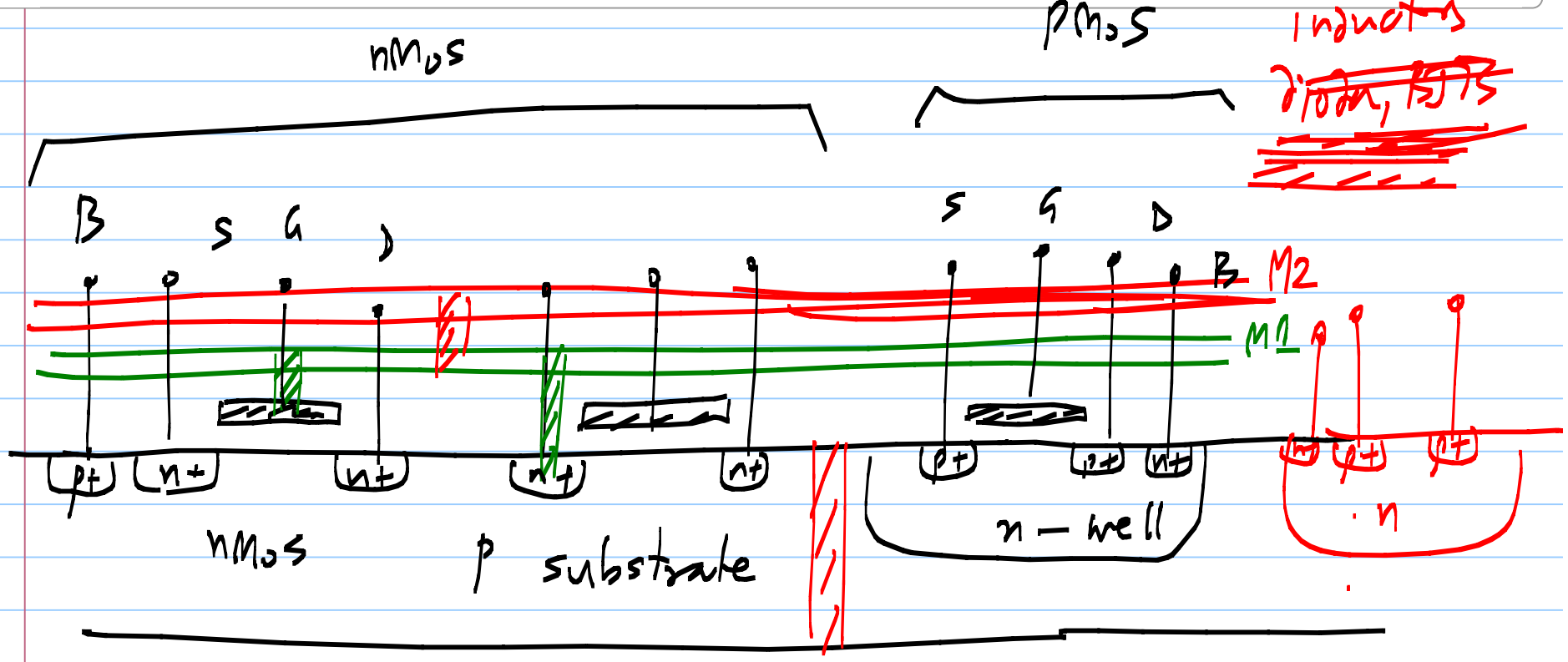
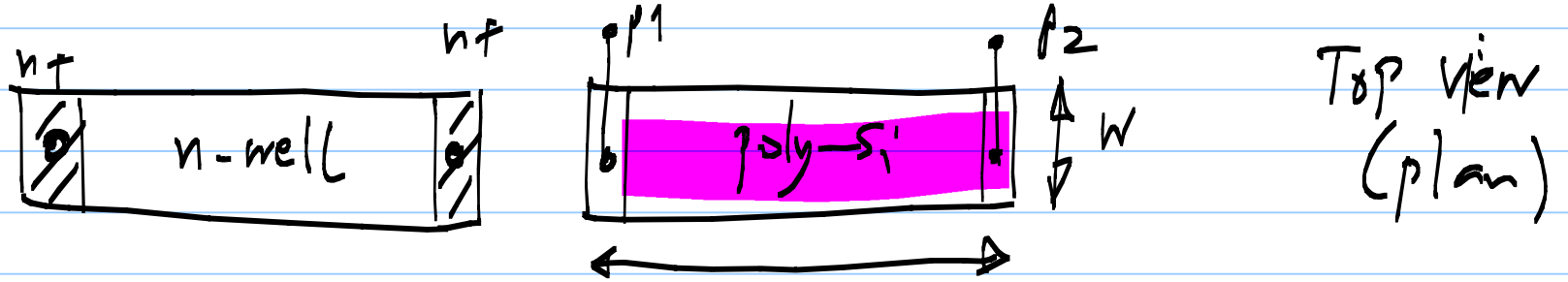
Lecture 2 12/1/2016

