EE 220 Circuits I

Lecture 14

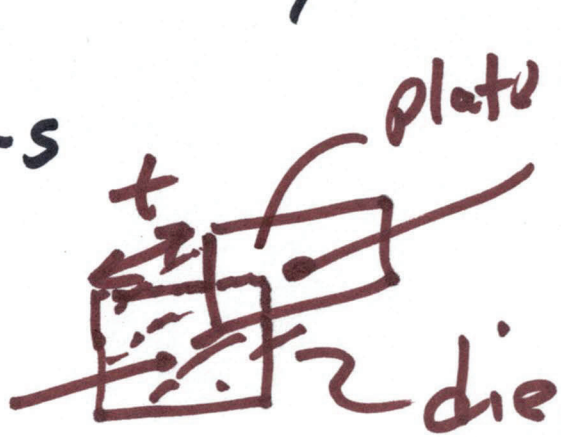
October 18, 2023

free space

$\epsilon_0 = 8.85 \times 10$

$C_{mat} = \frac{\epsilon}{\epsilon}$

Capacitors



$C = \frac{A \cdot \epsilon}{t}$

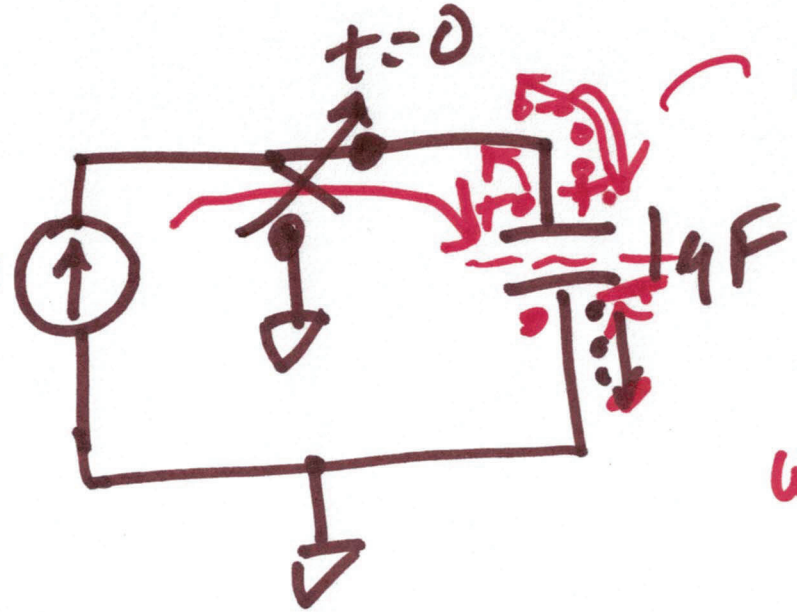
