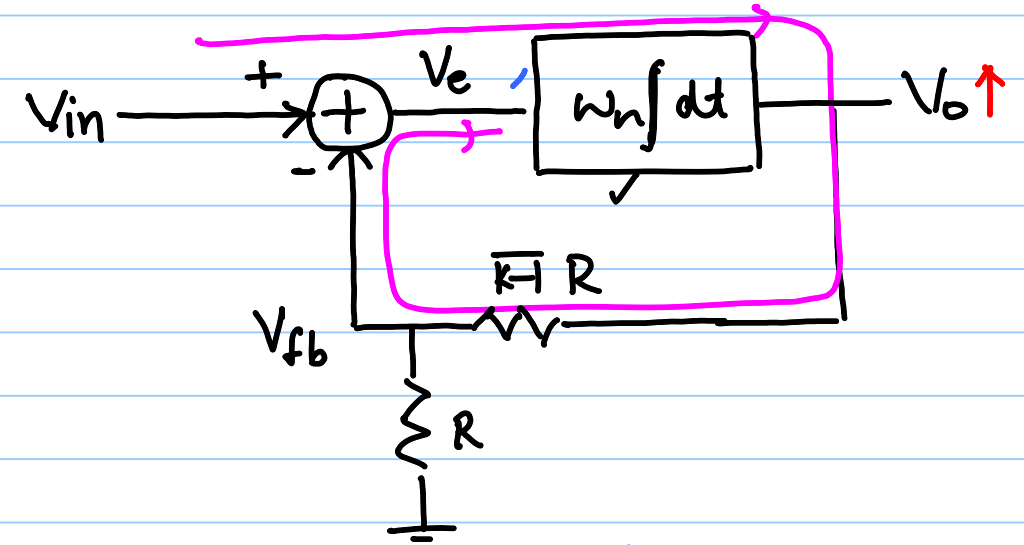
Note Title 27-01-2022

Lecture #5



$$V_{fb} = \frac{R}{R + \overline{K-1}\,R} V_o = \frac{V_o}{K}$$

$$V_e = V_{in} - V_{fb}$$

$$V_e = V_{in} - \frac{V_o}{K}$$

$$V_o = \omega_n \int V_e \, dt$$

$$V_o = \omega_n \int \left(V_{in} - \frac{V_o}{K}\right) dt \quad ✓$$

$$\frac{dV_o}{dt} = \omega_n \left(V_{in} - \frac{V_o}{K}\right)$$

$$\frac{dV_o}{dt} + \frac{\omega_n}{K} V_o = \omega_n . V_{in} \quad ✓$$

"Negative feedback"

t	V_{in}	V_e	V_o	V_{fb}
<0	0	0	0	0
0	1	1	0	0
0^+	1		Δ	
Δt	1	$\left(1 - \frac{\omega_n . \Delta t}{K}\right)$	$\omega_n . \Delta t$	$\frac{\omega_n . \Delta t}{K}$

$$\frac{d}{dt}\left(V_o e^{\omega_n t/K}\right) = \omega_n V_{in} . e^{\omega_n t/K}$$

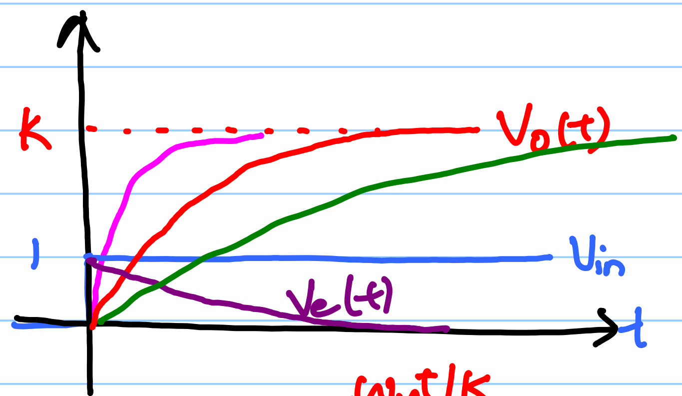
$$V_o = e^{-\omega_n t/K} \int \omega_n . V_{in} \, e^{+\omega_n t/K} \, dt + Q . e^{-\omega_n t/K}$$

for $t<0$, $V_{in}=0$, $V_o=0$

$t=0$, $V_{in}=u(t)\times V_{in}(0)$

$$V_o = e^{-\omega_n t/K}\int \omega_n . e^{+\omega_n t/K}\,dt + Qe^{-\omega_n t/K}$$

$$= e^{-\omega_n t/K}\,\frac{\omega_n . e^{\omega_n t/K}}{\omega_n/K} + Qe^{-\omega_n t/K}$$



$$V_o = K + Q e^{-\omega_n t/K}$$

$$\frac{dV_o}{dt} = K . e^{-\omega_n t/K} \times \frac{+\omega_n}{K} = \omega_n e^{-\omega_n t/K}$$

at $t=0$, $V_o=0$

$\Rightarrow \quad 0 = K + Q \Rightarrow Q = -K$

$$V_o = K - Ke^{-\omega_n t/K}$$

$$V_o = K V_{in}(0)\left(1 - e^{-\omega_n t/K}\right)$$

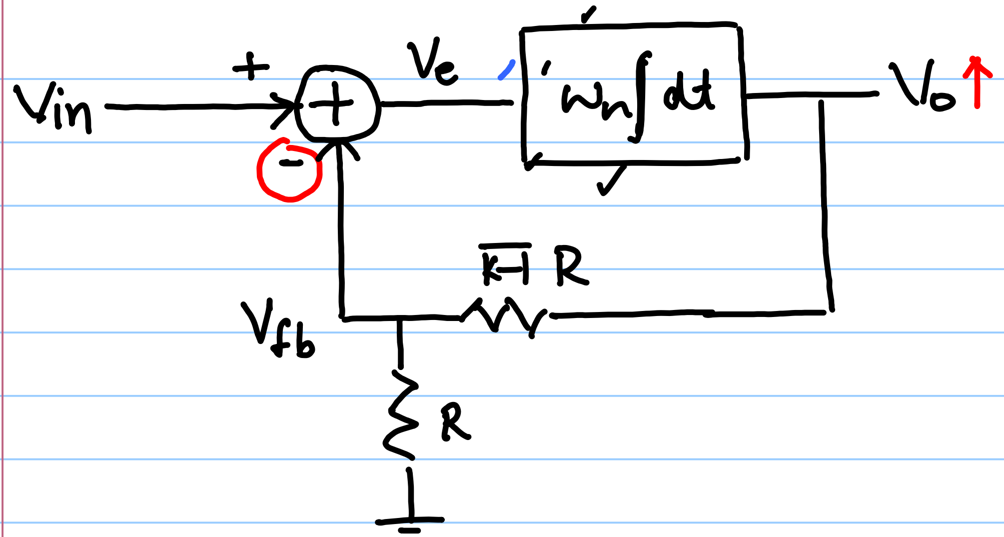
at $t\to\infty$, $V_o = K$

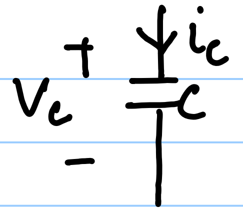
$$V_e(t) = V_{in} - \frac{V_o}{K}$$

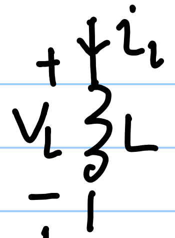
$$= V_{in}(0) . e^{-\omega_n t/K}$$

- Does final value of V_o depend on integrator coefficient ω_n?

- Does V_e depend on ω_n in steady state?





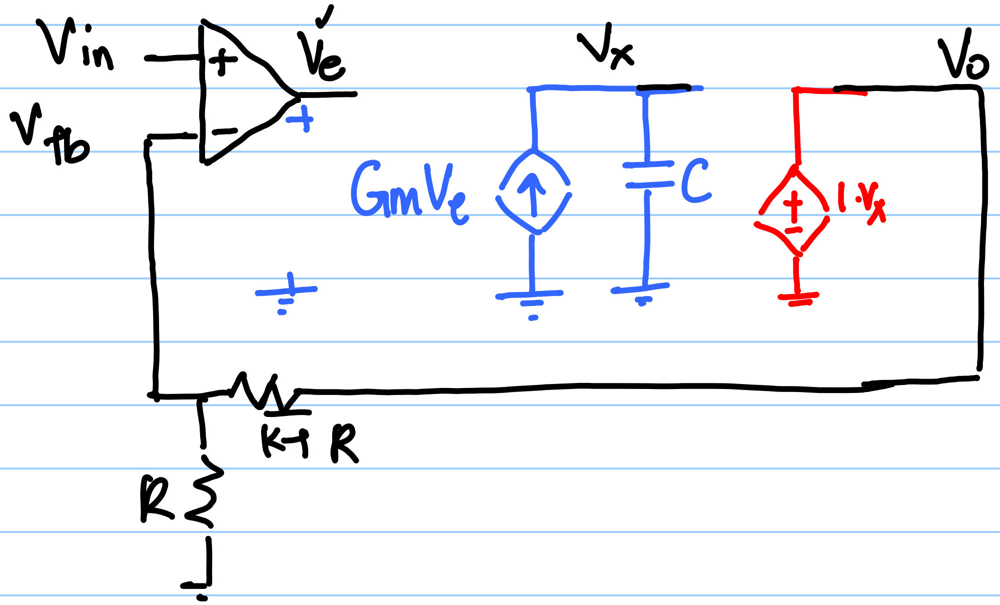


$$i_c = C\frac{dV_c}{dt}$$

$$V_c = \frac{1}{C}\int i_c \cdot dt$$

$$V_L = L\frac{di_L}{dt}$$

$$i_L = \frac{1}{L}\int V_L\, dt$$

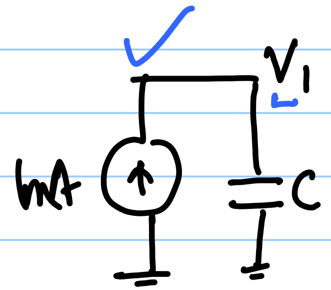


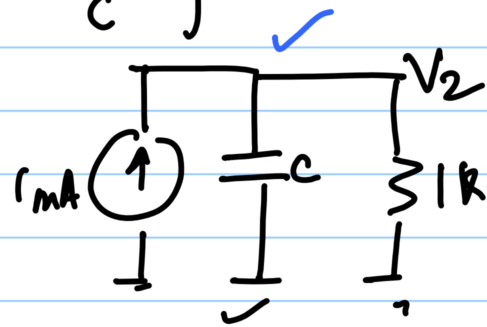
$$-\ V_o = \alpha \int V_e \cdot dt$$

$$-\ V_c = \frac{1}{C}\int i_c \cdot dt$$

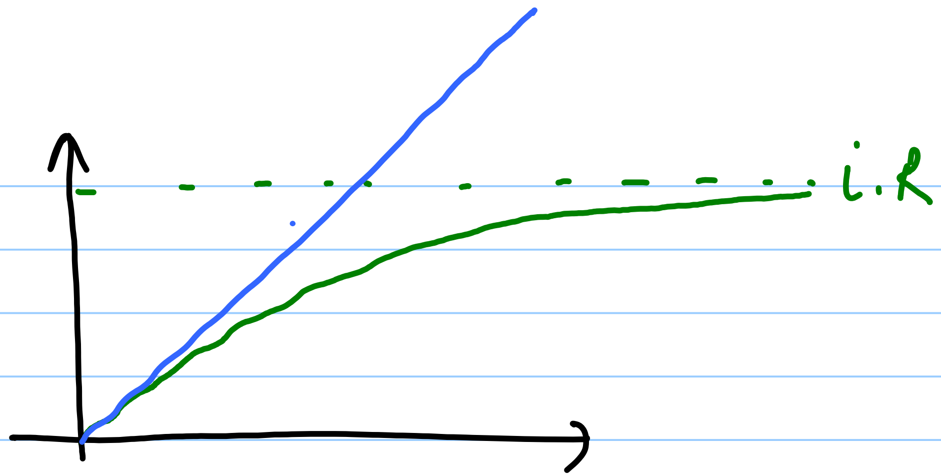
$$= \frac{1}{C}\int (G_m \cdot V_e)\ dt$$

