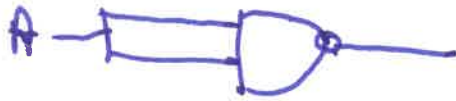


Wed 30 Nov 2016

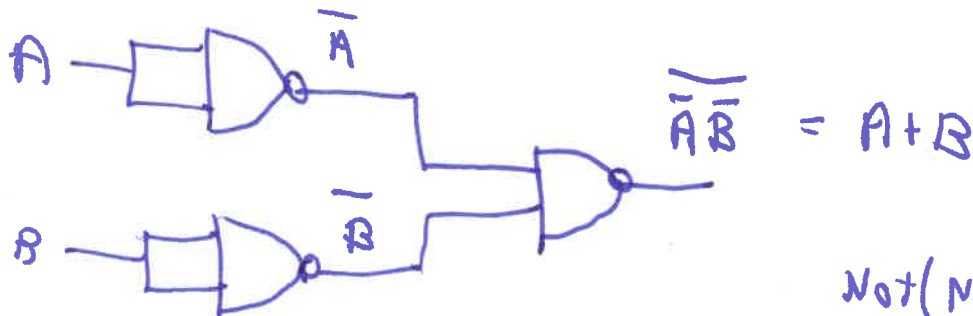
132

"Nuthin' BUT NANDS"

$$\overline{AA} = \bar{A} \quad \text{Not (A and A)}$$

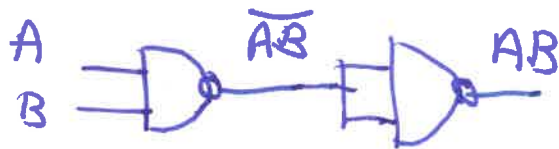


Inverter



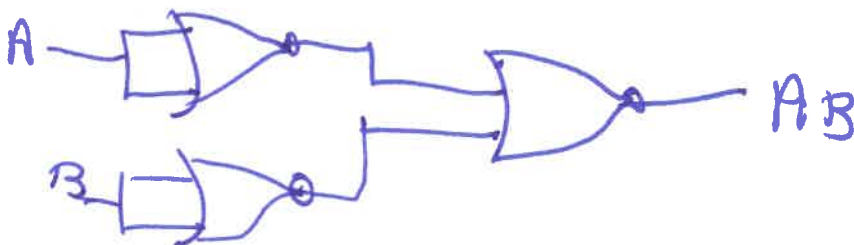
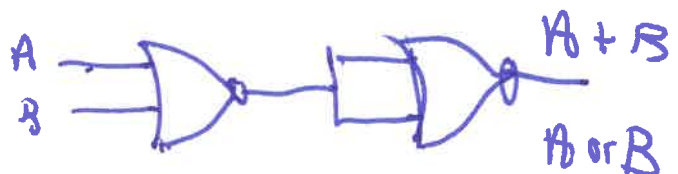
$$\overline{\overline{A} \overline{B}} = A + B$$

Not (Not(A) and Not(B))
= (A or B)



