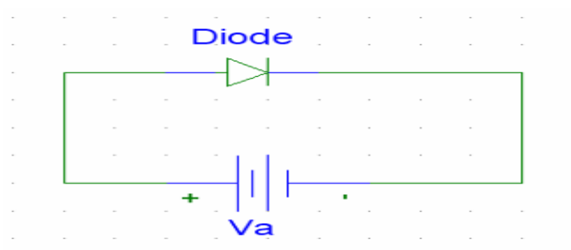
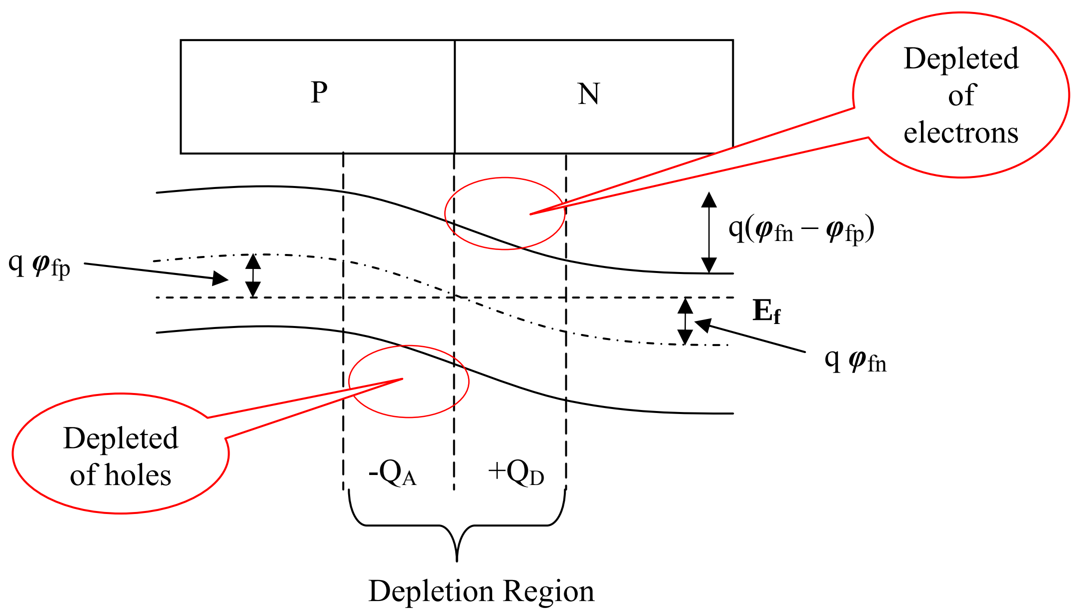
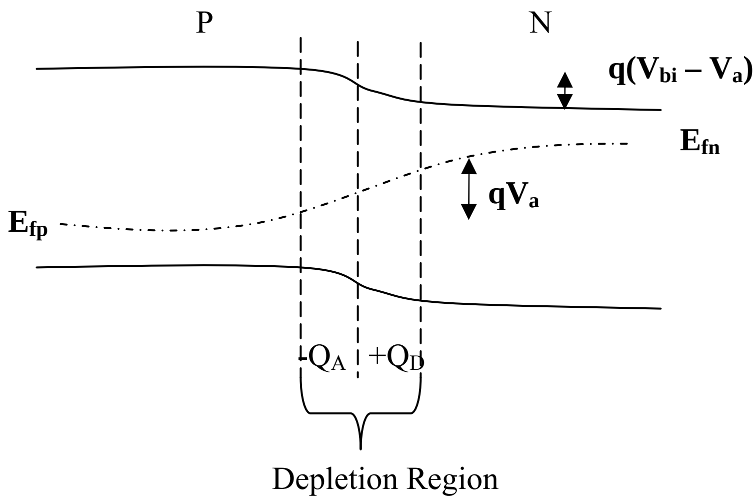
The P-N Junction:

- At Zero Bias, $V_a = 0$ V, a depletion region forms around the junction with space charges (+ve charge due to Donor ions on the N-side and –ve charge on the P-side due to Acceptor ion) ➔ $|Q_D| = |Q_A|$ ➔ equal magnitude with opposite sign ➔ the current = 0 ≈ J_S.

