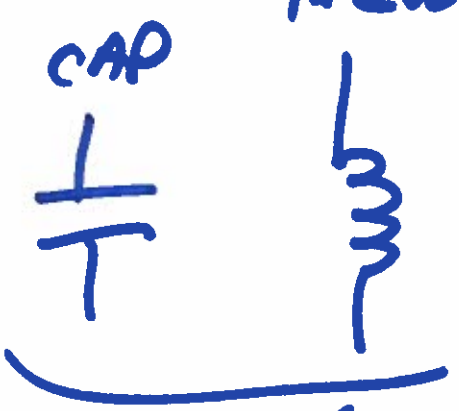
# EE 220 Circuits 1

OCT. 2, 2019

Lecture 11

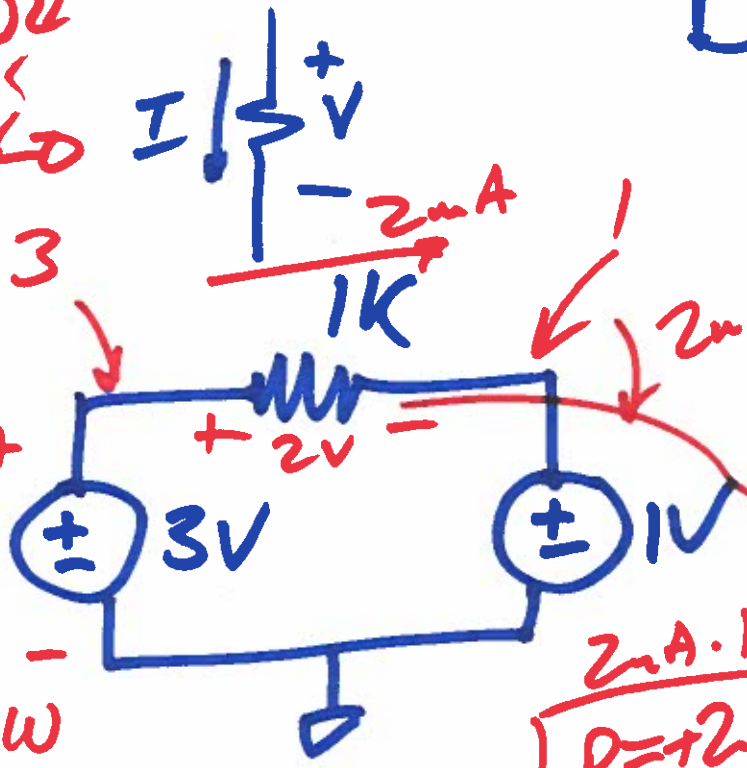




DC ckts

Power = I · V (WATts)

