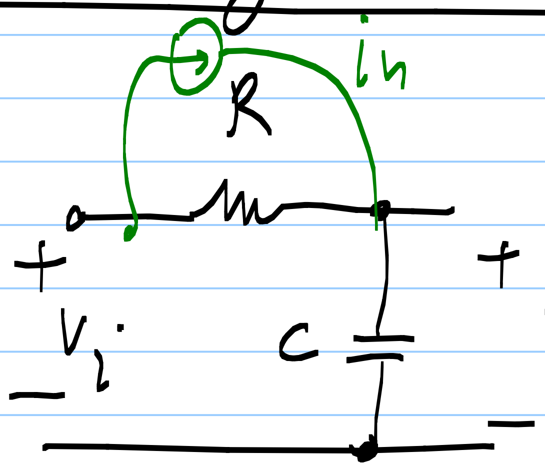
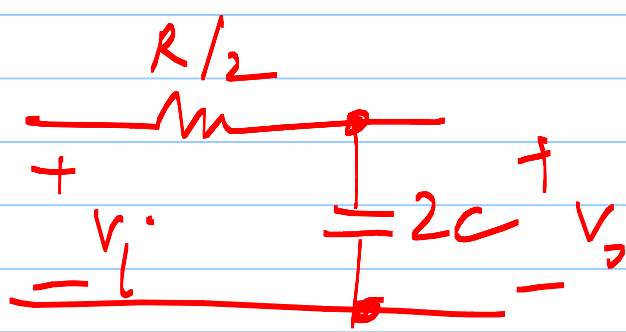
Lecture 13 15/2/2016