$$\text{not}(\text{not}(A \text{ and } B)) = (A \text{ and } B)$$

Nor s



Electrical Issues

133

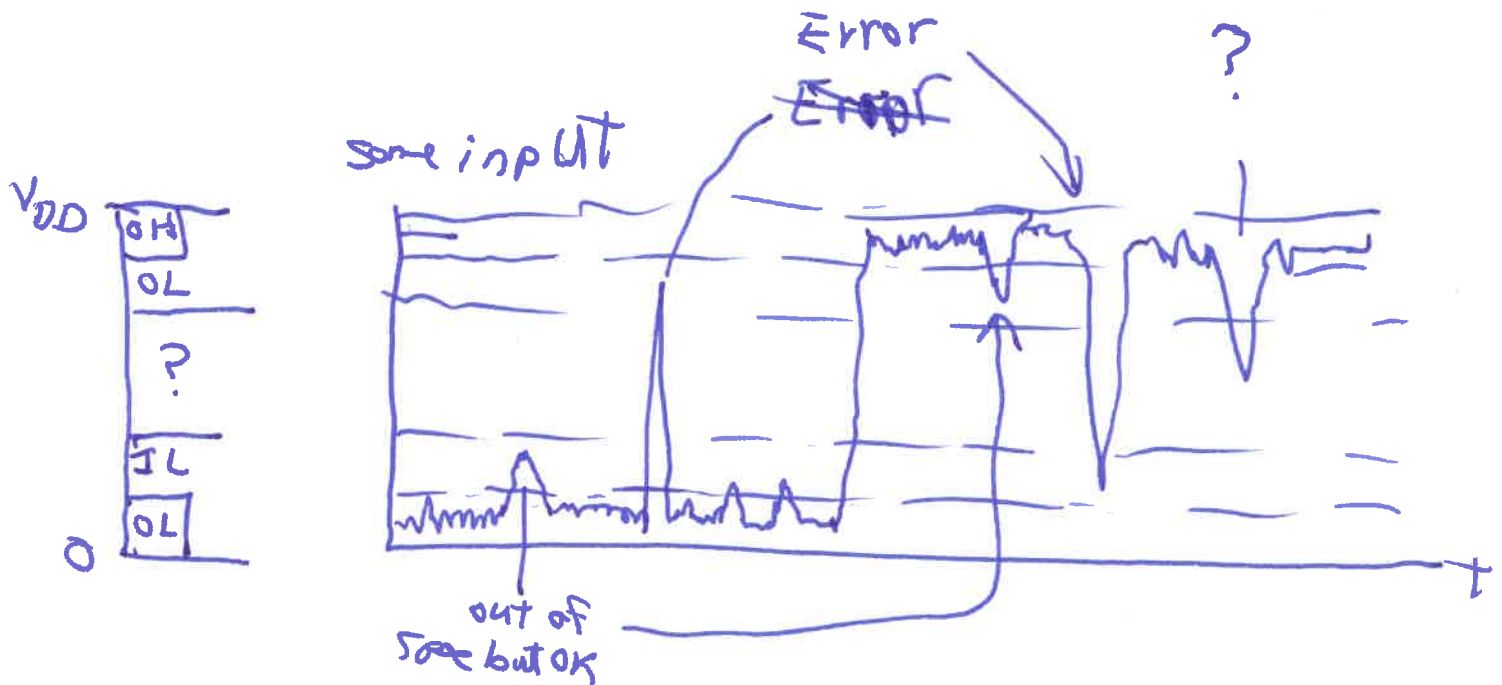
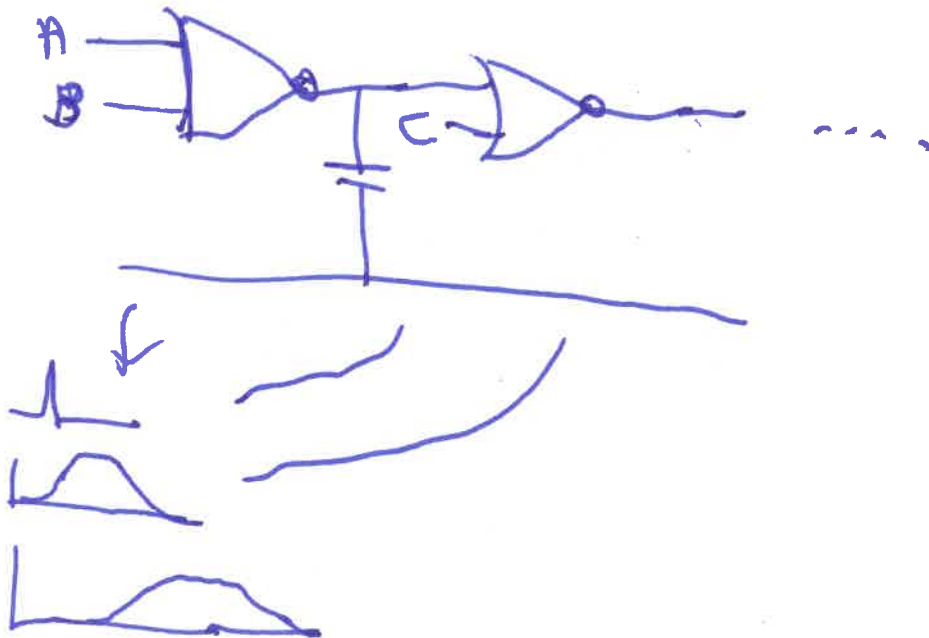
Diode Logic

RTL Resistor-Transistor logic,

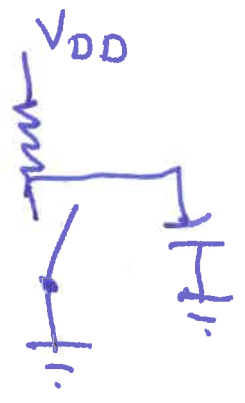
TTL Transistor-Transistor.

