Lecture 13

P-N Junction Diodes: Part 3

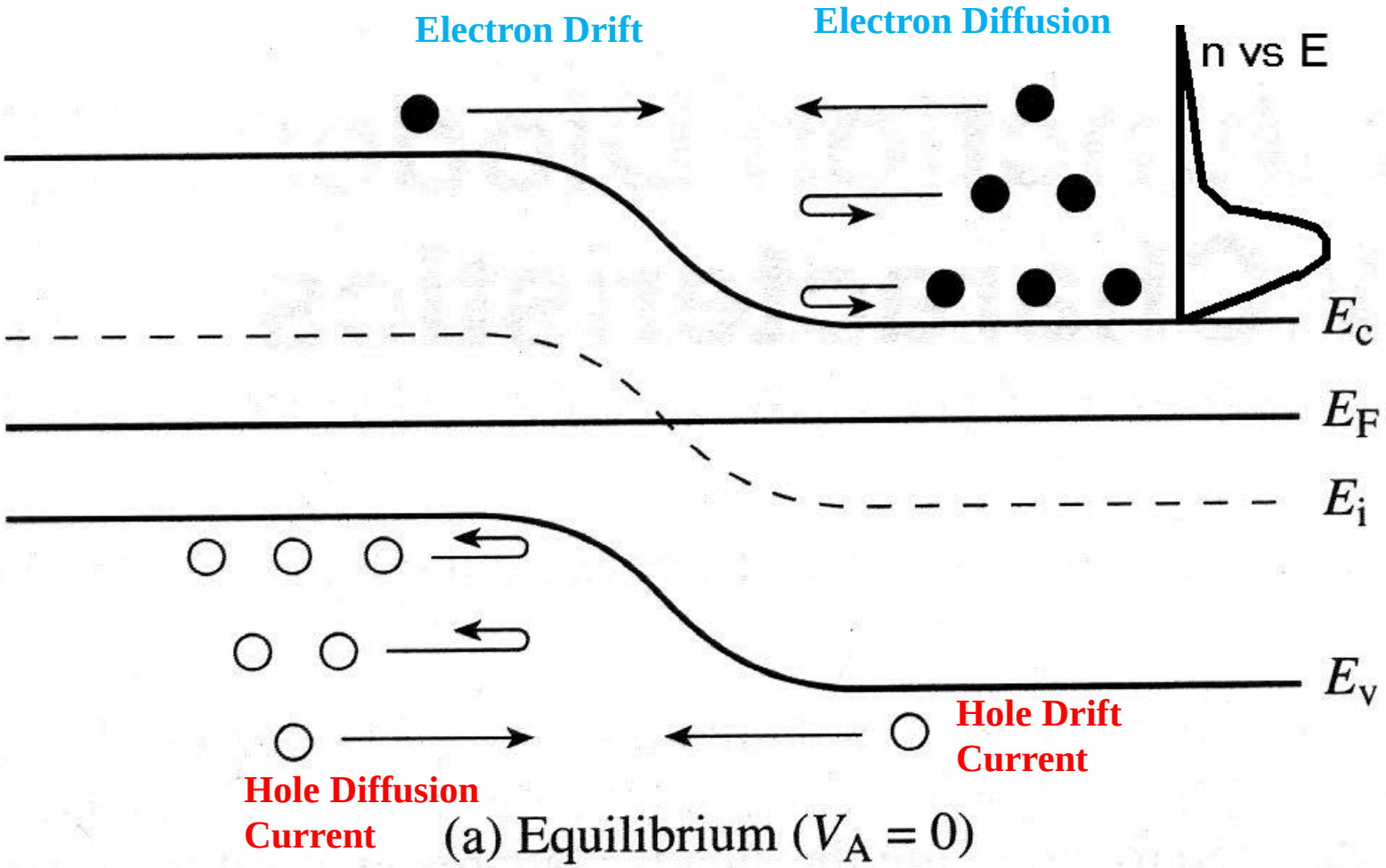
Current Flowing through a Diode

Reading:

Pierret 6.1

P-n Junction I-V Characteristics

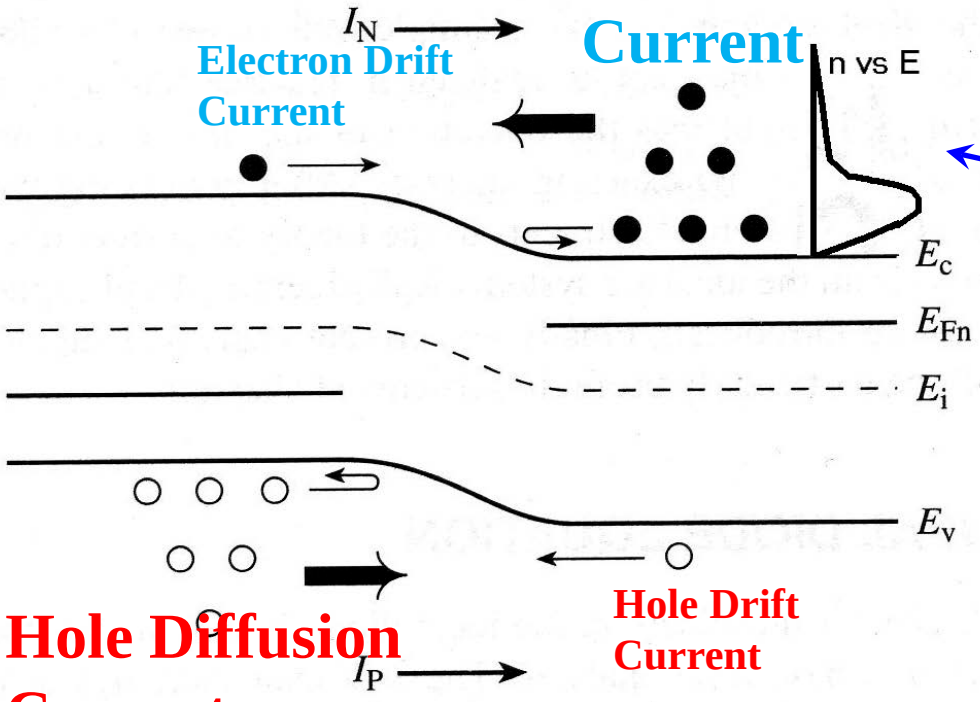
In Equilibrium, the Total current balances due to the sum of the individual components



(a) Equilibrium ($V_A = 0$)

P-n Junction I-V Characteristics

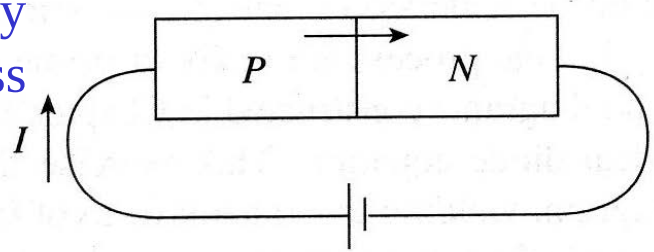
Electron Diffusion Current



Hole Diffusion Current

Current flow is proportional to $e^{(Va/Vref)}$ due to the exponential decay of carriers into the majority carrier bands

Current flow is dominated by majority carriers flowing across the junction and becoming minority carriers