$V = IR, \quad I = \frac{V}{R}$

$P = \frac{V^2}{R} = I^2 R$




2V · 2mA = 4mW

WATts = joules / s

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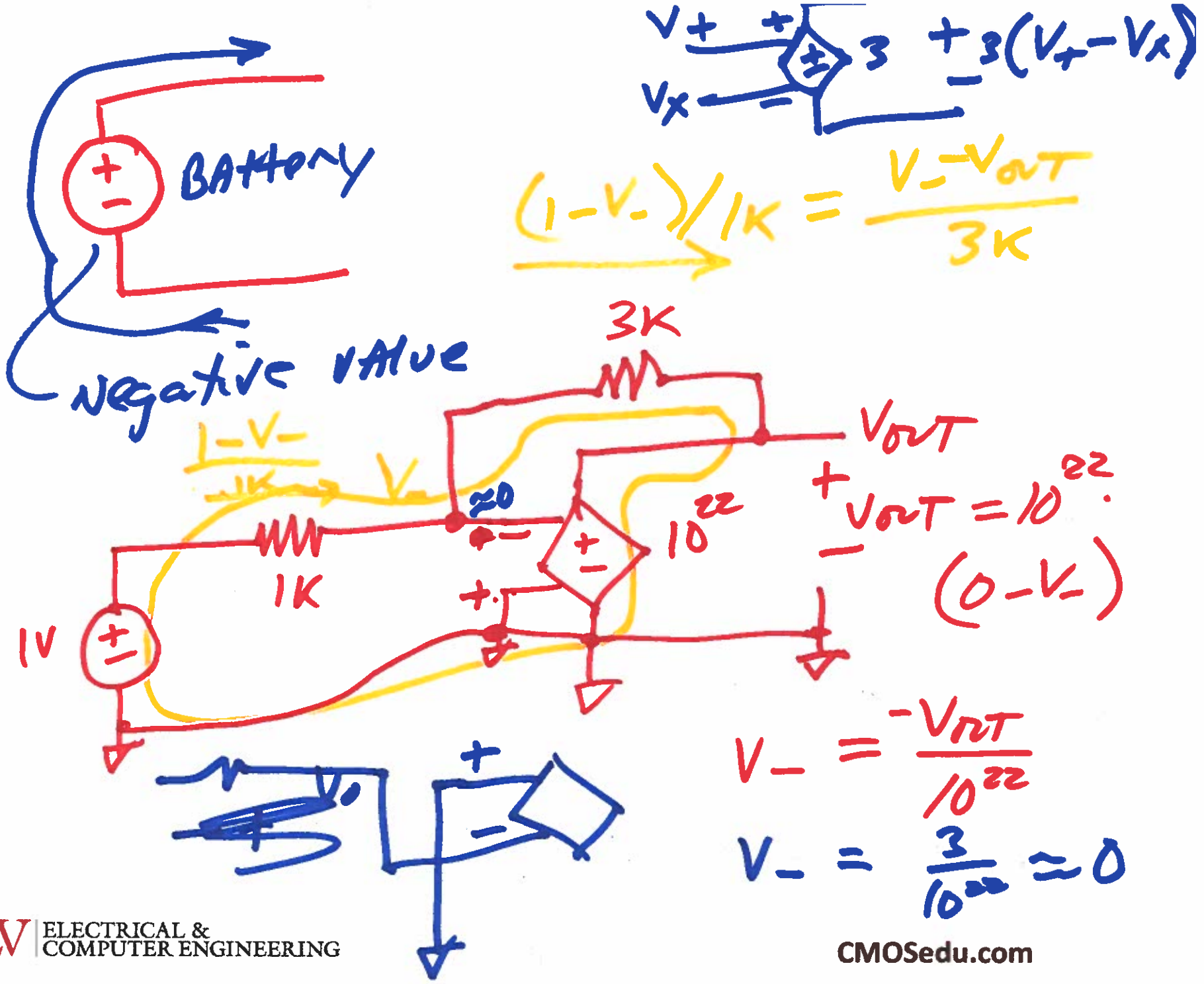
1)


BATTERY
Negative value
3K
1K
1V
≈0
$10^{22}$
$V_{OUT}$
$+V_{OUT} = 10^{22}\,(0 - V_-)$
$(1 - V_-)/1K = \frac{V_- - V_{OUT}}{3K}$
$V_- = \frac{-V_{OUT}}{10^{22}}$
$V_- = \frac{3}{10^{22}} \simeq 0$
$V_+$
$V_x$
$3(V_+ - V_x)$

