MOSFETS Part 2: Tools for MOS Analysis

Wednesday 11 March 2020 7:24 p.m.

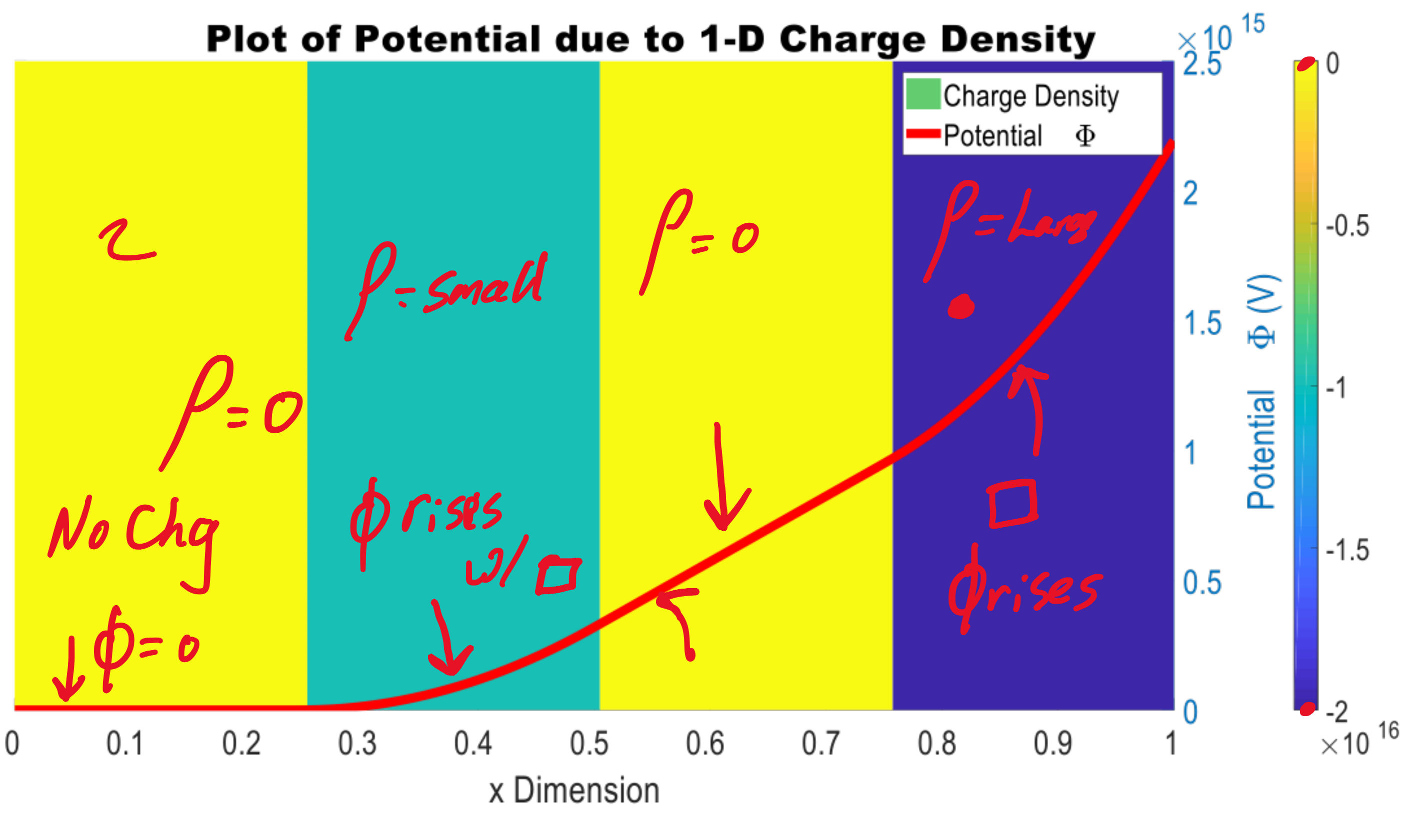
Poisson's Equation

$$\nabla^2(x,y,z)\cdot\phi(x,y,z) = \frac{-\rho(x,y,z)}{\varepsilon}$$

- 3rd Yr Electromag