insulator

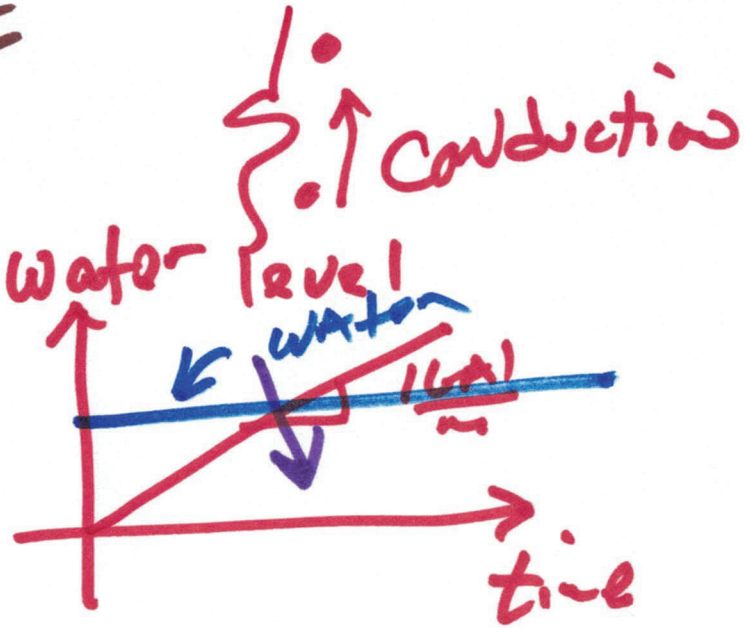
dielectric to flow

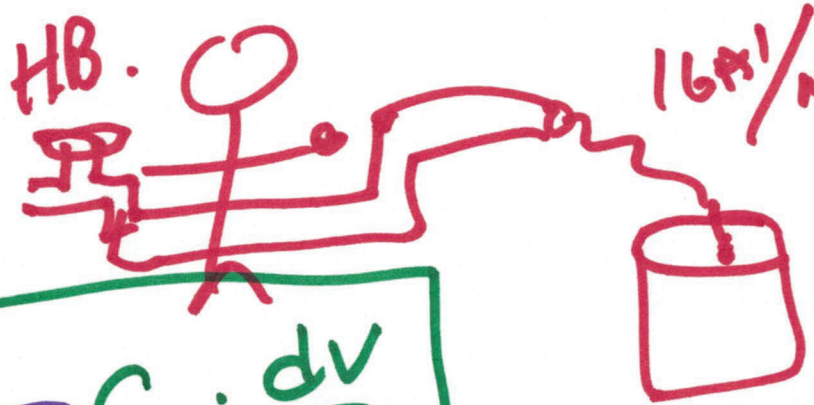
Capacitor to store charge

Charge, Q

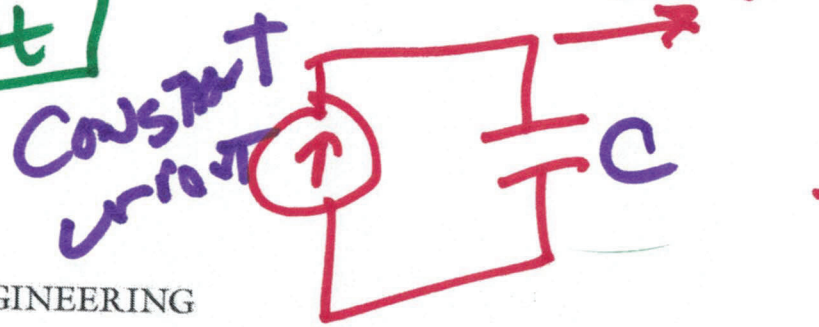
$CV = Q$

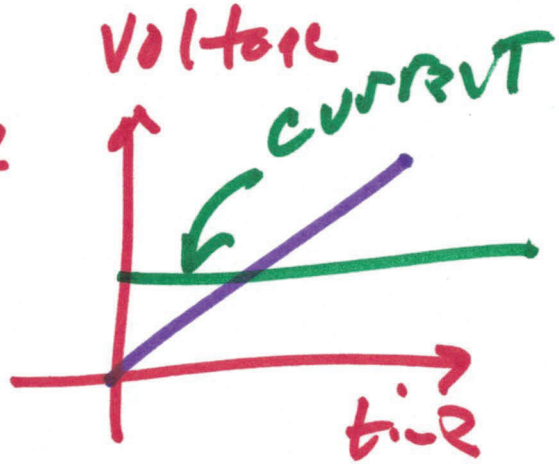




