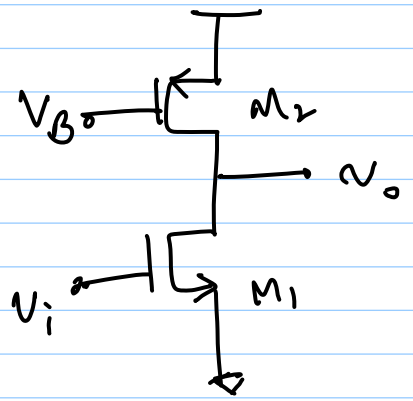
30-1-13

Lec 10

(1)



$$\frac{\overline{v_{on}^2}}{\Delta f} = \frac{8kT}{3}\left(r_{ds_1} \| r_{ds_2}\right)^2 \left(g_{m_1} + g_{m_2}\right)$$

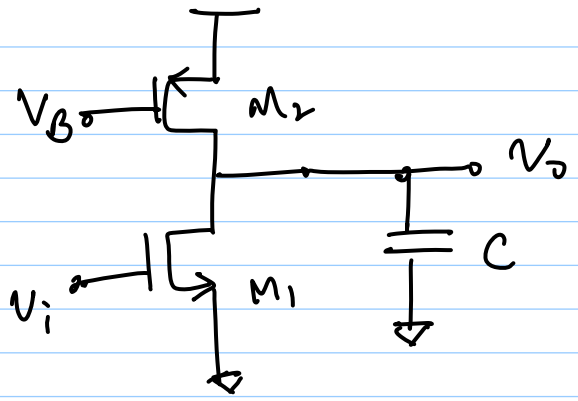
$$\frac{\overline{e_n^2}}{\Delta f} = \frac{\overline{v_{on}^2}}{\left[g_{m_1} \cdot \left(r_{ds_1} \| r_{ds_2}\right)\right]^2}$$

$$= \frac{8kT}{3} \cdot \left[\frac{1}{g_{m_1}} + \frac{g_{m_2}}{g_{m_1}^2}\right]$$

for low noise (in this case)

* $\uparrow g_{m_1}$
* $\downarrow g_{m_2}$

(2)



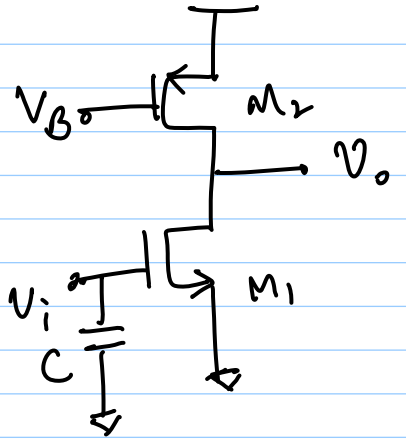
$$r_{ds_1} \| r_{ds_2} = R_o$$

$$\frac{\overline{v_{on}^2}}{\Delta f} = \frac{8kT}{3}\left(g_{m_1} + g_{m_2}\right) \cdot \left|\left[R_o \| \frac{1}{jwC}\right]\right|^2$$

$$= \frac{8kT}{3}\left(g_{m_1} + g_{m_2}\right) \cdot \frac{R_o^2}{1 + w^2 C^2 R_o^2}$$

$$\frac{\overline{e_n^2}}{\Delta f} = \frac{8kT}{3} \cdot \left[\frac{1}{g_{m_1}} + \frac{g_{m_2}}{g_{m_1}^2}\right]$$

