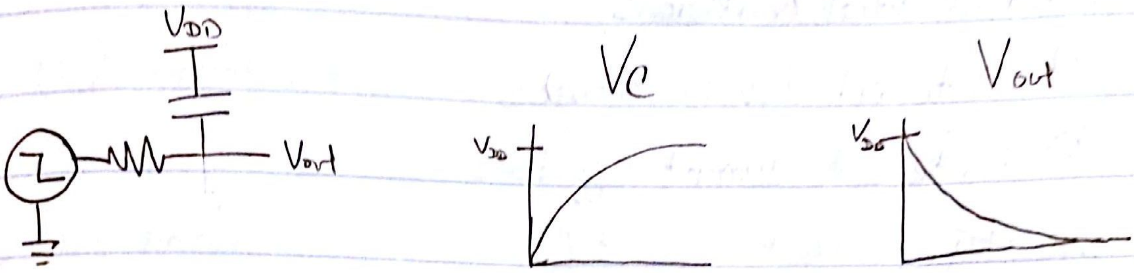
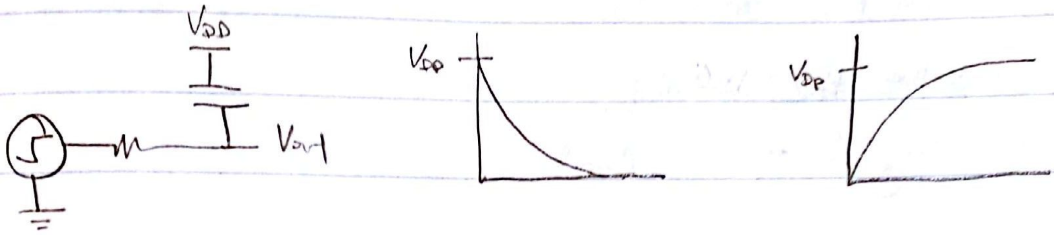
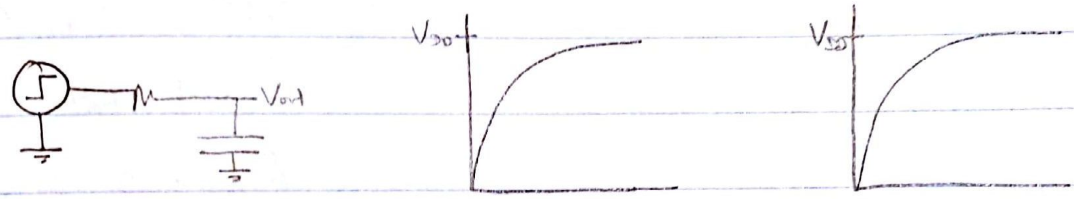
Discussion 6







c) $V_R = V_{in} - V_{out}$ $\qquad I = \frac{V_{in}-V_{out}}{R} = C\frac{dV_{out}}{dt}$

$V_c = V_{out}$ $\qquad V_{out} + CR\frac{dV_{out}}{dt} = V_{in} = V_{dd}$ after $t=0$

First solve homogenous,

$$V_{out} + RC\frac{dv}{dt} = 0$$

$$\frac{1}{RC}e^{st} + se^{st} = 0$$

$$s = \frac{-1}{RC}$$

$$\Rightarrow V_{out}' = ke^{-\frac{t}{RC}}$$

solve for the other side

$$A + RC\frac{dA}{dt} = V_{in} \quad (\tfrac{dA}{dt} = 0)$$

$$A = V_{in}$$

$$V_{out}^A + V_{out}' = V_{out}$$

$$V_{out} = ke^{-t/RC} + V_{in}$$

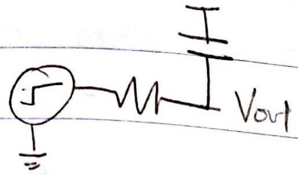
Plug in init cond for cond:

$$0 = Ke^{-0/RC} + V_{in}$$

$$K = -V_{in} = -V_{dd}$$

$$\Rightarrow V_{out} = -V_{dd}e^{-t/RC} + V_{dd}$$

1. Find initial conditions
2. Write out device voltages
3. Write out current equations
4. Plug in to get a Diff Eq
5. Solve the homogenous
6. Solve the Diff Eq
7. Plug in Initial Cond.

