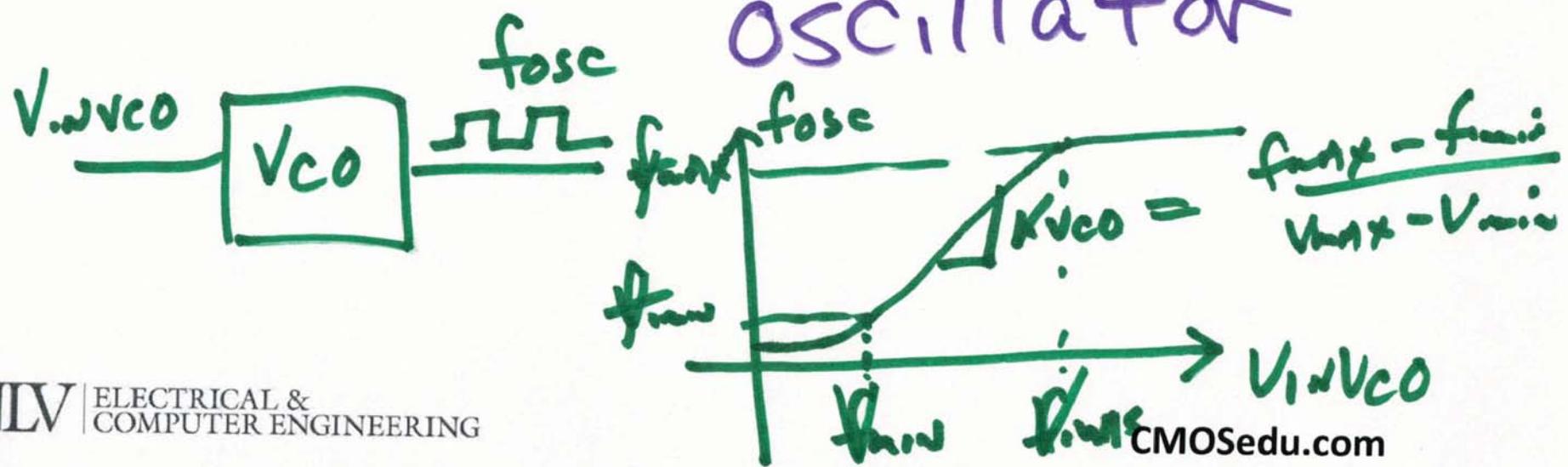


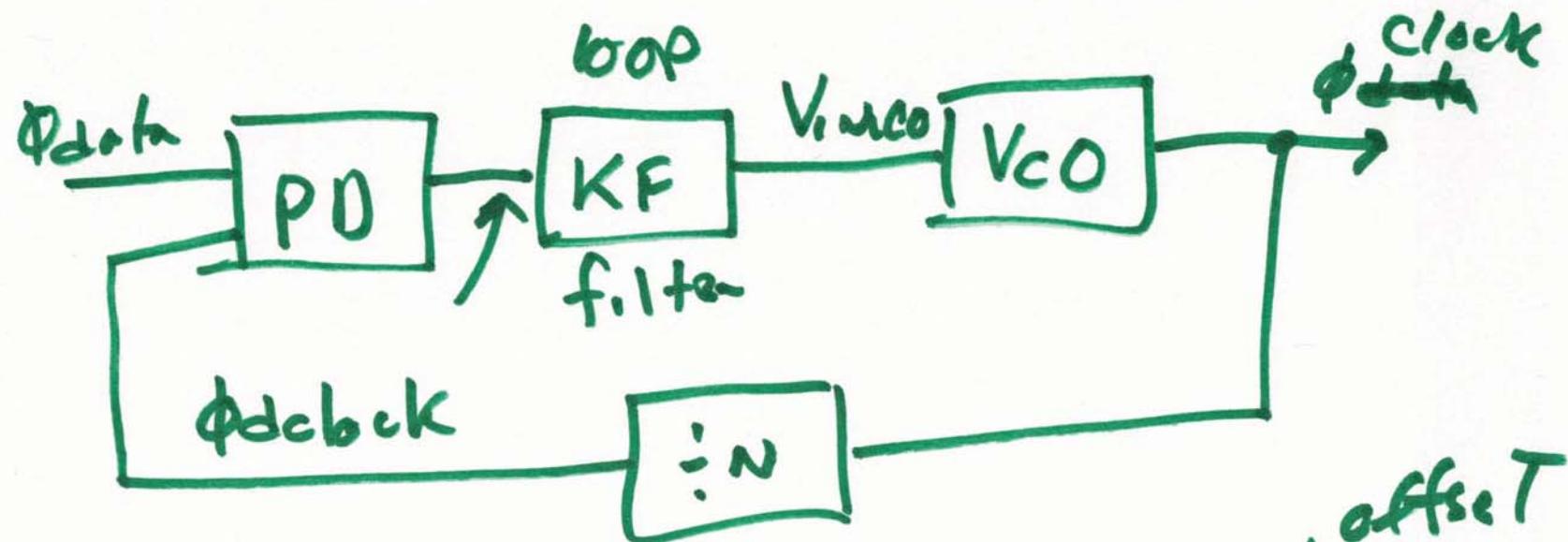
Lecture 17

OCT. 26, 2015

ECG 721 MEMORY
Circuit Design

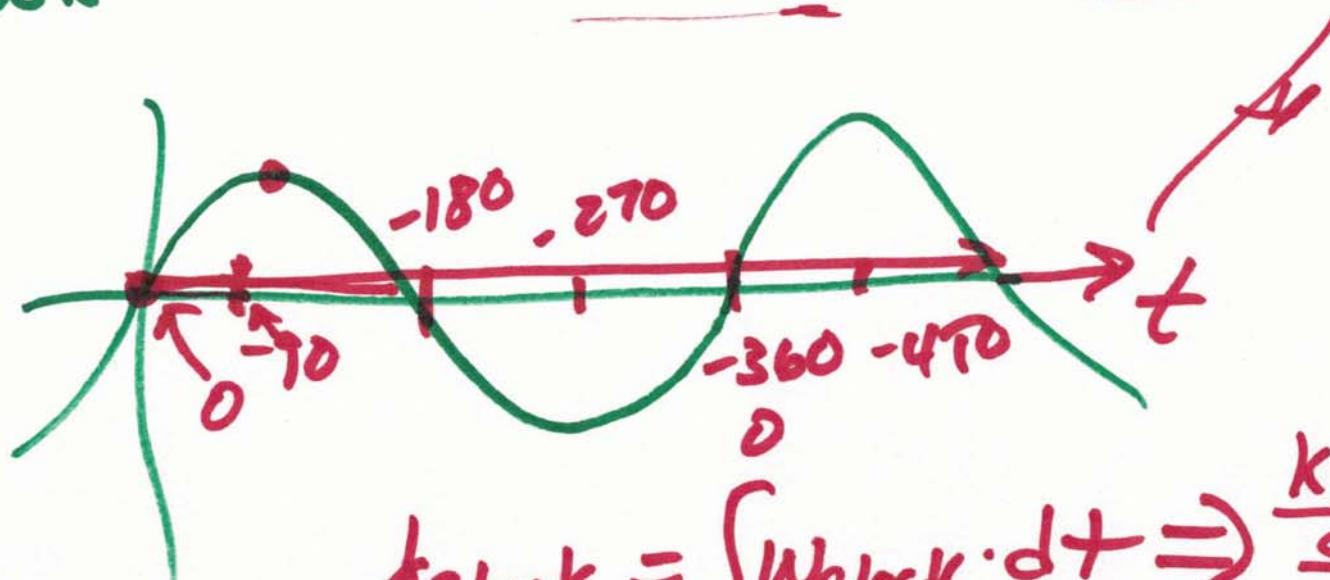