High is true

Noise Tolerance



power



Gate C is fF
Total Load often pF

charge
↓
 $Q = C_L V_{DD}$

Energy

$Q V_{DD}$

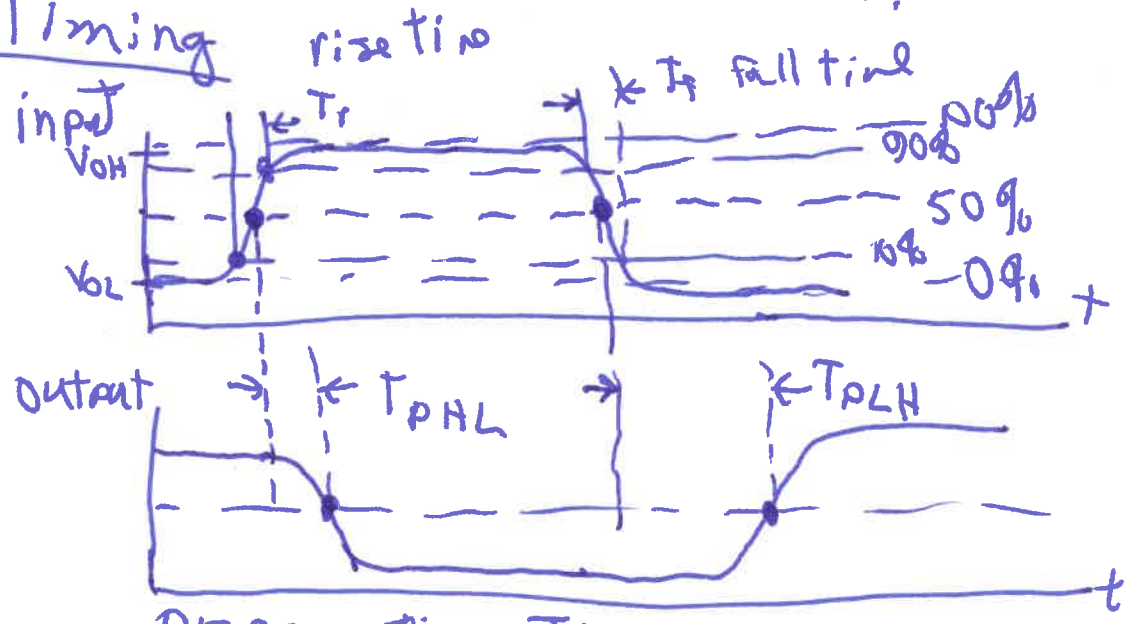
power

Frequency ↑ $f Q V_{DD} = f C_L V_{DD}^2$

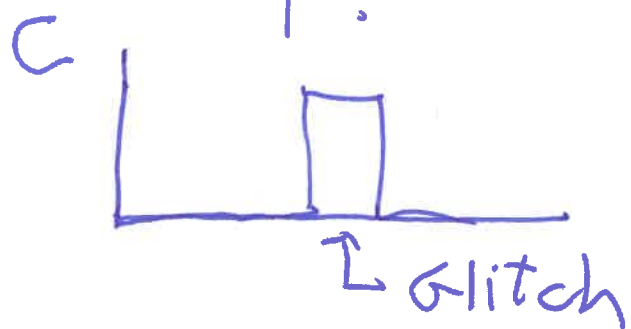
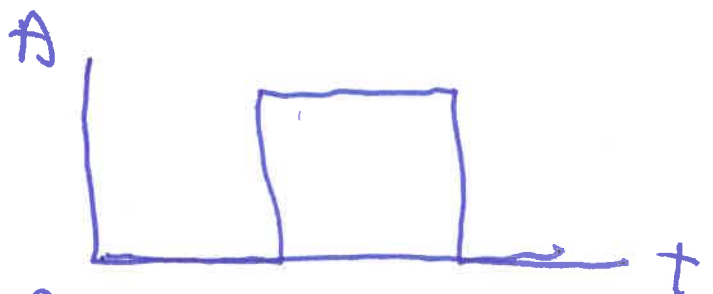
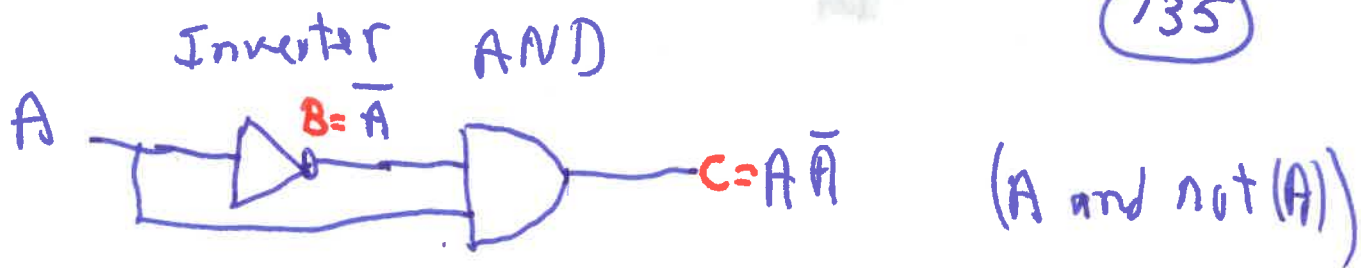
$\uparrow$ 10^9 $\uparrow$ 10^{12} $\uparrow$ 25 V^2
 $\downarrow$ $\downarrow$ $\downarrow$
 10^{-2} 10^{-1} F

