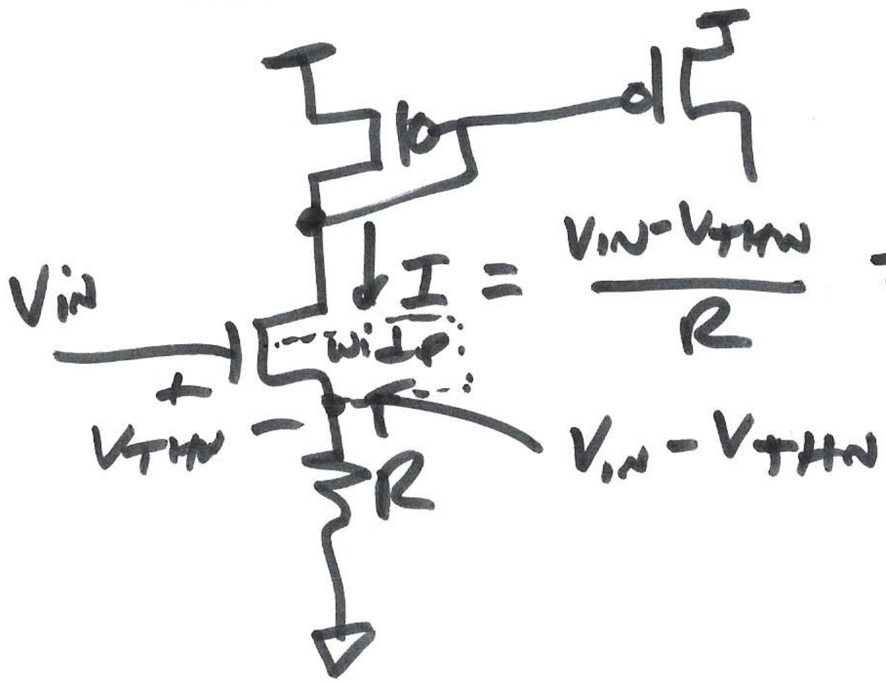
ECE 5/418 Memory Circuit Design

BOISE STATE UNIVERSITY

Lecture 23

April 25, 2010

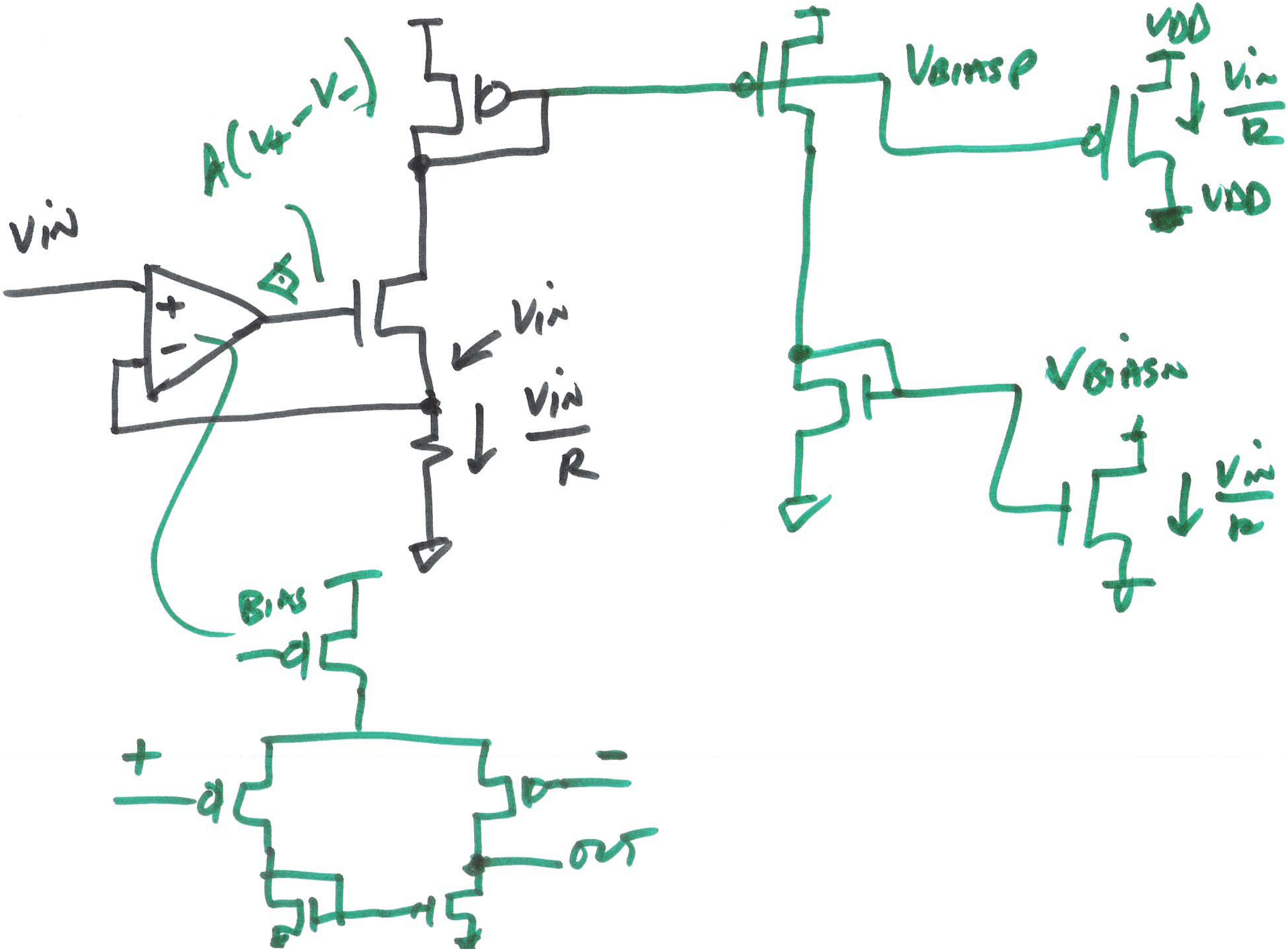