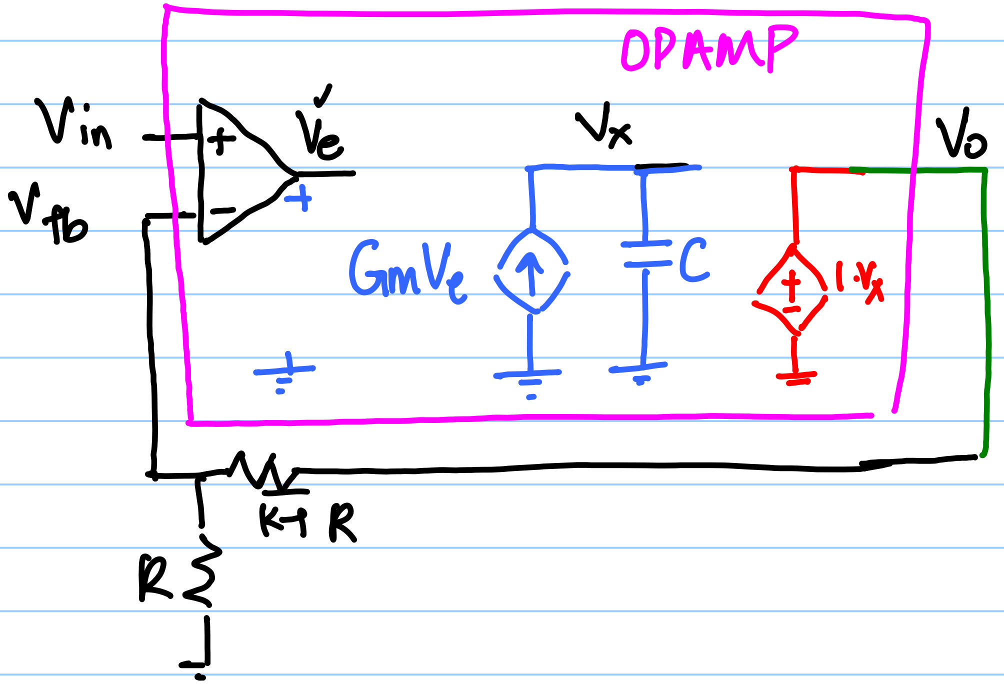
$$= \frac{G_m}{C}\int V_e \cdot dt$$

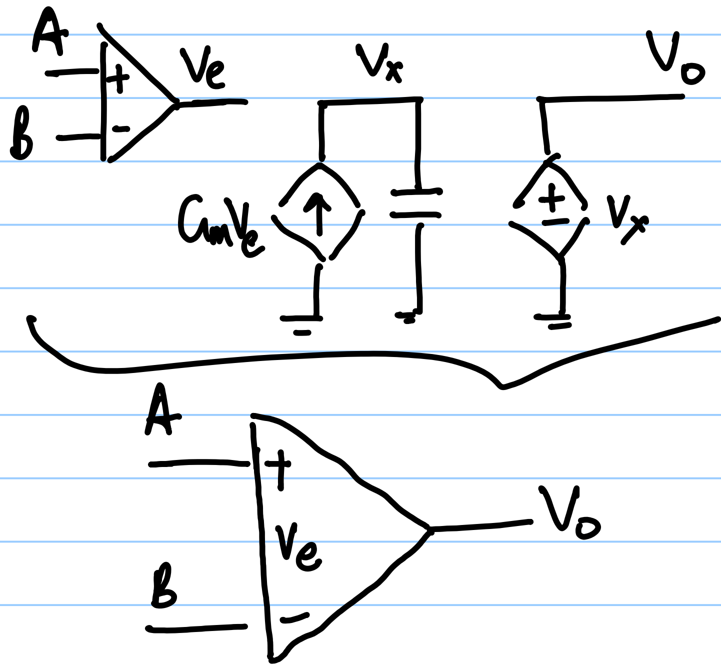




$t \to \infty$


i.R


OPAMP
Vin
Vfb
Ve
Vx
Vo
GmVe
C
1·Vx
R
K-1 R


A
B
Ve
Vx
Vo
GmVe
Vx
A
B
Ve
Vo

$$\frac{V_o(s)}{V_e(s)}$$