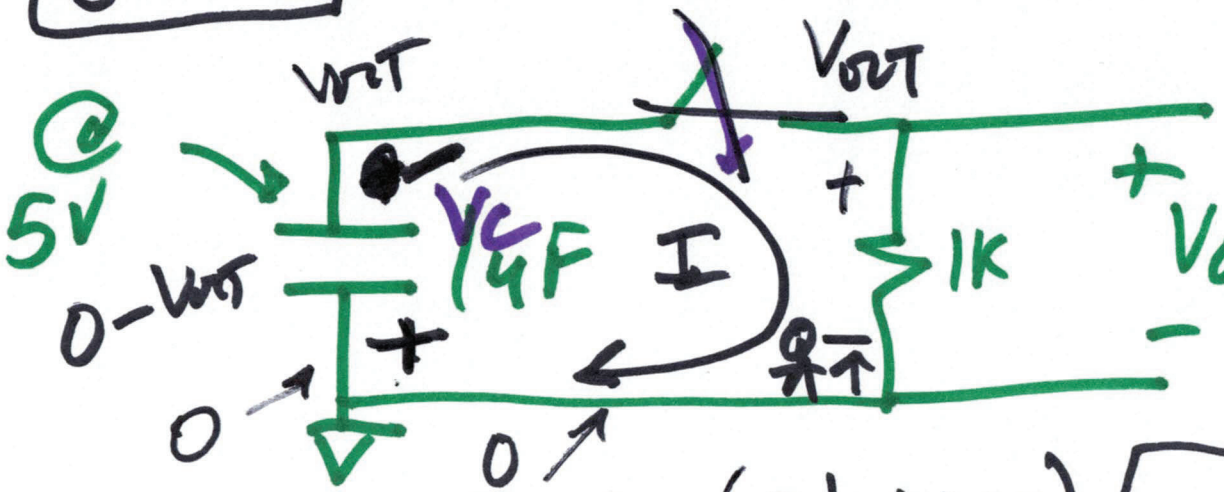


$I = C \cdot \frac{dV}{dt}$

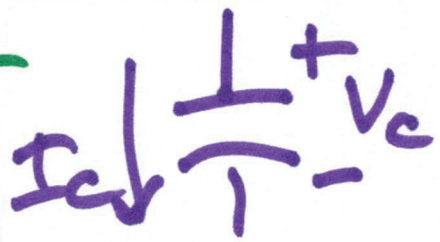




$CV = Q$

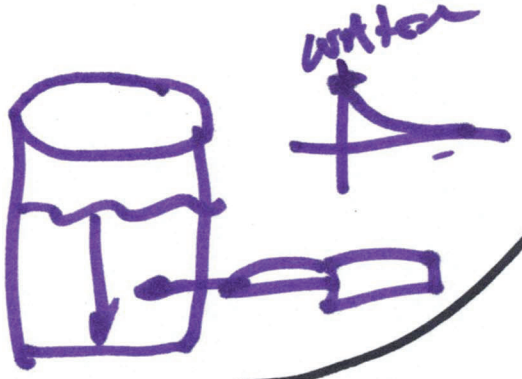


$$I_c = C\frac{dv_c}{dt}$$



$14 \cdot 5 = 5_4 C$ (charge)

