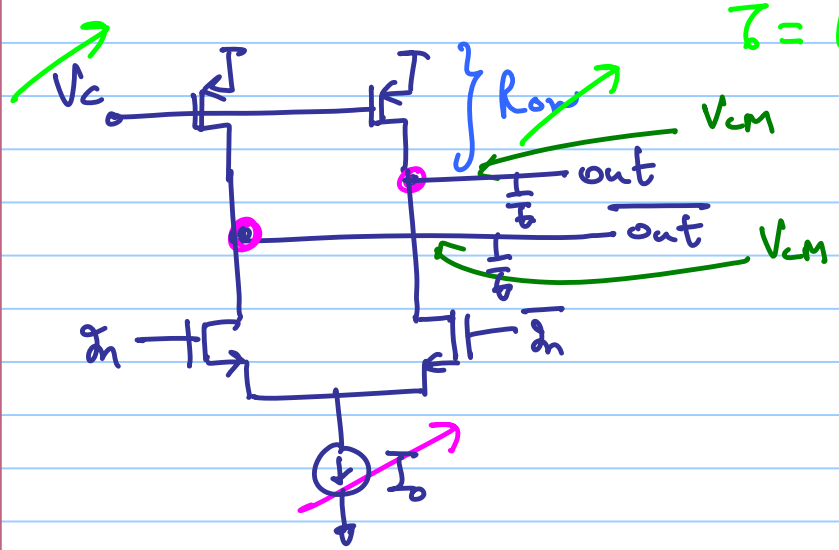
ECE 504 - Lecture 17

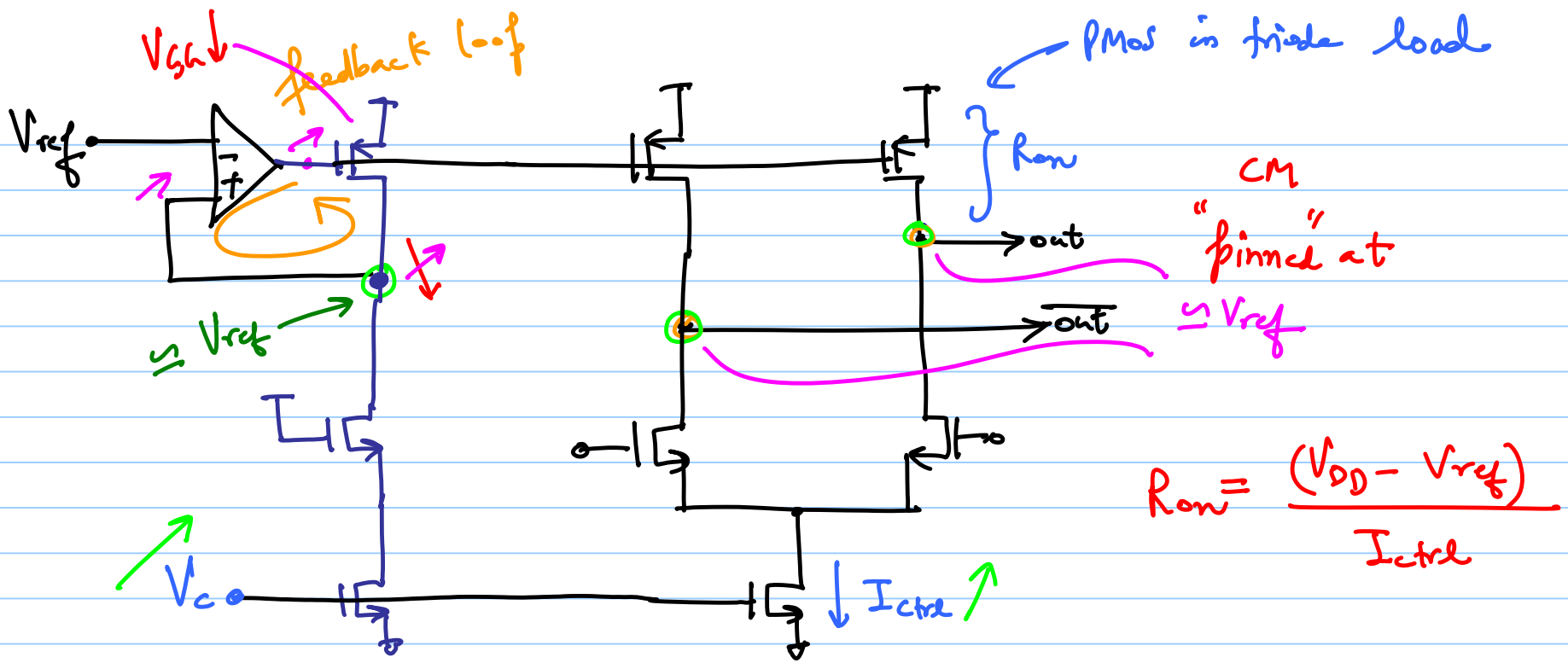
Note Title 10/19/2016



$\tau = R_{on} C$

$V_c \uparrow \Rightarrow R_{on} \uparrow$

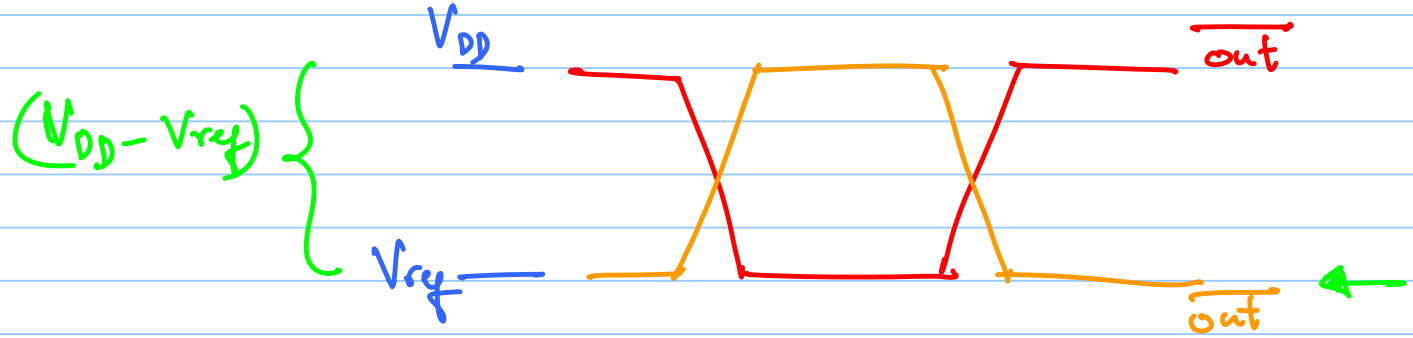
$\Rightarrow$ V_{cm} varies


$V_{sg}\downarrow$
feedback loop
PMOS in triode load
V_{ref}
R_{on}
CM
"pinned" at
$\simeq V_{ref}$
out
out
$\simeq V_{ref}$
V_c
$\downarrow I_{ctrl}\uparrow$
$R_{on} = \frac{(V_{DD} - V_{ref})}{I_{ctrl}}$

