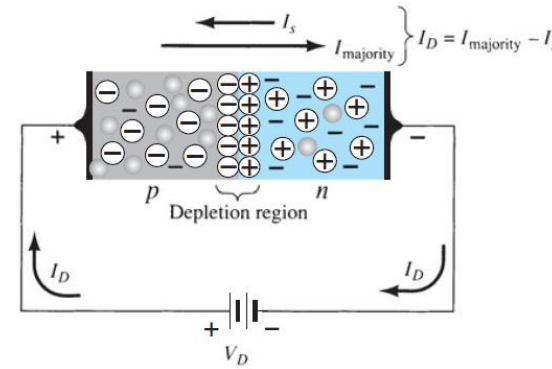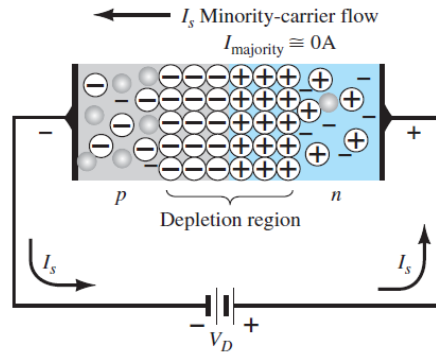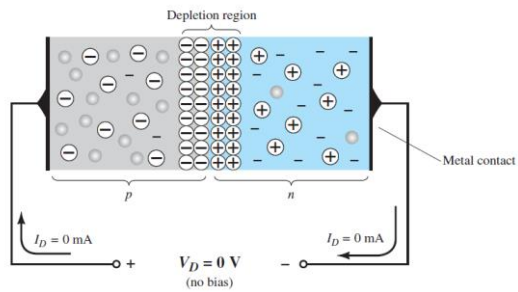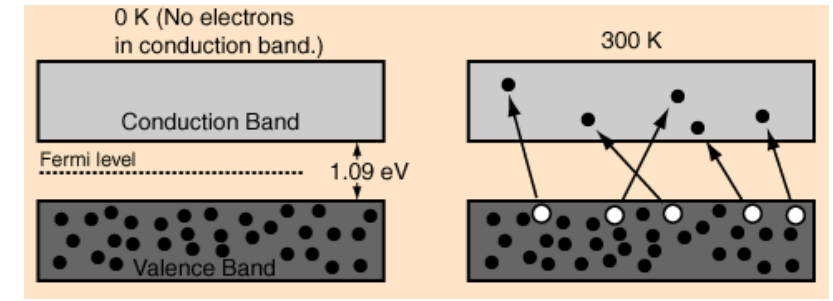# ECN 101

Introduction to Electronics and Communication Engineering

Review
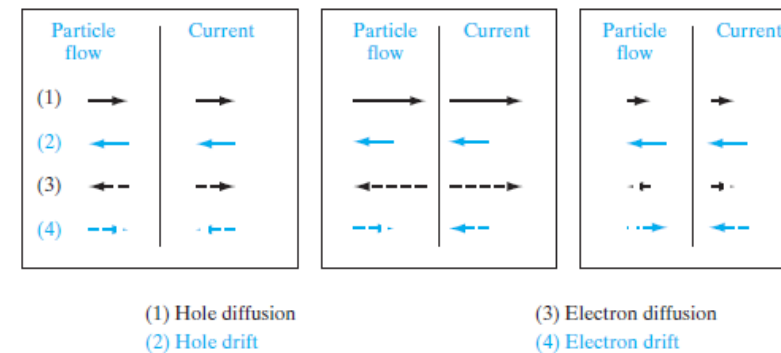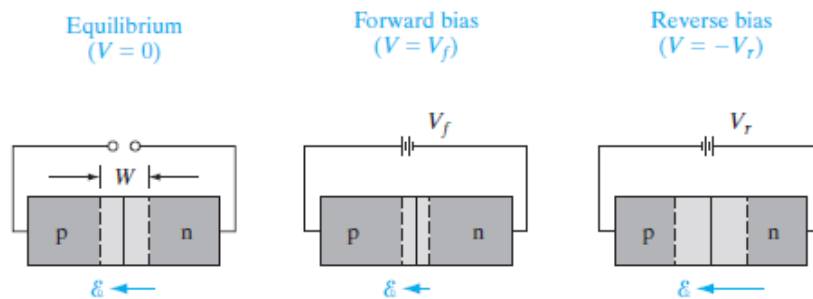
0 K (No electrons in conduction band.)

