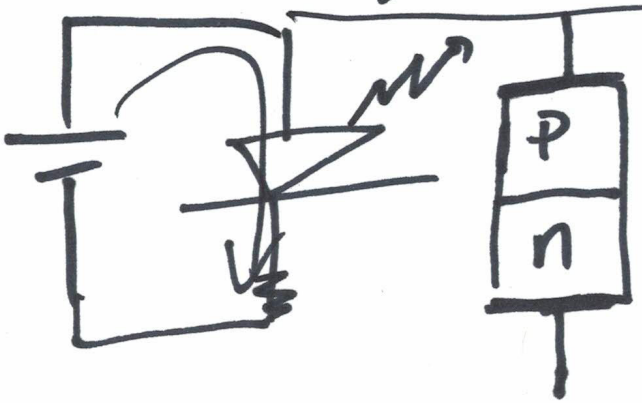
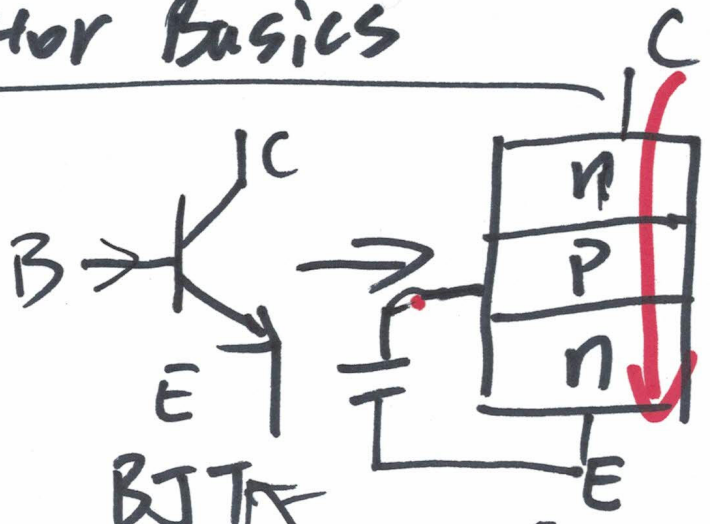
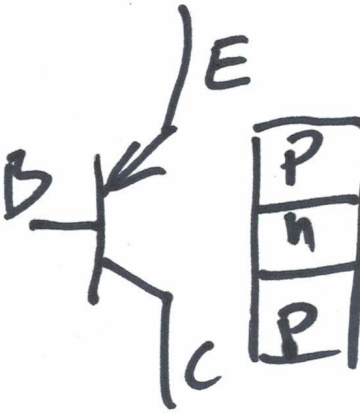
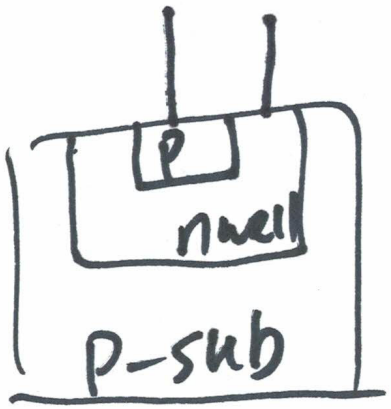
Semiconductor Basics



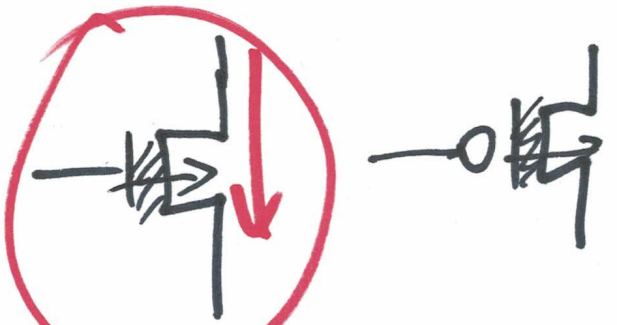




BJT
Bipolar Junction Transistor



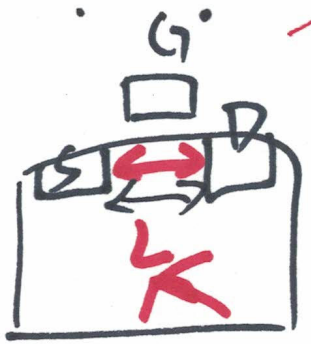
741

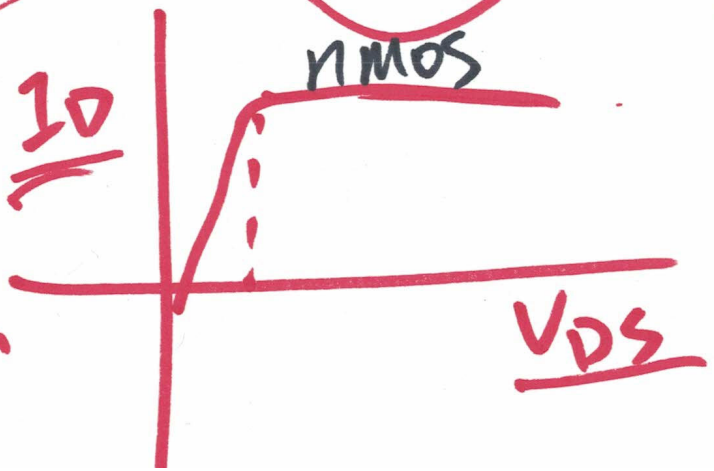


LT324

TTL

finFET





pMOS

① # of electrons in each shell : $2n^2$

Si: (+14) 2 8 4 → semiconductor; → valence electrons

Cu: (+29) 2 8 18 1 ← conductor

② elemental semiconductors

Silicon (Si), Germanium (Ge)