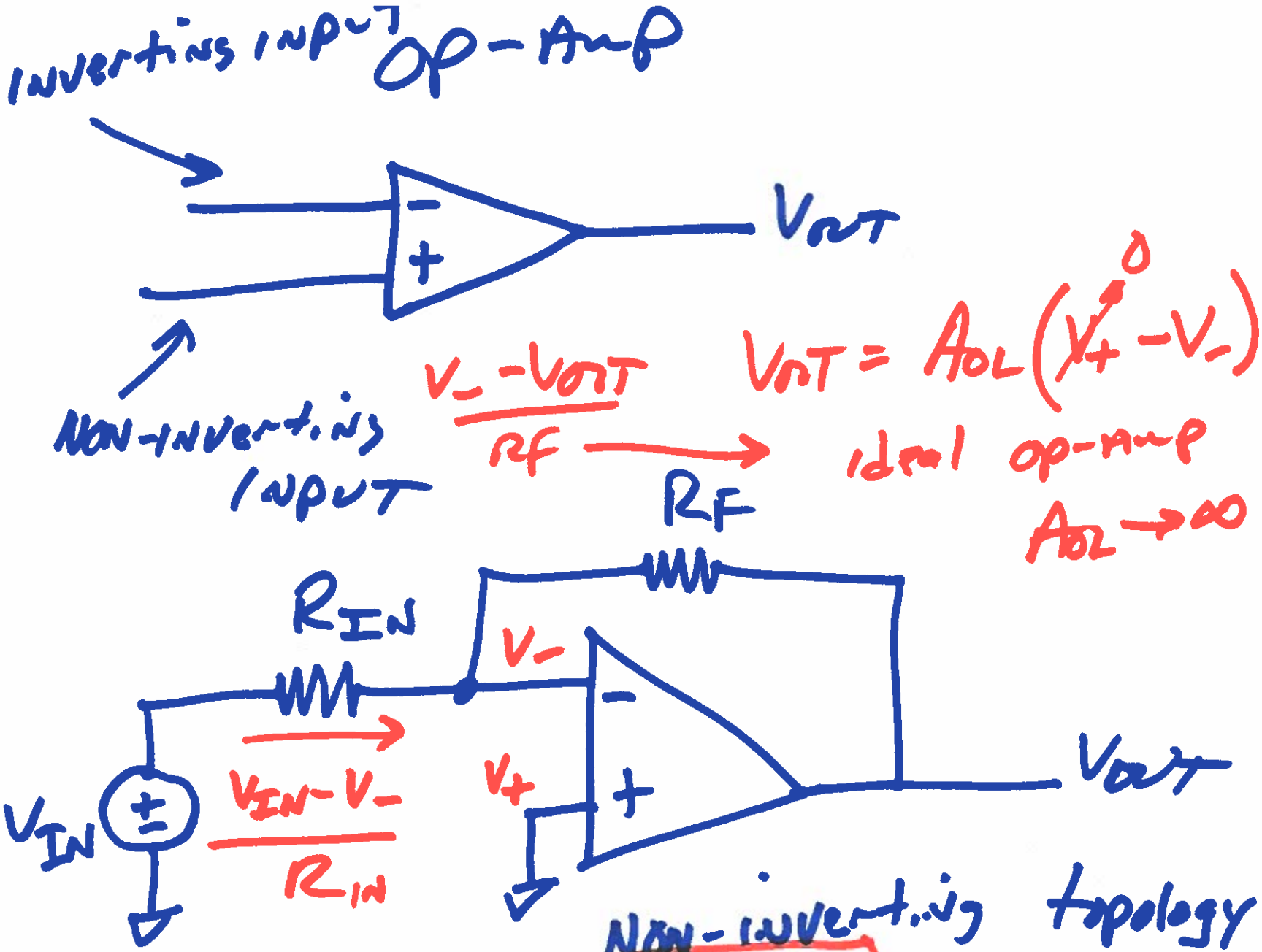
$$(1 - V_-)3 = V_- - V_{DT}$$

$$V_- = -\frac{V_{DT}}{10^{22}}$$

$$3 + \frac{3V_{DT}}{10^{22}} = -\frac{V_{DT}}{10^{22}} - V_{DT}$$

$$3 = -\frac{4V_{DT}}{10^{22}} - V_{DT}$$

$$\boxed{V_{DT} \approx -3}$$


INVERTING INPUT
OP-AMP
NON-INVERTING INPUT
$V_{OUT}$
$V_{OUT} = A_{OL}(V_+ - V_-)$
$V_+ \to 0$
ideal op-amp
$A_{OL} \to \infty$
$\frac{V_- - V_{OUT}}{R_F}$
$R_F$
$R_{IN}$
$V_-$
$V_+$
$V_{IN}$
$\frac{V_{IN} - V_-}{R_{IN}}$
$V_{OUT}$
NON-INVERTING topology
$\frac{V_{OUT}}{V_{IN}} = \frac{-R_F}{R_{IN}}$

