# Solutions for Chapter 2

## Exercise 2.1

We assume a forward voltage for the LED of 1.5V. Then for $I_{LED}$ we have

$$I_{LED} = \frac{V_R}{R} = \frac{3.3\text{V} - 1.5\text{V}}{330\Omega} \approx \boxed{\mathbf{5.5}\text{mA}}$$

To estimate the $\beta_{min}$ we need the current entering the base

$$I_B = \frac{3.3\text{V} - 0.6\text{V}}{10\text{k}\Omega} = 0.27\text{mA}$$

Thus

$$\beta_{min} \geq \frac{I_{LED}}{I_B} = \boxed{\mathbf{20}}$$

## Exercise 2.2

**NOTE: According to the errata** $0.63$ **should be replaced by** $0.76$ **and** $63\mu\,\text{sec}$ **by** $76\mu\,\text{sec}$**.**

Starting from the hint that the capacitor charges from $-4.4$V towards $+5$V, we would result to a total 9.4V for a full charge. However, the $V_{BE}$ of $Q_2$ is clipping the charging process at only 5V of the total (from $-4.4$V to 0.6V). Thus, the capacitor will be 53% charged at the end.
Solving the voltage equation for a charging capacitor gives us

$$V_C(t) = V_f * (1 - e^{-\frac{t}{RC}})$$

set $V_C(t_1) = 0.53 * V_f$

$$0.53 = 1 - e^{-\frac{t_1}{R_3 C_1}}$$

$$\Rightarrow$$

$$t_1 = -RC * ln(0.47) \approx \boxed{\mathbf{0.76 * R_3 C_1}}$$