$\nabla \to \frac{d}{dx}$

1 dim: $\frac{d^2\phi(x)}{dx^2} = \frac{-\rho(x)}{\varepsilon}$



Dimensions & Conventions

$V \to$ External Voltage

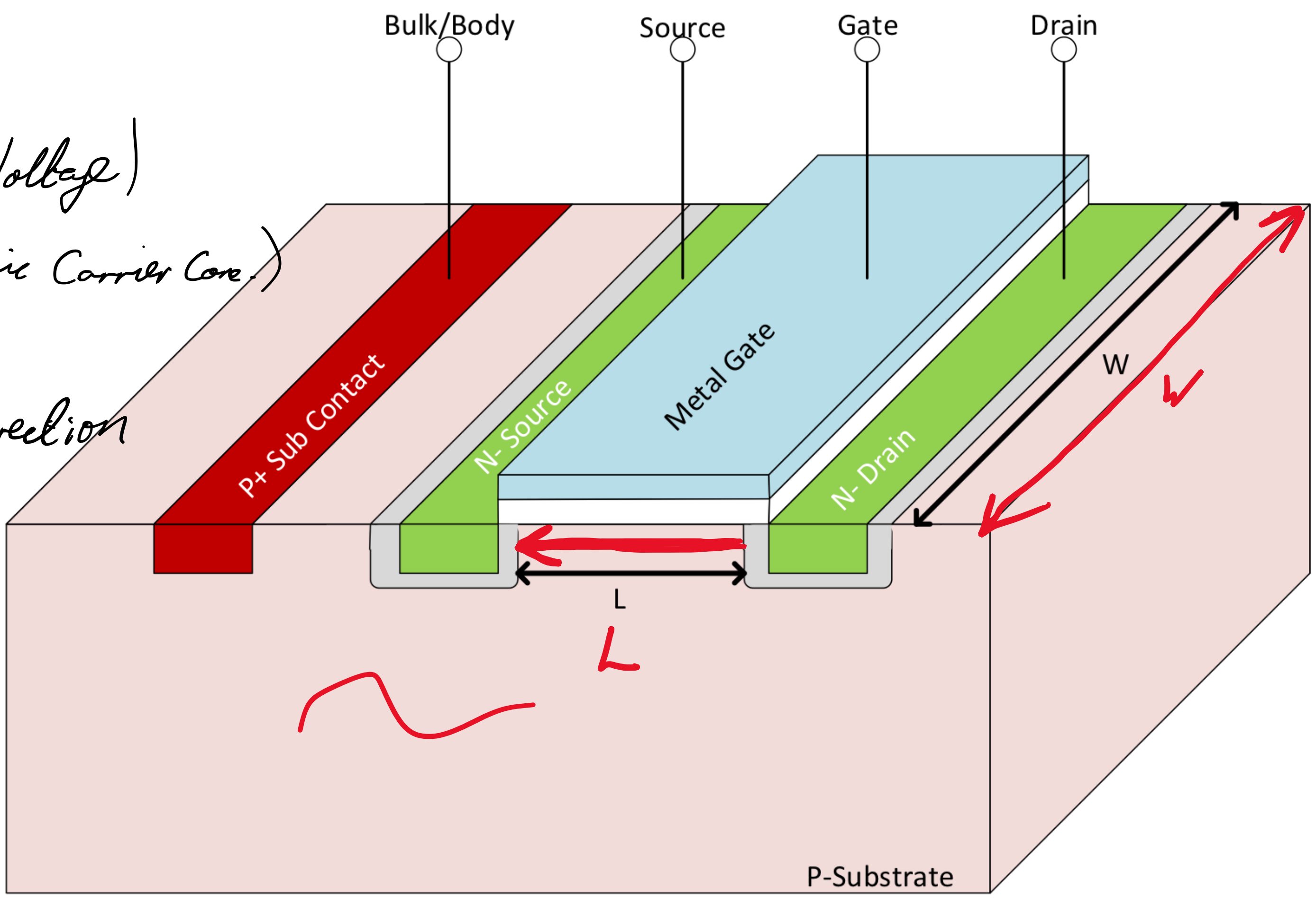
$\phi \to$ Internal Voltage (Built In Voltage)