The Voltage - Controlled
oscillator





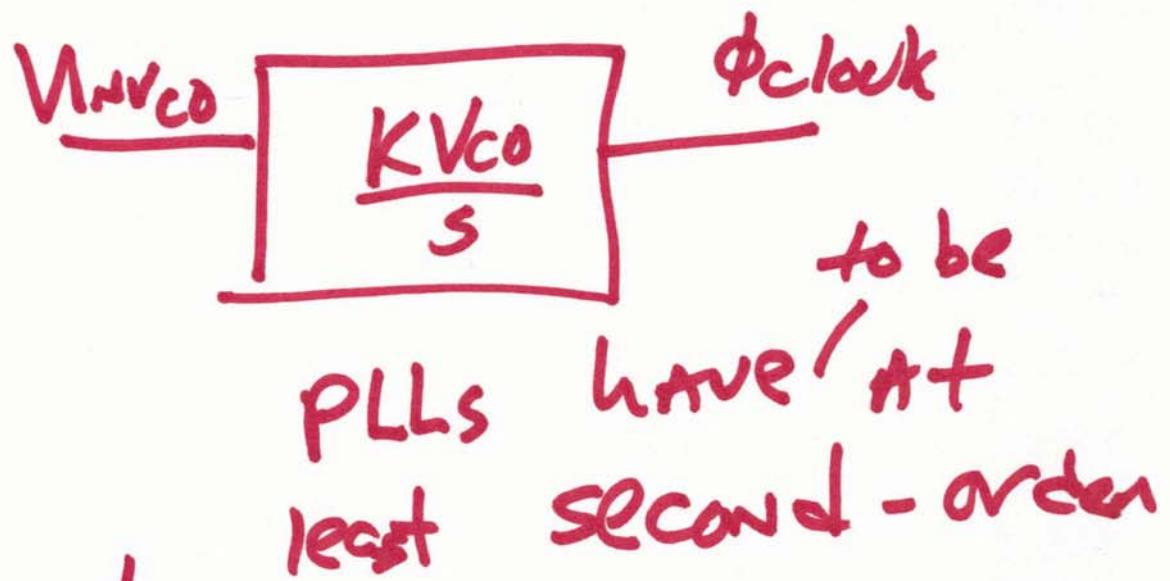
$$\omega_{\text{Clock}} = 2\pi f_{\text{Clock}} = \cancel{\pi} K_{\text{VCO}} \cdot V_{\text{VCO}} + \underline{\omega_0}$$