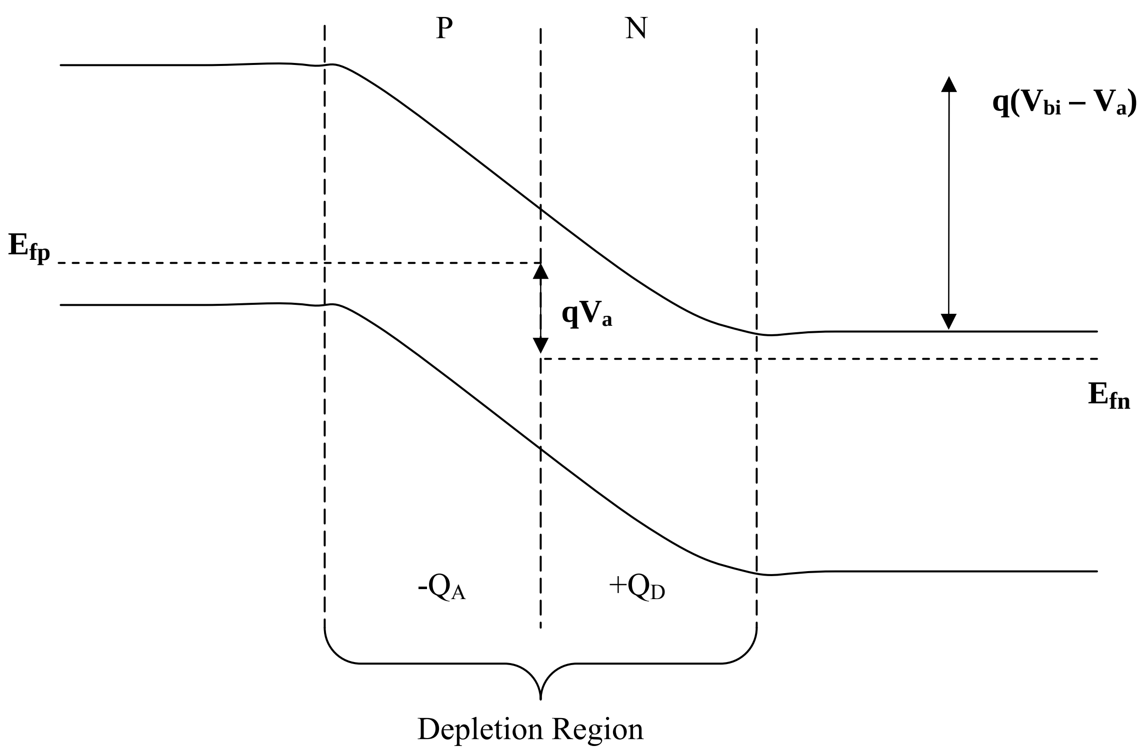




- At forward Bias, $V_a > 0$, amount of bending is reduced by (qV_a), the Fermi levels split by (qV_a), the depletion region is reduced in width and both Q_A and Q_D are reduced. Now the current $J = J_S [\exp (V_a/V_{bi})-1]$ (A/cm^2)
  J_S : constant that depends on N_a, N_D, type of semiconductor and temperature.
  J_S ➔ called reverse saturation current and it is very small.