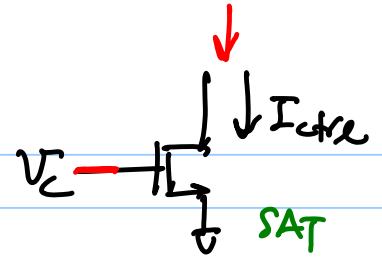
Replica Bias forces $R_{on} = \frac{(V_{DD} - V_{ref})}{I_{ctrl}}$

$$f_{out} \propto \frac{1}{\tau} = \frac{1}{R_{on} C} \propto \frac{I_{ctrl}}{(V_{DD} - V_{ref}) C}$$

$I_{ctrl} = f(V_c)$



$$I_{out} \propto I_{ctrl} = f(V_c)$$

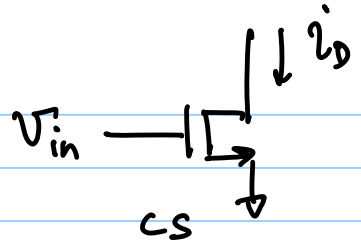


Here,

$$I_{ctrl} = f(V_c)$$

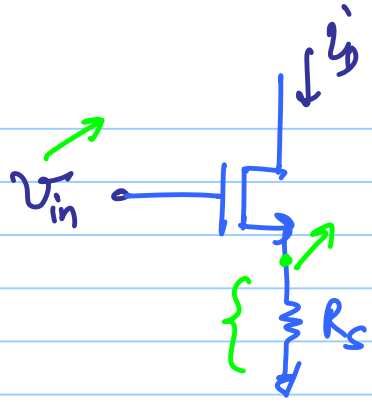
$$= \frac{K l_n}{2} \frac{W}{L} (V_c - V_{TH})^2$$

$$\approx g_m V_c \text{ for small } V_c$$



$i_d \simeq g_m V_{in}$ for small signal

$i_d \propto (V_{in} - V_{TH})^2$ for large signal



CS with Source degeneration

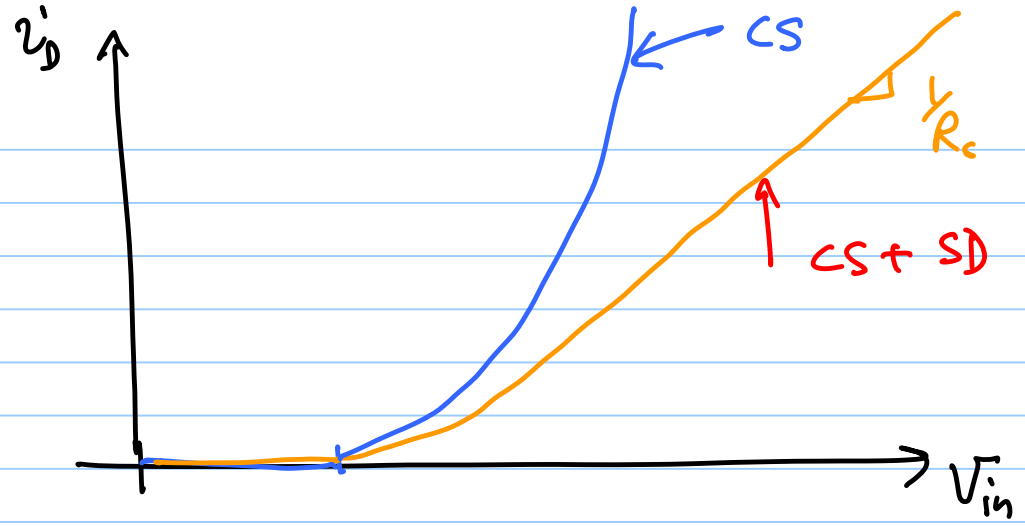
$$i_d = \frac{g_m}{1 + g_m R_S} V_{in}$$

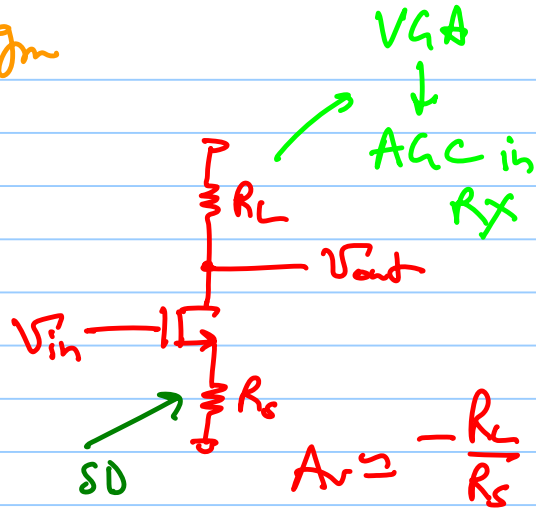
$$= \frac{1}{\frac{1}{g_m} + R_S} V_{in}$$