offset



$$f_{\text{Clock}} = \int \omega_{\text{Clock}} \cdot dt \Rightarrow \frac{K_{\text{VCO}}}{s} \frac{V_{\text{VCO}}}{\text{CO}}$$

$$\phi_{clock} = \frac{KVCO}{S} \cdot V_{INVCO}$$



$$\phi_{delock} = \frac{\phi_{clock}}{N}$$

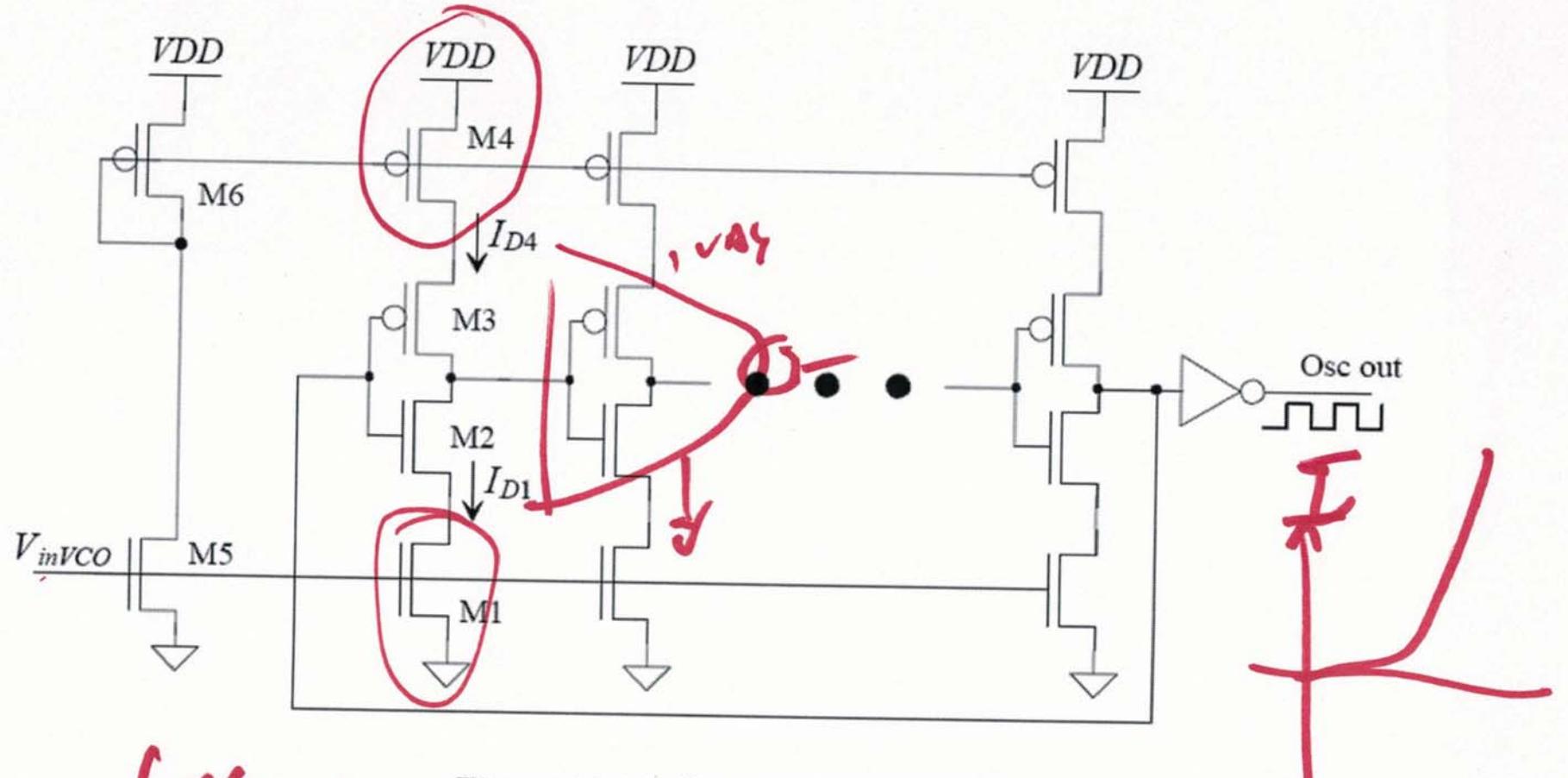
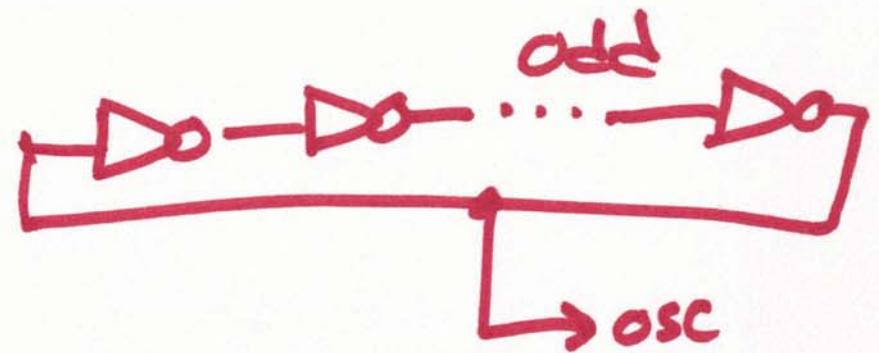
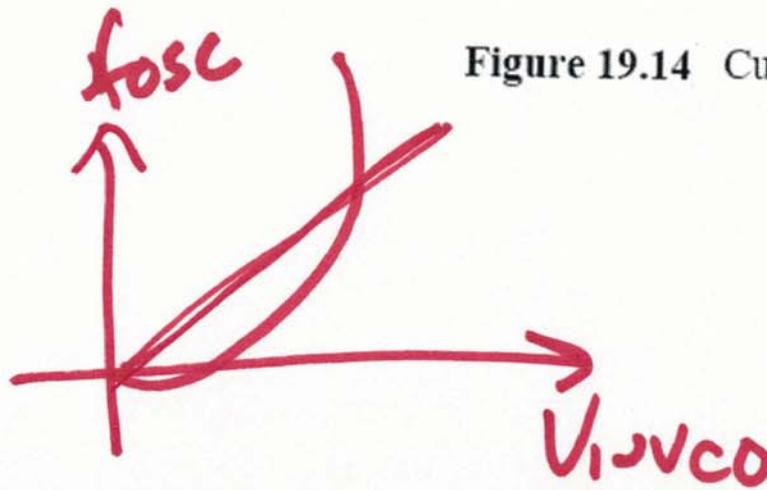


