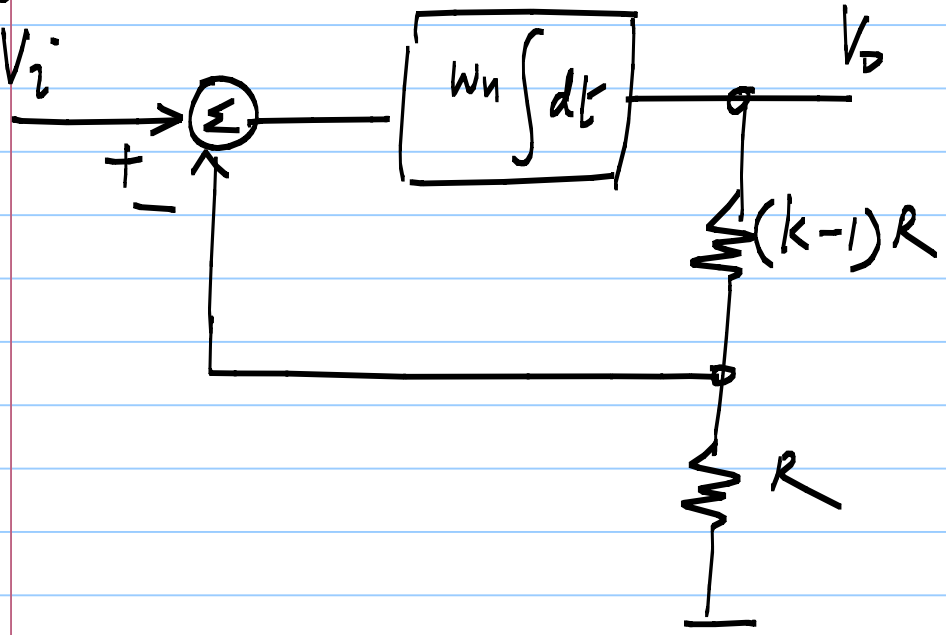
Lecture #5, Analog IC Design

Note Title 12/24/2010

Negative feedback amplifier



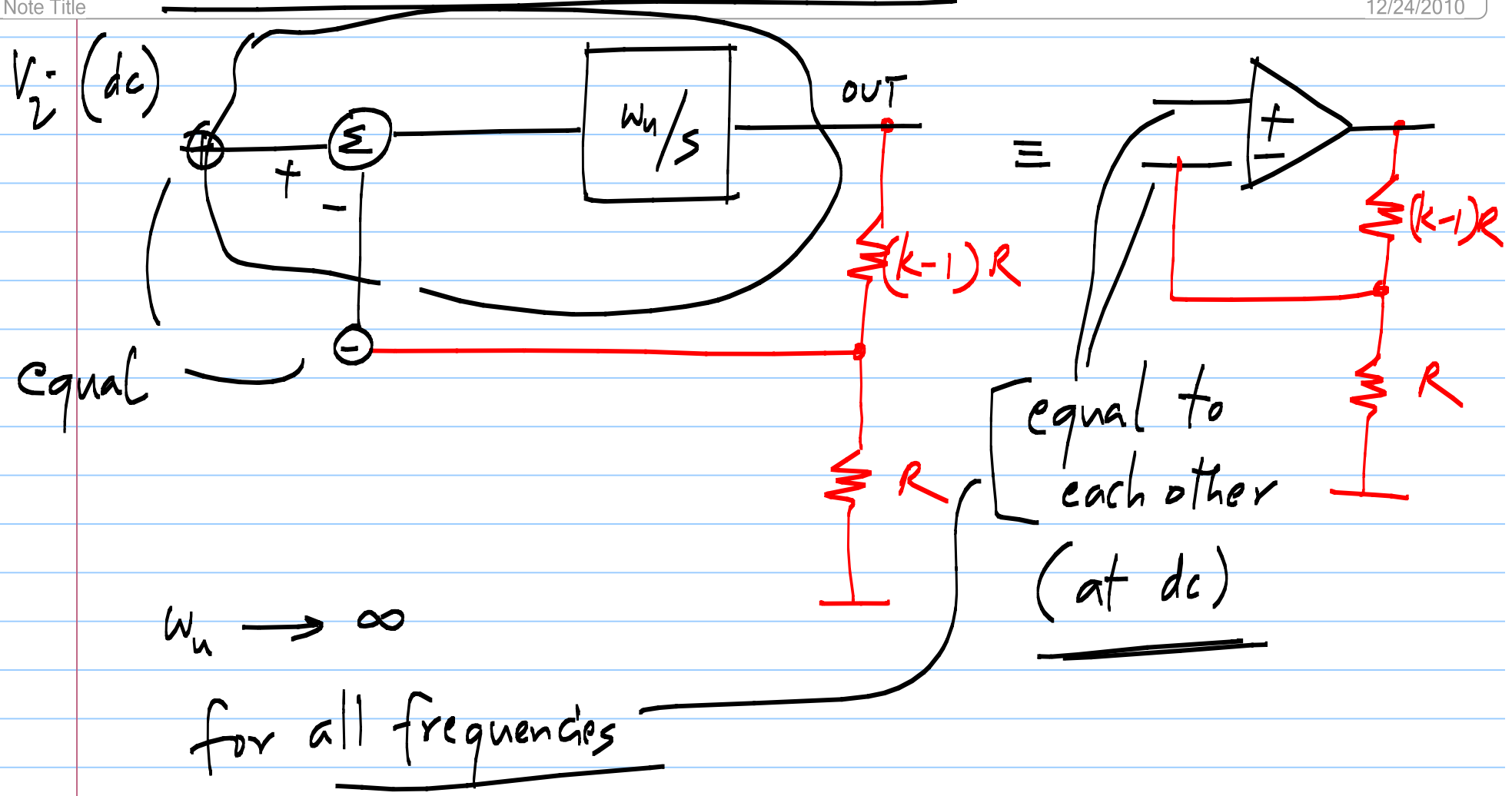
$$\text{time constant} = \frac{k}{w_n}$$