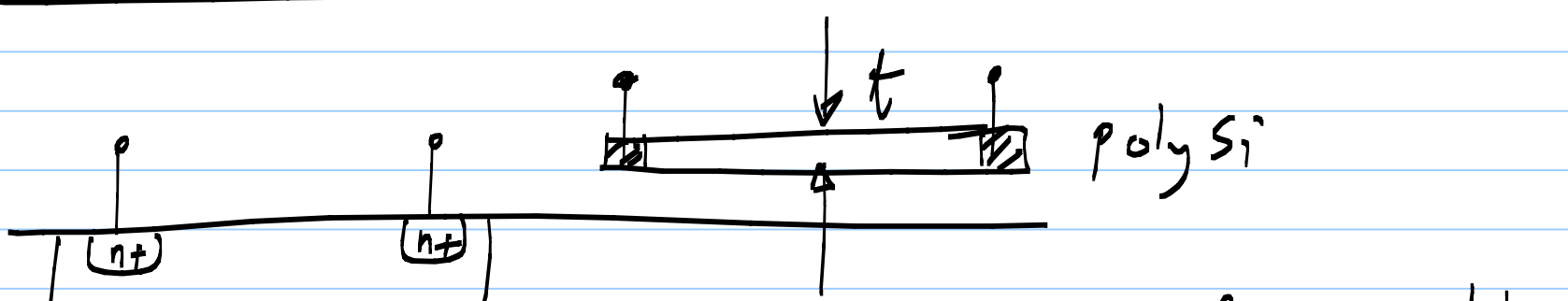
nmos, pmos, resistors, capacitors, inductors ~~diodes, BJTs~~



Resistors in a CMOS process

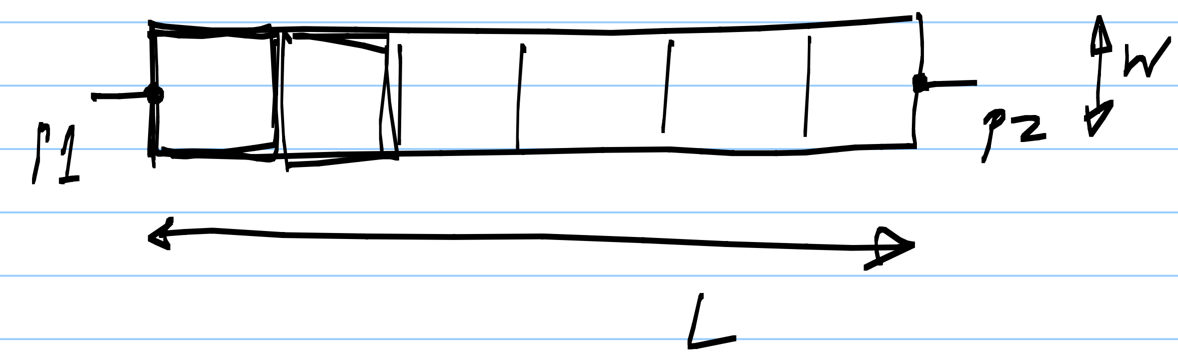
$$R = \rho \frac{L}{wt}$$





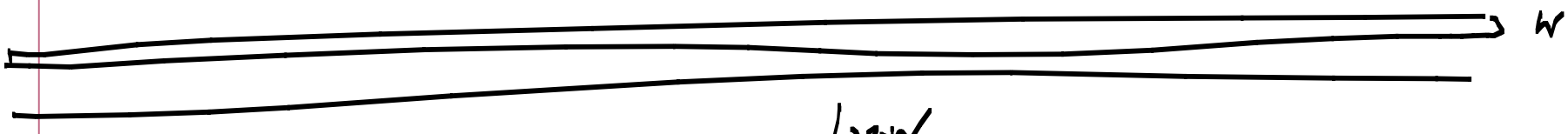
$$R = \left(\frac{\rho}{t}\right) \cdot \frac{L}{W} = R_{sh} \cdot \frac{L}{W}$$

sheet resistance ($\Omega/\square$)