Figure 19.14 Current-starved VCO.



$400mV \Rightarrow 80\text{MHz}$
 $I_{D4} = I_D$
 $500mV \Rightarrow 200\text{MHz}$
 $M3$
 $600mV \Rightarrow 300\text{MHz}$
 $M2$
 $700mV \Rightarrow 360\text{MHz}$
 $I_{D1} = I_D$
 V_{DD}
 C_{tot}

$$I = C \frac{dV}{dT}$$

Figure 19.15 Simplified view of a single stage of the current-starved VCO.

$$t_d = \frac{C_{TOT}}{I_D} \cdot \frac{V_{DD}}{2}$$

$$f_{osc} = \frac{1}{N \cdot t_d}$$

number of stages

5)

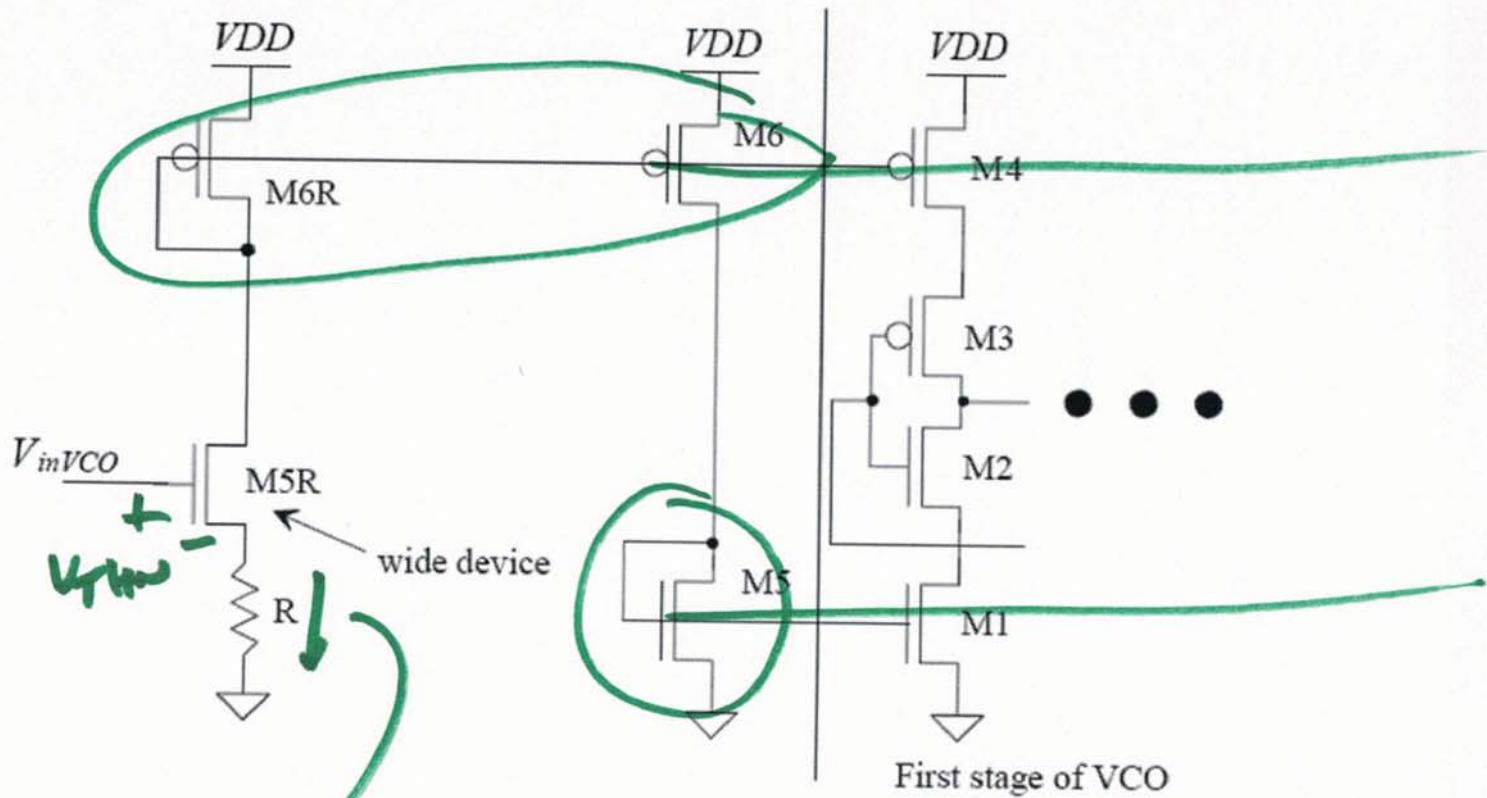
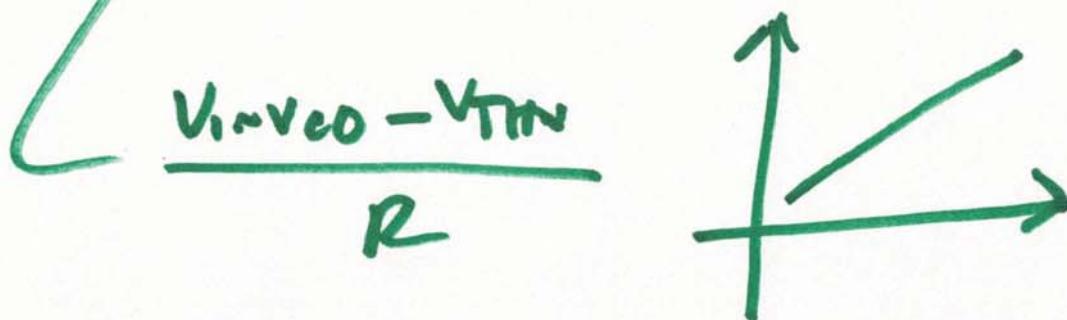


Figure 19.17 Linearizing the current in a current-starved VCO.