Coulombs



$+1kI + (-V_{OUT}) = 0$

$V_c = -V_{OUT}$

$1k\,C\frac{dv_c}{dt} - V_{OUT} = 0$

$(1k)C \cdot \frac{d(-V_{OUT})}{dt} = V_{OUT}$

$\frac{dV_{OUT}}{V_{OUT}} = -RC\,dt$

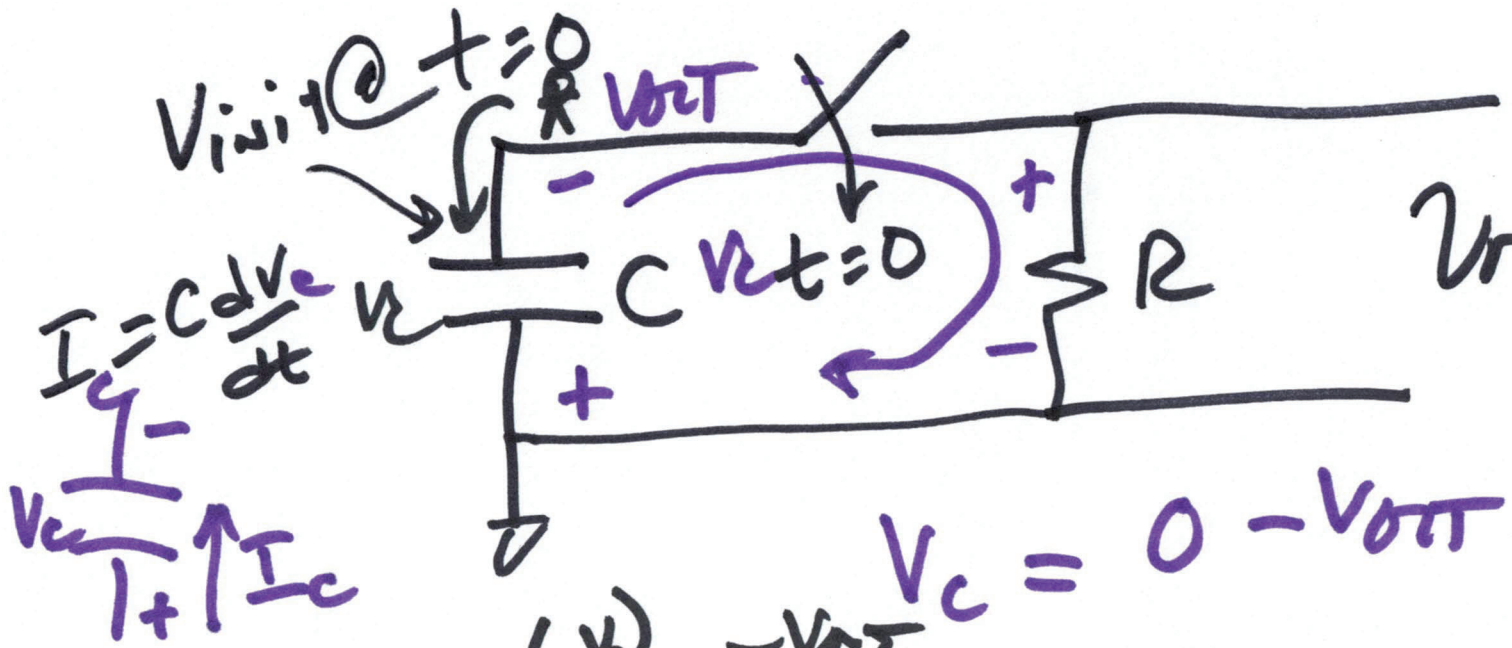
$$\int_{V_{init}}^{V_{OUT}} \frac{dV_{OUT}}{V_{OUT}} = \int_0^t -\frac{1}{RC}\,dt$$

$$\ln V_{OUT}(t) - \ln V_{init} = -\frac{1}{RC}\Big|_0^t$$

$$\ln \frac{V_{OUT}(t)}{V_{init}} = -\frac{1}{RC}\,t$$

$$e^{\ln \frac{V_{OUT}(t)}{V_{init}}} = e^{-t/RC}$$

$$V_{OUT}(t) = V_{init}\, e^{-t/RC}$$



$$V_C = 0 - V_{oT} = -V_{oT}$$

$$I = C\frac{d(-V_{oT})}{dt} + V_C + I \cdot R = 0$$

$$-I = C\frac{dV_C}{dt}$$

$$I = C \cdot \frac{dV_C}{dt} = C \cdot \frac{d(-V_{oT})}{dt}$$

$$-V_{oT} + RC \cdot \left(\frac{-dV_{oT}}{dt}\right) = 0$$

$$-\frac{RC}{dt} \cdot dV_{oT} = V_{oT}$$

$$\int_a^b \frac{dx}{x} \Rightarrow \ln x \Big|_a^b$$

$$\int_{V_{init}}^{V_{OUT}(t)} \frac{dV_{OUT}}{V_{OUT}} = \int_0^t -\frac{dt}{RC}$$