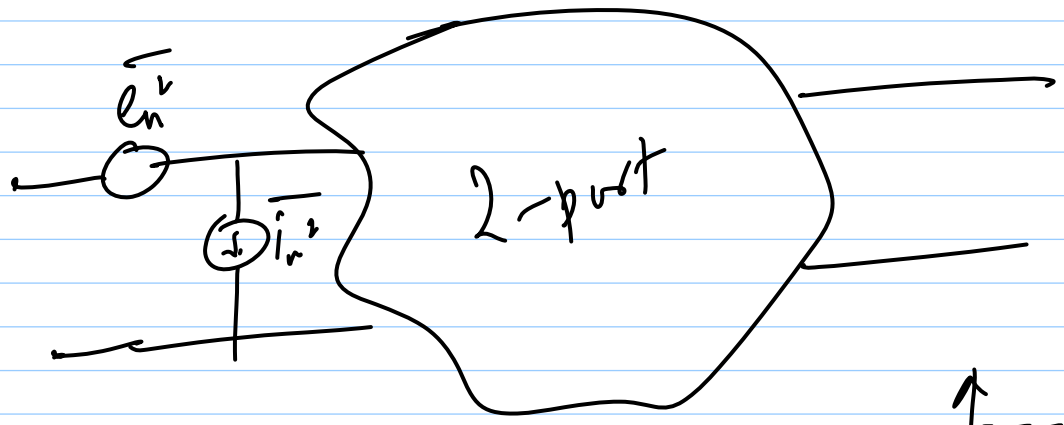
(3)



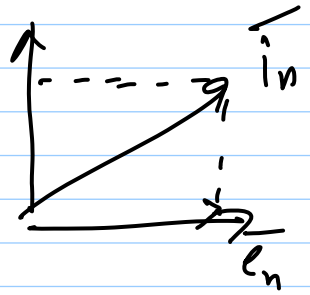
$\overline{V_{on}^2}/\Delta f$ = Same as (1)

$\overline{e_n^2}/\Delta f$ = same as (1)

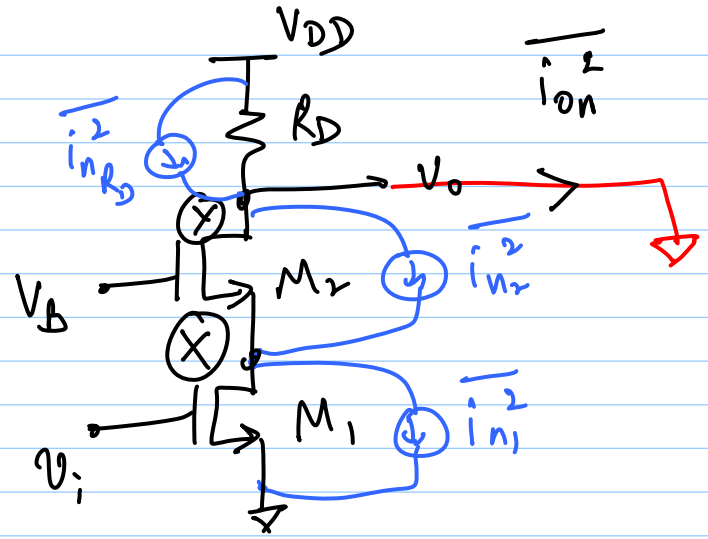
$\overline{i_n^2}/\Delta f \cdot \frac{1}{\omega^2 C^2} = \overline{e_n^2}$



$\overline{i_n} = \overline{i_{nc}} + \overline{i_{nu}}$



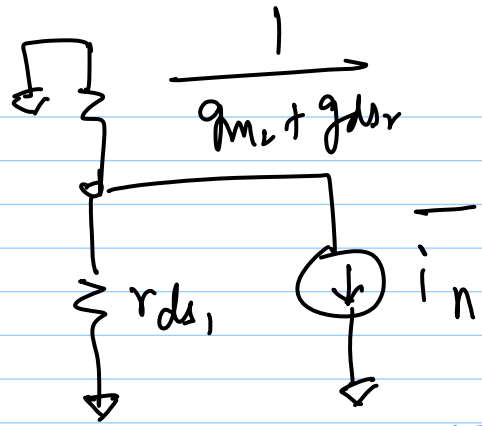
(4)



$$\overline{e_n^2} = \frac{\overline{i_{on}^2}}{g_{m_1}^2}$$

a) R_D: $\dfrac{4kT}{R_D}$

b) M_1: $\dfrac{8kT}{3} \cdot g_{m_1} \left(\dfrac{r_{ds_1}}{r_{ds_1} + 1/g_{m_2}} \right)^2 \approx \dfrac{8kT}{3} g_{m_1}$



$g_m \gg \dfrac{1}{r_{ds}}$

$\Rightarrow$ all of $\overline{i_{n_1}}$ flows through M_2

c) M_2: