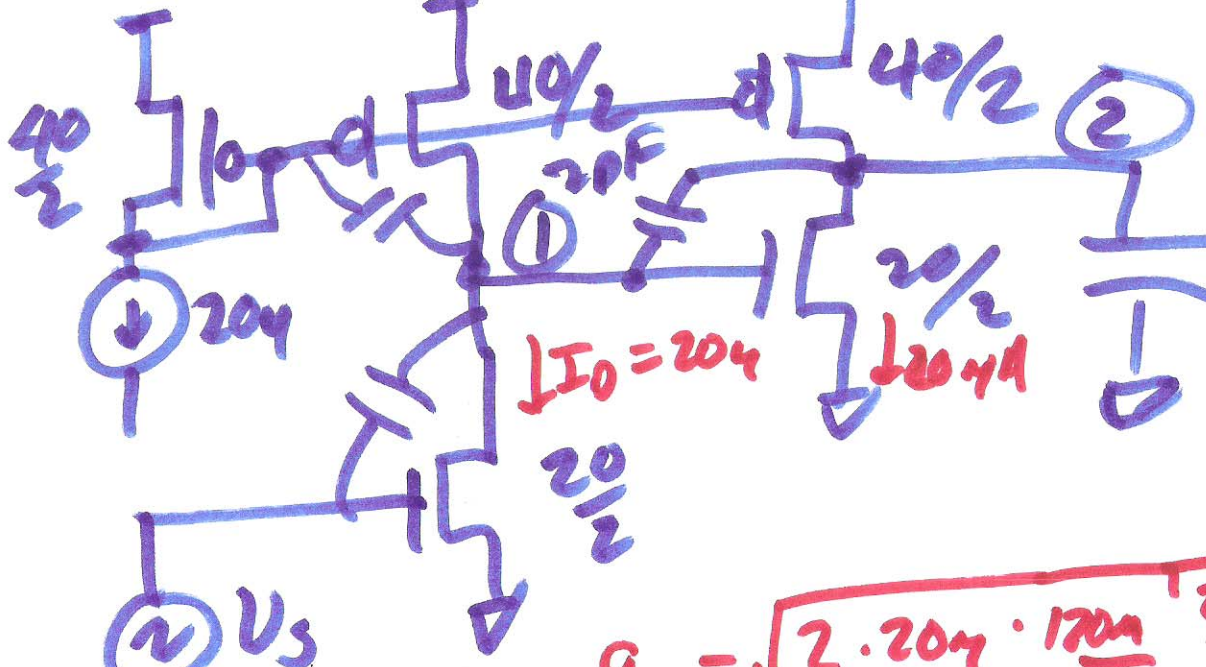
EE 422 EGG 622
Analog IC Design

4/17/13

Lecture 24

A21.23

$C_1 = C_{gs} + C_{gd} + C_{ds}$



$r_{op} = \frac{1}{20\mu \cdot .0125\frac{V}{V}} = 4M\Omega$

$r_{oN} = \frac{1}{20\mu \cdot .01} = 5M\Omega$

$g_{mN} = \sqrt{2 \cdot 20\mu \cdot 120\mu \frac{20}{2}} = \sqrt{40 \cdot 1200}\ \frac{\mu A}{V} = \sqrt{48{,}000}\ \frac{\mu A}{V}$

$R_1 = R_2 = r_{op} \| r_{oN} = 2.22M\Omega$

$g_{m1} = g_{m2} = g_m$

$g_m = 220\mu\frac{A}{V}$

$C_c = 2pF$

1)

$$C_1 = C_{gsN} + C_{gdN} + C_{dgP}$$

46.6 4 8

$C_1 = 58.6\,fF$

$C_2 \simeq 10\,pF$

$R_1 = R_2 = 7.2e6$

$g_{m1} = g_{m2} = 220\mu A$

$g_{m1} \cdot R_1 = g_{m2} \cdot R_2 = 485 \rightarrow$

$g_{m1} \cdot g_{m2} \cdot R_1 \cdot R_2 = 485^2$

$= 240K$

Low freq. gain $\rightarrow$ 107dB

2)

$$f_1 \approx \frac{1}{2\pi g_{m2} R_1 R_2 C_c} = \frac{1}{2\pi \cdot 488 \cdot 2.2e6 \cdot 2pF}$$

$$= \frac{1}{(2\pi)(488)(4.4e{-}6)}$$

$$f_1 = \frac{1}{15 \cdot 10^{-3}} = \frac{1}{.015}$$

$$= \underline{74\ Hz}$$

$$f_2 = \frac{g_{m2}}{2\pi \cdot C_c} \qquad 2204$$

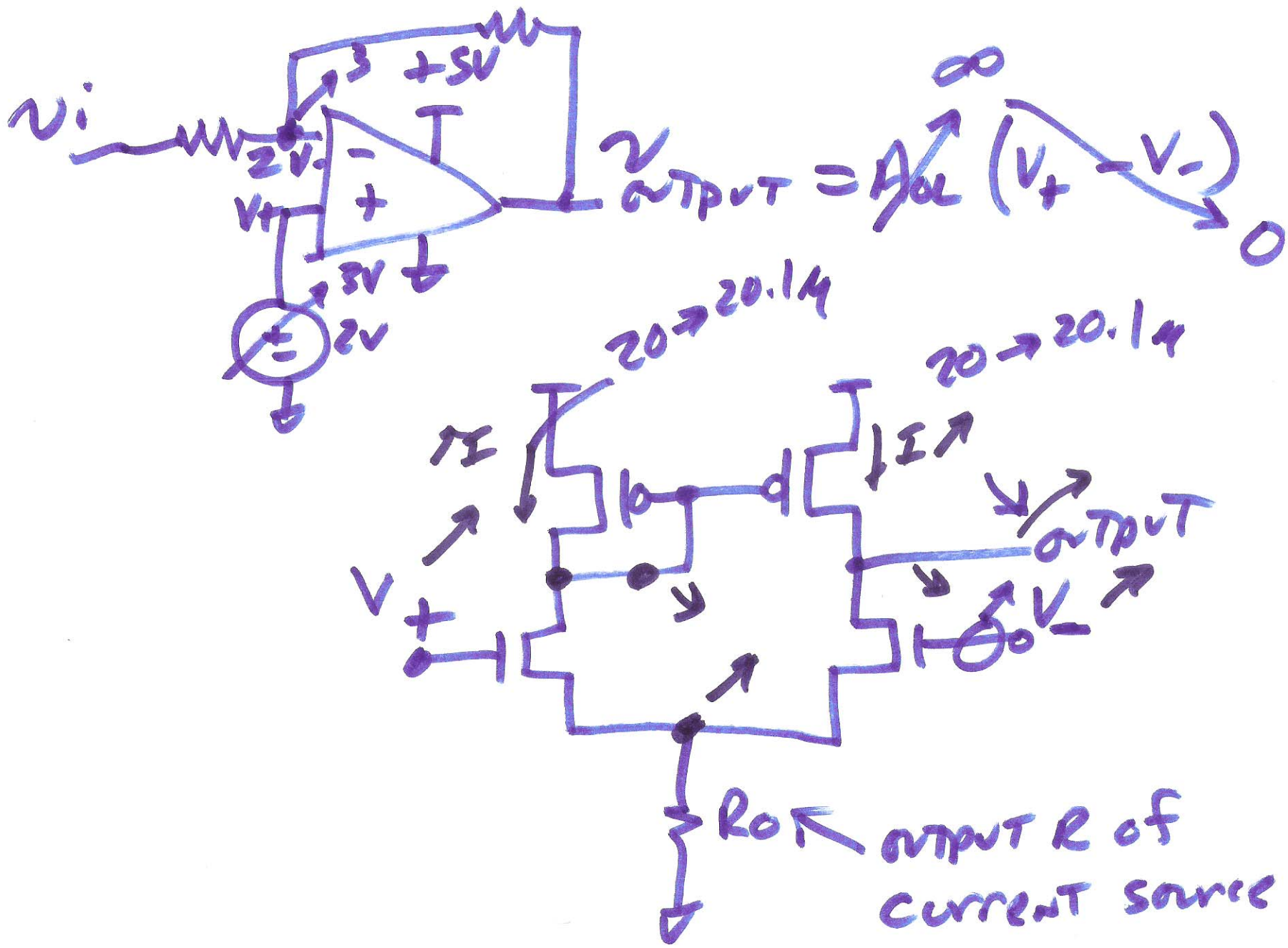
$$= \frac{2204}{2\pi \cdot 2pF} = \frac{2204}{2\pi \cdot 2pF} = \underline{17.5MHz}$$

$$f_2 = \frac{g_{m2}}{2\pi \cdot \left(C_1 + \frac{C_1 C_2}{2204 C_c} + C_2\right)} \qquad \frac{2204}{2\pi \cdot 10.3p}$$

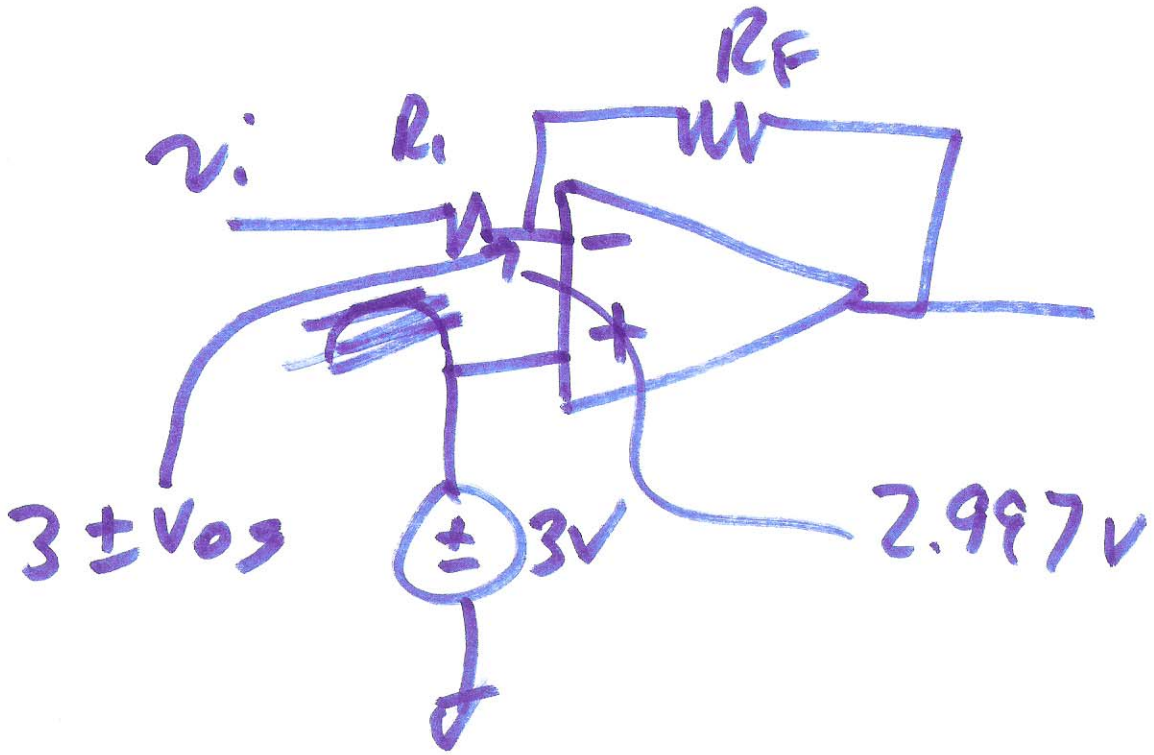
$$= \frac{}{2\pi\left(58.6f + \frac{58.6 \cdot 10pF}{2pF} + 10pF\right)}$$

$$f_2 = \underline{3.48MHz}$$

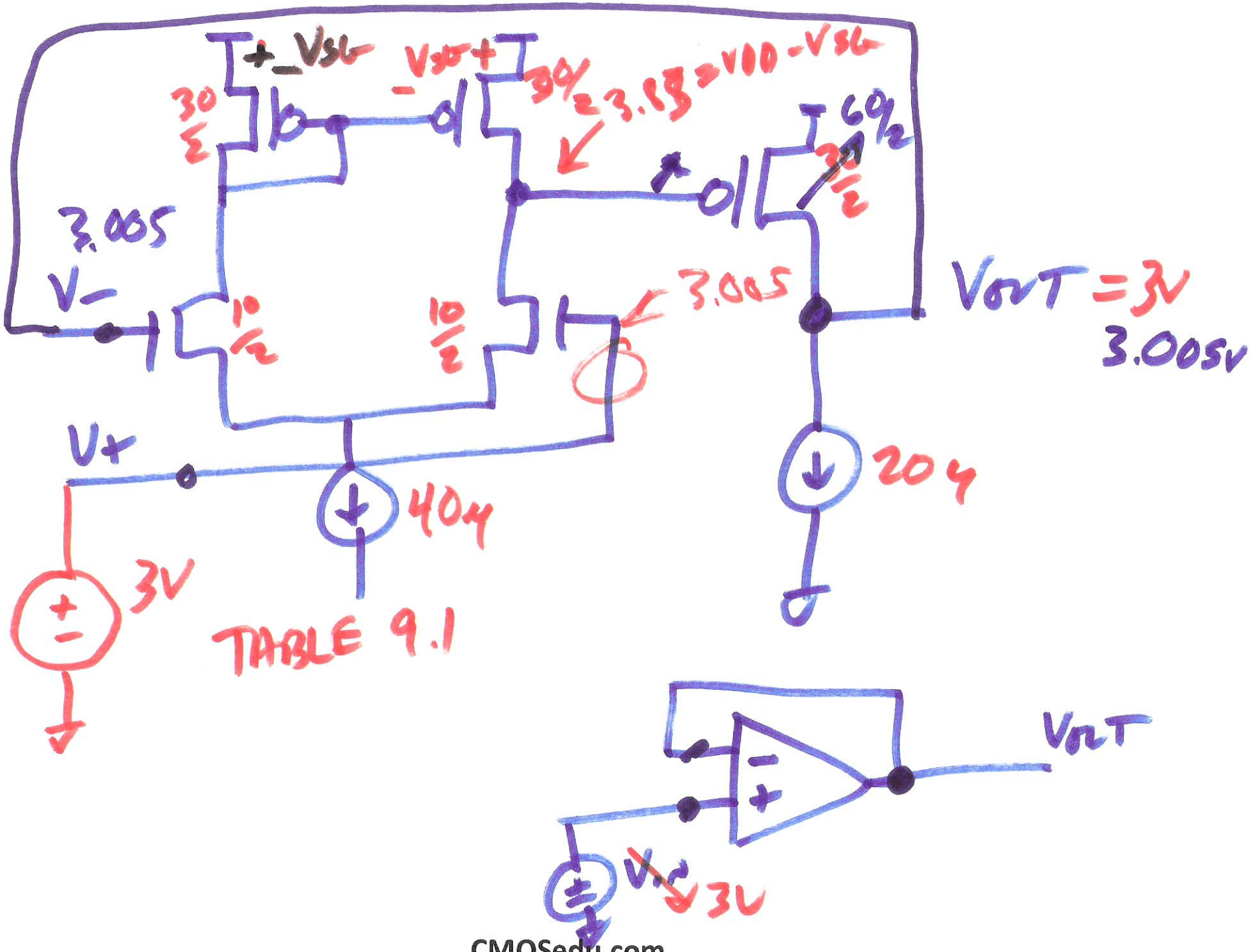
3)


Vi
3
+5V
2Vi
V+
5V
2V
Voutput = AOL (V+ − V−)
∞
0
20 → 20.14
20 → 20.14
I
I
V+
V−
output
RO ← output R of current source

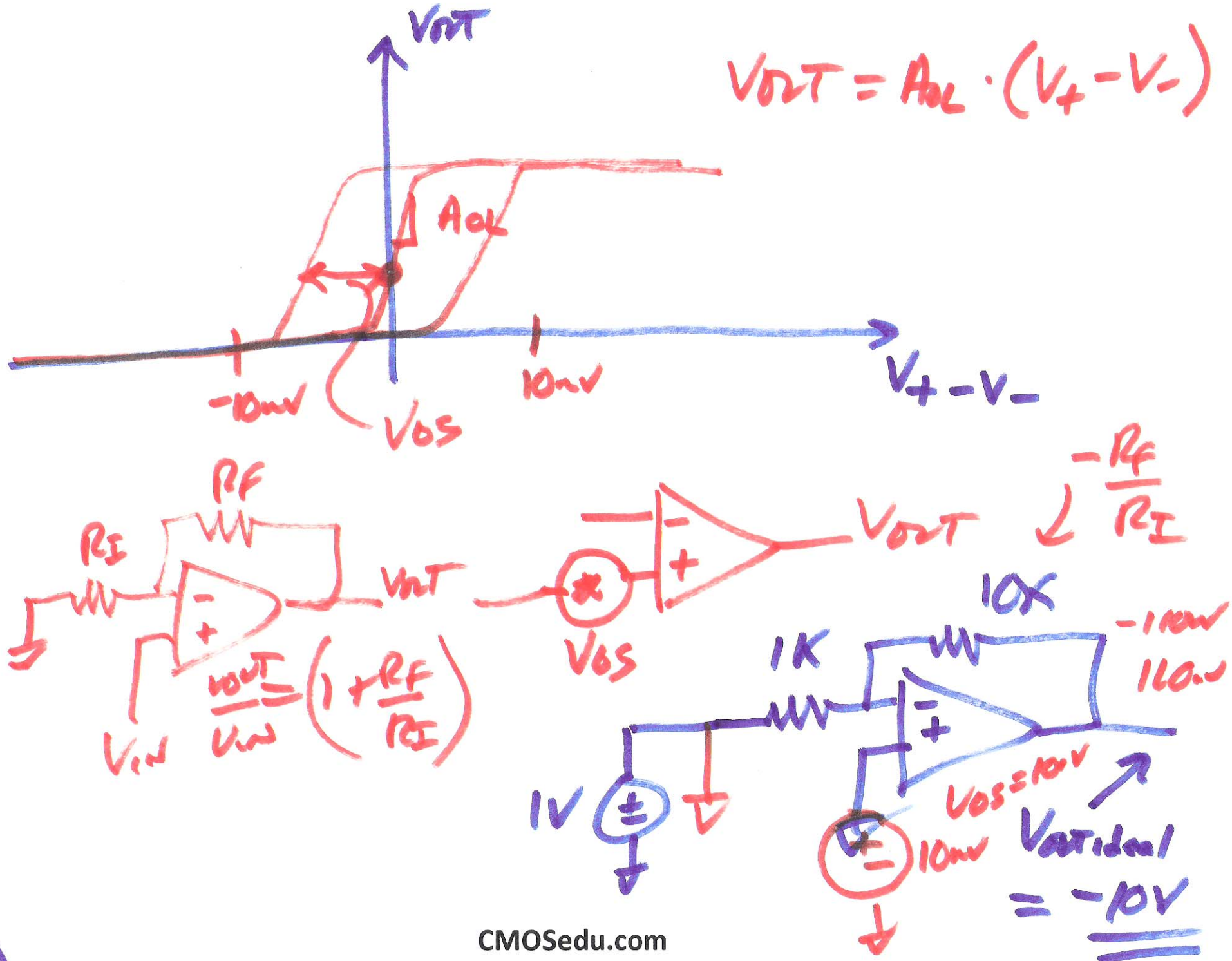
4)



5)



6)



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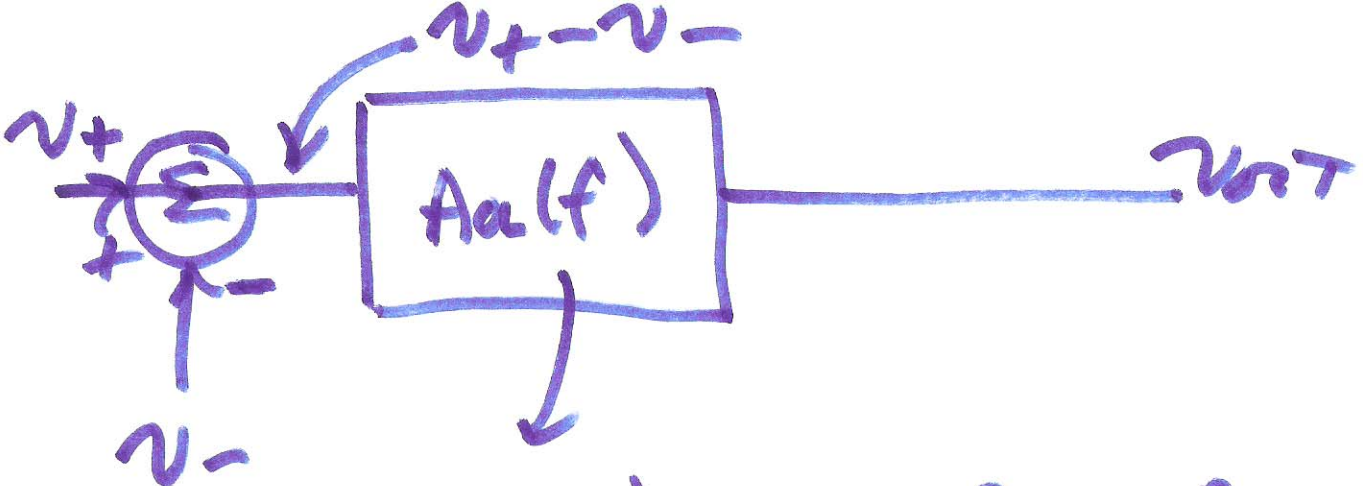
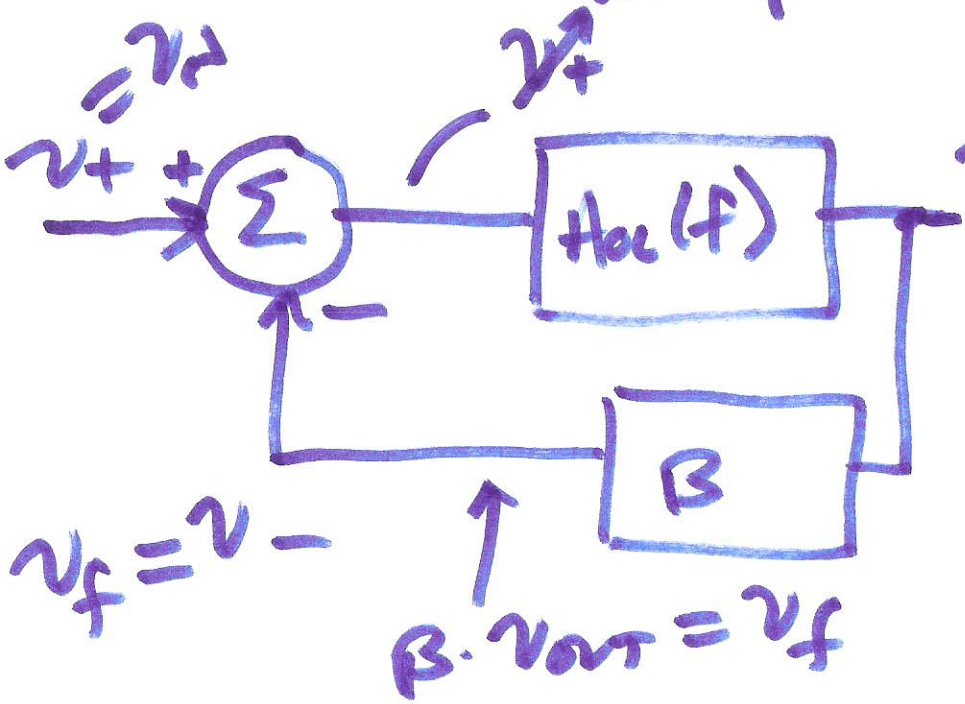
7)



$$A_{OL}(f) = g_{m1} R_1 g_{m2} R_2 \cdot \frac{1 - j\frac{f}{f_{z2}}}{\left(1 + j\frac{f}{f_1}\right)\left(1 + j\frac{f}{f_{p2}}\right)}$$



$$v_{OUT} = A_{OL}(f)(v_{in} - \beta v_{OUT})$$

$$\frac{v_{OUT}}{v_{in}} = \frac{A_{OL}}{1 + \beta A_{OL}} \xrightarrow{-1}$$

$$= \frac{1}{\frac{1}{A_{OL}} + \beta}$$

$$A_{CL} = \frac{v_{OUT}}{v_{in}}\Big|_{A_{OL} \to \infty} = \frac{1}{\beta}$$

8)

$$\frac{V_{OUT}}{V_{IN}} = 1 + \frac{R_F}{R_E}$$

$$\beta = \frac{1}{10} \qquad A_{CL}\Big|_{ideal} = 10 = \frac{1}{\beta}$$

$A_{OL} = \infty$

UNSTABLE

$$A_{CL}(f) \cdot \beta = -1$$

$$|A_{CL} \cdot \beta| = 1 \qquad \angle A_{OL} \cdot \beta = 180^\circ$$

when all V_{OUT} fedback $\beta = 1$

$$|A_{OL}| = 1 \qquad \angle A_{OL} = 180^\circ$$