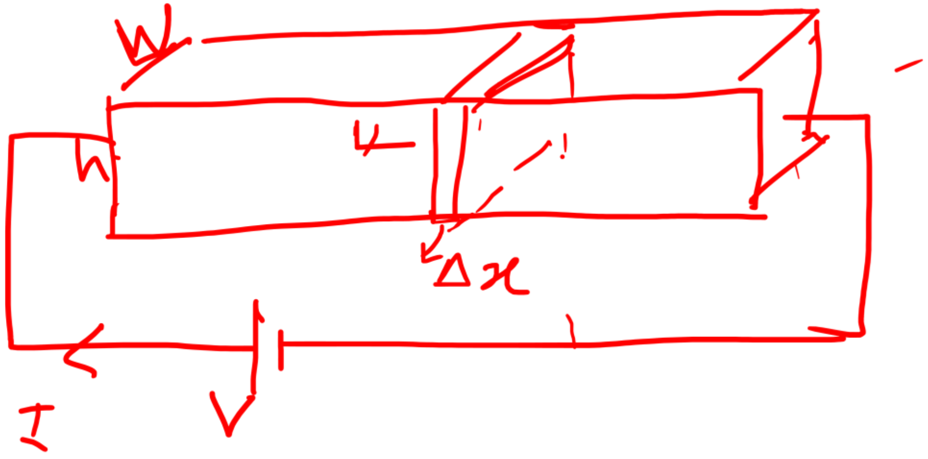
Passive IC Devices

09 June 2025

Resistance

$$n \rightarrow \frac{Q}{V} \Rightarrow Q = n \cdot W \cdot L \cdot h \qquad I \propto V \Rightarrow IR = V$$



$$\frac{\Delta Q}{\Delta t} = I$$

$$+q \xrightarrow{E}$$

$$F = qE$$

$$v \propto E \qquad \boxed{v = \mu E}$$

$$I = f(V, W, L, h, n, \mu) \qquad \boxed{Q_s = n \cdot W \cdot h}$$

$$\boxed{E = V/L}$$

$$I = \frac{Q_s \times \Delta x}{\Delta t} = Q_s \cdot v = Q_s \cdot \mu \frac{V}{L} = \frac{n \cdot W \cdot h \cdot \mu}{L} \cdot V$$

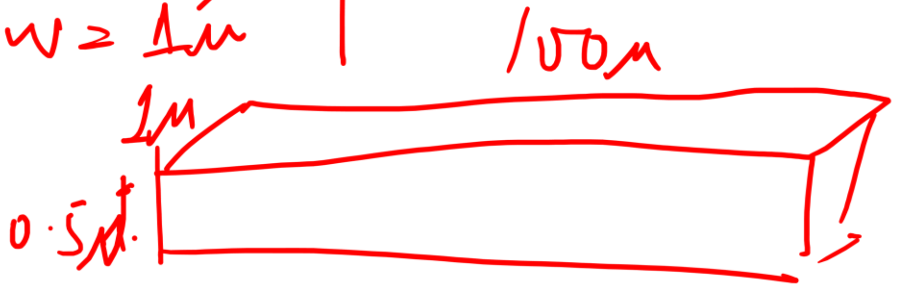
$$\boxed{V = \left(\frac{L}{W \cdot h} \times \frac{1}{n \cdot \mu}\right) I}$$

$$\boxed{R = \left(\frac{\rho}{h}\right) \cdot \frac{L}{W}} = \boxed{R = \rho_{\square} \cdot \frac{L}{W}}$$

	ρ Ω-cm	MP(T)	R_s / 10 μm
Al	2.65	660 °C	2.06/-
Cu	1.68	1080 °C	8.53/-
Au	2.44	1064 °C	1 lack