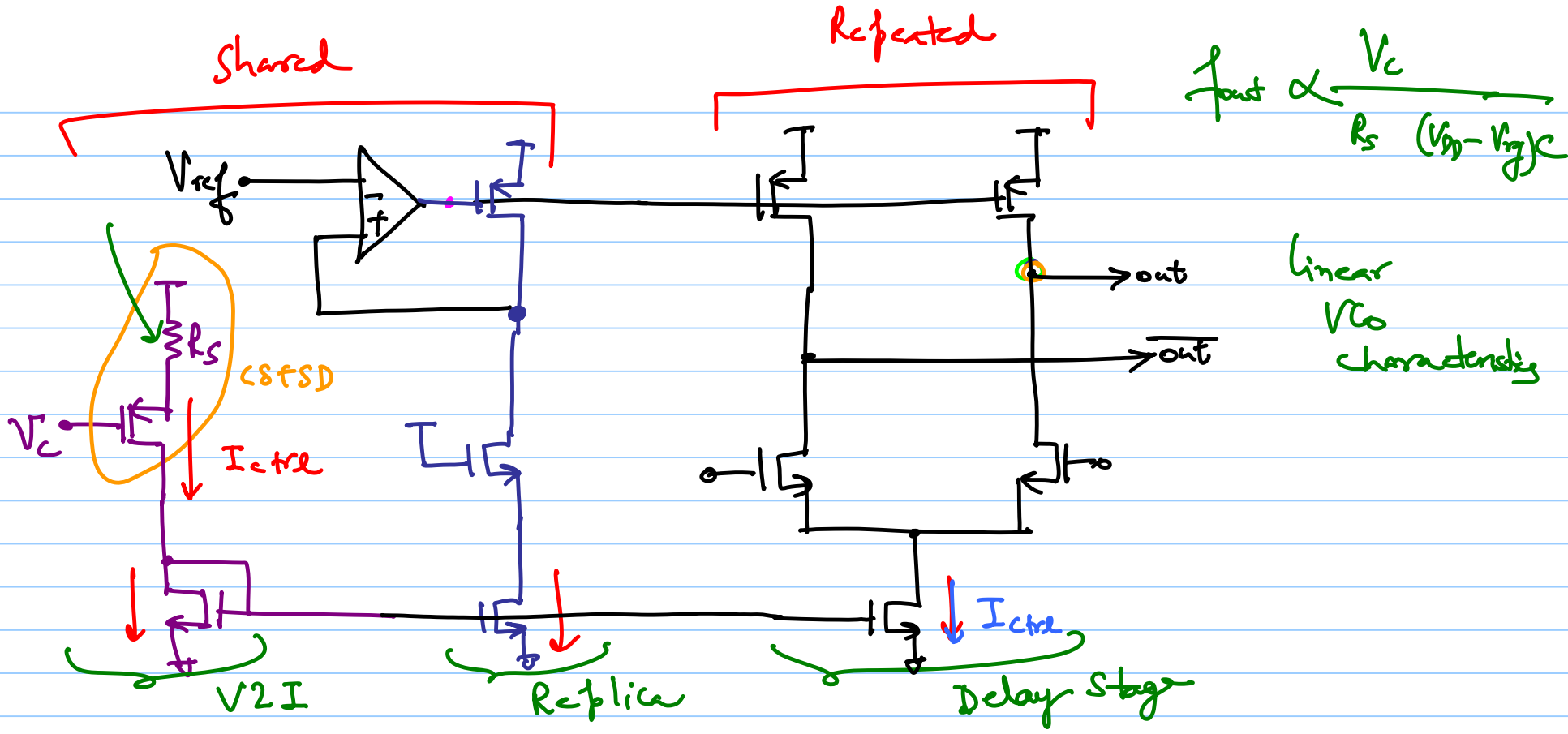
$$\simeq \frac{V_{in}}{R_S}$$

if $\frac{1}{g_m} \ll R_S$

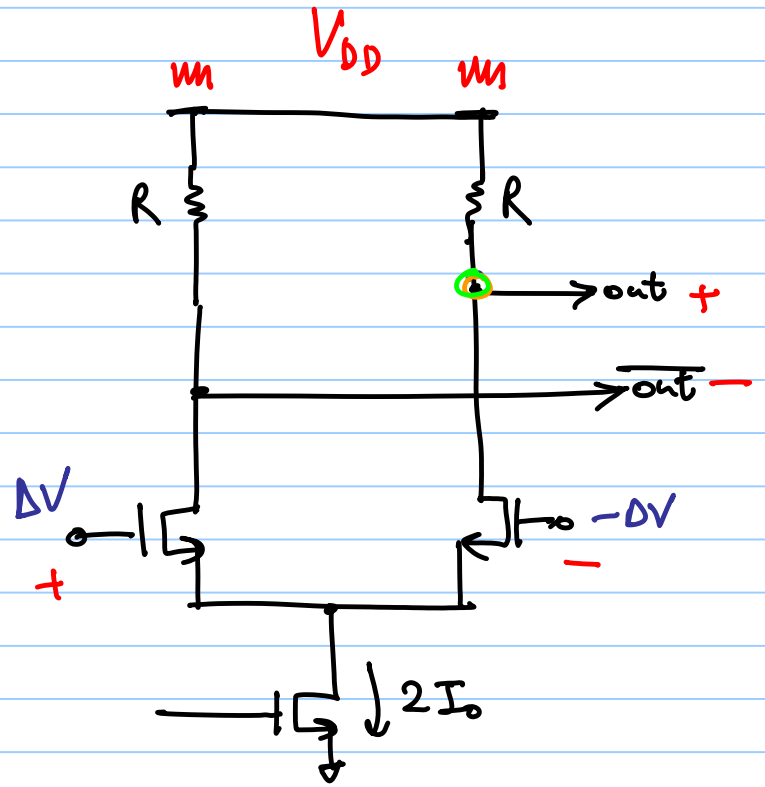
or $g_m \gg \frac{1}{R_S}$


i_D
CS
$\frac{1}{R_s}$ for large g_m
CS + SD
V_{in}


VGA
AGC in Rx
R_L
V_{out}
V_{in}
R_s
SD
$A_v \simeq -\frac{R_L}{R_s}$


Shared
Repeated
$f_{out} \propto \frac{V_c}{R_s (V_{DD} - V_{tp}) C}$