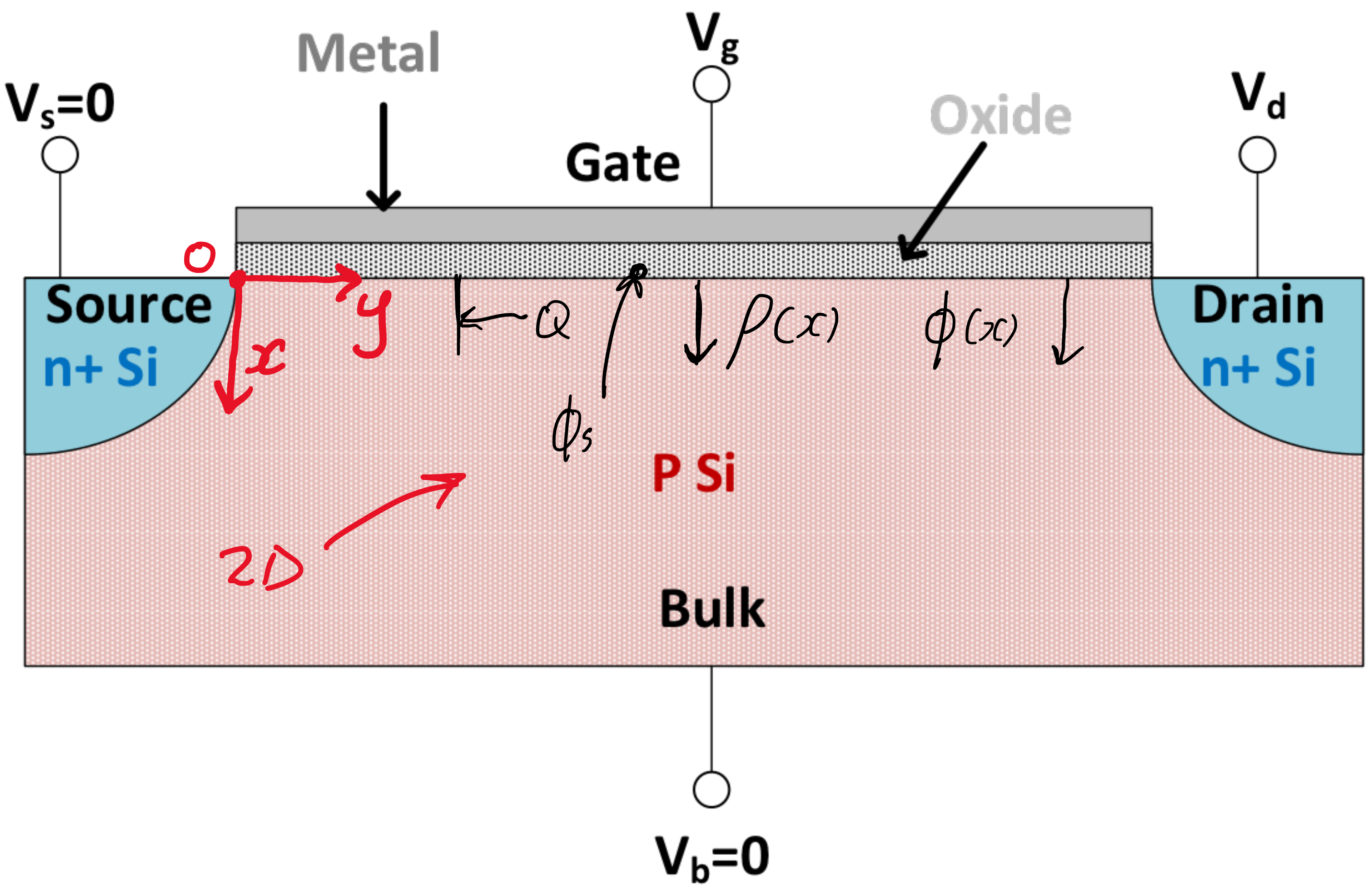
$\rho / n \to$ no. Carriers (eg. n_i – Intrinsic Carrier Conc.)
↳ Carrier Conc.

