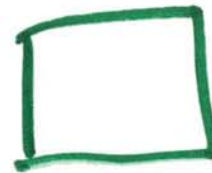


EE 421 / ECE 621

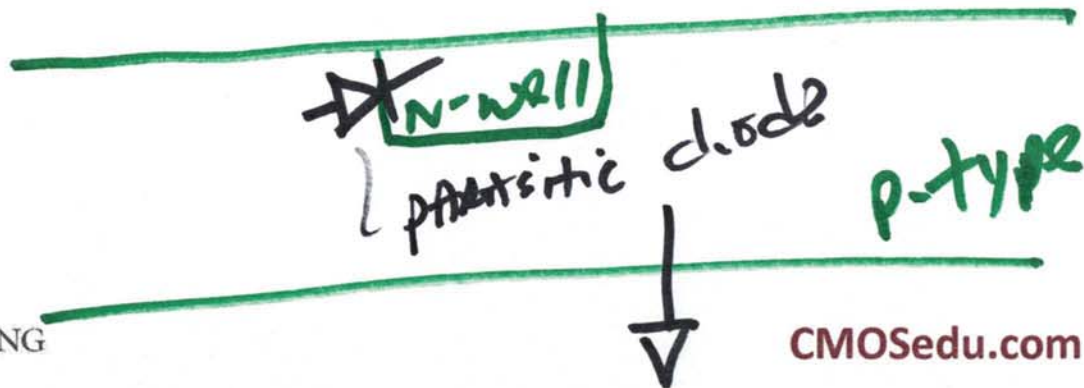
Digital IC Design

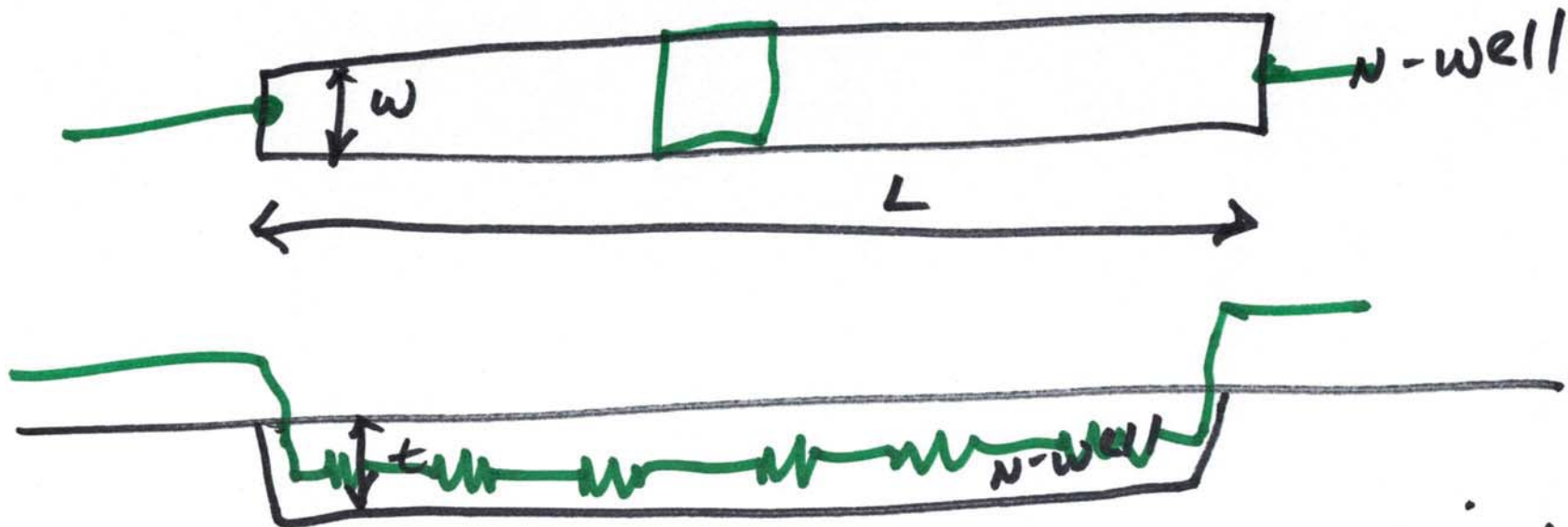
8/31/16

Lecture 2



n-well  
LAYOUT





$$R = \frac{\rho}{t} \cdot \frac{L}{w}$$

$\frac{\rho}{t}$  sheet resistance  
 $\frac{\Omega}{\square}$

Sheet resistance  
 = resistance is  
 $\Omega \cdot \text{cm}$   
 resistivity

LAYOUT An 8k resistor using N-well

N-well sheet resistance  
 $= 800 \frac{\Omega}{\square} = R_D$

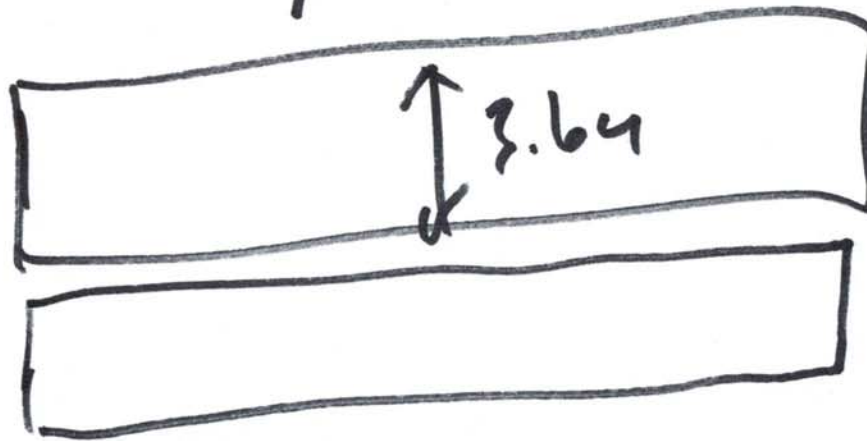
$R = R_D \cdot \frac{L}{W}$

$8k = 800 \cdot \frac{10}{W}$

$W = 10^{-6}$



$$\frac{364}{100} = 3.64$$



Si valence electrons - 4  
density  $5 \times 10^{20}$  atoms/cm<sup>3</sup>  
intrinsic  $\rightarrow$  NO DOPANT atoms

---

N-type

Phosphorous  $\rightarrow$  electrons 5