300 K

Conduction Band

Fermi level .... 1.09 eV

Valence Band

I_s Minority-carrier flow

$I_{majority} \cong 0A$

Depletion region

I_s

Depletion region

I_s

V_D

I_s

$I_{majority}$ } $I_D = I_{majority} - I_s$

p n

Depletion region

I_D

I_D

V_D

Depletion region

$I_D = 0$ mA $I_D = 0$ mA

$V_D = 0$ V
(no bias)

Metal contact

$$I_D = I_s(e^{V_D/nV_T} - 1)$$

Depletion region increases with voltage increase and vice versa   **Barrier**

Equilibrium
$(V = 0)$

Forward bias
$(V = V_f)$

Reverse bias
$(V = -V_r)$

V_f

V_r

W

p n

p n

p n

$\mathcal{E}$

$\mathcal{E}$

$\mathcal{E}$

	Particle flow	Current
(1)	→	→
(2)	←	←
(3)	← -	→ -
(4)	→ -	- ← -

	Particle flow	Current
	→	→
	←	←
	← - - -	- - - →
	→ -	← -

	Particle flow	Current
	→	→
	←	←
	- ←	→ -
	- →	← -

(1) Hole diffusion   (3) Electron diffusion
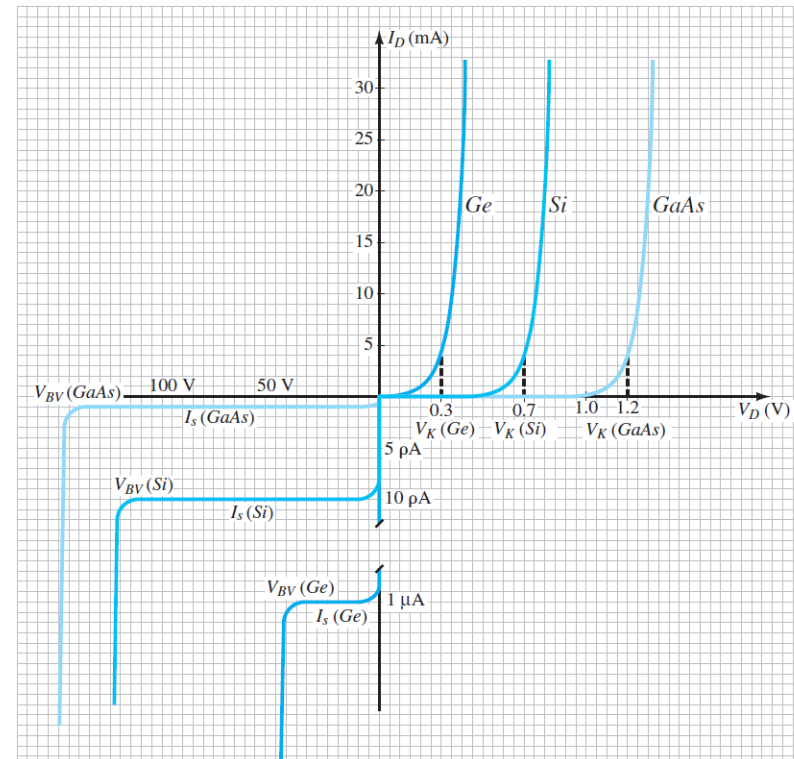(2) Hole drift   (4) Electron drift