Linear VCO characteristic
V_{ref}
R_s
CSFSD
V_c
I_{ctrl}
out
$\overline{out}$
I_{ctrl}
V2I
Replica
Delay Stage

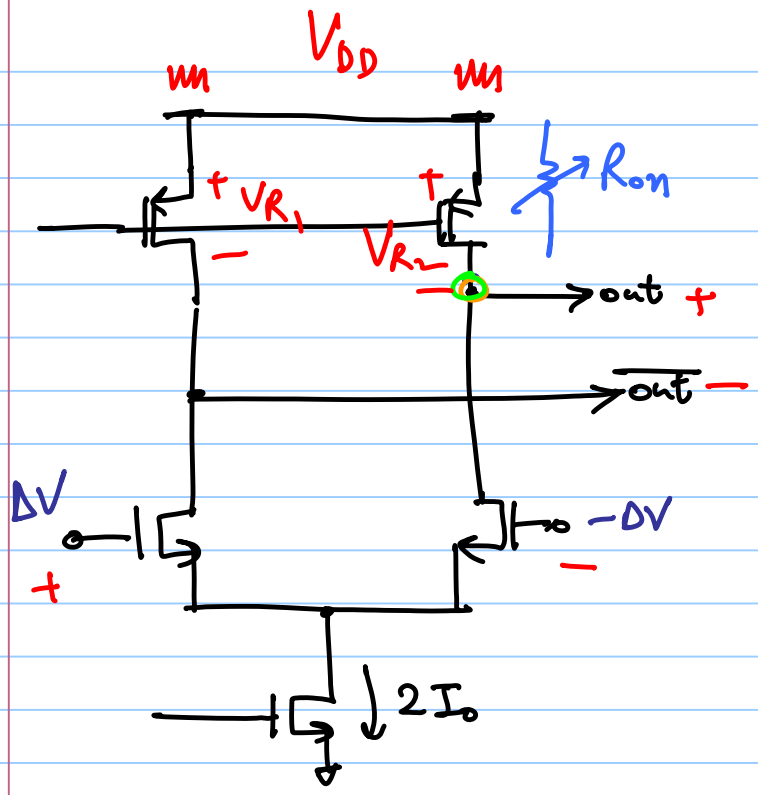
Power Supply Rejection



$$out = V_{DD} - (I_o + \Delta I)R$$

$$\overline{out} = V_{DD} - (I_o - \Delta I)R$$

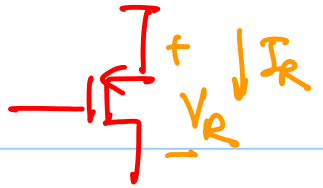
$$out - \overline{out} = -2(\Delta I)R$$