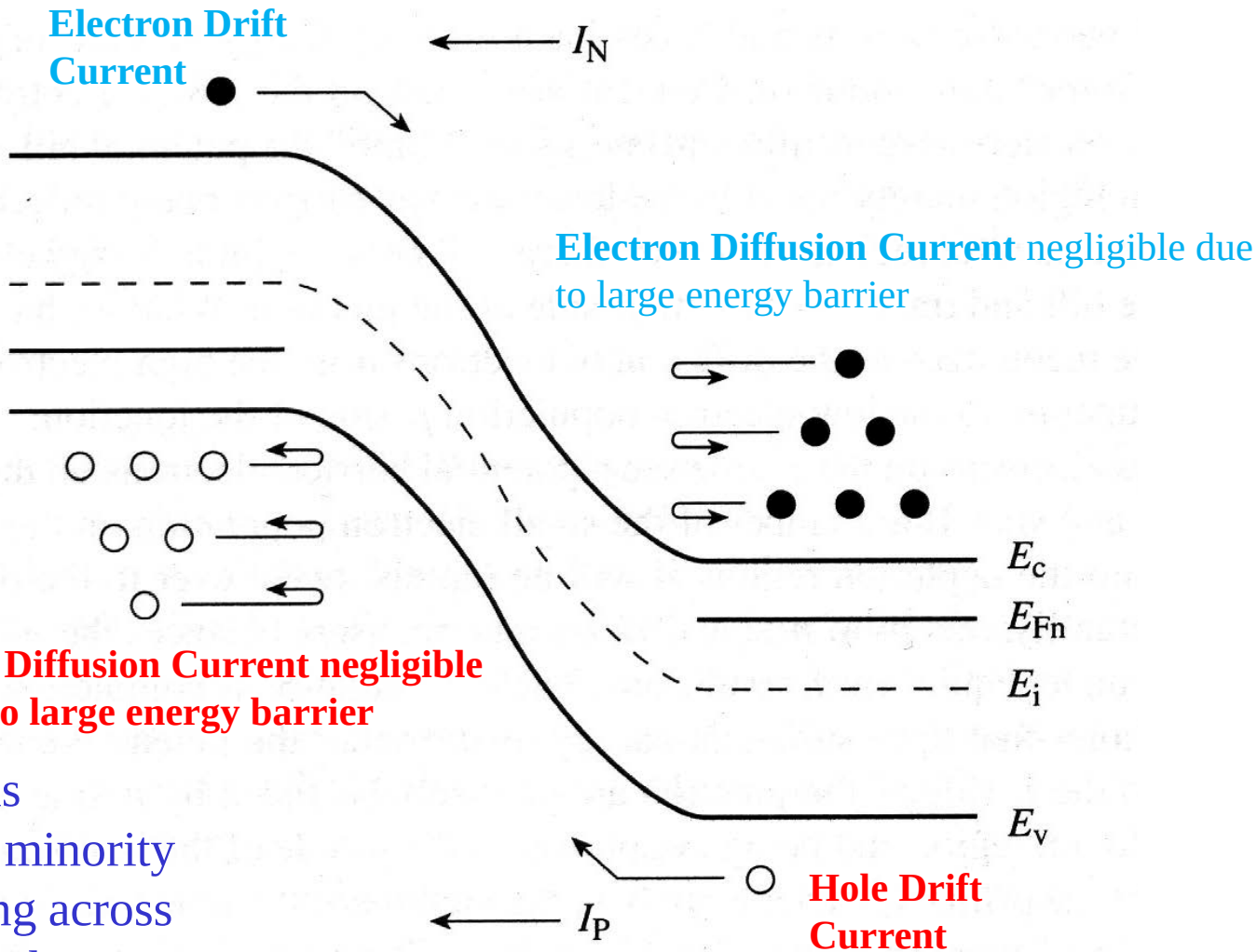


(b) Forward bias ($V_A > 0$)

QuickTime Movie

P-n Junction I-V Characteristics

Current flow is constant due to thermally generated carriers swept out by E-fields in the depletion region



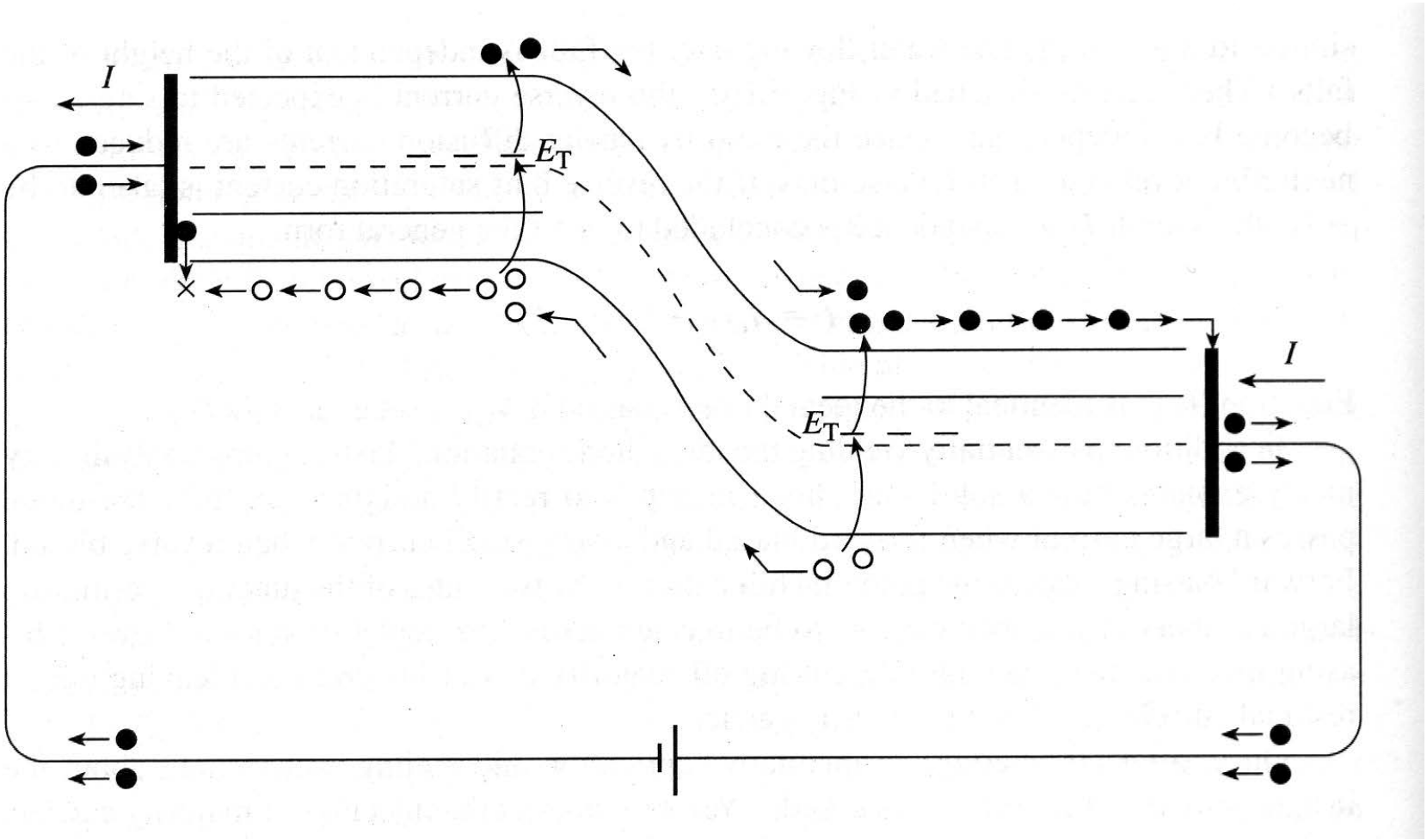
(c) Reverse bias ($V_A < 0$)