Linear Voltage-to-current converters



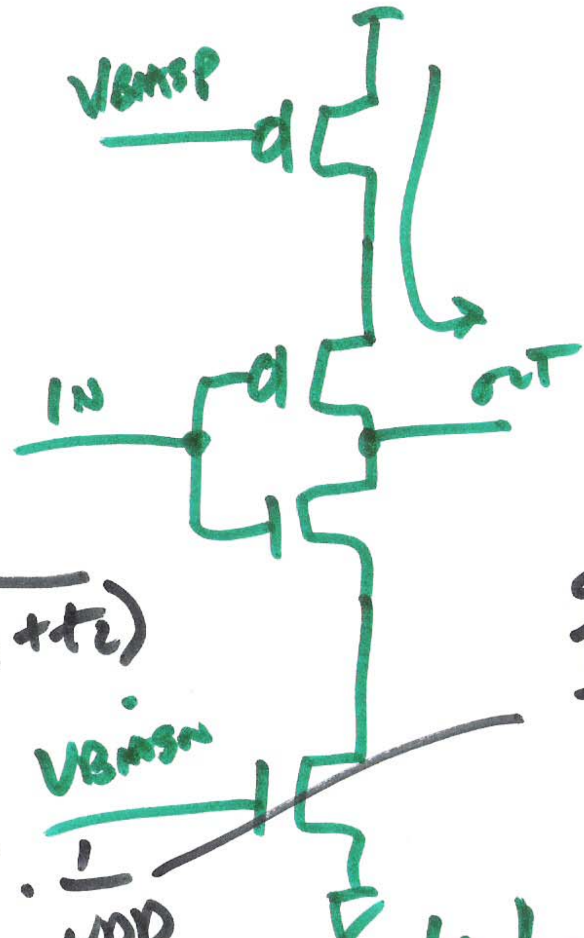
$$I = \frac{V_{IN} - V_{THN}}{R} = \frac{V_{IN}}{R} - \underbrace{\frac{V_{THN}}{R}}$$