Reducing noise in a circuit



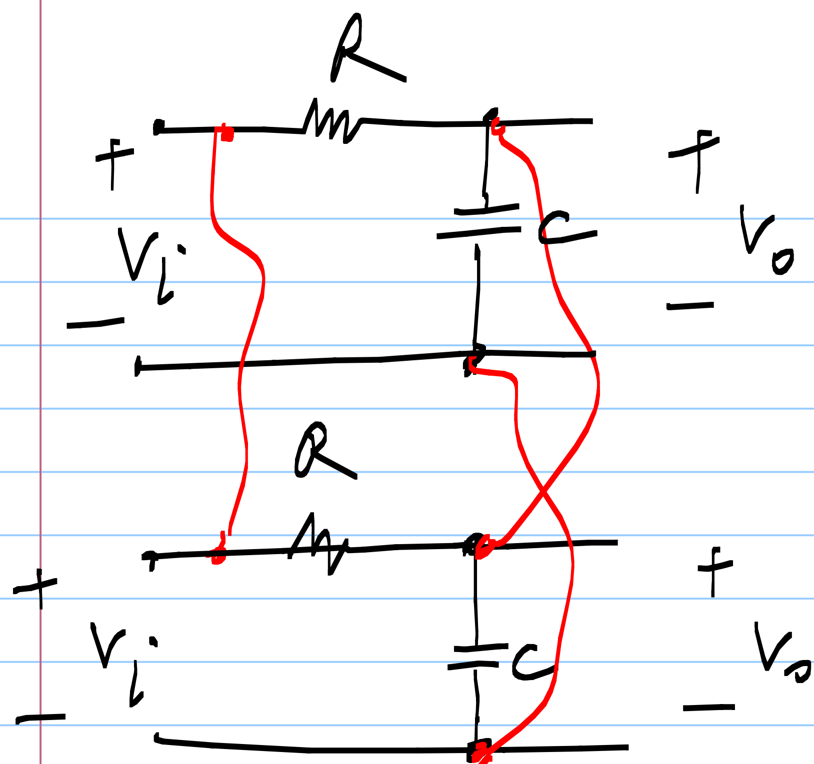
$$\frac{v_o}{v_i} = \frac{1}{1+sCR}$$

$$\overline{v_{on}^2} = \frac{kT}{C}$$



$$\frac{v_o}{v_i} = \frac{1}{1+sCR}$$

$$\overline{v_{on}^2} = \frac{kT}{2C}$$



Impedance scaling

$\{R, L, C\} \rightarrow \{R/2, L/2, 2C\}$

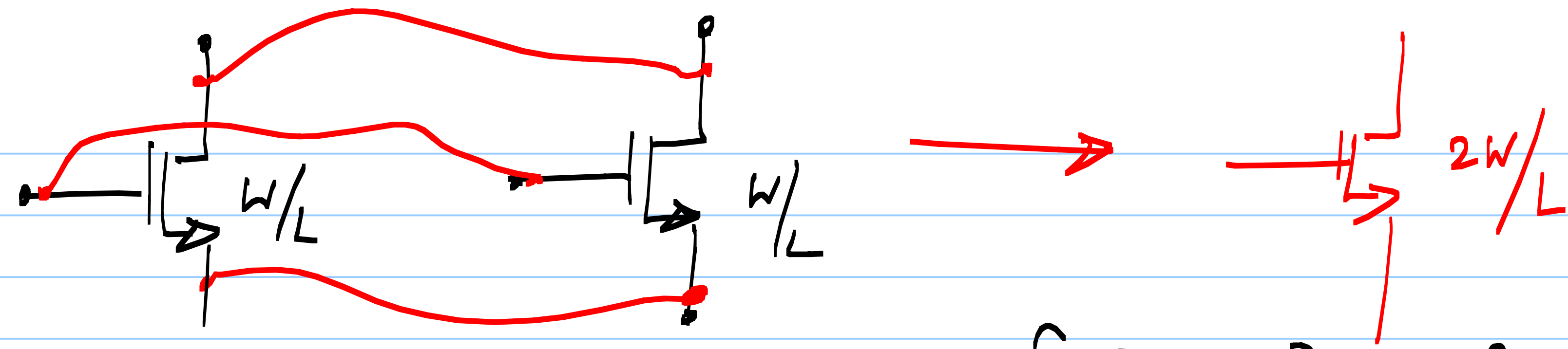
$\{R/n, L/n, nC\}$

Preserves TF

Reduces mean squared voltage noise or voltage noise PSD

Power dissipated ↑ n×

by a factor n

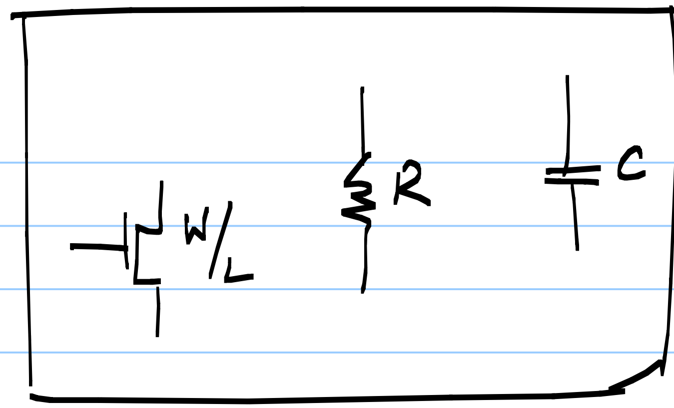


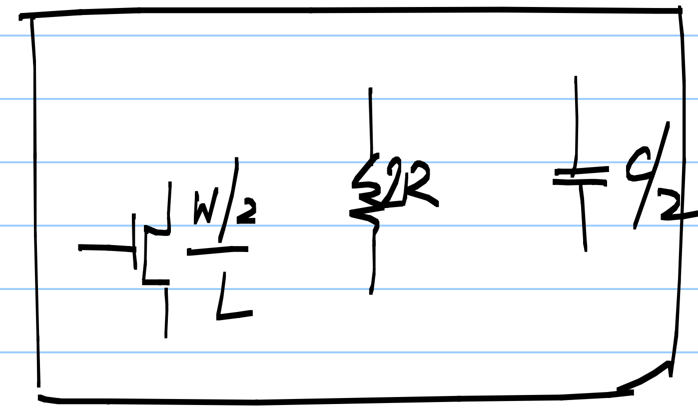
$$\{g_m, g_{ds}, g_{mb}\} \xrightarrow{2\times} \{2g_m, 2g_{ds}, 2g_{mb}\}$$