$Al = 2.65 \times 10^{-6}\ \Omega\text{-cm}$

$L = 100\ \mu m$, $w = 1\mu$ | $h = 0.5\mu$



$$R = \rho \frac{L}{w \cdot h} = 5.3\ \Omega$$

$530\ \Omega$

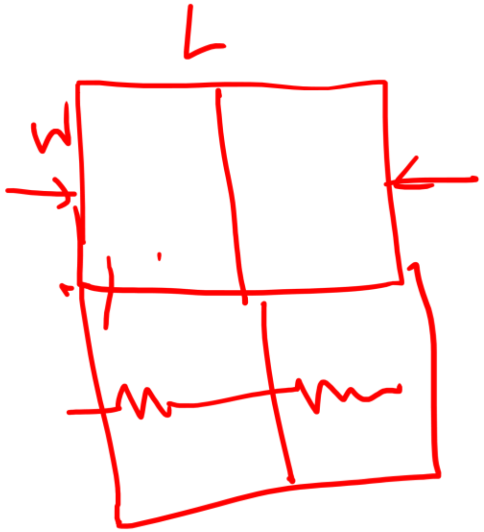
$$R_{Al} = 2.65 \times 10^{-6}\ \Omega\text{-m} \times \frac{100}{0.5} = \frac{2.65 \times 10^{-8} \times 200}{10^{-6}\ m}$$

$$= 200 \times 2.65 \times 10^{-2} = 5.3\ \Omega$$

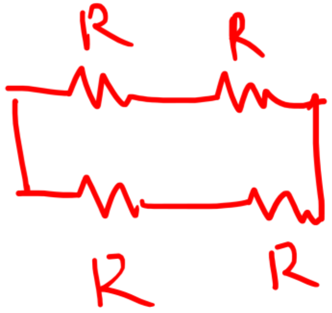
$$R_{Cu} = 5.3 \times \frac{1.68}{2.65} = 3.36$$

$$R_{Au} = 5.3 \times \frac{2.44}{2.65} = 4.88$$

$$R = \left(\frac{\rho}{n}\right)\frac{L}{W} = \rho_\square \cdot \frac{L}{W} \qquad \rho_{\square\,Al} = \frac{5.33\,\Omega \times 1}{100} = 0.0533\,\frac{\Omega}{\square}$$



$$R = \rho_\square \cdot \frac{L}{W}$$

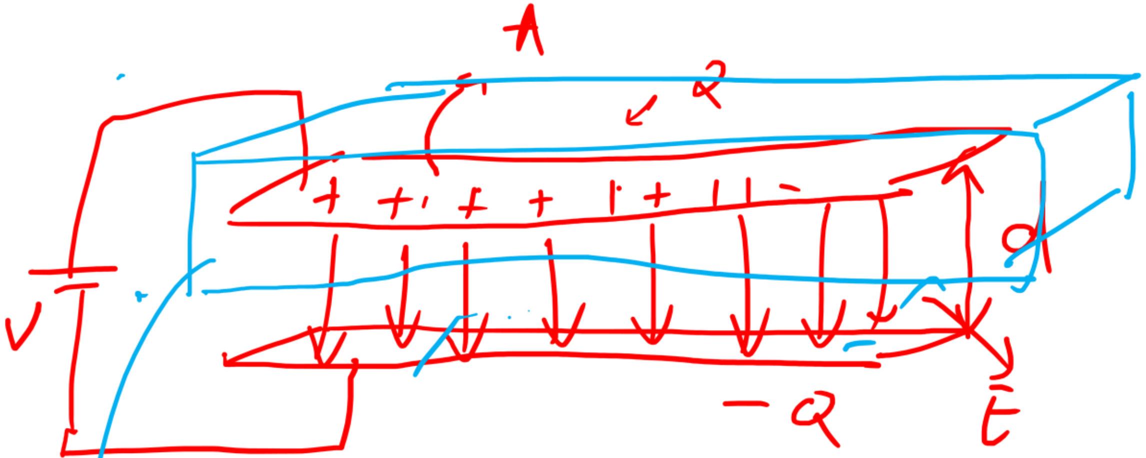


$$\frac{2R}{2} = R$$

$$100\,\frac{\Omega}{\square}$$

Capacitance

$$V = \int E \cdot dl$$



$$Q_{tot} \propto V \qquad C = f(A, d, \epsilon_0)$$

$$Q_{tot} = C\, V$$

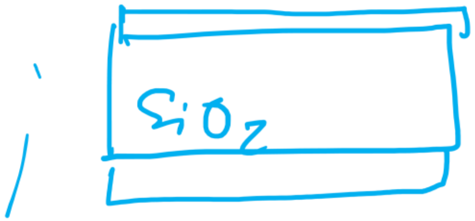
$$\nabla \cdot E = \frac{q}{\epsilon_0}$$