b) 

$V_c = V_{dd} - 0$

$V_R = V_{in} - V_{out}$

$V_c = V_{DD} - V_{out}$

$I = \frac{V_R}{R} = C\frac{dV_c}{dt}$

$\frac{V_{in} - V_{out}}{R} = C\frac{d(V_{dd} - V_{out})}{dt}$

$V_{in} - V_{out} = RC\left(\frac{dV_{dd}}{dt} - \frac{dV_{out}}{dt}\right)$

$V_{in} - V_{out} = RC\frac{dV_{out}}{dt}$

$V_{out} + RC\frac{dV_{out}}{dt} = V_{in}$

solve homogenous

$V_{out} + RC\frac{dV_{out}}{dt} = 0$

$V_{out} = Ke^{-t/RC}$

solve constant

$A + RC\frac{dA}{dt} = V_{in}$

$A = V_{in}$

Plug in init. cond

$V_{out} = Ke^{-t/RC} + V_{in}$

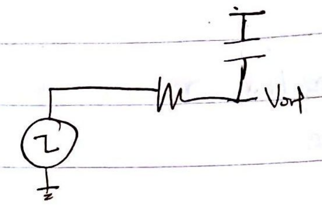
$0 = Ke^{-0/RC} + V_{in}$

$K = -V_{in}$

$V_{out} = -V_{in}e^{-t/RC} + V_{in}$

$V_{out} = -V_{dd}e^{-t/RC} + V_{dd}$

a)



All the same things from last time apply, but the initial cond, & Vin are diff

init cnd ⇒ $V_{out}^{0^-} = V_{DD}$

$V_{in}^{0^+} = 0$

$V_{out} = Ke^{-t/RC} + V_{in}$

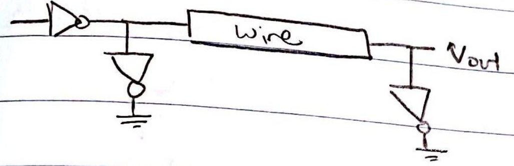
$V_{DD} = Ke^{-0/RC} + V_{in}$

$K = V_{DD} - V_{in}$

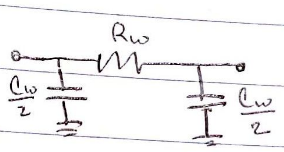
$V_{out} = (V_{DD} - V_{in})e^{-t/RC} + V_{in}$

$V_{out} = V_{DD}e^{-t/RC}$

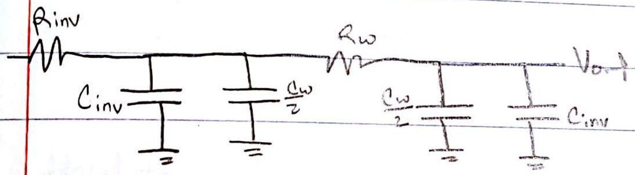
Go over setting up a second order:

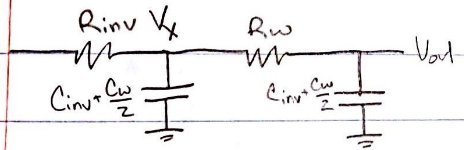


where wire =



So we can rewrite:





$V_{R_{inv}} = V_{in} - V_x$ $\quad\quad$ $V_{Rw} = V_x - V_{out} \Rightarrow V_x = V_{Rw} - V_{out}$

$$\frac{V_{R_{inv}}}{R_{inv}} - C\frac{dV_x}{dt} - \frac{V_{Rw}}{R_w} = 0 \quad\quad \frac{V_{Rw}}{R_w} - C\frac{dV_{out}}{dt} = 0$$

$$V_{in} - V_x - R_{in} R_w C \frac{d(V_{Rw} - V_{out})}{dt} - \frac{V_{Rw}}{R_w} = 0$$

, where $V_{Rw} = R_w C \frac{dV_{out}}{dt}$

$$V_{in} - R_w C\frac{dV_{out}}{dt} - R_{in} R_w C \frac{d(R_w C\, dV_{out}/dt)}{dt} - R_{in} R_w C \frac{dV_{out}}{dt} - C\frac{dV_{out}}{dt} = 0$$

arrange prettily, but don't solve!