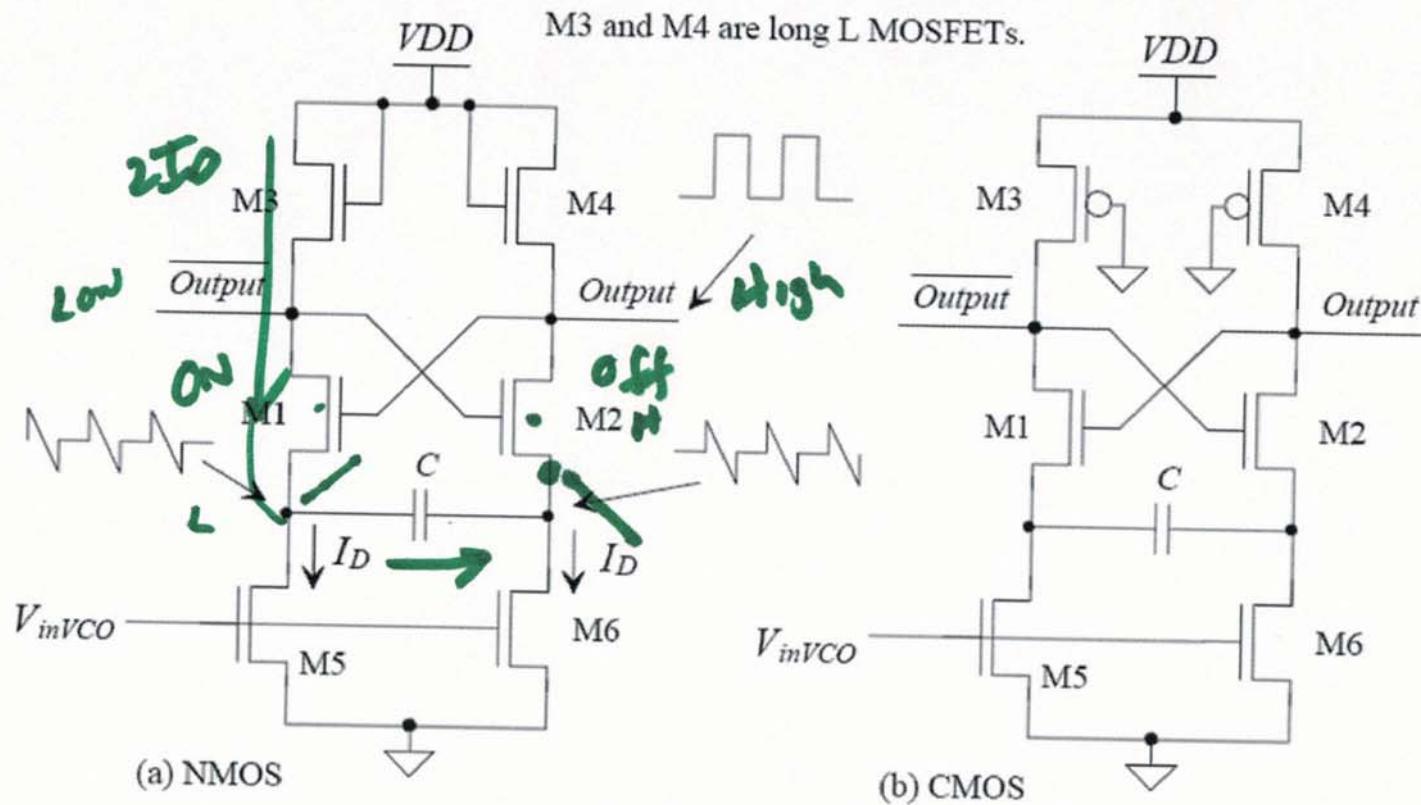
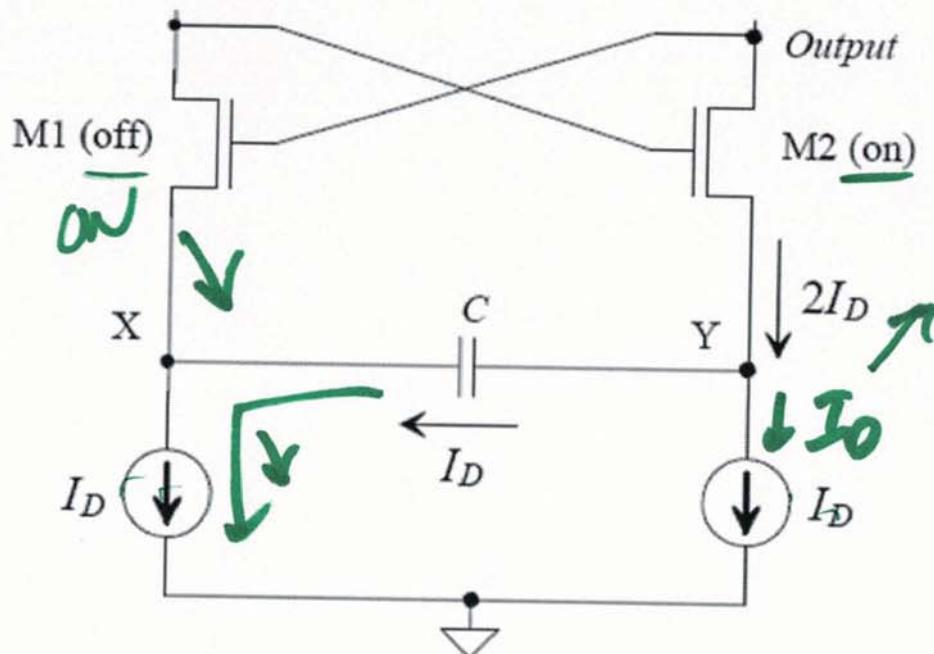