$$\ln a - \ln b$$

$$\ln \frac{a}{b}$$

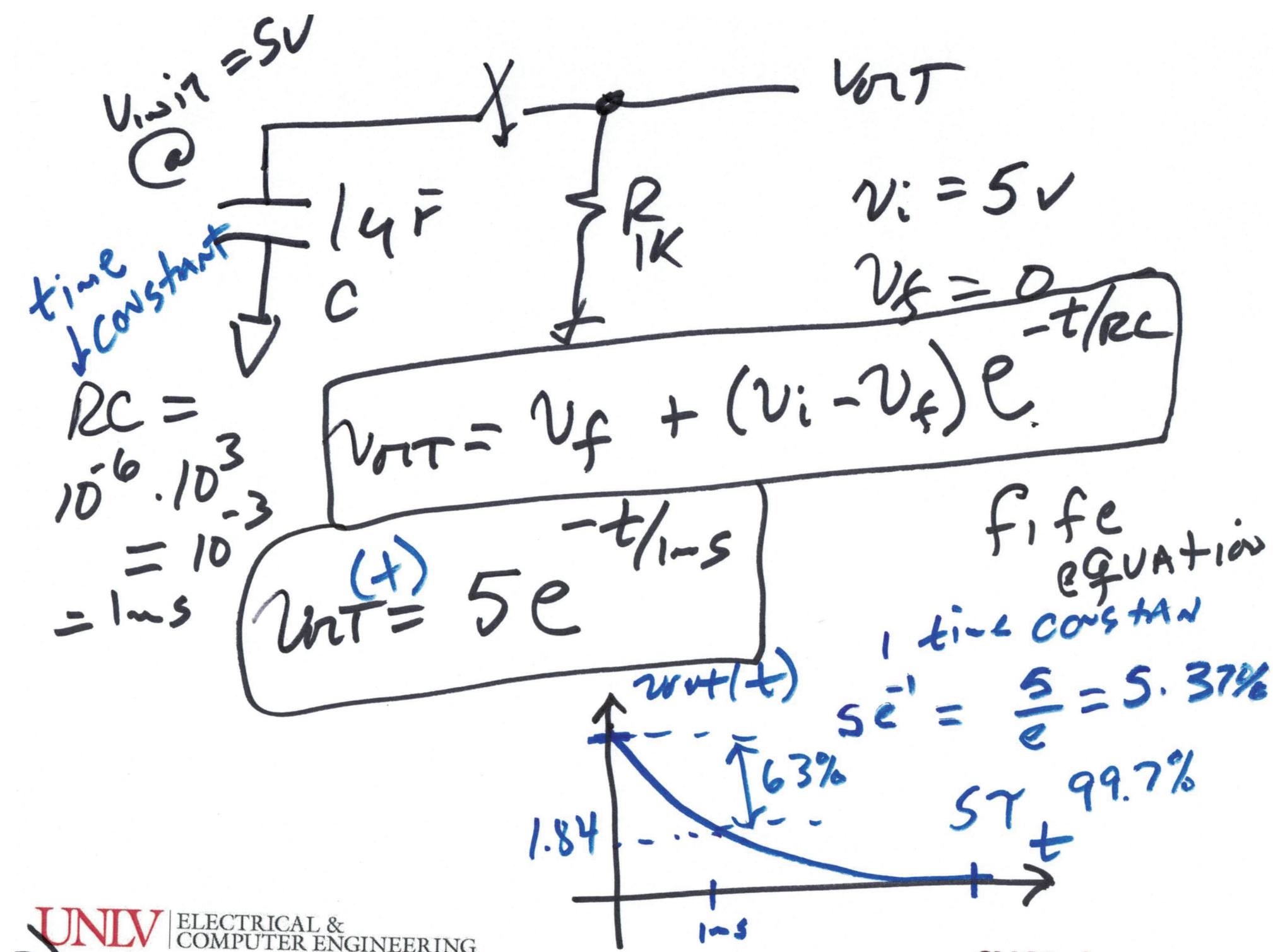
$$\ln x \Big|_{V_{init}}^{V_{OUT}(t)} = -\frac{t}{RC}$$