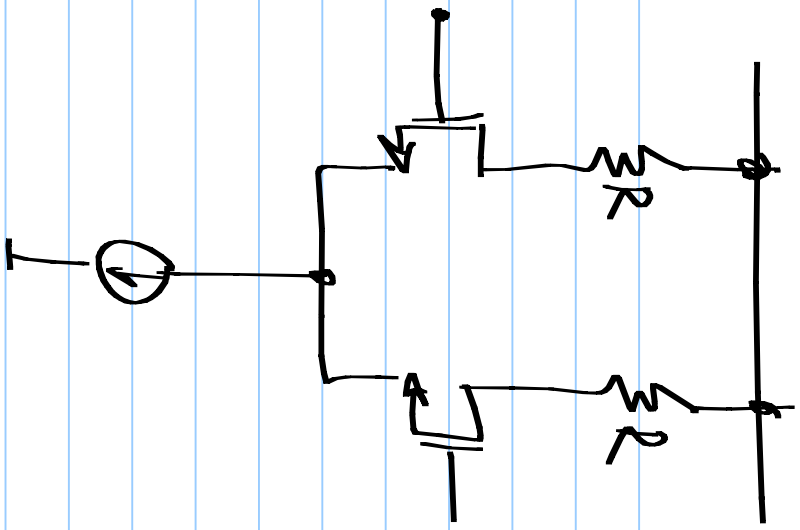


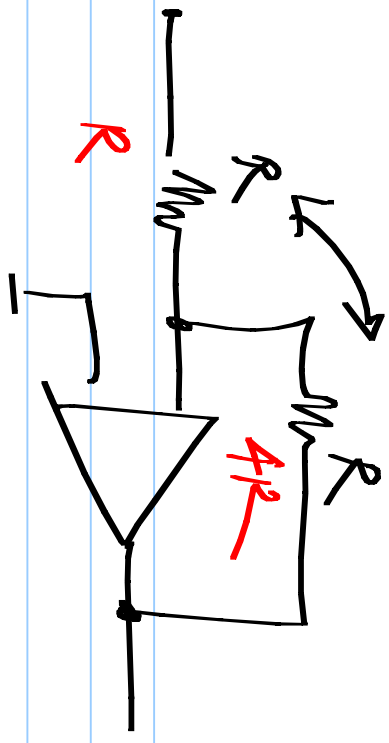
$100\,\Omega/\text{sq.}$

$$\frac{W}{L} = 10 \Rightarrow R = \underline{1\,k\Omega}$$



Meandered layout for high resistances

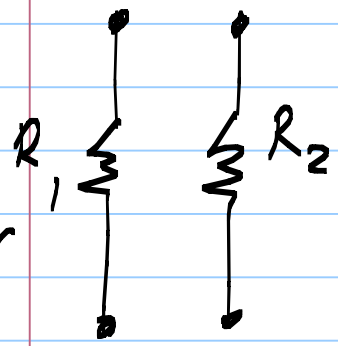

R
R

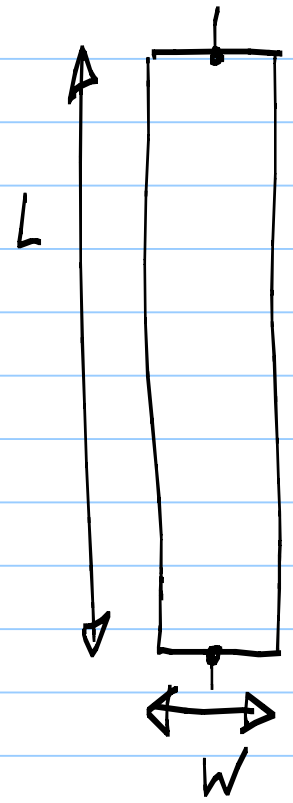

R
R
R
4R

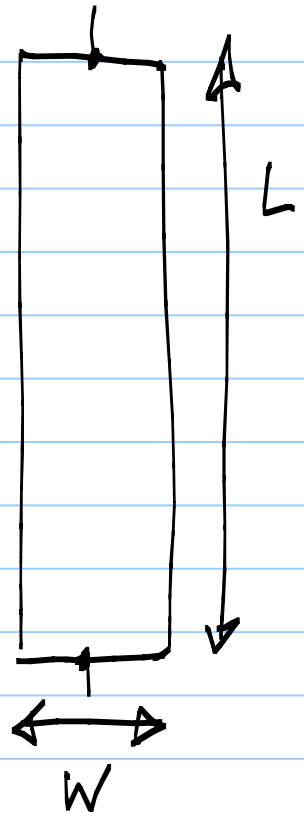
Identical resistors

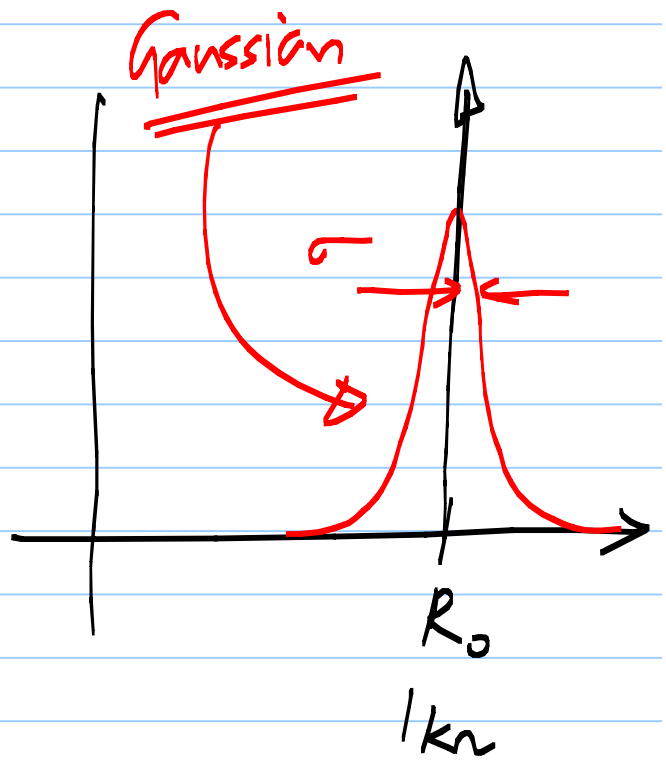
Random mismatch

$$\left(R_{sh}\right)\frac{L}{W}$$