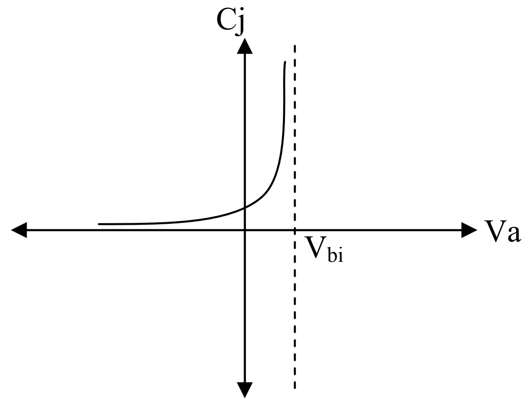
- At reverse Bias, $Va < 0$, the amount of bending increases by (qV_a), Depletion region width increases and QA and QD increases.
  The current $J \approx J_S \approx 0$ (zero current).



- <u>Diode Junction Capacitors:</u>

  The increase or decrease in the depletion region charge due to the applied voltages constitute a non-liner, voltage-dependent denote capacitor called junction capacitance. This capacitance alone with series resistance determines how fast we can turn the diode on & off. $C_j = \dfrac{C_o}{\left[1 - \dfrac{V_a}{V_{bi}}\right]^n}$

  $C_0 = C_j$ at $V_a = 0$ (zero-bias junction capacitance), $0 < n < 1$, typically ½



Junction capacitance as a function of applied voltage Va

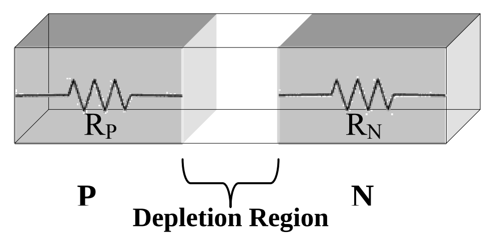
- <u>Diode series resistance:</u>

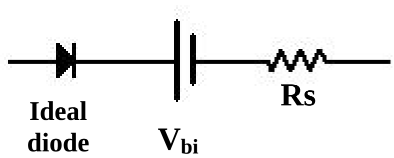
  This resistance $Rs = R_n + R_p$

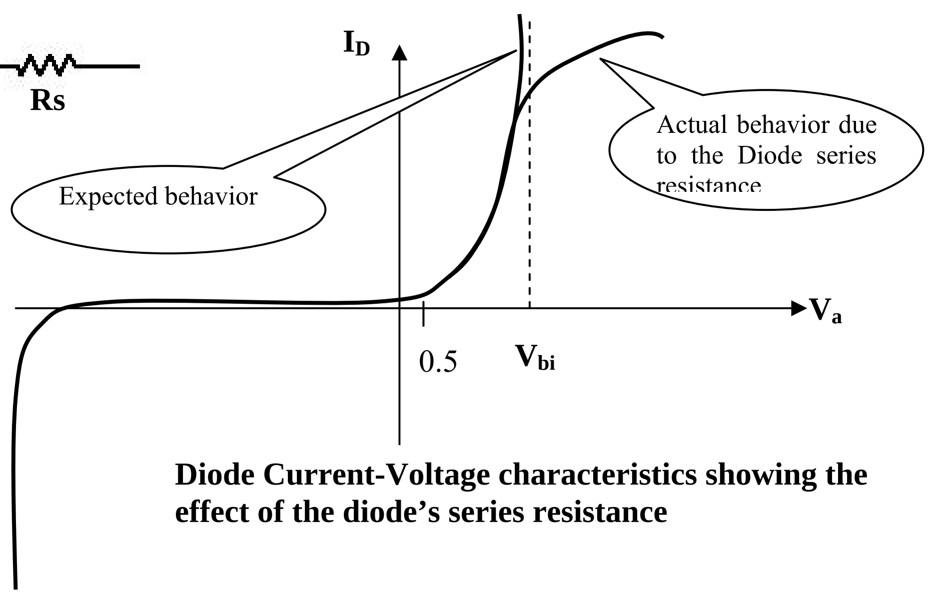
  R_n = Resistance of N-side

  R_p = Resistance of P- side

  Hence we model the Diode as :







Diode Current-Voltage characteristics showing the effect of the diode's series resistance