$$\frac{V_{IN} - V_-}{R_{IN}} = \frac{V_- - V_{OUT}}{R_F}$$

$$V_- = -\frac{V_{OUT}}{A_{OL}}$$

$$\frac{R_F}{R_{IN}}\left(V_{IN} + \frac{V_{OUT}}{A_{OL}}\right) = \frac{-V_{OUT}}{A_{OL}} - V_{OUT}$$

$$\lim_{A_{OL}\to\infty} \frac{R_F}{R_{IN}} \cdot V_{IN} = V_{OUT}\left(-\frac{R_F}{R_I}\cdot\frac{1}{A_{OL}} - \frac{1}{A_{OL}} - 1\right)$$

$$V_{OUT} = -\frac{R_F}{R_I} \cdot V_{IN}$$

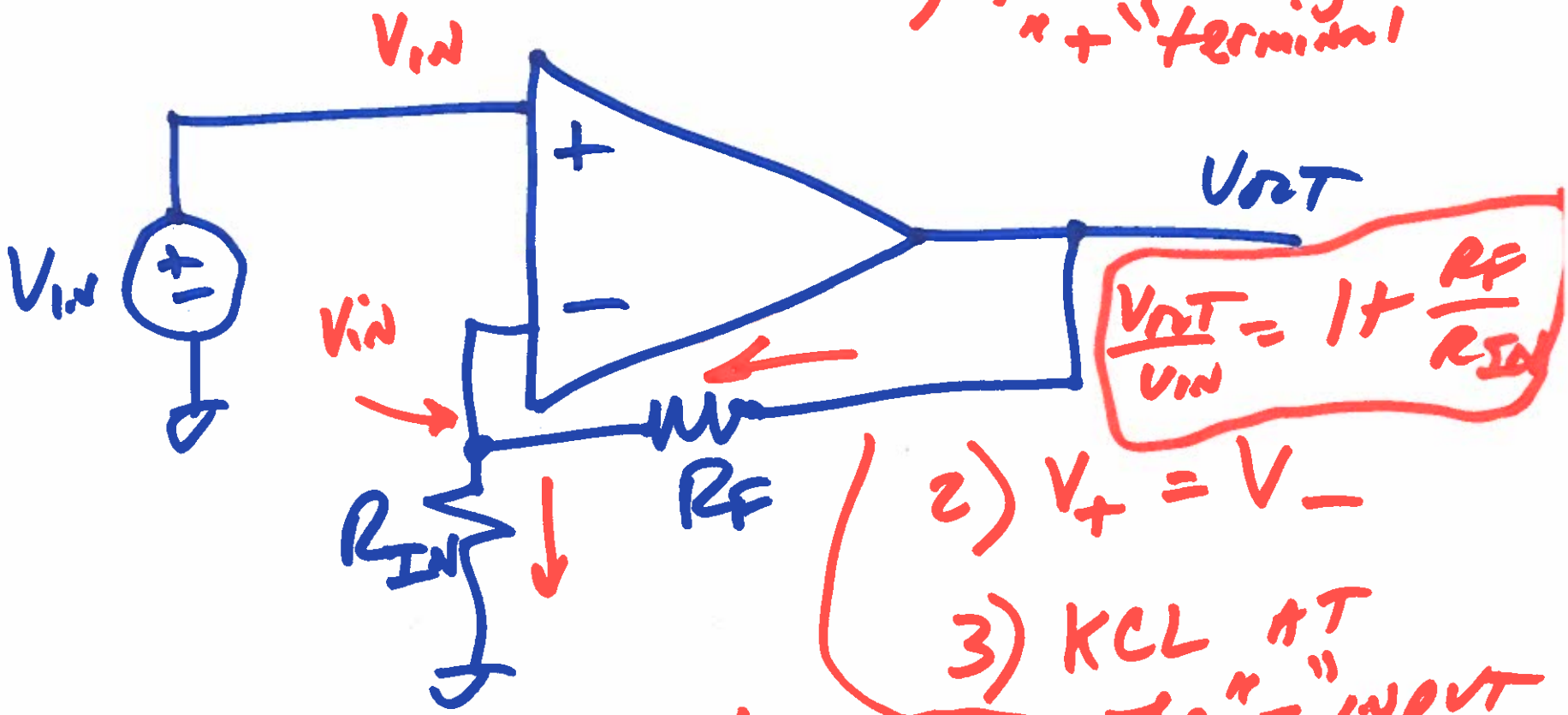
$$\boxed{\frac{V_{OUT}}{V_{IN}} = -\frac{R_F}{R_{IN}}}$$

