Chapter 7.

PN Junction Diode : Small-Signal Admittance

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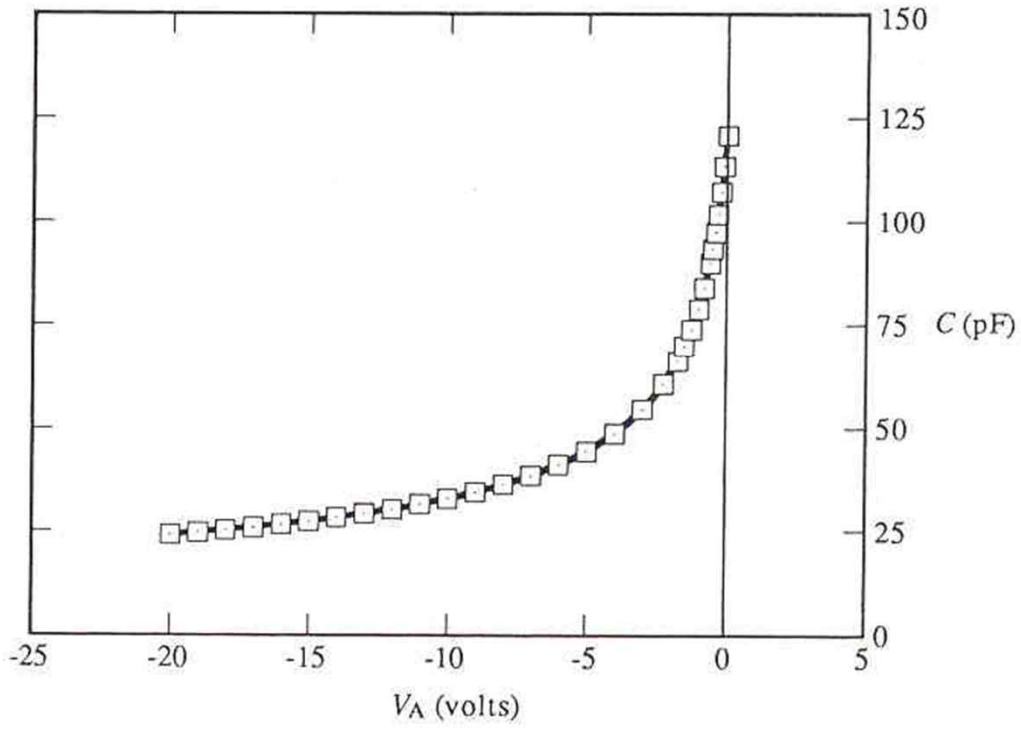
❑ Reverse-Bias Junction Capacitance

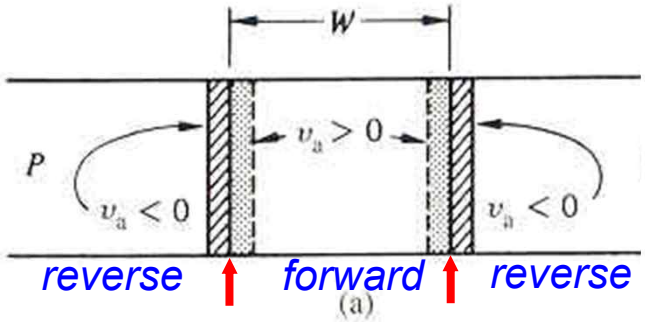
✓ When reverse biased, the *pn* junction diode becomes functionally equivalent to a capacitor



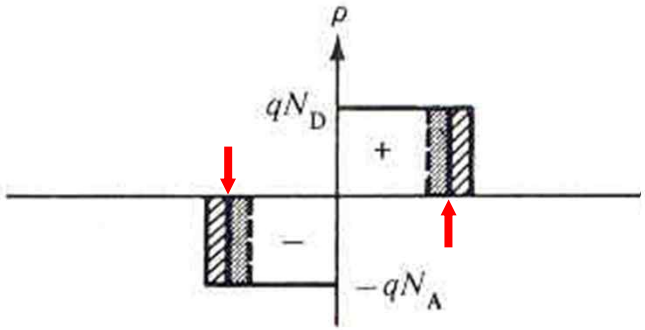
✓A small sinusoidal voltage (v_a) is superimposed on the dc bias

✓Total voltage drop becomes V_A+v_a

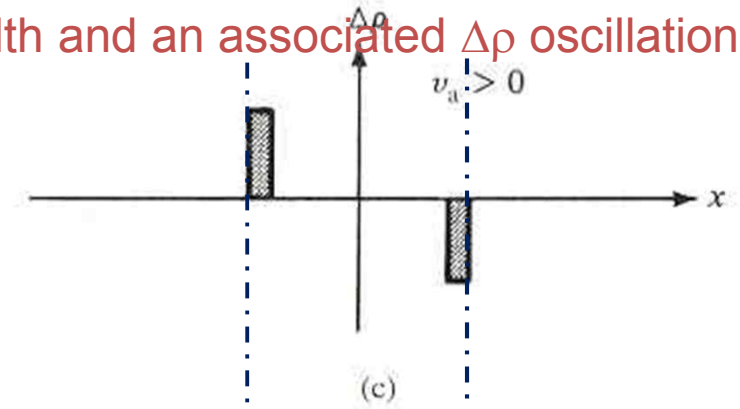
✓ The overall effect of the a.c. signal may be viewed as a small oscillation of the depletion width and an associated $\Delta\rho$ oscillation



(a)

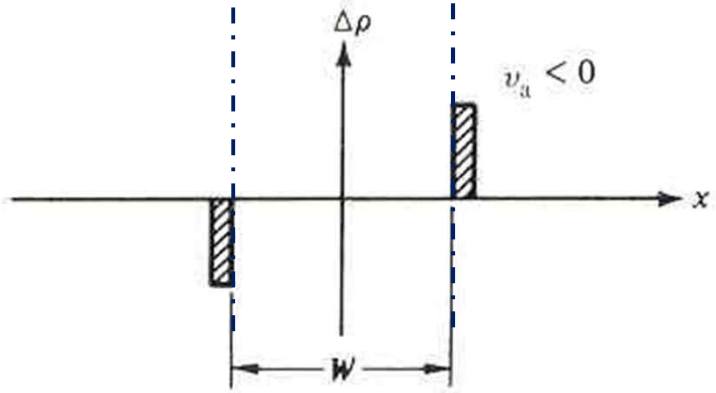


(b)



(c)

$$\Delta\rho = \rho_{final} - \rho_{init}$$



(d)

✓ Effectively, it looks like plus and minus charges are being alternately added and subtracted from two planes separated by a width *W*.

$$C_J = \frac{K_S \varepsilon_0 A}{W}$$

junction or
depletion-layer capacitance

• C-V Relationships

$$W = \left[\frac{2K_S \varepsilon_0}{qN_B} (V_{bi} - V_A) \right]^{1/2} \quad \ldots \text{ asymmetrical step junction}$$

✓ The junction depletion capacitance is

$$C_J = \frac{K_s \varepsilon_0 A}{\left[\frac{2K_s \varepsilon_0}{qN_B}\left(V_{bi} - V_A\right)\right]^{\frac{1}{2}}}$$

$$C_{J0} = C_J\big|_{V_A=0} = \frac{K_s \varepsilon_0 A}{\left[\frac{2K_s \varepsilon_0}{qN_B} V_{bi}\right]^{\frac{1}{2}}}$$

Summary

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