At 300 K, the silicon npn bipolar junction transistor (BJT) from the earlier example has the following parameters:

Emitter (*n*-region)	**Base** (*p*-region)	**Collector** (*n*-region)
$n_{E0} \cong N_E = 10^{18}$ cm^{-3}	$p_{B0} \cong N_B = 10^{16}$ cm^{-3}	$n_{C0} \cong N_C = 10^{15}$ cm^{-3}
$p_{E0} = 225$ cm^{-3}	$n_{B0} = 22{,}500$ cm^{-3}	$p_{C0} = 225{,}000$ cm^{-3}
$\mu_{nE} = 280$ cm^2/V-s	$\mu_{pB} = 420$ cm^2/V-s	$\mu_{nC} = 1200$ cm^2/V-s
$D_E = 7.24$ cm^2/s	$D_B = 10.86$ cm^2/s	$D_C = 31.02$ cm^2/s
$L_E = 2.69$ µm	$L_B = 7.37$ µm	$L_C = 17.61$ µm
$\tau_{E0} = 10$ ns	$\tau_{B0} = 50$ ns	$\tau_{C0} = 100$ ns
$x_E = 1.5$ µm	$x_B = 0.75$ µm	$x_C = 90$ µm

Also, $A_{BE} = 5 \times 10^{-3}$ cm^2 = 5×10^{-7} m^2, $V_{BE} = 0.64$ V and $V_{CE} = 5$ V.

From Table B.4, $n_i = 1.5 \times 10^{10}$ cm^{-3}. At 300 K, (7.10) $V_t = k_BT/e = 0.025852$ V.

We wish to find the emitter currents.

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Currents from BE junction (forward-biased)

Using the expression for the excess holes at $x' = 0$ (emitter side of BE depletion region), we can compute the **hole current density** using (12.33a) & (12.34a)

$$J_{pE} = J_p(x'=0) = -eD_E \left.\frac{d\delta p_E(x')}{dx'}\right|_{x'=0} = \frac{eD_E p_{E0}}{L_E}\left[e^{V_{BE}/V_t} - 1\right]\frac{1}{\tanh(x_E/L_E)}$$

$$= \frac{1.6022 \bullet 10^{-19}(7.24 \bullet 10^{-4})225 \bullet 10^{6}}{2.69 \bullet 10^{-6}}\left[e^{0.64/0.025852} - 1\right]\frac{1}{\tanh(1.5/2.69)}$$

$\Rightarrow$ **$J_{pE} = 1081.373$ A/m^2**.

Then, the **hole current** is $I_{pE} = J_{pE}\,(A_{BE}) = 1081.373(5 \times 10^{-7})$

$\Rightarrow$ **$I_{pE} = 5.406865 \times 10^{-4}$ A = 0.541 mA**.

Using the expression for the excess electrons at $x = 0$ (base side of BE depletion region), we can compute the **electron current density** using (12.33b) & (12.34b)

$$J_{nE} = J_n(x=0) = -eD_B \left.\frac{d\delta n_B(x)}{dx}\right|_{x=0} = \frac{eD_B n_{B0}}{L_B}\left\{\frac{1}{\sinh(x_B / L_B)} + \frac{e^{V_{BE}/V_t} - 1}{\tanh(x_B / L_B)}\right\}$$

$$= \frac{1.6022 \bullet 10^{-19}(10.86 \bullet 10^{-4})22{,}500 \bullet 10^{6}}{7.37 \bullet 10^{-6}}\left\{\frac{1}{\sinh(0.75 / 7.37)} + \frac{e^{0.64/0.025852} - 1}{\tanh(0.75 / 7.37)}\right\}$$

$\Rightarrow$ **$J_{nE} = 2.955277 \times 10^5$ A/m^2**.

Then, the **hole current** is $I_{nE} = J_{PE}\,(A_{BE}) = 2.955277 \times 10^5\,(5 \times 10^{-7})$

$\Rightarrow$ **$I_{nE} = 0.147764$ A = 147.764 mA**.

The overall emitter current density and current

$J_E = J_{pE} + J_{nE} = 1081.373 + 2.955277 \times 10^5$ $\Rightarrow$ **$J_E = 2.96609 \times 10^5$ A/m^2**.

$I_E = I_{pE} + I_{nE} = 5.406865 \times 10^{-4} + 0.147764$ $\Rightarrow$ **$I_E = 0.1483$ A = 148.3045 mA**.

Note that electrons account for **99.635%** of the overall emitter current.