file: e:\courses\spring2006\303\inv_charg.mcd RWN 03/10/06

values for mnmosis transistors

$KPn := 5.048 \cdot 10^{-5}$ $VTOn := 0.858153$ $KPp := 1.908 \cdot 10^{-5}$ $VTOp := -0.889271$

$Wn := 7 \cdot 10^{-6}$ $Ln := 7 \cdot 10^{-6}$ $Wp := 7 \cdot 10^{-6}$ $Lp := 7 \cdot 10^{-6}$

$\lambda n := 1.843384 \cdot 10^{-2}$ $\lambda p := 5,011626 \cdot 10^{-2}$

$VDD := 5$ $CL := 3 \cdot 10^{-12}$

$VGSn := VDD$ $Vsn := VGSn - VTOn$ $Vsn = 4.142$

$\beta n := \left(\frac{KPn}{2}\right) \cdot \left(\frac{Wn}{Ln}\right)$ $\beta p := \left(\frac{KPp}{2}\right) \cdot \left(\frac{Wp}{Lp}\right)$

time at which a transition from saturation to Ohmic occurs

$ts := \left(\frac{CL}{\beta n}\right) \cdot \left(\frac{VTOn}{Vsn^2}\right)$ $ts = 5.946 \cdot 10^{-9}$

capacitor voltage for t<=ts, Using $\Phi(.)$ as the unit step function,

$vc1(t) := \left[VDD - \left(\frac{\beta n}{CL}\right) \cdot Vsn^2 \cdot t\right] \cdot \Phi(ts - t)$ $vc1(ts) = 4.142$

capacitor voltage for t>=ts:

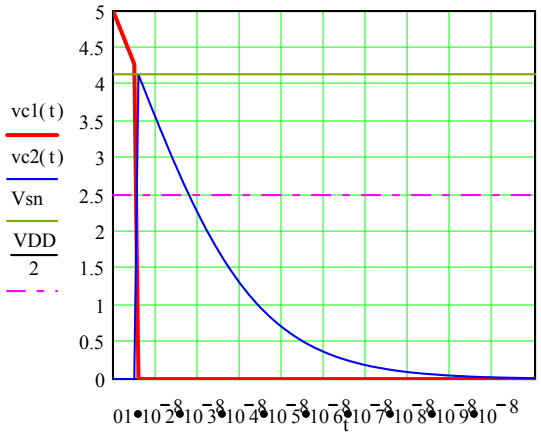
$vc2(t) := \left[\frac{(2 \cdot (Vsn))}{\left[1 + \exp\left[2 \cdot Vsn \cdot \left(\frac{\beta n}{CL}\right) \cdot (t - ts)\right]\right]}\right] \cdot \Phi(t - ts)$ $vc2(ts) = 4.142$

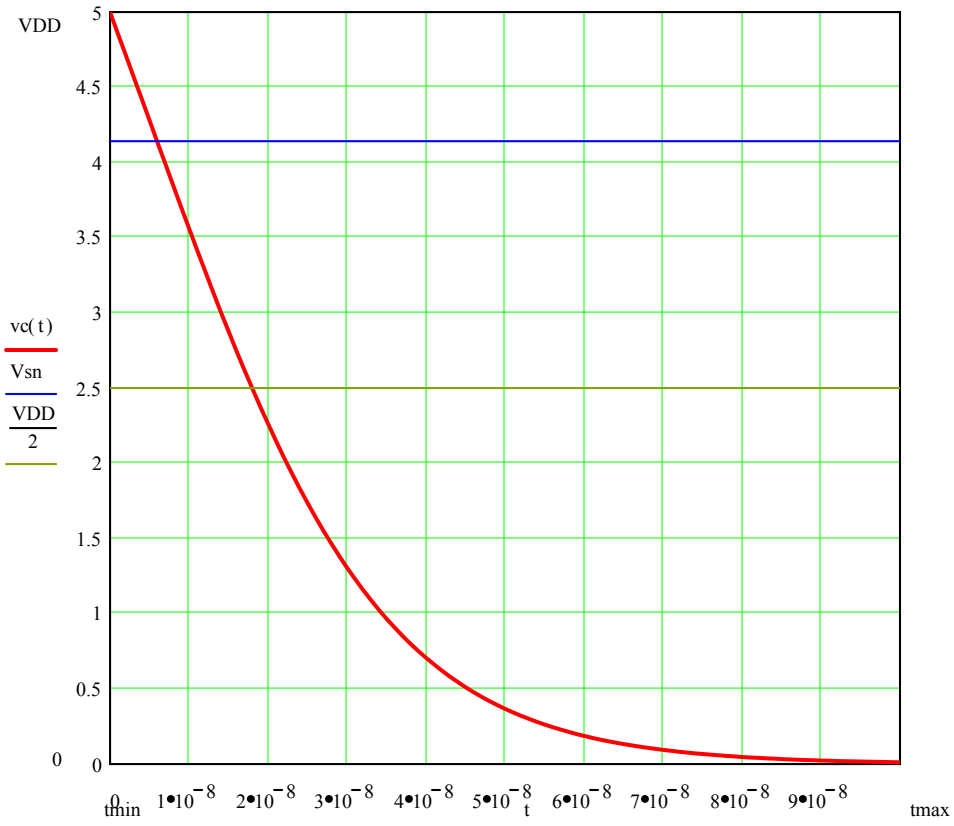
combining the voltage for the two regions of time:

$vc(t) := vc1(t) + vc2(t)$

$tmin := 0$ $tmax := 1 \cdot 10^{-7}$ $\Delta t := 0.01 \cdot 10^{-7}$

$t := tmin, tmin + \Delta t .. tmax$





delay time, td = time to reach VDD/2, which occurs in Ohmic region

$$td := ts - \left(\frac{CL}{\beta n}\right)\cdot\left(\frac{1}{2\cdot Vsn}\right)\cdot \ln\left[\frac{\left(\frac{VDD}{Vsn}\right)}{\left[4-\left(\frac{VDD}{Vsn}\right)\right]}\right] \qquad td = 1.798\cdot 10^{-8}$$