$$\frac{R_1 + R_2}{2} = R$$

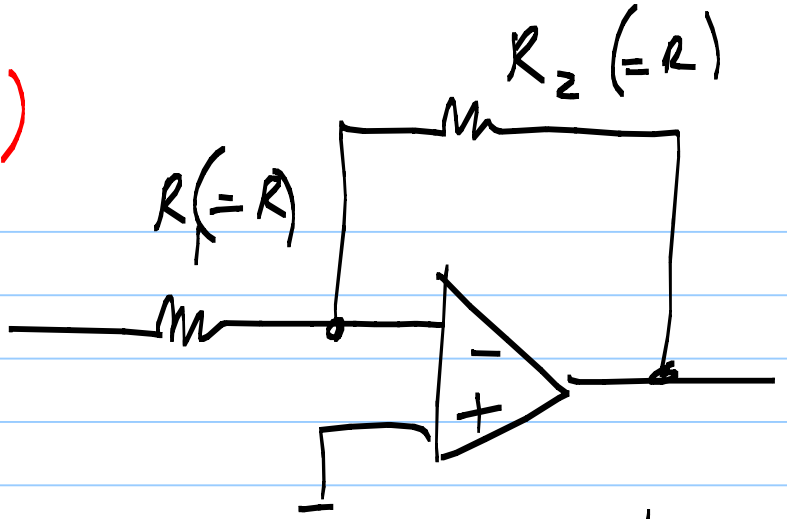
$$R + \frac{\Delta R}{2}$$

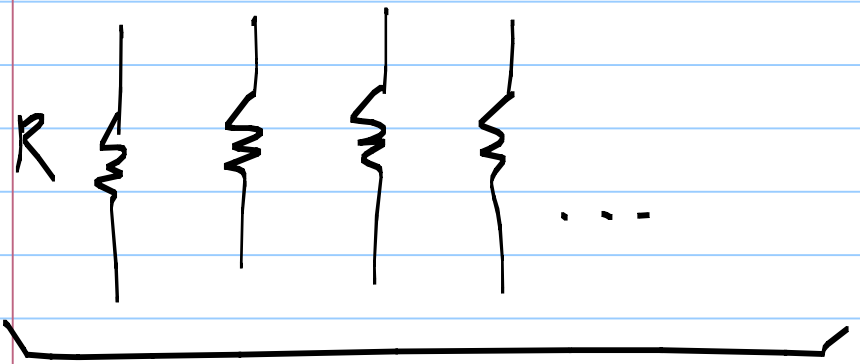
$$R - \frac{\Delta R}{2}$$

$$\Delta R = R_2 - R_1$$

$$\sqrt{E\left(R_i - R_0\right)^2} \qquad \sigma(R)$$

$$\sigma_R = \sigma\left(\frac{R}{R_0}\right)$$





I would like $0.999 < |G| < 1.001$

I have $0.998 < |G| < 1.002$

$$\sigma_R = \sigma\left(\frac{R}{R_0}\right) = 1\%$$

mean

$$|A_V| = \left|\frac{V_0}{V_i}\right|$$