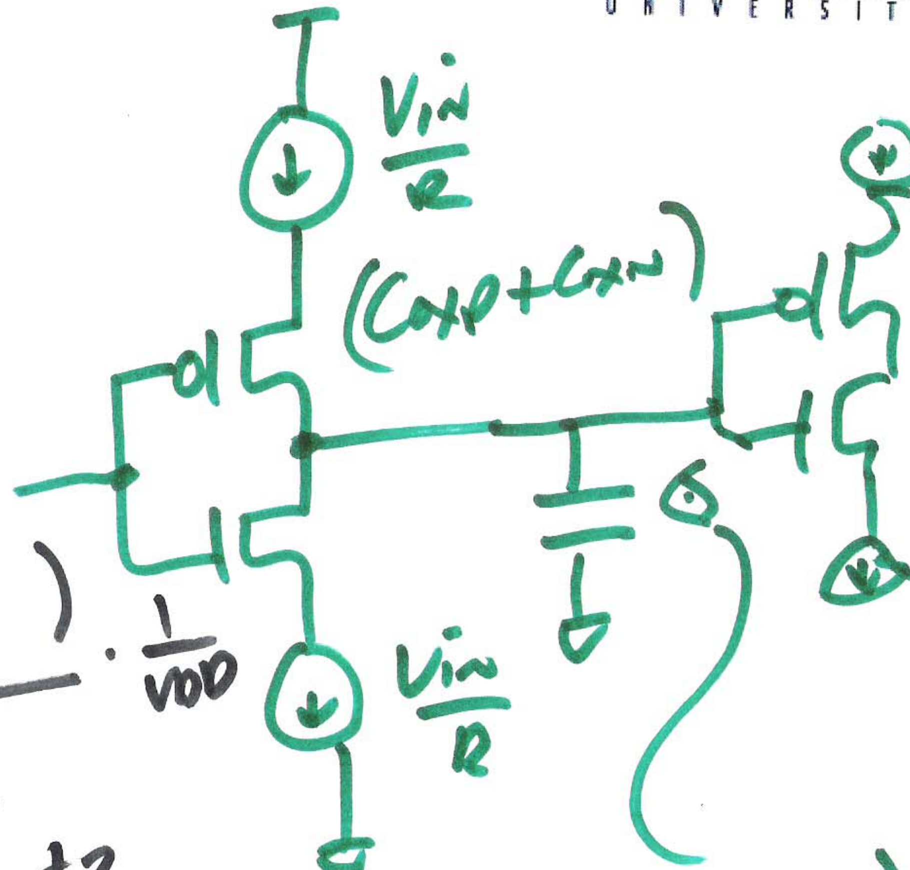
1)

Better V to I converter.



2)

