8.37 (*a*) Calculate the small-signal diffusion capacitance and diffusion resistance of a silicon pn junction diode biased at $I_{DQ} = 1.2$ mA. Assume the minority carrier lifetimes are 0.5 μs in both the n and p regions. (*b*) Repeat part (*a*) for the case when the diode is biased at $I_{DQ} = 0.12$ mA.

Per (8.68), $r_d = \frac{V_t}{I_{DQ}}$.

Per (8.105), $C_d = \frac{1}{2V_t}\left(I_{po}\tau_{po} + I_{no}\tau_{no}\right)$

Per (8.104), $g_d = \frac{1}{V_t}\left(I_{po} + I_{no}\right) = \frac{I_{DQ}}{V_t} = \frac{1}{r_d}$

So, when $\tau_{no} = \tau_{po}$, $C_d = \frac{\tau_{no}}{2r_d}$

$$V_t = \frac{kT}{e} = \frac{8.617333\times10^{-5}\,eV/K\,(300K)}{e} = 0.25852\,V$$

a) $r_d = \frac{0.025852}{1.2\times10^{-3}} \Rightarrow \underline{\underline{r_d = 21.543\,\Omega}}$

$C_d = \frac{0.5\times10^{-6}}{2(21.543)} \Rightarrow \underline{\underline{C_d = 11.605\,nF}}$

b) $r_d = \frac{0.025852}{0.12\times10^{-3}} \Rightarrow \underline{\underline{r_d = 215.433\,\Omega}}$

$C_d = \frac{0.5\times10^{-6}}{2(215.433)} \Rightarrow \underline{\underline{C_d = 1.1605\,nF}}$