Current flow is dominated by minority carriers flowing across the junction and becoming majority carriers

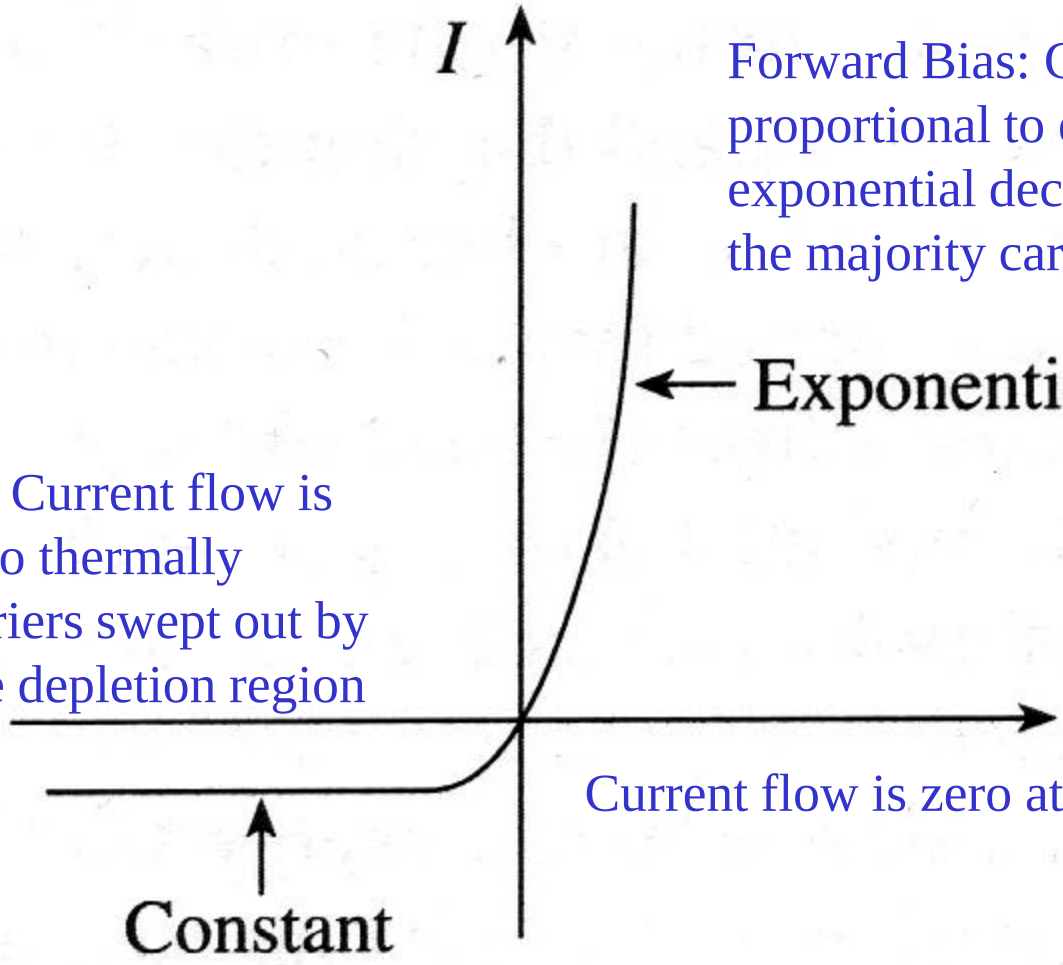
QuickTime Movie

P-n Junction I-V Characteristics

Where does the reverse bias current come from? Generation near the depletion region edges "replenishes" the current source.



P-n Junction I-V Characteristics
Putting it all together



Forward Bias: Current flow is proportional to $e^{(Va/Vref)}$ due to the exponential decay of carriers into the majority carrier bands

Reverse Bias: Current flow is constant due to thermally generated carriers swept out by E-fields in the depletion region

Current flow is zero at no applied voltage

$$I=I_o(e^{Va/Vref} - 1)$$