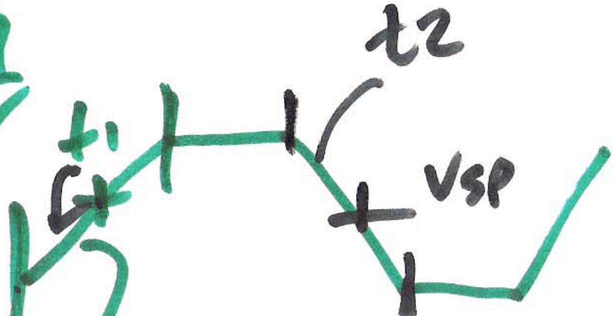




$$f_{osc} = \frac{1}{N(t_1 + t_2)}$$

$$\frac{\frac{5}{2}(\ )}{\frac{V_{in}}{R}} \cdot \frac{1}{VDD}$$

$$t_1 + t_2 = \frac{C}{I} \cdot \frac{1}{VDD}$$

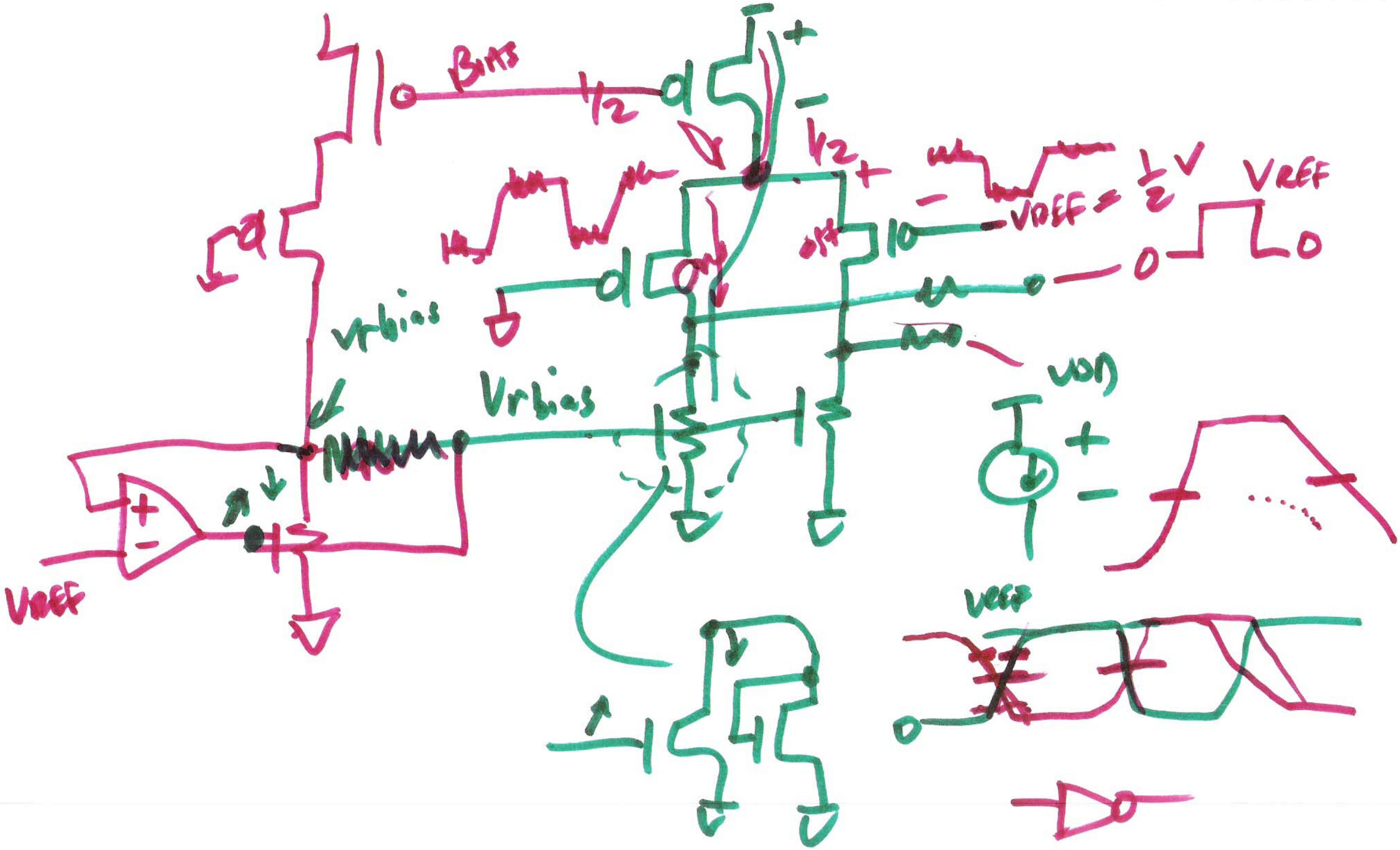


$$\frac{3}{2}(C_{oxn} + C_{oxp})$$

$$\frac{VDD - V_{SP}}{t_2} = \frac{\frac{V_{in}}{R}}{\frac{5}{2}(\ )}$$

$$\frac{0 \rightarrow V_{SP}}{t_1} = \frac{dV}{dT} = \frac{I}{C} = \frac{V_{in}/R}{\frac{5}{2}(C_{oxn} + C_{oxp})}$$