$$\ln V_{OUT}(t) - \ln V_{init} = -\frac{1}{RC}\int_0^t dt$$

$$e^{\frac{-t}{RC}} = \ln \frac{V_{OUT}}{V_{init}}$$

$$e^{-t/RC} = \frac{1}{RC}\, t \Big|_0^t$$

$$V_{OUT}(t) = V_{init} e^{-t/RC} = \frac{1}{RC}(t-0)$$



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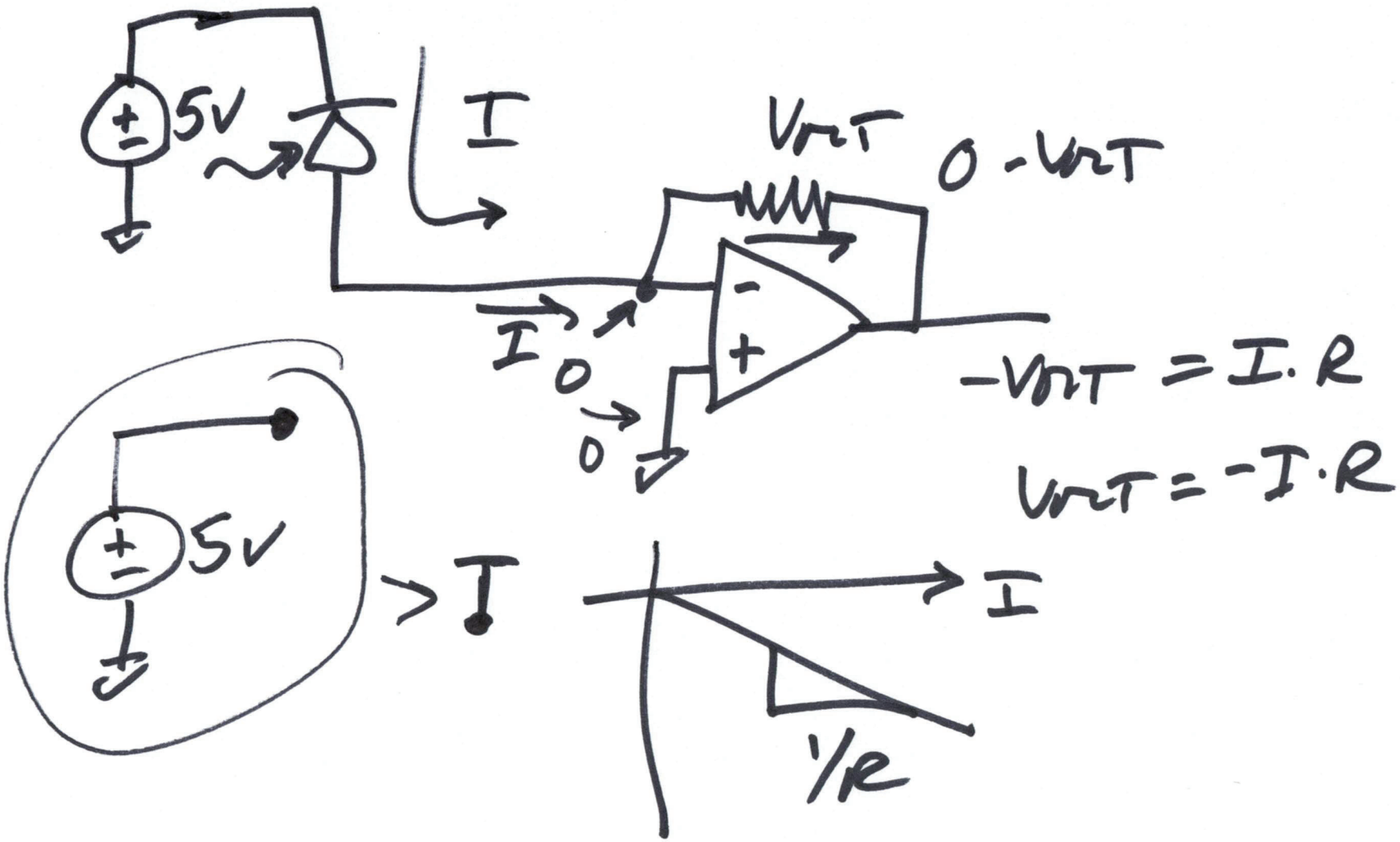
5V
I
V_{OUT}
0 - V_{OUT}
I
0
0
$-V_{OUT} = I \cdot R$
$V_{OUT} = -I \cdot R$
5V
I
I
1/R