$$\frac{Q}{\epsilon_0} = E \cdot A \Rightarrow Q = \epsilon_0 \vec{E} \cdot A$$

$$V = E \cdot d \Rightarrow E = \frac{V}{d}$$

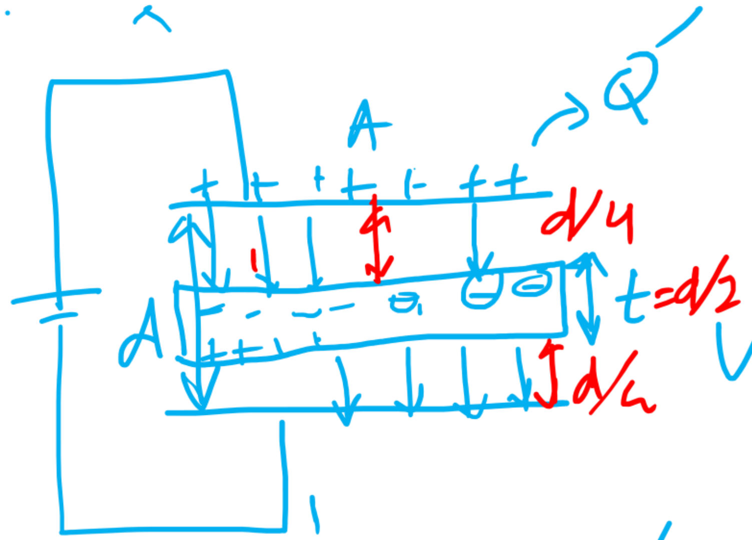
$$Q = \underbrace{\left(\frac{\epsilon_0 A}{d}\right)}_{C} V$$

$$\boxed{C = \frac{\epsilon_0 A}{d}}$$



$$C = \frac{\epsilon_{SiO_2} \cdot A}{d} = \frac{K_{SiO_2} \cdot \epsilon_0 \cdot A}{d}$$

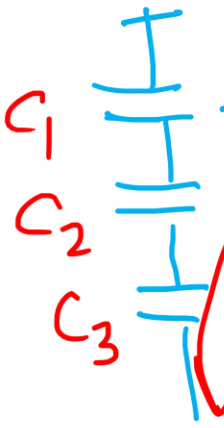
$K_{SiO_2} \rightarrow 4$



$$\frac{Q}{\epsilon_0} = E \cdot A$$

$$V = E\int_0^{d-t/2} dl + E\int_{d-t/2+t}^{d} = E \cdot (d-t)$$

$$C = \frac{\epsilon_0 \cdot A}{d} \qquad C' = \frac{\epsilon_0 \cdot A}{(d-t)}$$



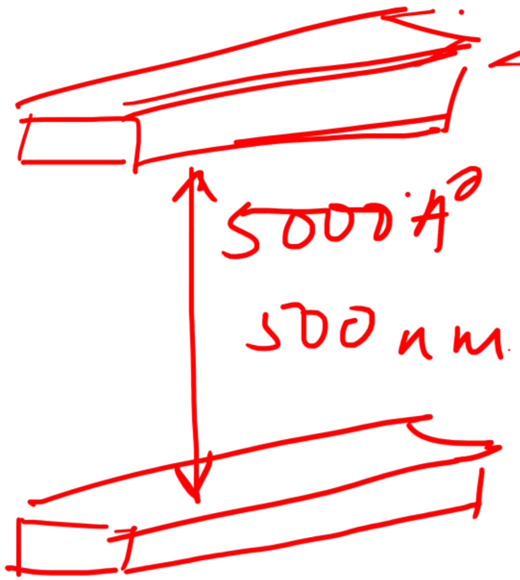
$$C_1 = \frac{\epsilon_0 \cdot A}{d/4}$$

$$C_2 = \frac{\epsilon_0 K_{Si} \times A}{d/2}$$

$$C_3 = \frac{\epsilon_0 \cdot A}{d/4}$$

$$C'_{12} = \frac{\epsilon_0 \cdot A}{d/2}$$

$$\frac{1}{C_f} = \frac{1}{C_1} + \frac{1}{C'_{2}}$$



$\rightarrow 10\,\mu m \times 10\,\mu m$

$\rightarrow SiO_2$

$$\rightarrow \frac{C}{\mu m^2} = \frac{K_{SiO_2} \times \epsilon_0 \cdot A}{d} = \frac{K_{SiO_2} \times \epsilon_0}{d}$$