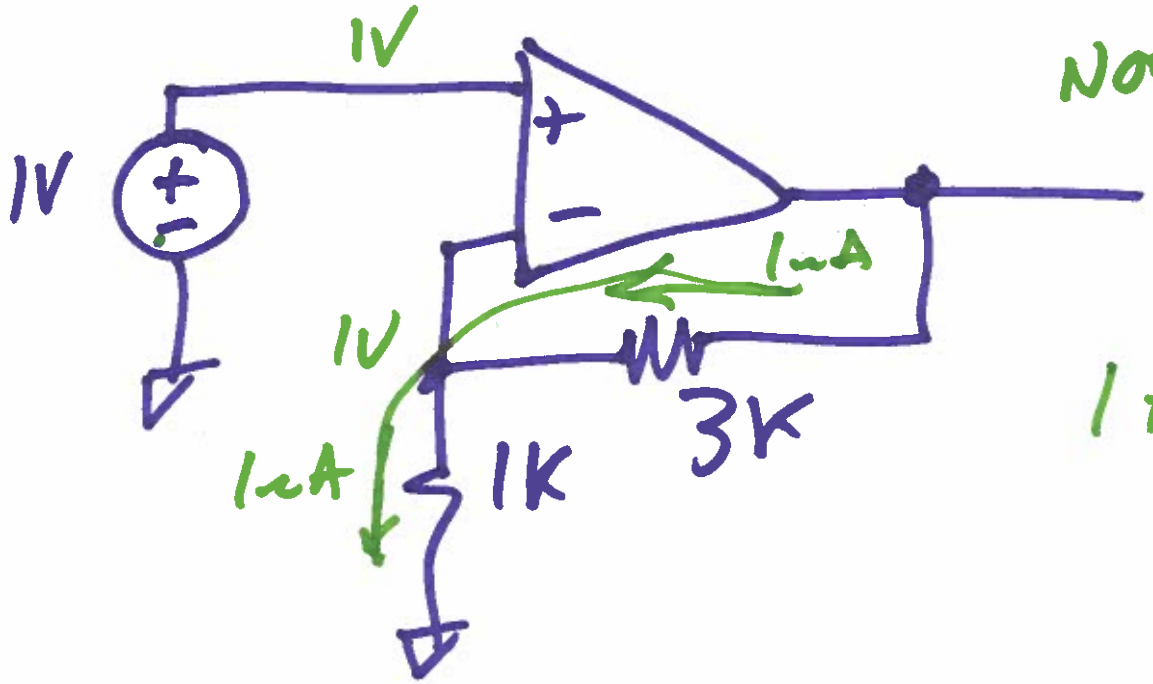
0 → −1

0 → −5 V

−5 → −5

# NON-INVERTING topology






$$1 + \frac{3K}{1K} = \frac{V_{OUT}}{1V}$$

$$= 4V$$

$$\frac{V_{OUT} - 1}{3K} = \frac{1}{1K}$$

$$V_{OUT} - 1 = 3$$

$$\boxed{V_{OUT} = 4V}$$