Figure 19.19 Source coupled voltage-controlled oscillators (also known as source coupled multivibrators).



Note: C should be laid out with the same parasitic capacitance at X and Y.

Figure 19.20 Simplified schematic of source coupled oscillator, M1 is on and M2 is off.

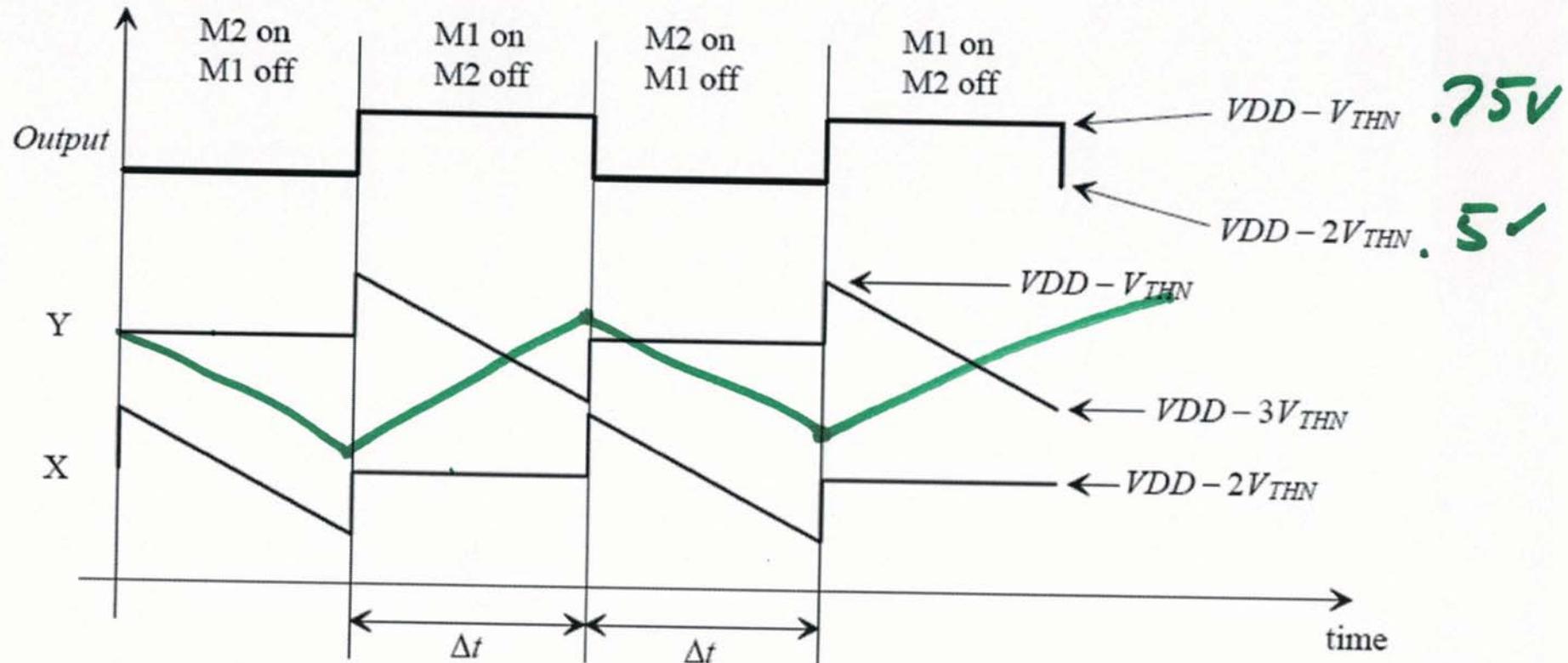
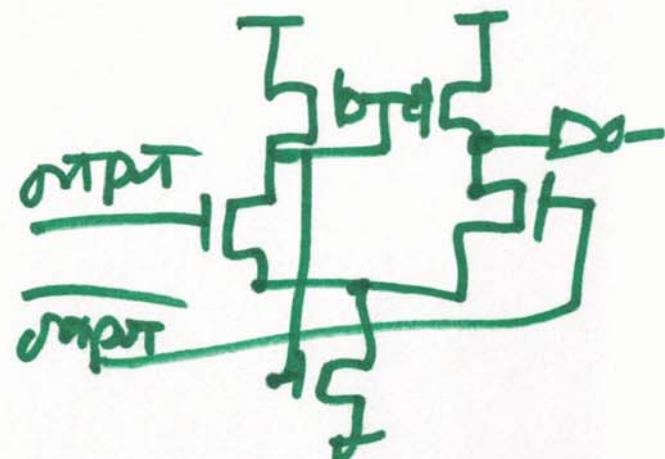