$$out = V_{DD} - (I_o + \Delta I) R_{on}$$

$$\overline{out} = V_{DD} - (I_o - \Delta I) R_{on}$$

$f(V_{R_1})$ $f(V_{R_2})$



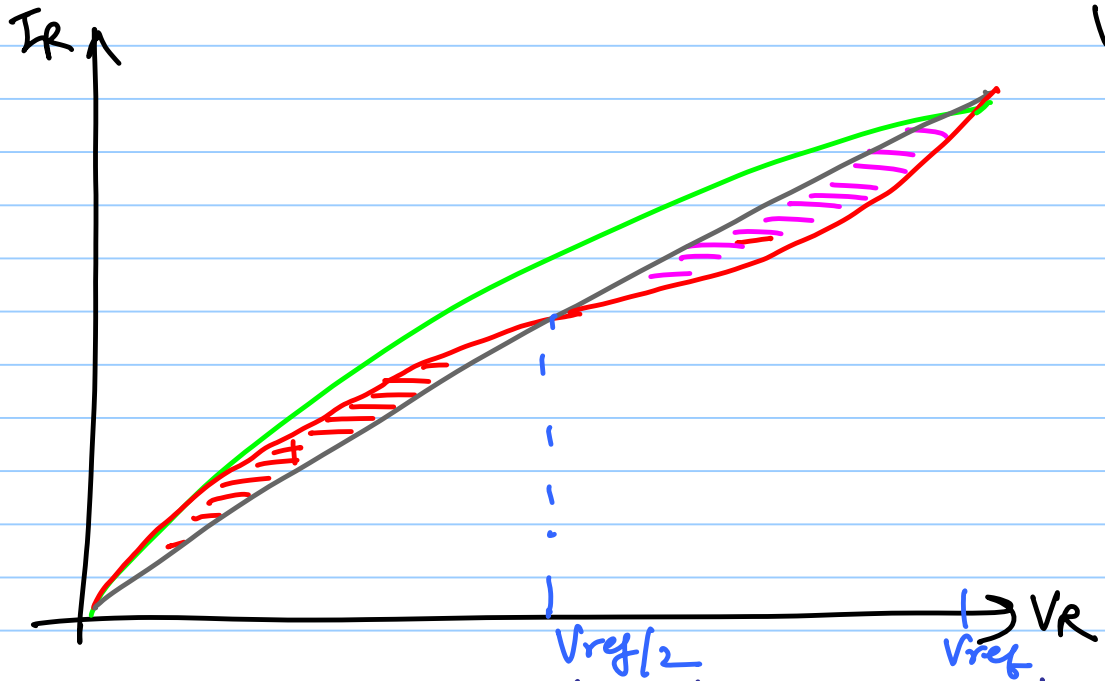
$R_{on} = R(V_R, I_R)$

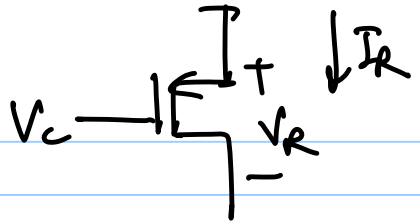
Non-linear

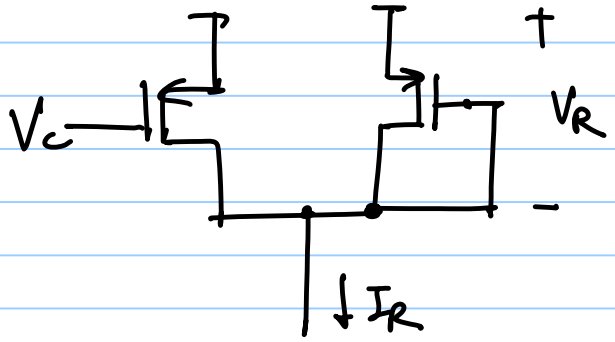
Non-linear resistor converts supply noise into differential output

↳ PSRR

Power supply (noise) Rejection Ratio







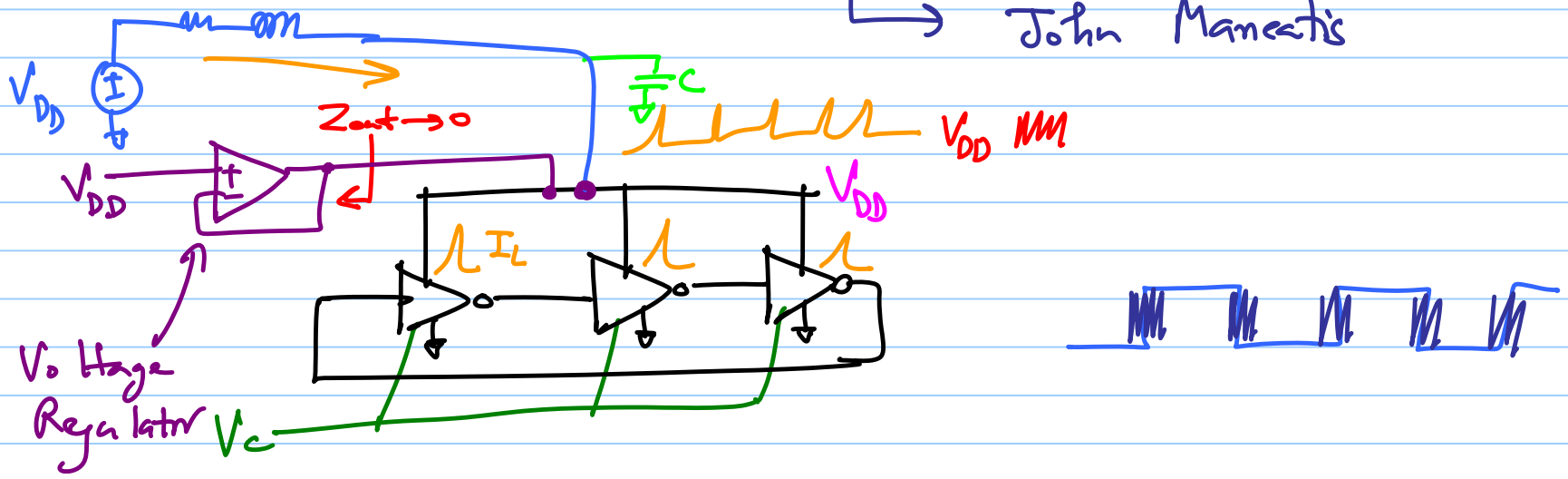
Symmetric I-V characteristics about the center of voltage swing