Diode IV characteristics and breakdown
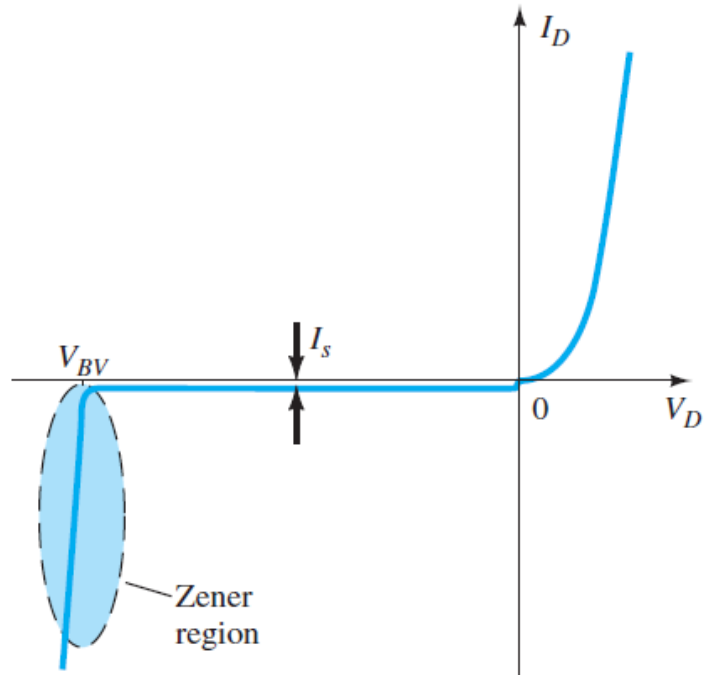
- As the voltage across the diode increases in the reverse-bias region, the velocity of the minority carriers responsible for the reverse saturation current Is will also increase.

- Eventually, their velocity and associated kinetic energy will be sufficient to release additional carriers through collisions with otherwise stable atomic structures.
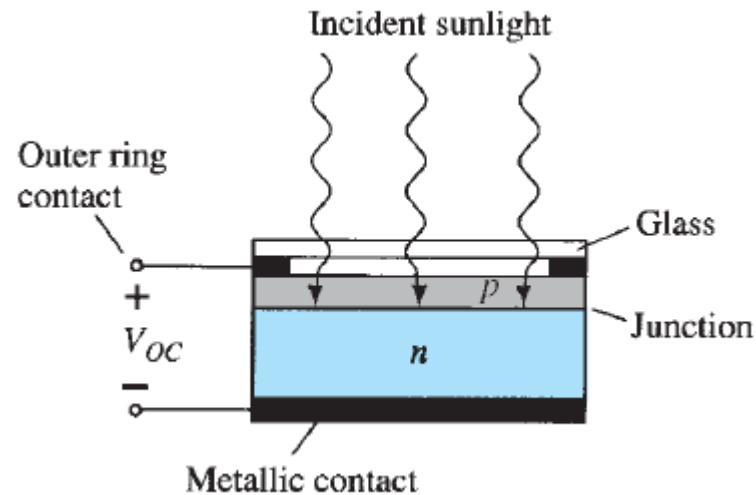

Diode: different semiconductors

Si = 1.1 eV

Ge = 0.67 eV

GaAs = 1.42 eV

Diode applications

Solar Cells

Incident sunlight

Outer ring contact

$+$

V_{OC}

$-$

Glass

p

n

Junction

Metallic contact

Open circuit voltage

Short circuit current

LEDs

- In Si and Ge diodes the greater percentage of the energy converted during recombination at the junction is dissipated in the form of heat within the structure, and the emitted light is insignificant.

- Diodes constructed of GaAs emit light in the infrared (invisible) zone during the recombination process at the p–n junction.

Emitted visible light

P N

$(-)$

$(+)$

Metal contact

Metal contact

I_D V_D

(b)