Figure 19.21 Voltage waveforms for the NMOS source-coupled VCO.

$$f_{osc} = \frac{I_D}{4C \cdot V_{THN}}$$



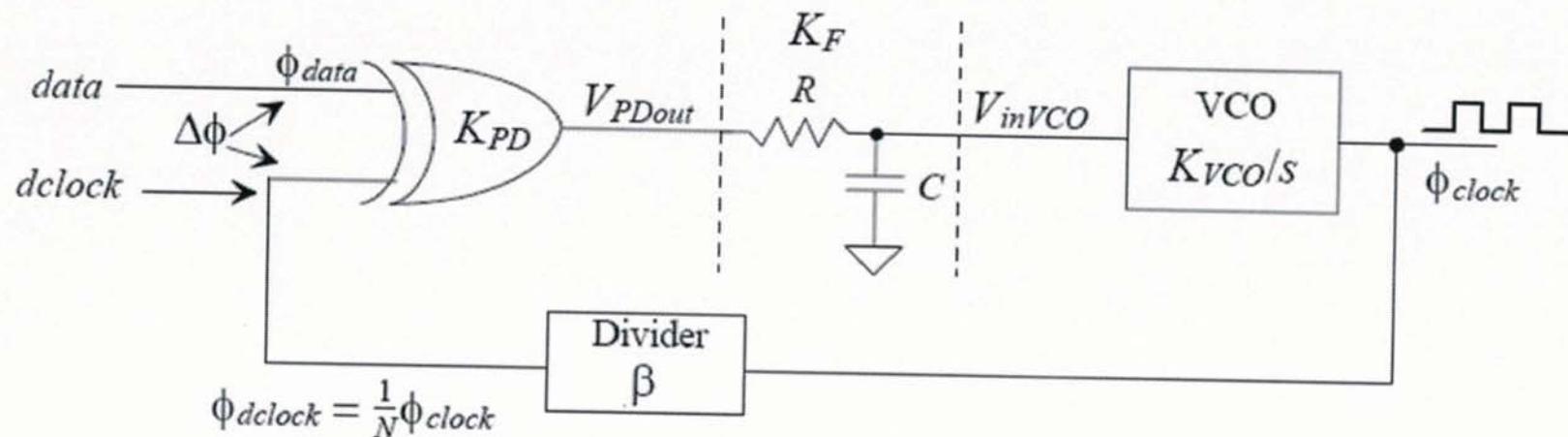


Figure 19.22 Block diagram of a DPLL using a XOR phase detector

$$V_{PDout} = K_{PD}(\phi_{data} - \phi_{dclock})$$

$$V_{inVCO} = K_F \cdot V_{PDout} \Rightarrow K_F = \frac{1}{1 + S \tau C}$$

$$\phi_{clock} = V_{inVCO} \cdot \frac{K_{VCO}}{s}$$

$$\phi_{clock} = \frac{k_{vco}}{s} \cdot k_f \cdot k_{pd} \cdot (\phi_{data} - \phi_{clock})$$

$\frac{1}{1 + sRc}$

$$\phi_{clock} \left(1 + \frac{k_{vco}}{s} \cdot \frac{k_{pd}}{1 + sRc} \right) = \phi_{data} \cdot \frac{k_{vco}}{s} \cdot \frac{k_{pd}}{1 + sRc}$$

$$\left. \frac{\phi_{clock}}{\phi_{data}} \right|_{n=1} = \frac{1}{\frac{s(1 + sRc)}{k_{vco} \cdot k_{pd}} + 1}$$

$$= \frac{\frac{k_{pd} \cdot k_{vco}}{RC}}{s^2 + \frac{s}{RC} + \frac{k_{pd} \cdot k_{vco}}{RC}}$$