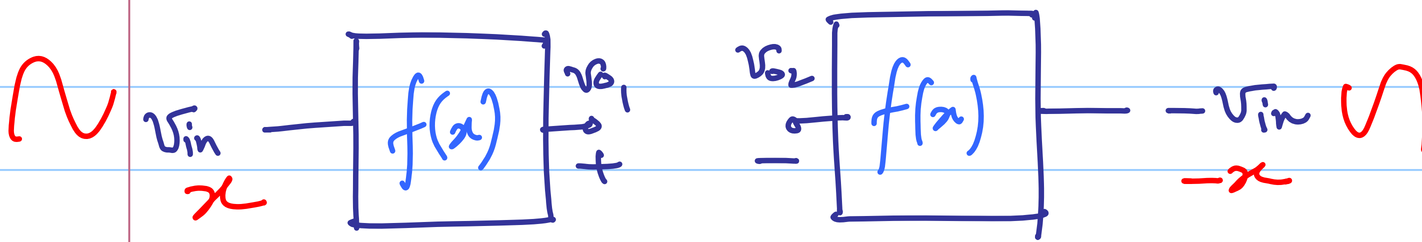
② 

SF Circuit



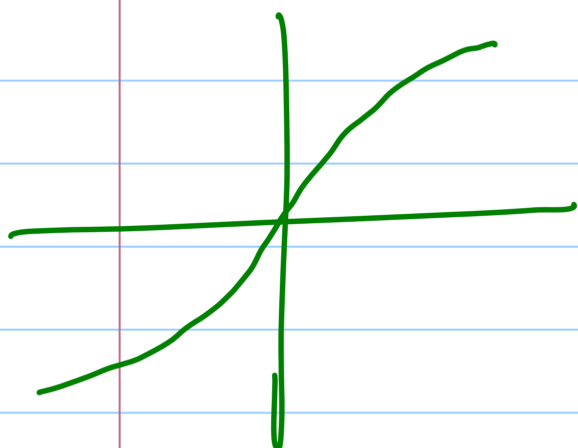
rejects correlated supply noise

③ Simple-biasing ⇒ Differential amplifiers don't need big R&C for biasing



$v_d = v_{o1} - v_{o2} = f(x) - f(-x)$ Odd function

$v_{cm} = \frac{v_{o1} + v_{o2}}{2} = f(x) + f(x)$ even function



$$V_d = f(x) - f(-x) \qquad \text{odd function}$$

$$= [\alpha_0 + \alpha_1 x + \alpha_2 x^2 + \alpha_3 x^3] + \cdots$$

$$- [\alpha_0 - \alpha_1 x + \alpha_2 x^2 - \alpha_3 x^3] + \cdots$$

$$= 2\alpha_1 x + \underline{\underline{2\alpha_3 x^3}} + \underline{\underline{x^5}} + \cdots$$

gets rid of even-order non-linearity

"More linear"

CS