10^{-2} to 10^{-1} W/unit.

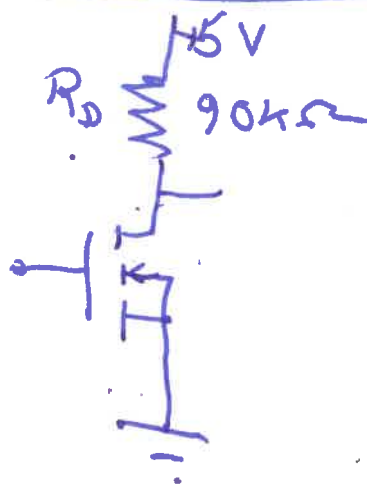
Timing



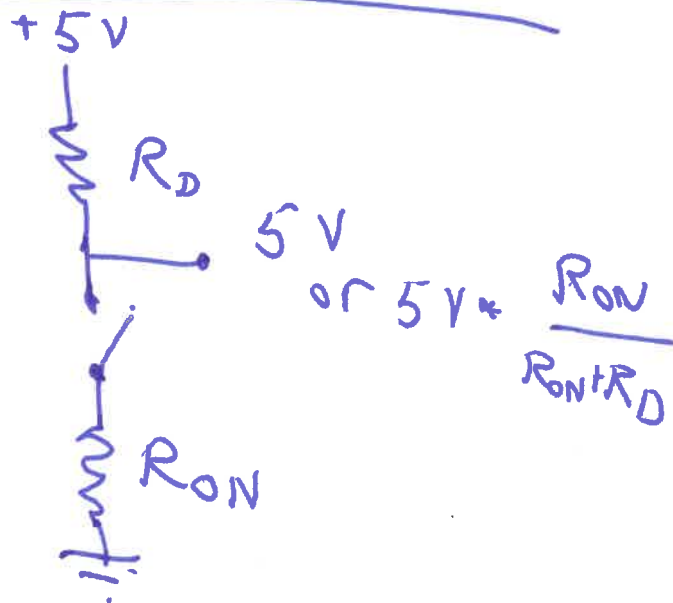
Propagation Times.

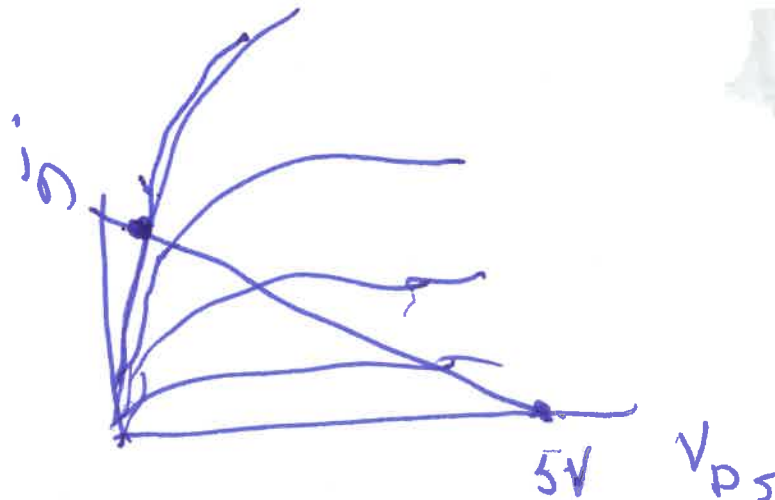


Don't Look at
The output
too quickly.



=





$$i_D = K \left[2(V_{GS} - V_{TO}) V_{DS} - V_{DS}^2 \right]$$

$\uparrow$
 Small

$$i_D \approx K 2 (V_{GS} - V_{TO}) V_{DS}$$

$$R_{on} = \frac{V_{DS}}{i_D} = \frac{V_{DS}}{2K(V_{GS} - V_{TO}) V_{DS}}$$

$$K = \frac{k_p}{2} \frac{W}{L}$$