$$\text{bandwidth} = \frac{w_n}{k}$$

$$w_{n,loop} = \frac{w_n}{k}$$

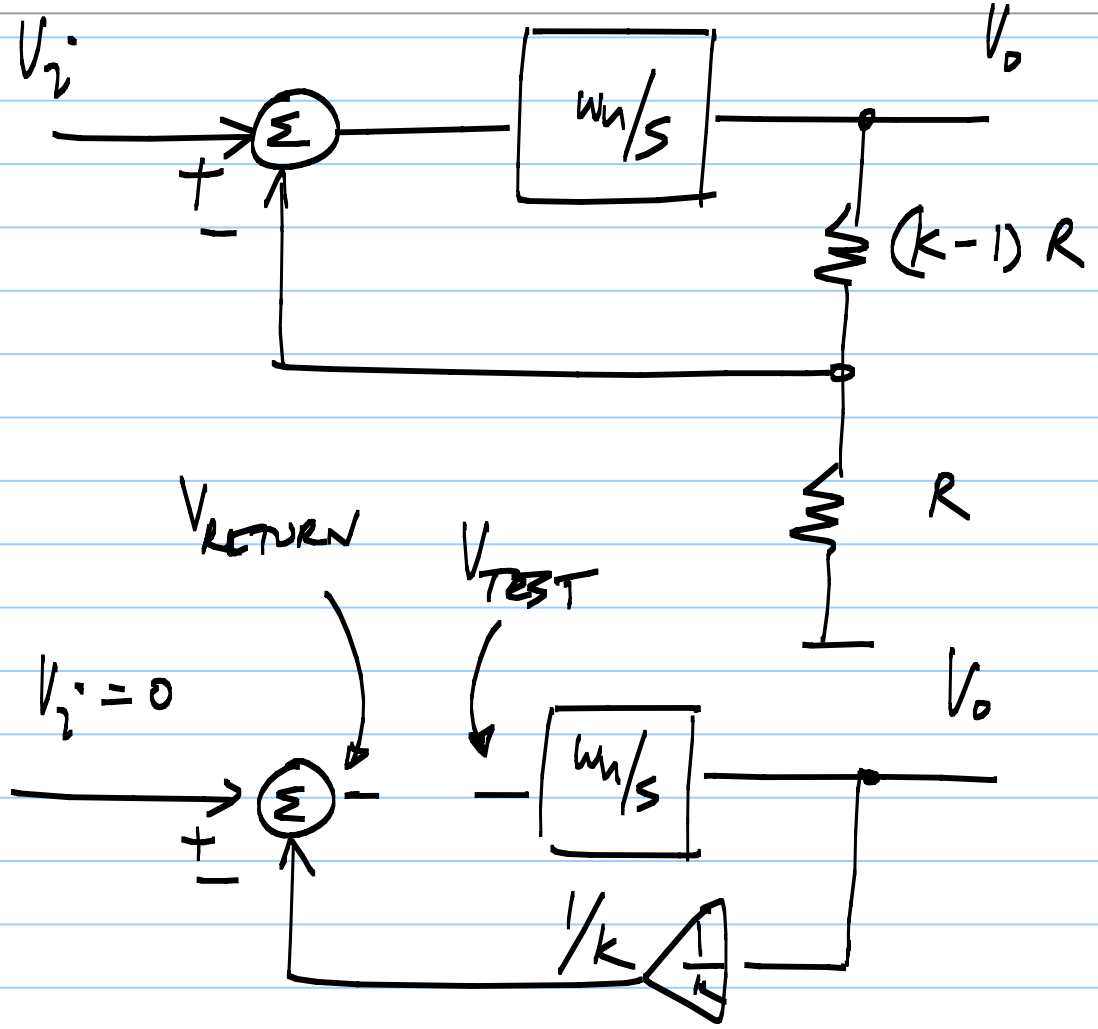
Operational amplifier: (opAmp)

Note Title 12/24/2010



Loop gain :

Note Title 12/24/2010



$$V_{RETURN} = -L(s) \cdot V_{TEST}$$

Loop gain

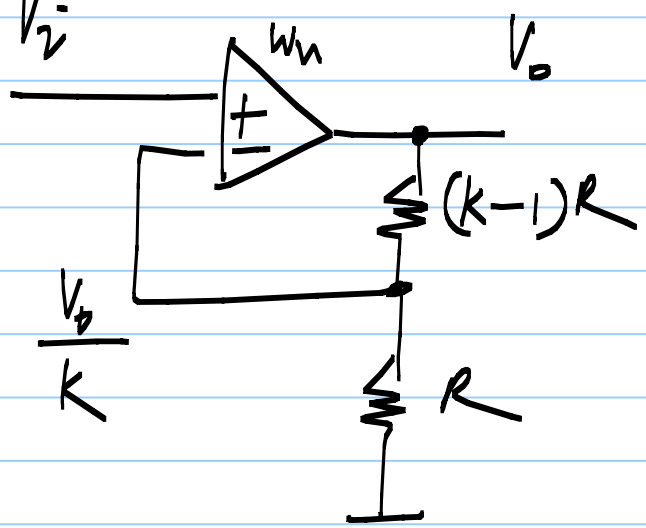
$|L(s)| \gg 1$

strong negative feedback

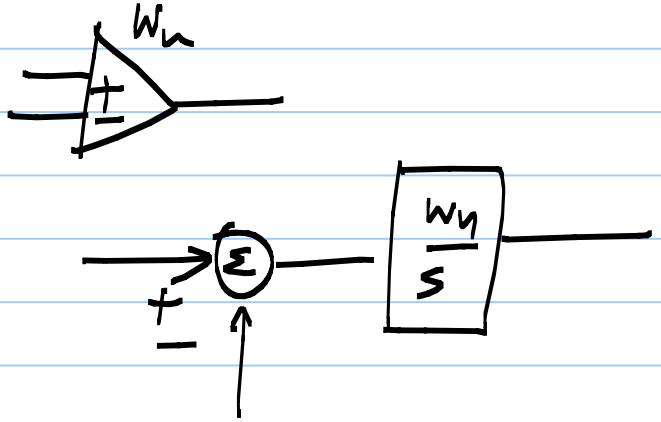
Other amplifiers using an opAmp.

Note Title 12/24/2010

VCVS:



$$V_o = k \cdot V_i$$



CCVS:

$$V_o = R_f \cdot I_i$$

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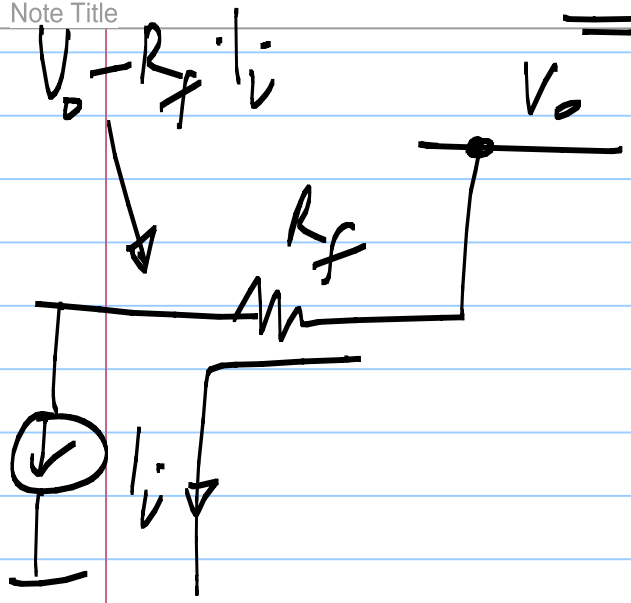
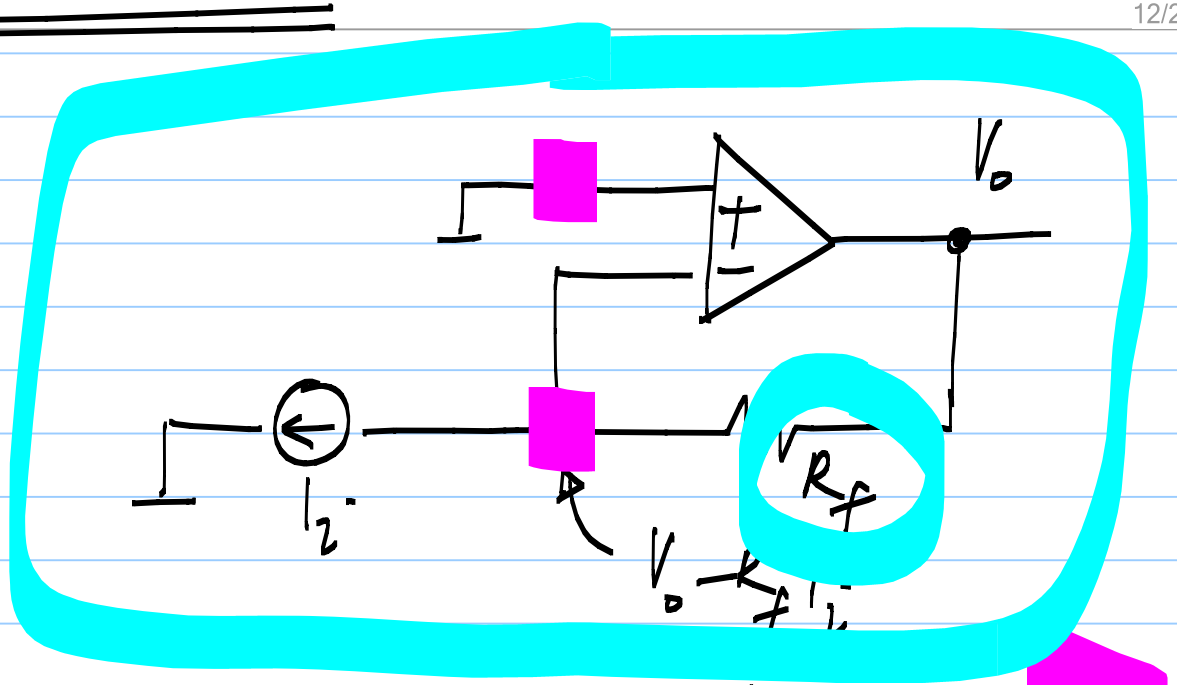
Note Title 12/24/2010



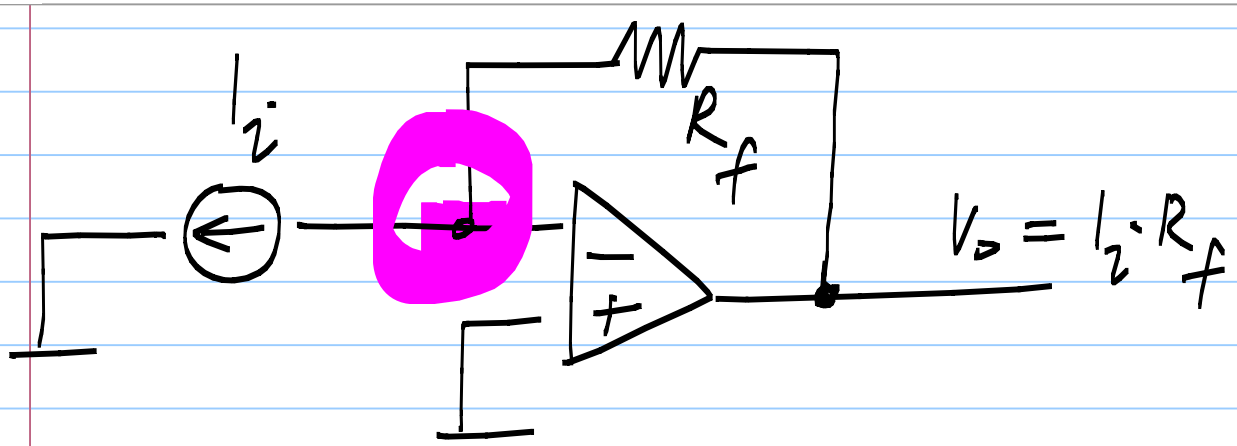


$(V_o - R_f \cdot I_i) > 0$ reduce V_o

$(V_o - R_f I_i) < 0$ increase V_o

CCVS: $V_o = I_i \cdot R_f$

Note Title 12/24/2010

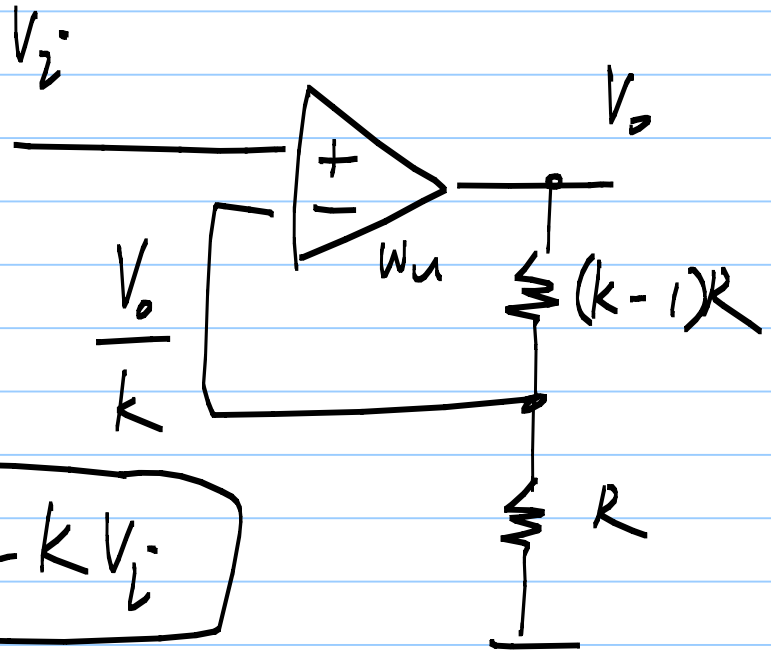


I_i (dc)

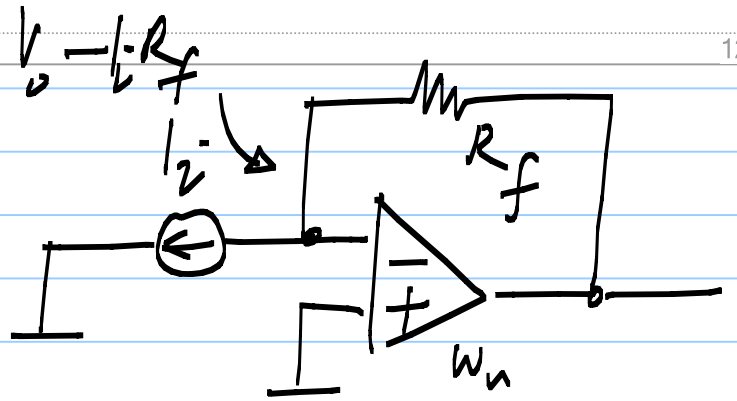
VCVS

CCVS

Note Title 12/24/2010



$V_o = k V_i$



$V_o = I_i \cdot R_f$

dc: $V_o/k = V_i$

$V_o - I_i \cdot R_f = 0$

$\omega_u \to \infty$ for all freq. $\frac{V_o}{k} = V_i$

$V_o - I_i \cdot R_f = 0$ IDEAL

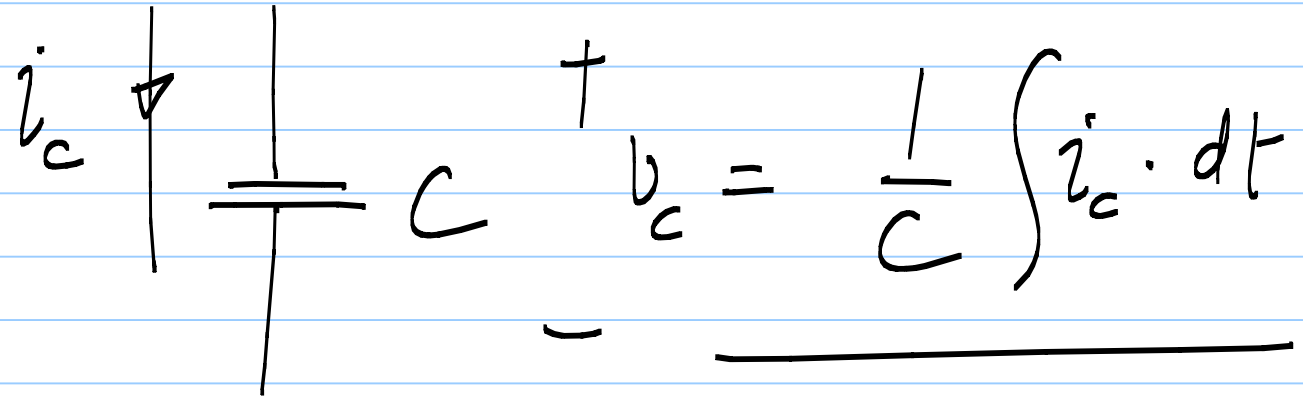
Integrator realization:

Note Title 12/24/2010

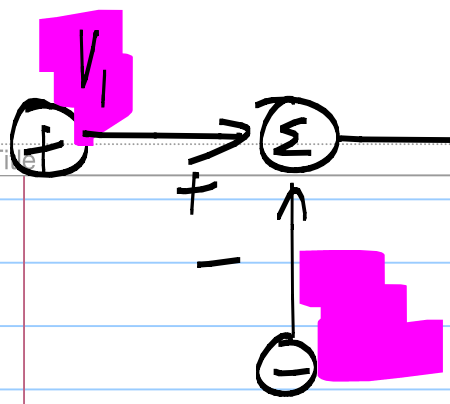
Integration using L or C

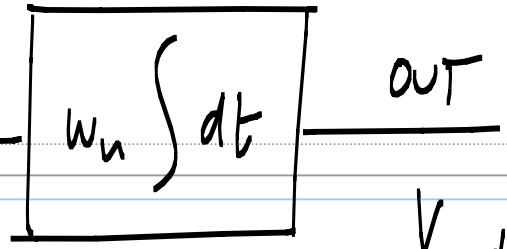
↓

Impractical

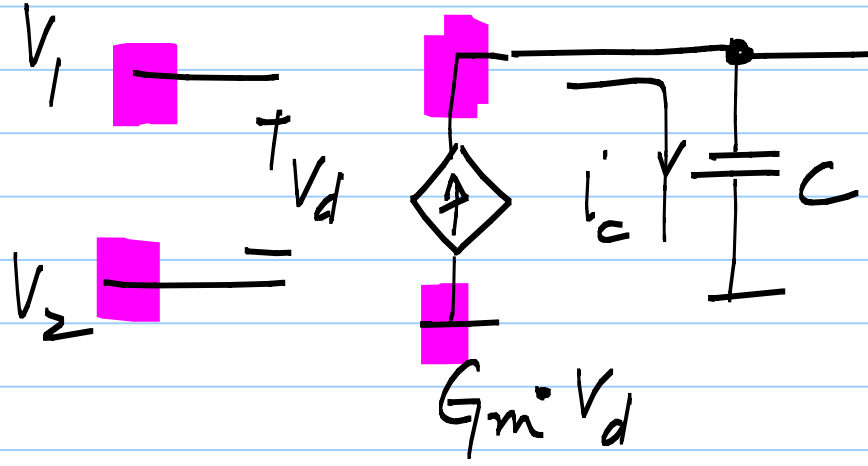


Note Title 12/24/2010





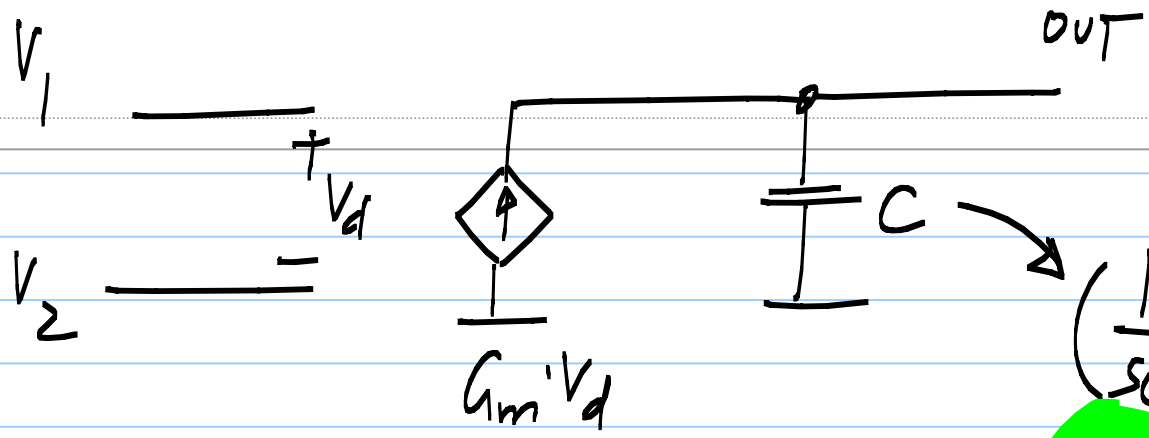
$$V_{out} = w_n \int (V_1 - V_2)\, dt$$



$$i_c = G_m \cdot V_d$$

$$\frac{G_m}{C} \cdot \int V_d \cdot dt$$

$$= \frac{G_m}{C} \int (V_1 - V_2)\, dt$$



$$V_{out} = G_m \cdot V_d \cdot \frac{1}{sC} = \frac{G_m}{sC}(V_1 - V_2)$$

$$V_{out} = \frac{\omega_u}{s}(V_1 - V_2)$$

$$\boxed{\omega_u = \frac{G_m}{C}}$$

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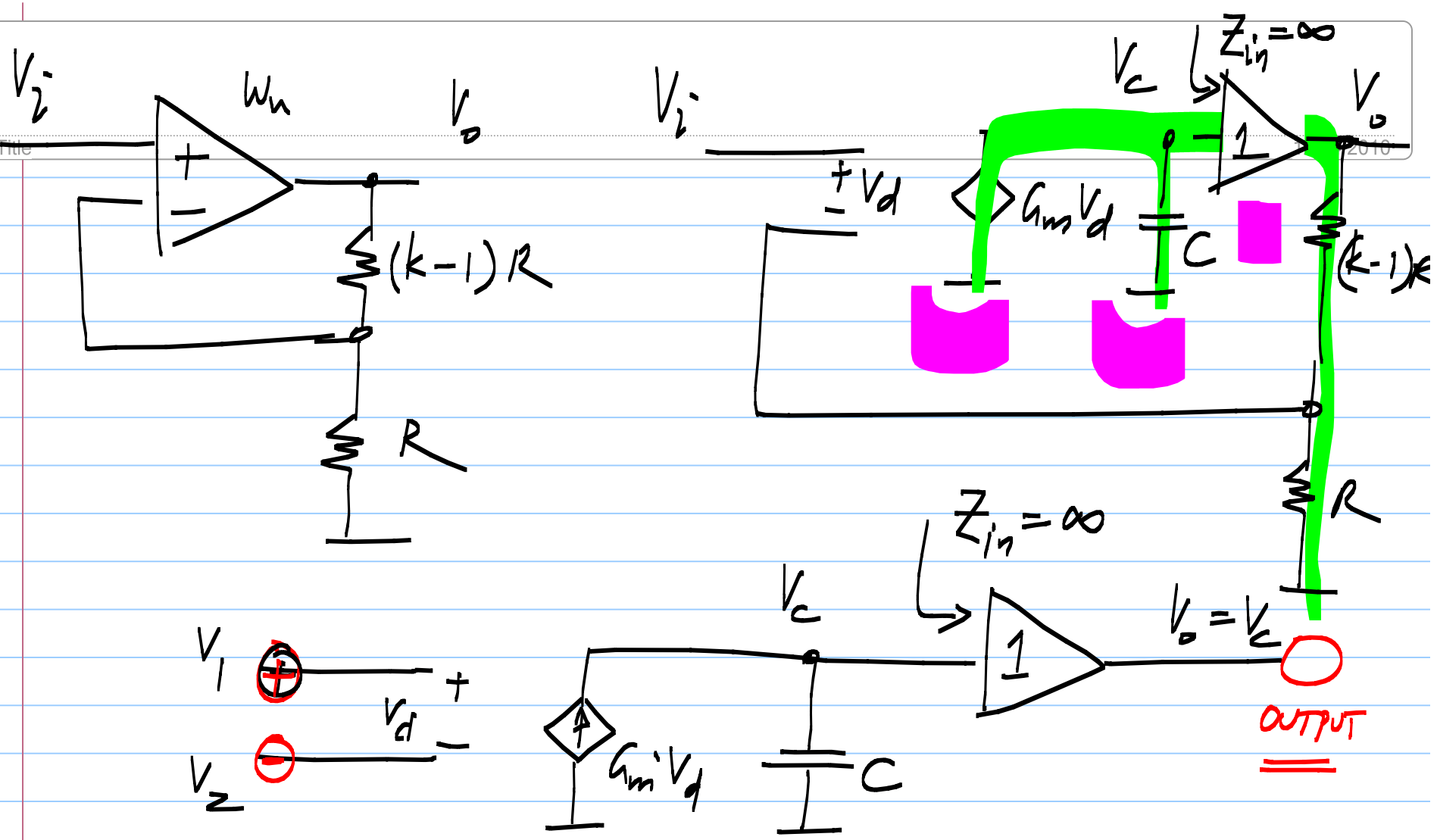
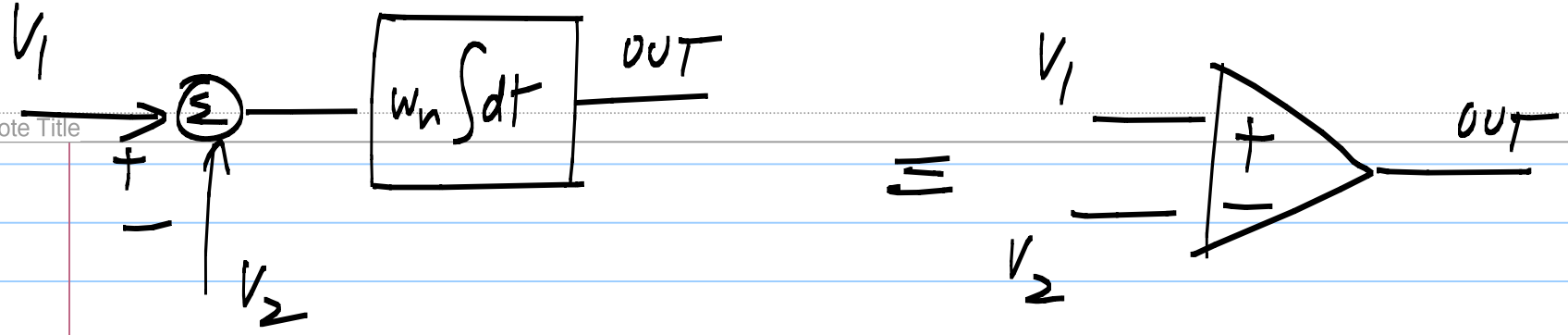
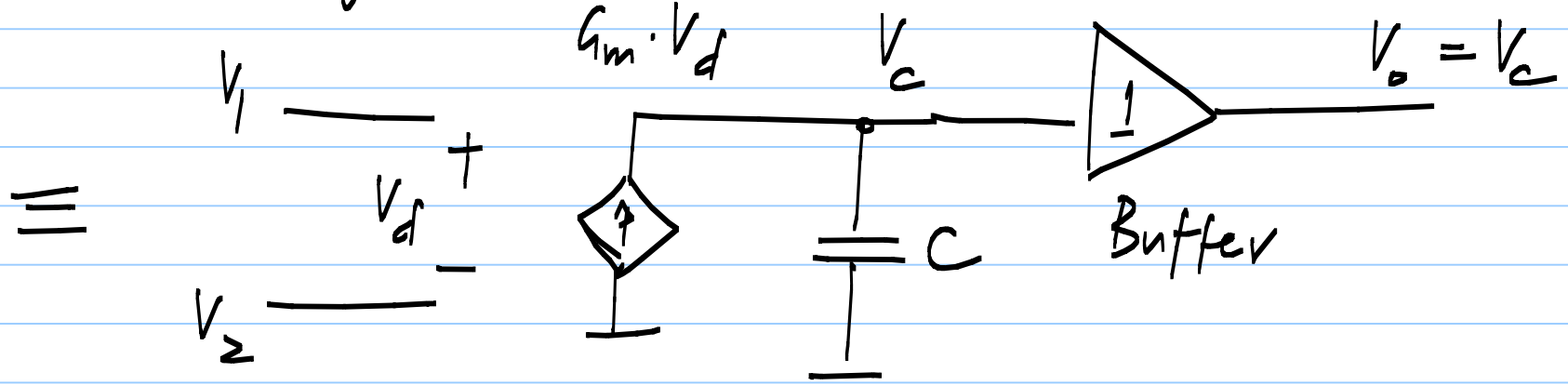

V_i
W_n
V_o
$(k-1)R$
R
V_i
V_c
$Z_{in}=\infty$
V_o
$\pm V_d$
$G_m V_d$
C
$(k-1)R$
R
$Z_{in}=\infty$
V_c
$V_o = V_c$
V_1
V_2
V_d
$G_m V_d$
C
OUTPUT



Take the difference & integrate

opamp



Realization

Note Title 12/24/2010