$$= 0.823\ \mu F/A^{\circ 2}$$

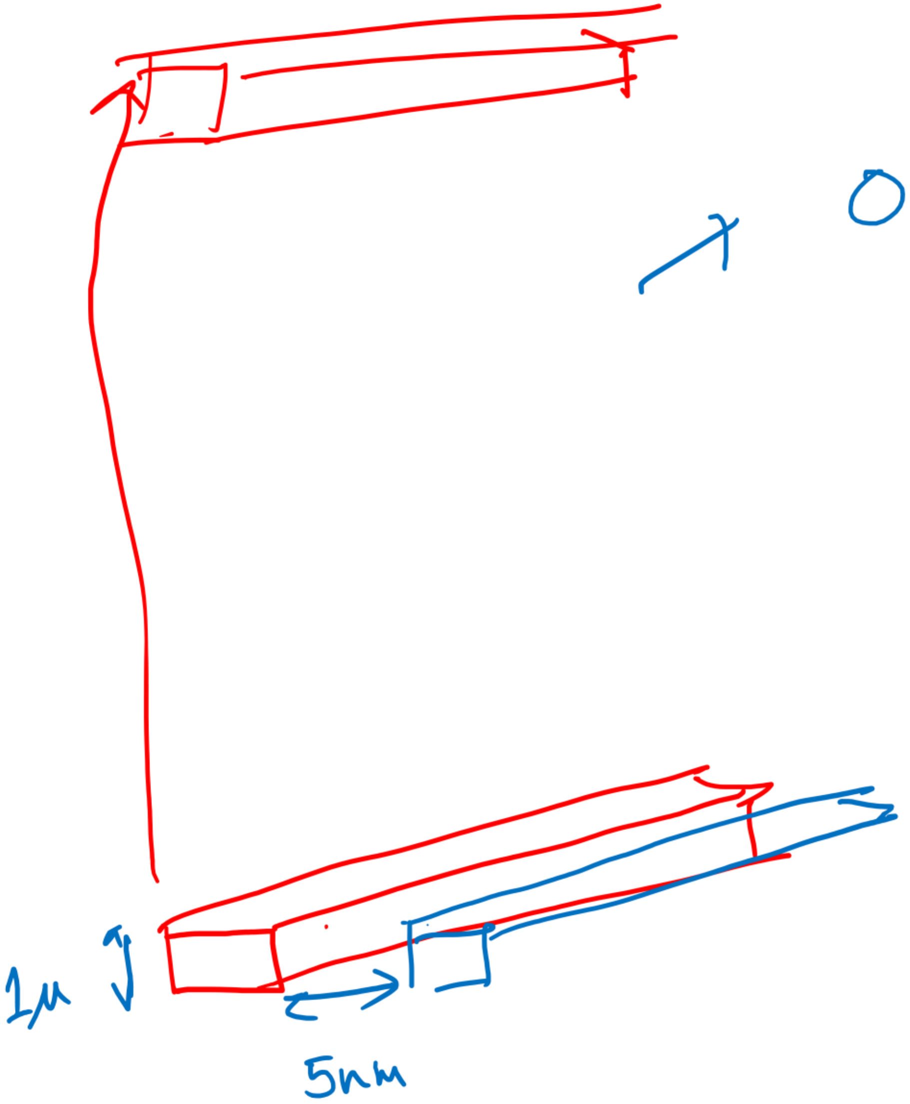
$$= \frac{4 \times 8.85 \times 10^{-12}\ F/m}{5 \times 10^{-7}\ m} = \frac{35 \times 10^{-12}}{5 \times 10^{-7}}\ F/m$$

$$= 7 \times 10^{-5}\ F/m^2$$

$$= 7 \times 10^{-5-12}\ \frac{F}{\mu m^2}$$

$$= 7 \times 10^{-17}\ F/\mu m^2$$

$$\boxed{C_{SiO_2} \simeq 0.7\ \frac{aF}{\mu m^2}}$$



$$\frac{0.7\,aF}{\mu m^2}$$