compound semiconductors

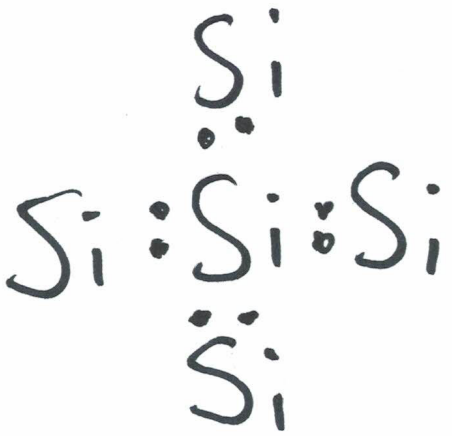
GaN, GaAs, GaP

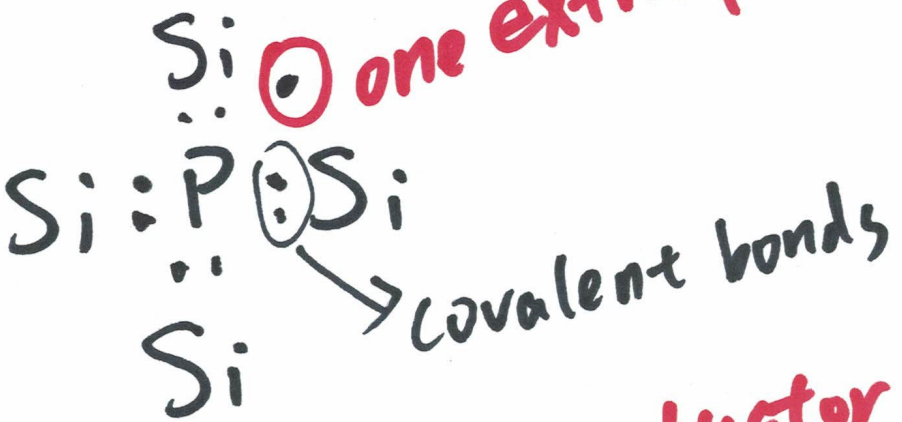
(Arsenide)

② Control the conductivity by doping

Dopants: Phosphorus, Boron

Phosphorus: 

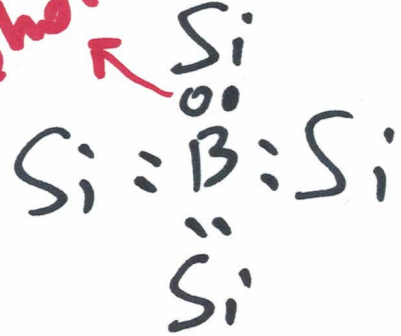




n-type semiconductor

Boron: 

free hole



p-type semiconductor

④ n_i: # of free electrons and holes in an intrinsic silicon in each unit volume ($/cm^3$) at room temperature. (25^oC)

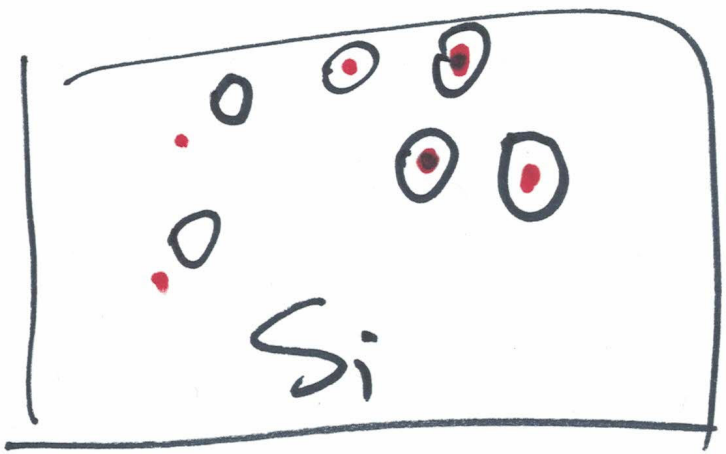
$$n \times p = n_i^2$$

works for both intrinsic and extrinsic semiconductors

n_i, Si, at room temp $1.5 \times 10^{10} / cm^3$

n: conc. of free electrons

p: conc. of free holes



equilibrium achieved

recombination rate = regeneration rate

⑤ Concentration of Donor atoms: N_D → donor
↘ negative

$N_D \approx n_n$

given

n_n → conc. of electrons

n-type semiconductor

More electrons than holes

majority

minority

$n_n \cdot p_n = n_i^2$

$\hookrightarrow \boxed{p_n} = \frac{n_i^2}{n_n} = \frac{n_i^2}{N_D} = \dots$

(6) Concentration of Acceptor atoms: N_A

$N_A \approx P_p$ → p-type

given

Conc. of hole

$$P_p \cdot n_p = n_i^2$$

$$n_p = \frac{n_i^2}{P_p} = \frac{n_i^2}{N_A}$$

(7) n-type silicon, dopant concentration: $N_D = 10^{17}/cm^3$, Find electron and hole concentrations at room temp ($T = 300K$)

$N_D = n_n$

$$n_n \cdot P_n = n_i^2$$

$$P_n = \frac{n_i^2}{n_n} = \frac{n_i^2}{N_D} = \frac{(1.5\times10^{10})^2}{10^{17}} = \frac{2.25\times10^{20}}{10^{17}}$$

$= 2.25\times10^3/cm^3$

∴ Conc. of holes is ...
Conc. of electrons is ...