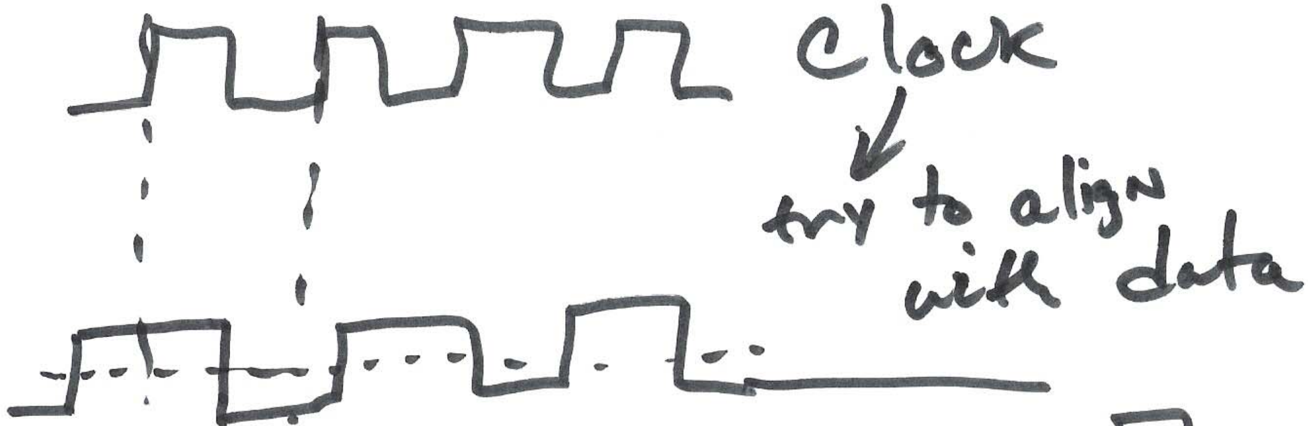
3)