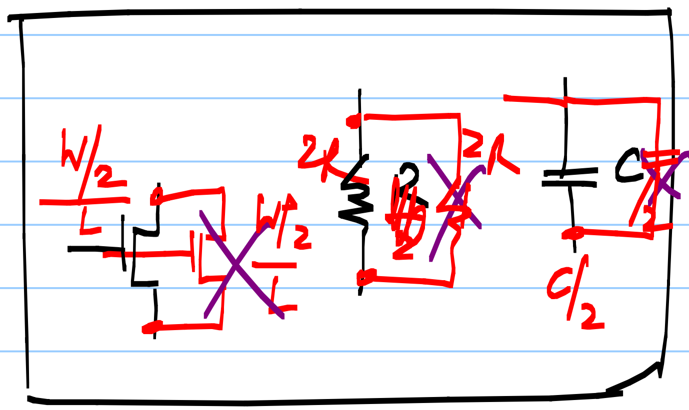
Noise voltage = Noise current $\times$ $\begin{Bmatrix} \text{Impedance} \\ \text{Transimpedance} \end{Bmatrix}$

$$\text{PSD} = \underbrace{\text{Noise PSD}}_{\uparrow\, n} \times \underbrace{|\text{Transimpedance}|^2}_{\downarrow\, n^2}$$

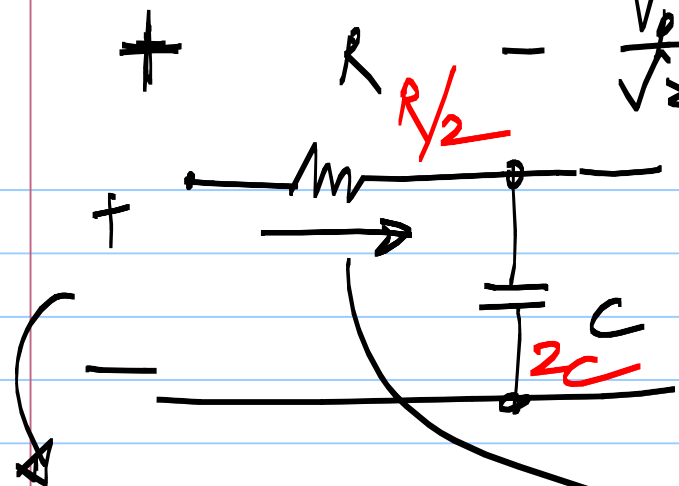
* Parasitic capacitances of the device; Body effect
* Mismatch
* Noise