$\rho(x) \to$ Charge density in the x direction
↳ # Charge / length

$Q \to$ Charge along a length

$C \to$ Capacitance
↳ F/m^2



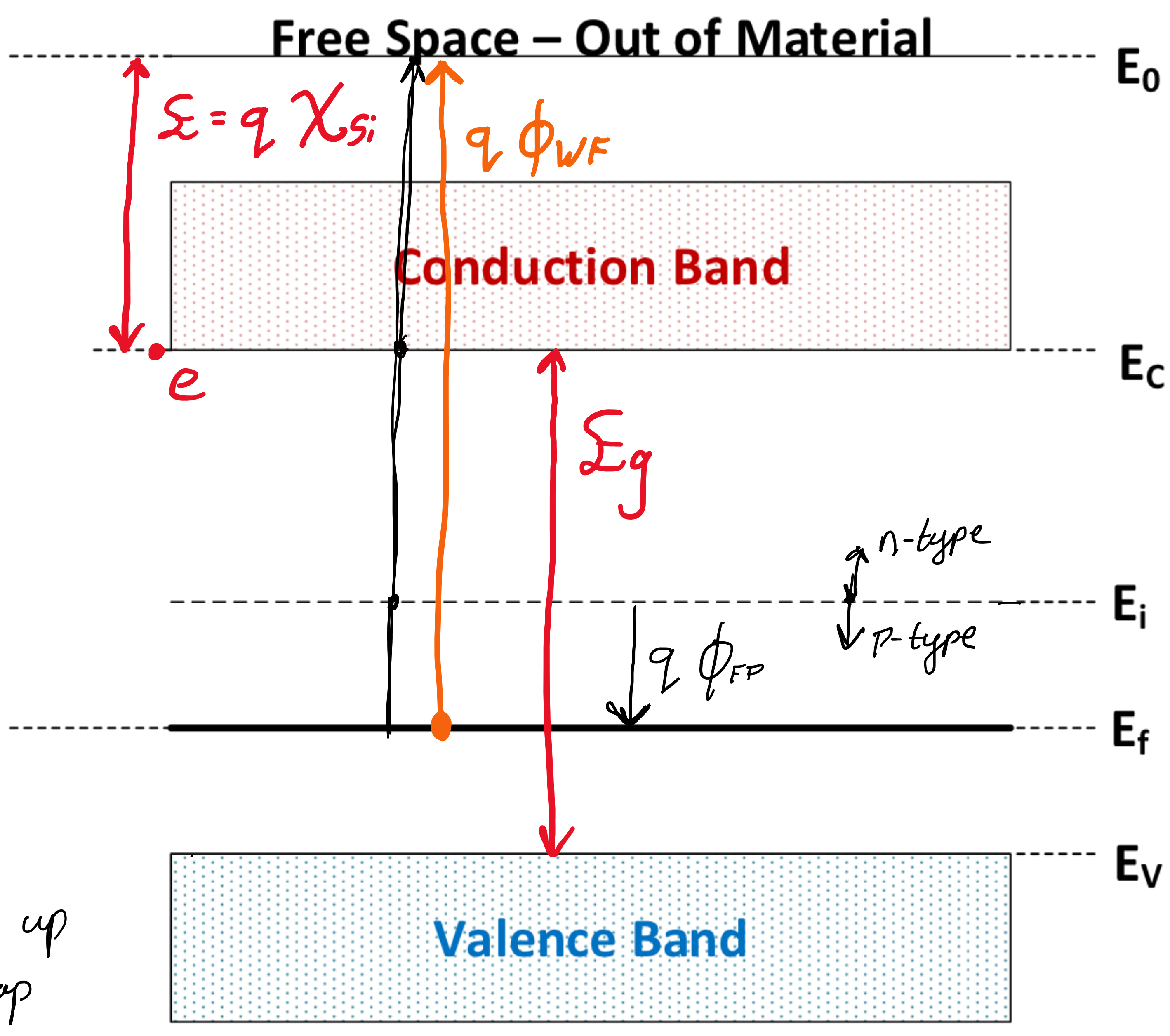


Energy Band Terminology

$E = q(V) \to E = q\phi$

Electron Affinity: $q\chi_{Si}$
↳ Energy needed to take e from bottom of Cond. band to free Space

Bandgap energy
↳ energy e get to transition from valence to Cond. band



Intrinsic Si: fermi level ½ way up the gap

$E_f = E_i = E_v + \frac{E_G}{2}$

Doped Si: Moves the fermi level

Fermi Potential: ϕ_{FP} The amount the fermi level is shifted by doping

e.g. p type

$$\phi_{FP} = \frac{kT}{q}\ln\left(\frac{N_A}{n_i}\right)$$

#Acceptors

ϕ_{WF} = energy req.d to take e @ E_f out to free Space

$$q\phi_{WF} = q\chi_{Si} + \frac{E_G}{2} + q\phi_{FP}$$