$N_D \rightarrow 10^{16}$  atoms/cm<sup>3</sup>  
 $\nearrow$  dopant atoms  $\searrow$   
dimer Si

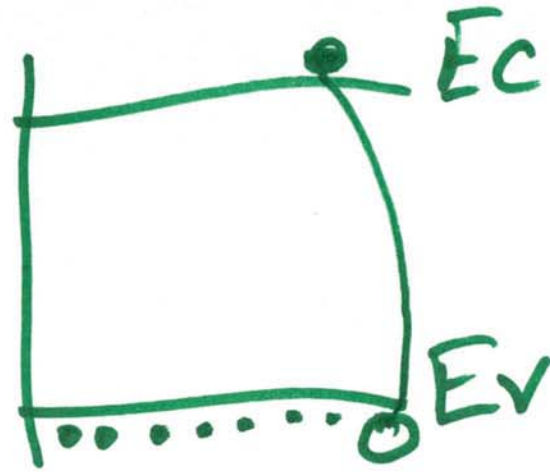
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P-type

Boron ~~5~~ valence electrons  
3



Temp.



$$N = N_D \frac{A_{\text{total}}}{\text{cm}^3}$$

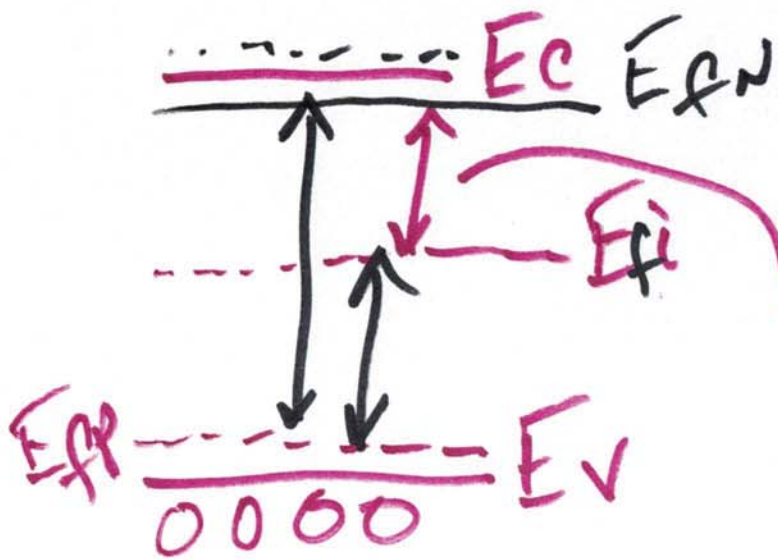
↑  
electrons  
cm<sup>3</sup>

$$N_i = 1.45 \times 10^9 \frac{\text{CARRIERS}}{\text{cm}^3}$$

$$p_n = n_i^2$$

$$p = nA$$

5)

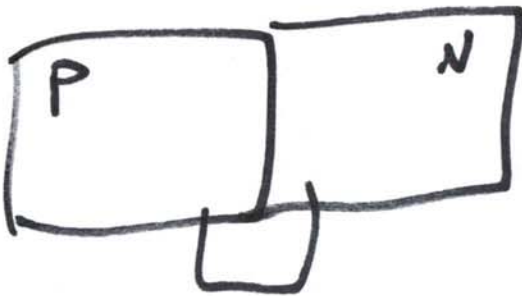


N-type  $N_D$

$V_{thermal}$

$$\frac{kT}{q} \ln \frac{N_D}{N_i} = E_{fi} - E_{fN}$$

$$-\frac{kT}{q} \ln \frac{N_A}{N_i} = E_{gp} - E_{fi}$$



$$\frac{kT}{q} \ln \frac{N_D}{N_i} - \left( -\frac{kT}{q} \ln \frac{N_A}{N_i} \right)$$

$$V_{bi} = \frac{kT}{q} \ln \frac{N_D N_A}{N_i^2}$$

6)

