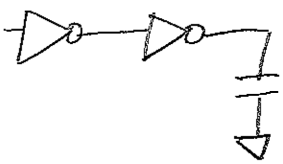
EE16B Section 6B

Warmup



$t_{A\to B} = (10k)(1f+2f)\ln 2 = 20.7ps$

$t_{B\to C} = (10k)(50f)\ln 2 = 345ps$

$t_{A\text{-}C} = 366ps$

$C_{tot} = 56fF$

$\alpha = 0.5$

$P = \alpha C_{tot} V_{DD}^2 f$

$= .05 \cdot 56fF \cdot (1V)^2 \cdot 2GHz$

$= 5.6\mu W$

If inverter 2 is upsized:

$t_{A\to B} = (10k)(12f)\ln 2 = 82.8ps$

$t_{B\to C} = (2.5k)(50f)\ln 2 = 86.3ps$

$t_{A\to C} = 169.1ps$

$C_{tot} = 65$

$P = 6.5\mu W$

50% less delay, 20% more power...

Feedback Debrief

Questions from Lecture

Sampling, continued

Highlights from lecture:

- $x_d(n) = x_c(nT_s)$ (This is how to sample a CT signal.)
- If $x_c(t) = e^{i\omega t}$, then $x_d(t) = e^{i\omega T_s n}$;
  if $\hat{x}_c(t) = e^{i(\omega + k\omega_s)t}$, then $\hat{x}_d(t) = e^{i\omega T_s n}$; the signals are indistinguishable!

• If $x_{c1}(t) = \cos\left(\left(\frac{\omega_s}{2} + \Delta\omega\right)t\right)$ and $x_{c2}(t) = \cos\left[\left(\frac{\omega_s}{2} - \Delta\omega\right)t\right]$, then $x_{d1}(n) = x_{d2}(n)$!

Does the same hold for sine?

Define:

$$x_{c3}(t) = \sin\left[\left(\frac{\omega_s}{2} + \frac{\omega_s}{4}\right)t\right] = \sin\left(\frac{3\omega_s}{4}t\right) \qquad x_{c4} = \sin\left[\left(\frac{\omega_s}{2} - \frac{\omega_s}{4}\right)t\right] = \sin\left(\frac{\omega_s}{4}t\right)$$

Then:

$$x_{d3}(n) = \sin\left(\frac{3\omega_s}{4} nT_s\right) = \sin\left(\frac{3n}{4}\omega_s\left(\frac{2\pi}{\omega_s}\right)\right) = \sin\left(\frac{3\pi}{2}n\right) = \sin\left(-\frac{\pi}{2}n\right) = -\sin\left(\frac{\pi}{2}n\right)$$

$$x_{d4}(n) = \sin\left(\frac{\omega_s}{4} nT_s\right) = \sin\left(\frac{\pi}{2}n\right)$$

So in general,

If $x_{c3}(t) = \sin\left[\left(\frac{\omega_s}{2} + \Delta\omega\right)t\right]$ and $x_{c4} = \sin\left[\left(\frac{\omega_s}{2} - \Delta\omega\right)t\right]$, then $x_{d3}(n) = -x_{d4}(n)$.