W/L
R
C


W/2
L
2R
C/2


W/2
L
W/2
L
2R
R
2R
C
C/2

$-\frac{V_p}{\sqrt{2}}\cos\left(\frac{t'}{RC}+\pi/4\right)$



$+\frac{V_p}{\sqrt{2}}\cos\left(\frac{t}{RC}-\frac{\pi}{4}\right)$

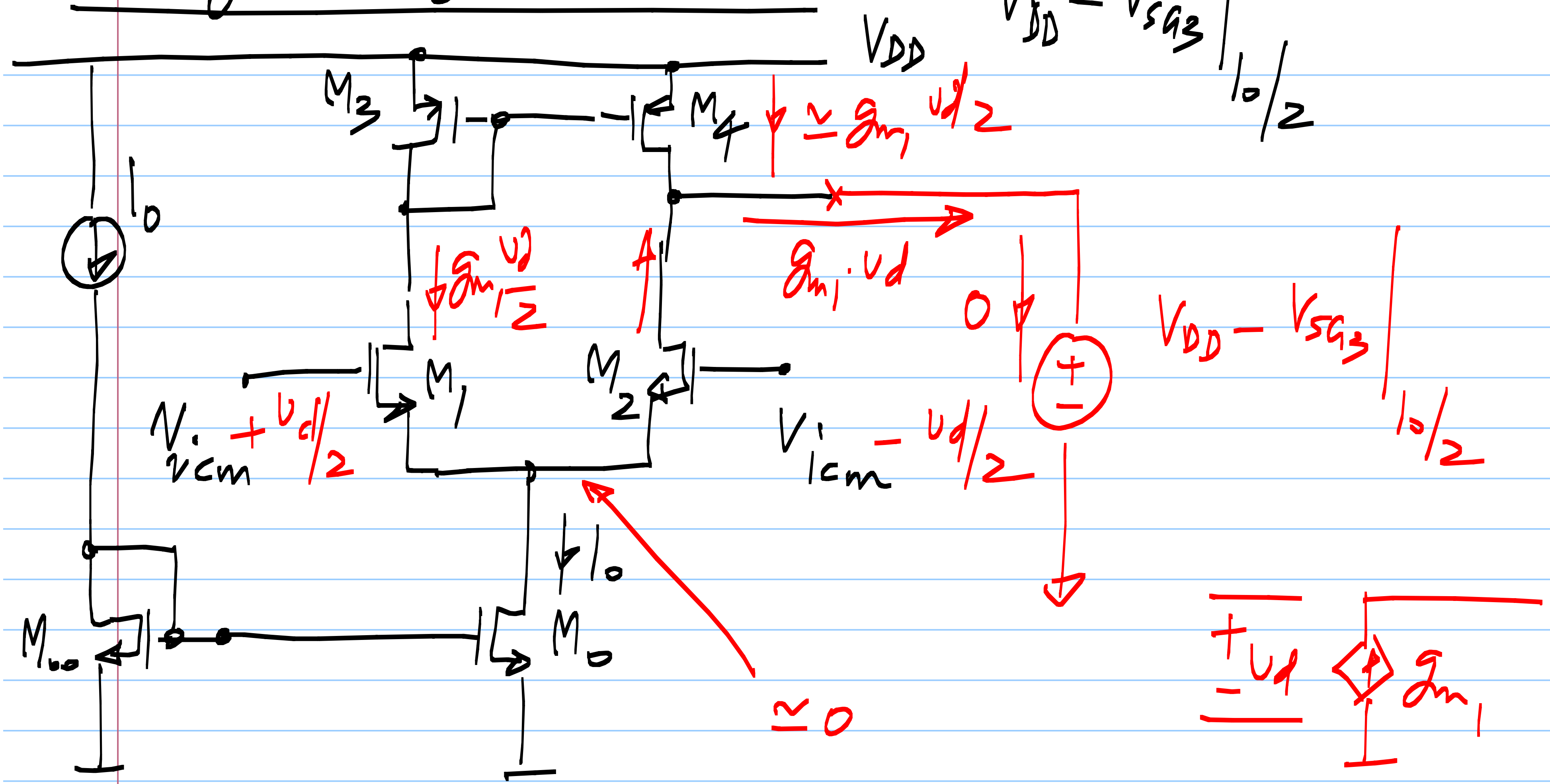
$-$

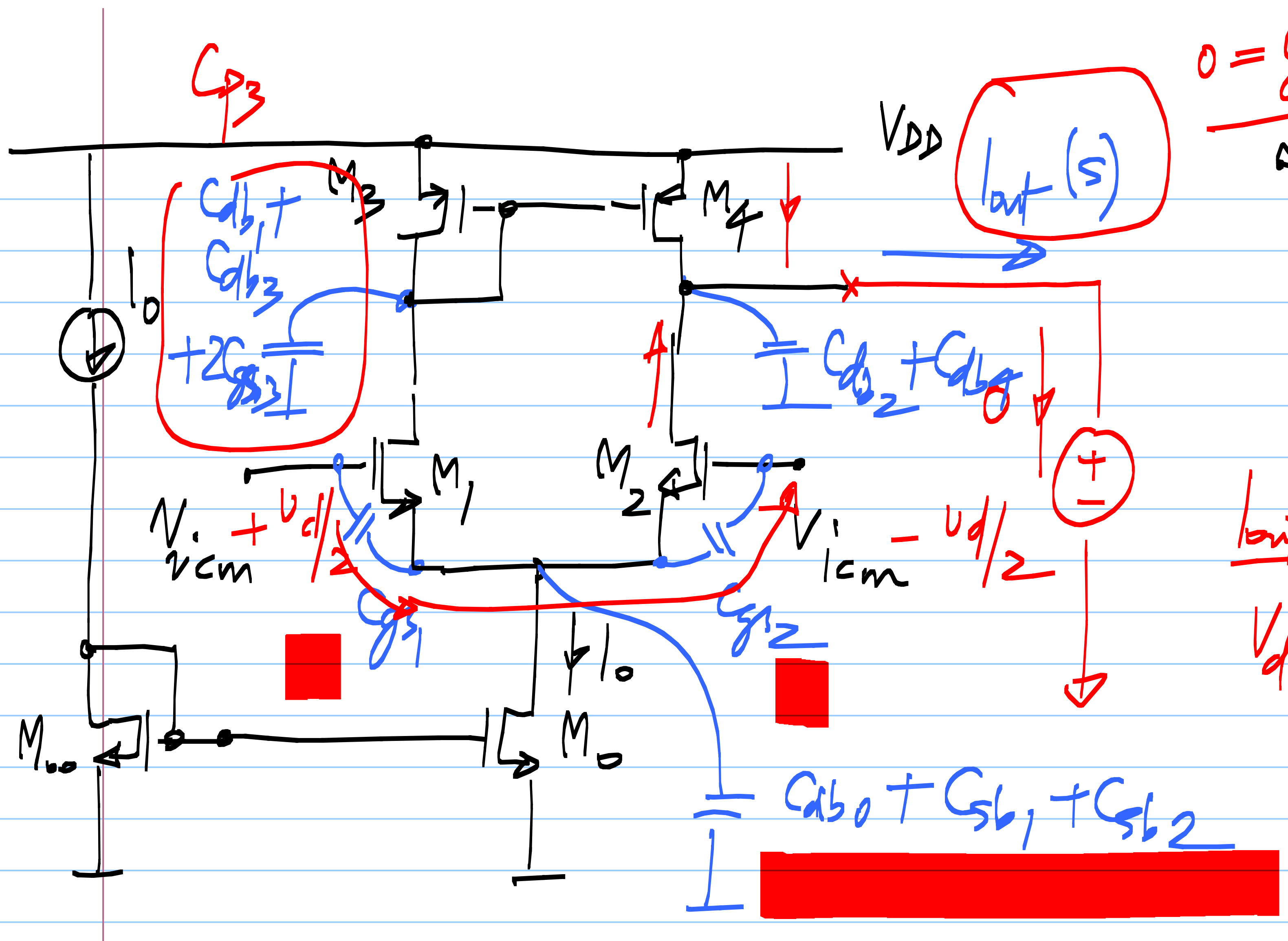
$V_p \cos(t/RC)$

