

EE 421 / ELG 621

Digital IC Design

Lecture 6

Sept. 16, 2016

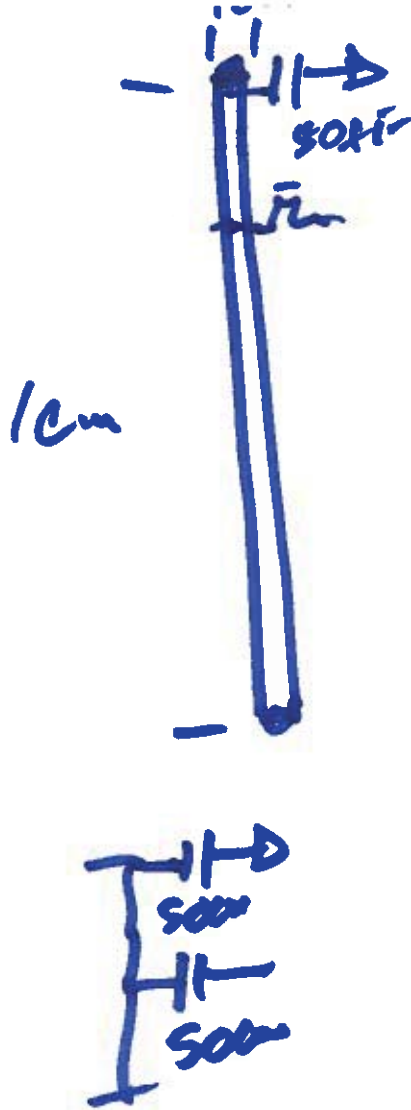
Sheet resistance

$$R_D = 0.1 \Omega/\square$$



$$R = 0.1 \cdot \frac{4000}{1} = 400 \Omega$$

11



$$R_D = 0.1 \Omega / \square$$

$$500 \mu\text{m} \rightarrow 50 \text{ FF}$$

$$t_d = 0.35 r c l^2$$

$$= 0.35 \cdot 0.1 \cdot \frac{10,000 \mu\text{s}}{0.14}$$

$$50 \text{ FF} \cdot \frac{10,000 \mu\text{s}}{0.54}$$

$$= 0.35 \left(\frac{0.1 \Omega}{0} \right) (100,000 \square) \cdot 50 \text{ FF} \cdot (20,000)$$

$$l = \# \text{ of squares}$$

$$r = \text{res}/\square$$

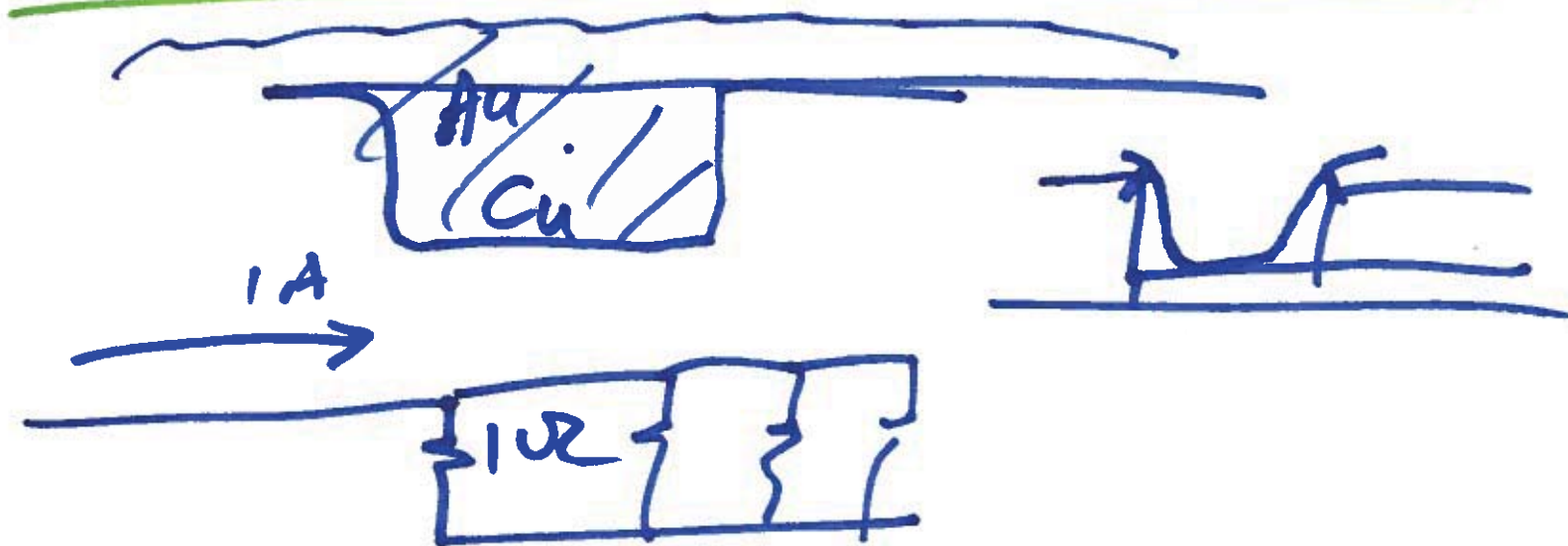
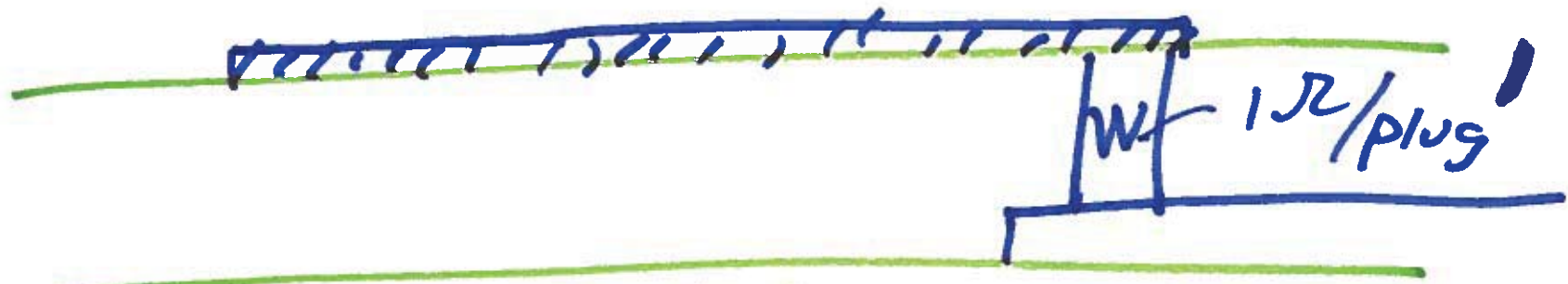
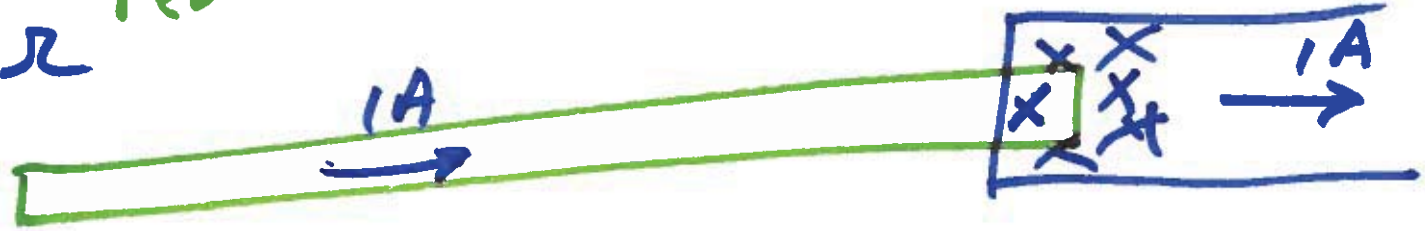
$$c = \text{cap}/\square$$

$$r \cdot l = \text{TOTAL RES.}$$

$$c \cdot l = \text{TOTAL CAP.}$$

Long runs of metal.
 resistance of metal matters

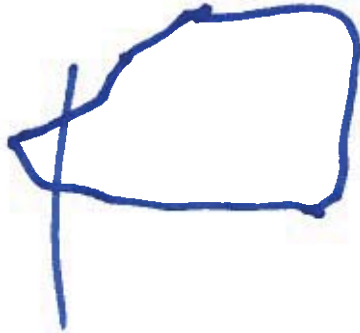
0.1Ω



3)

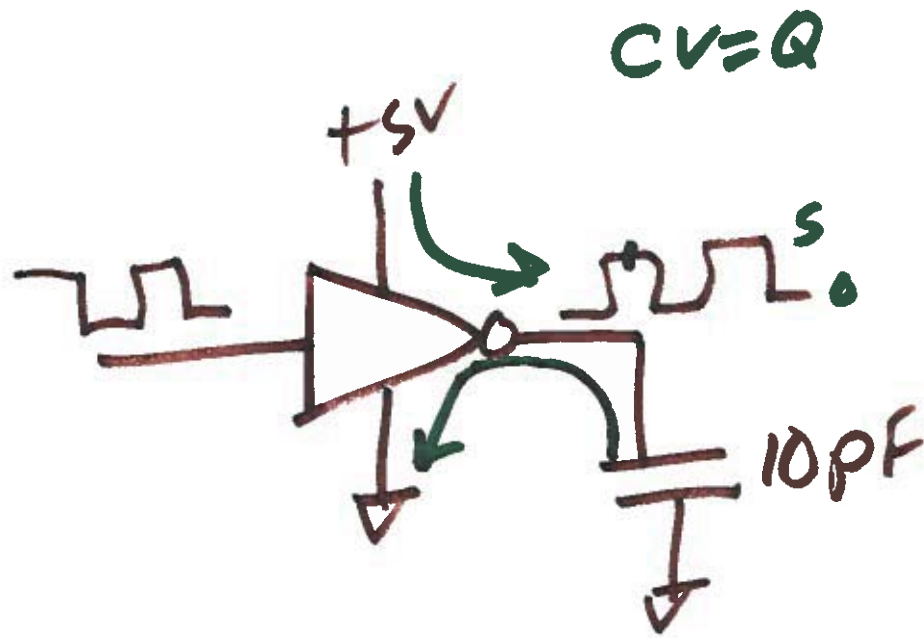
Electromigration

$$J_{Al} = \frac{1 \text{ mA}}{4 \mu\text{m}}$$



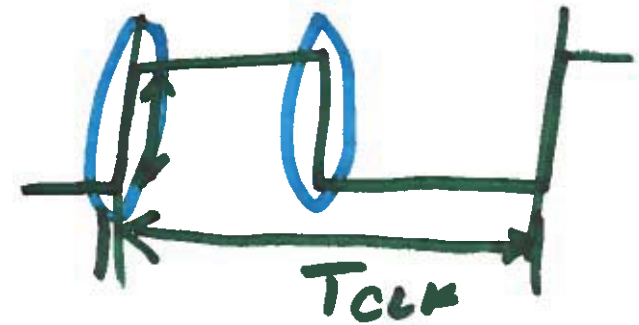


5)



$$10\text{pF} \cdot 5\text{V} = 50\text{pC}$$

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



$$f_{\text{CLK}} = \frac{1}{T_{\text{CLK}}}$$

$$16\text{Hz} \Rightarrow$$

$$T_{\text{CLK}} = 1\text{ns}$$

$$I_{\text{INV}} = \frac{50\text{pC}}{T_{\text{CLK}}}$$

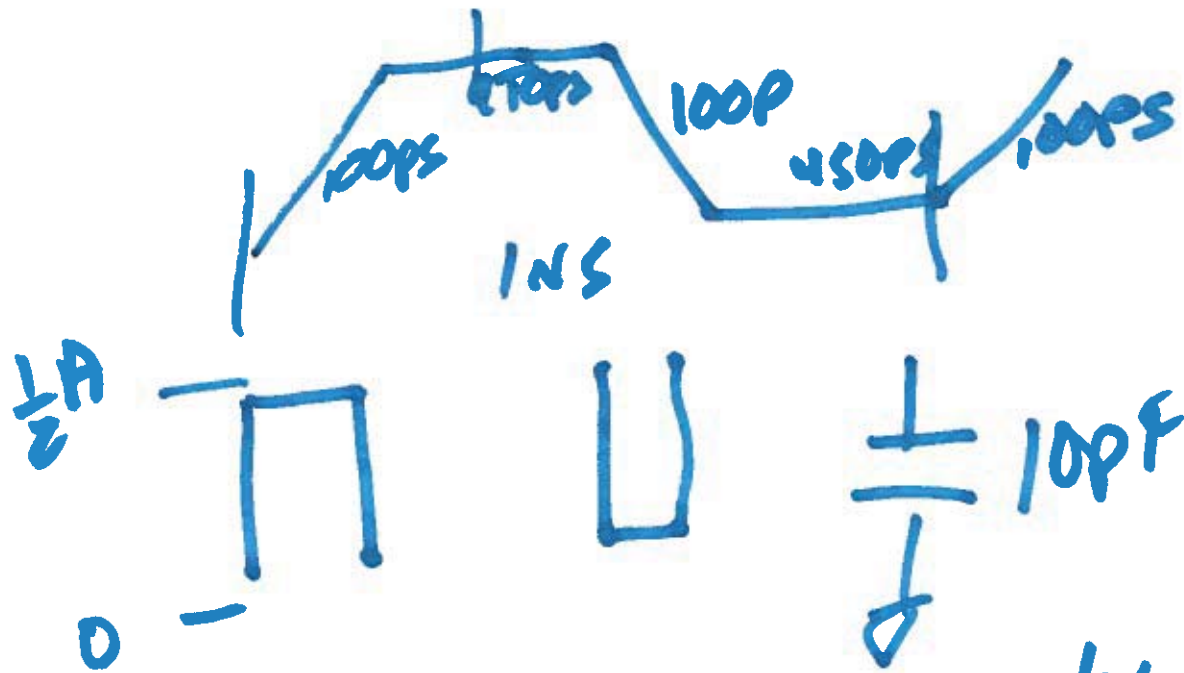
$$I_{\text{INV}} = \frac{50\text{pC}}{1\text{ns}} = 50\text{mA}$$

$$P_{\text{INV}} = V_{\text{DD}} \cdot I_{\text{INV}}$$

$$= 5 \cdot 50\text{mA}$$

$$= 250\text{mW!}$$

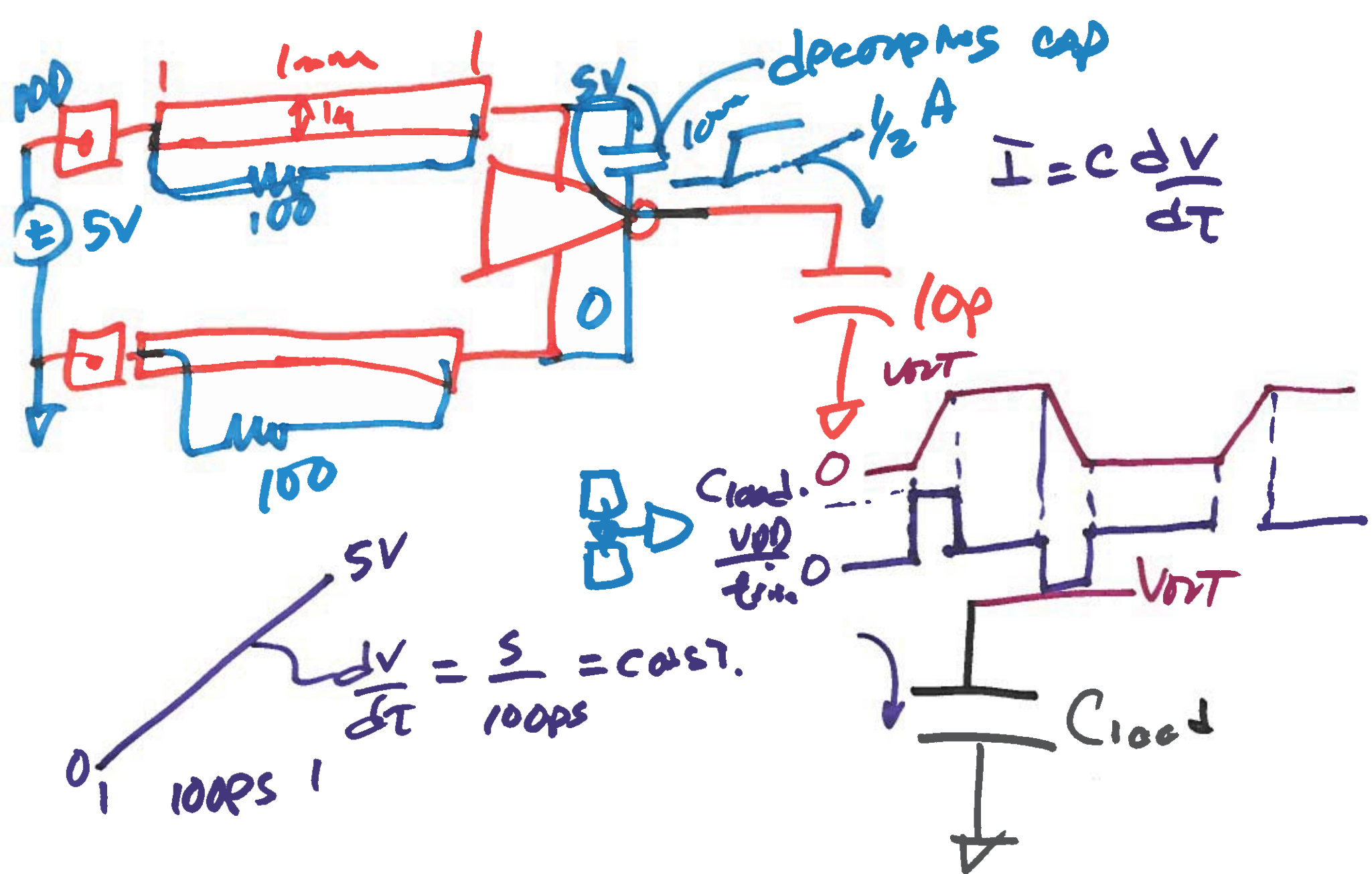
6)



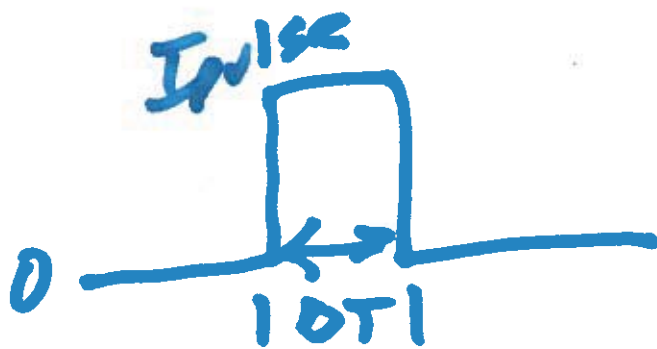
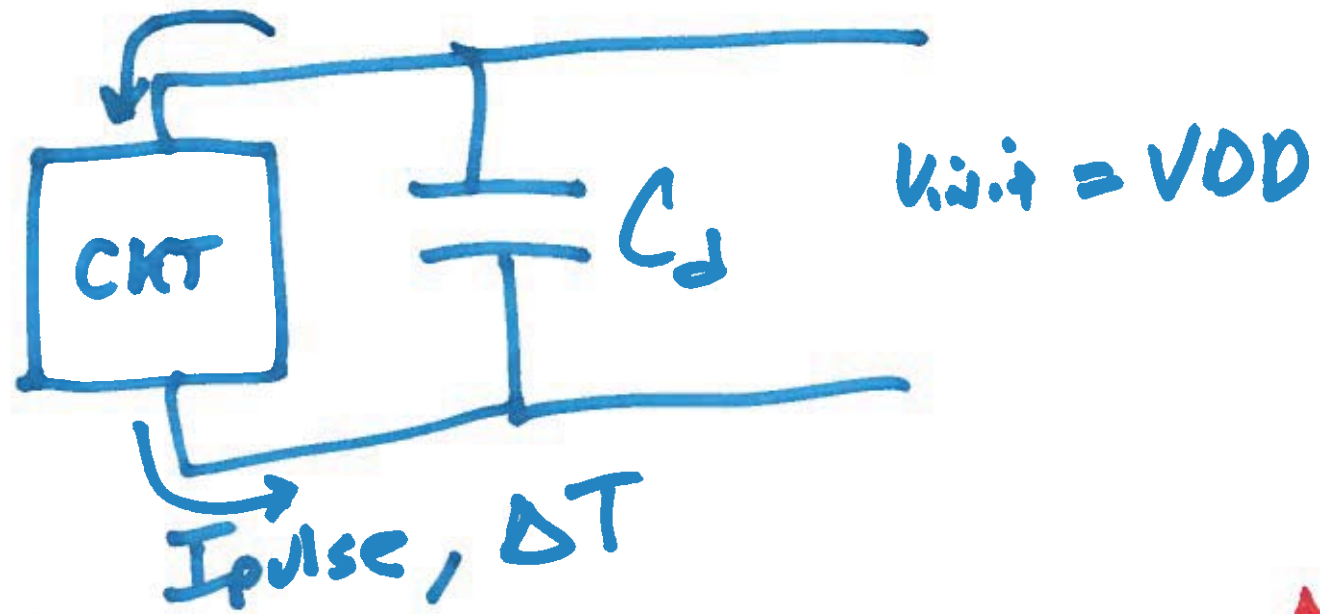
$$I_{\text{peak}} = 10 \text{ pF} \cdot \frac{dv}{dt} = 10 \text{ pF} \cdot \frac{5}{100 \text{ ps}}$$

$$I_{\text{peak}} = \frac{1}{2} \text{ A} = 500 \mu\text{A}!$$

$$I_{\text{peak}} = C_{\text{load}} \cdot \frac{V_{DD}}{t_{\text{rise}}}$$



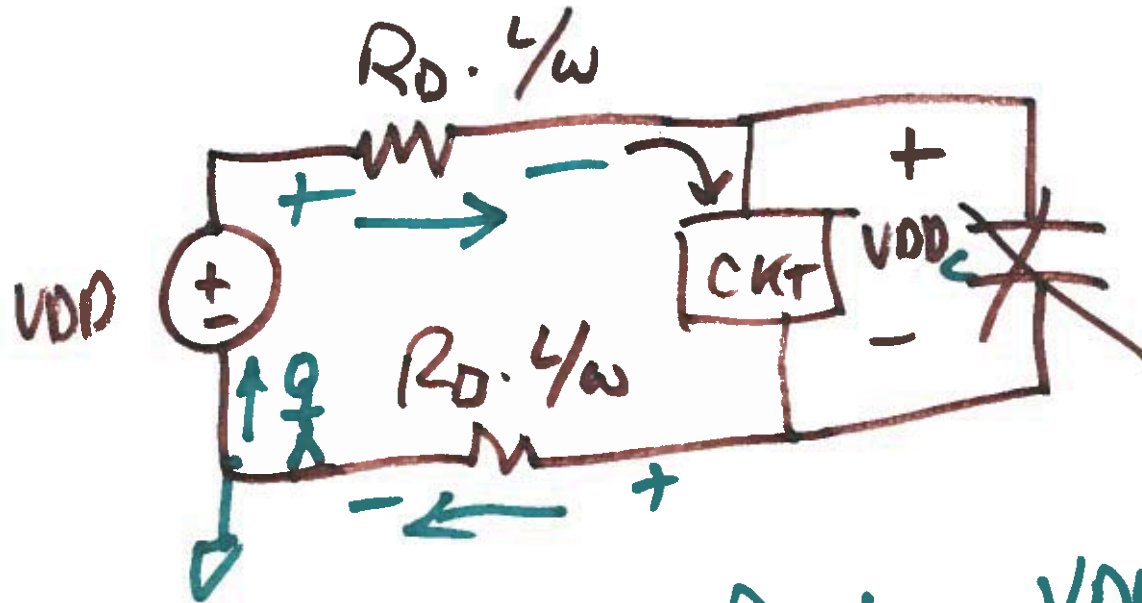
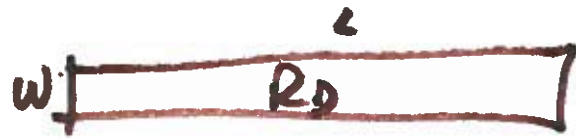
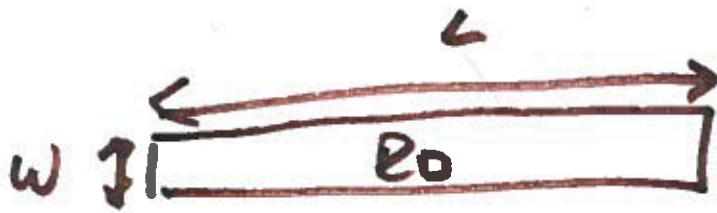
8)



$$I = C \frac{dV}{dt} = C_d \cdot \frac{\Delta V_{DD}}{\Delta T}$$

$$I_{pulse} = C_d \cdot \frac{\Delta V_{DD}}{\Delta T}$$

$$200 \text{ pF} = C_d = \frac{\Delta T \cdot I_{pulse}}{\Delta V_{DD}} = \frac{100 \text{ p} \frac{1}{2} \text{ A}}{.25}$$



$$V_{DD} - I \cdot R_D \cdot \frac{L}{w} - V_{DD_c} - I \cdot R_D \cdot \frac{L}{w} = 0$$

10)