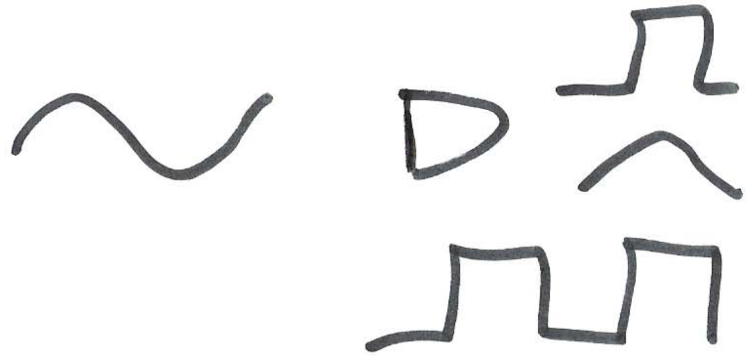

Bias
1/2
1/2
Vrbias
Vrbias
VREF
VREF = 1/2 V
VREF
0
0
0
VDD
VREF
0
on
off

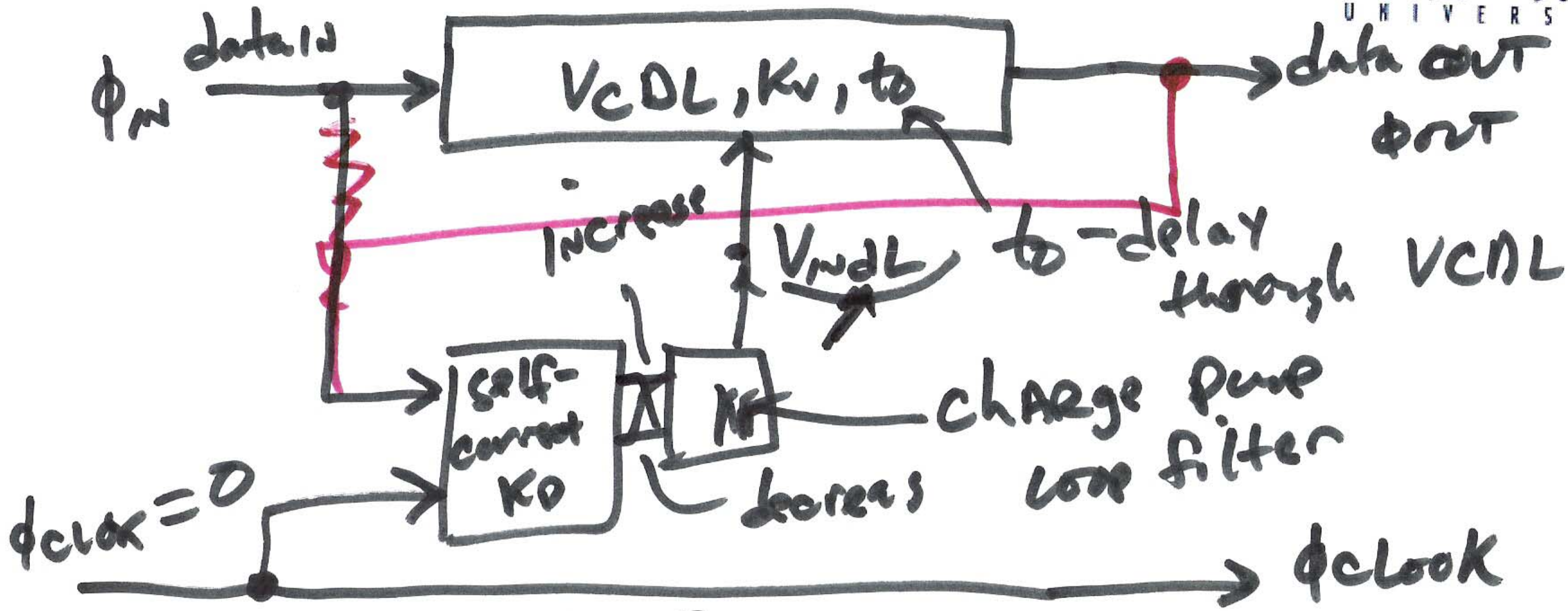
4)

Delay-Locked Loop

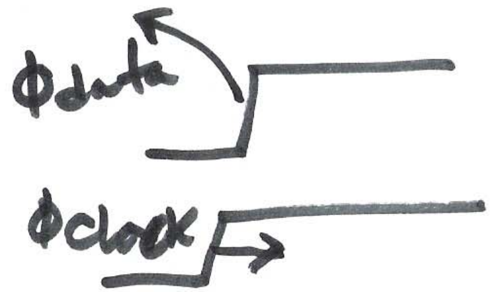
with data







$$\phi = \frac{t_d}{T}\cdot 360$$



$t_D\cdot f\cdot 2\pi$

$$\phi_{OUT} = \phi_{IN} + \frac{t_D}{T}\cdot 2\pi$$

$\Delta\phi = (\phi_{OUT} - \phi ...)$

ϕ_{OUT}

$$t_D = V_{indel}\cdot K_V$$

$$V_{indel} = K_D\cdot\Delta\phi\cdot K_F$$

6)

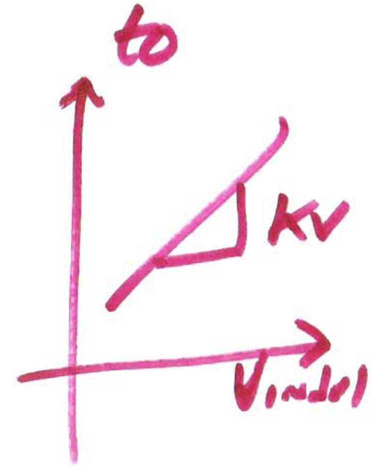
$$\phi_{OUT} = \phi_{IN} + 2\pi \frac{t_0}{T}$$

$$t_0 = V_{indel} \cdot K_V$$

$$V_{indel} = K_D \cdot \phi_{OUT} \cdot K_F$$

↑ includes charge pump

$$\phi_{OUT} = \phi_{IN} + 2\pi \cdot f \cdot K_D \cdot \phi_{OUT} \cdot K_F \cdot K_V$$



$$\frac{\phi_{OUT}}{\phi_{IN}} = \frac{1}{1 - 2\pi f \cdot K_D \cdot K_F \cdot K_V}$$

fix & work

$$K_D = -\frac{I_{pump}}{\pi}$$

↑ By switching inc & dec.

$$K_F = \frac{1}{sC}$$

7)