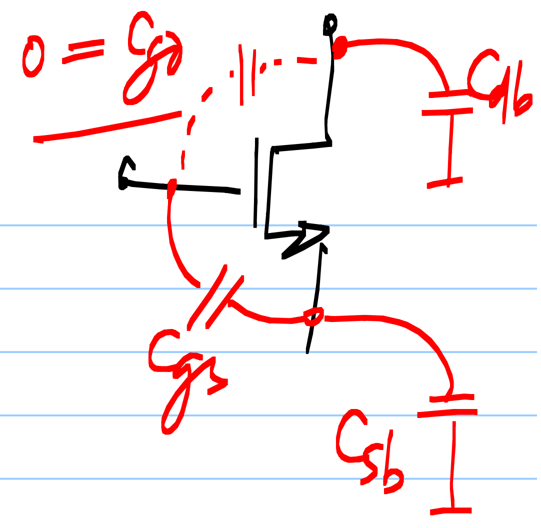
$\frac{V_p}{\sqrt{2}R}\cos\left(\frac{t}{RC}+\pi/4\right)$

output voltage	signal	$V_p^2/4$	$V_p^2/4$
(mean sq.)	noise	kT/C	$kT/2C$
Resistor current		$V_p^2/4R^2$	V_p^2/R^2

Single stage opamp.







$$\frac{I_{out}(s)}{V_d(s)} =$$