↳ nominally equal incremental resistance

↳ Excellent PSRR

Symmetric Load Delay Cell

↳ John Maneatis



Small-swing Differential VCO

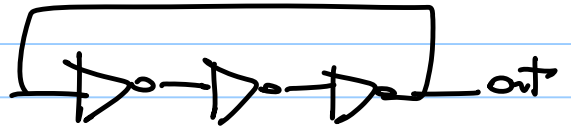
PSRR ✓

Swing 

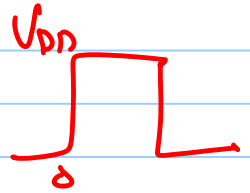
Phase Noise 

Need low-swing to rail-to-rail swing converters

Large - Swing VCOs



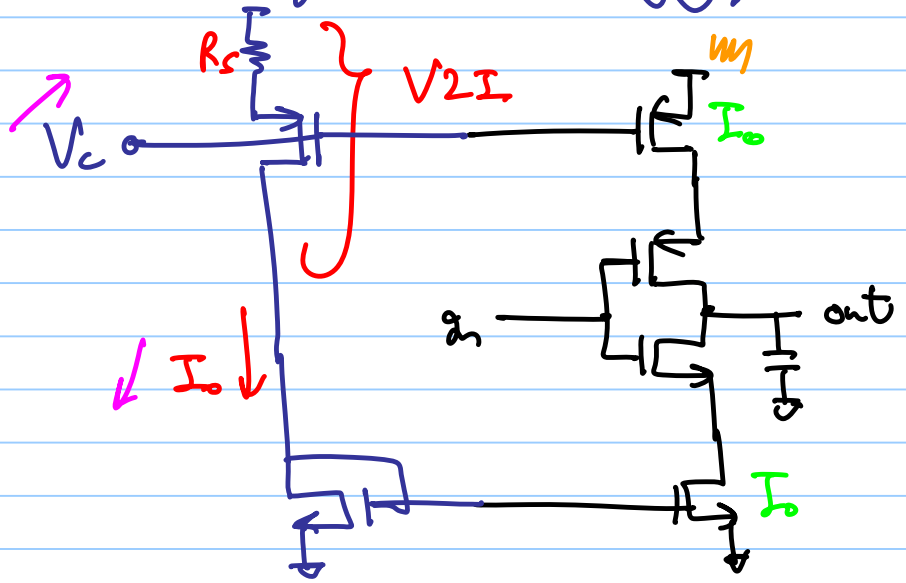
+ Simpler delay cells
+ Rail-to-rail output swings



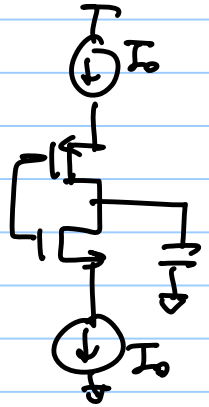
- Poor PSRR
+ Better phase noise performance
  - ↳ devices are mostly in Triode

Variable Delay Inverter

① Vary the charging/discharging Current



f_{out} ↓



Current-Controlled Oscillator (CCO)

↳ current starved VCO

② Vary load Capacitance