Ex npn transistor $V_T = 25mV$

$v_{BE1}, i_{C1} \Rightarrow 0.7V, 1mA$

$v_{BE2}, i_{C2} \Rightarrow$ ——, $0.1mA$

$v_{BE3}, i_{C3} \Rightarrow$ ——, $10mA$

a $v_{BE2} - v_{BE1} = V_T \ln\left(\frac{i_{C2}}{i_{C1}}\right)$

$v_{BE2} - 0.7 = 0.025 \cdot \ln\left(\frac{0.1}{1}\right)$

$v_{BE2} = 0.64\ V$

b $v_{BE3} - v_{BE1} = V_T \ln\left(\frac{i_{C3}}{i_{C1}}\right)$

$v_{BE3} - 0.7 = 0.025 \ln\left(\frac{10}{1}\right)$

$v_{BE3} = 0.76V$

EX npn transistor

β range 50 to 150

α range ?

$$\alpha = \frac{\beta}{\beta+1} \qquad \alpha = 0.98 \text{ to } 0.993$$

EX npn transistor

$i_B = 14.46\,\mu A$

$i_E = 1.46\,mA$

$v_{BE} = 0.7\,V$

Find i_C, I_S, β, α

$$i_B = \frac{i_C}{\beta}$$

$$\beta = \frac{i_C}{i_B} = \frac{1.446 \times 10^{-3}}{14.46 \times 10^{-6}}$$

$$\beta = 99.97 \simeq 100$$

$$\alpha = \frac{\beta}{\beta+1} = 0.99$$

$$i_C + i_B = i_E$$

$$i_C = i_E - i_B$$

$$= 1.446\,mA$$

$$= 1.45\,mA$$

$$I_S = \frac{i_C}{\exp(v_{BE}/V_T)}$$

$$= \frac{1.446 \times 10^{-3}}{\exp(.7/.025)}$$

$$I_S = 9.995 \times 10^{-16}\,A$$

$$= 10 \times 10^{-16}\,A$$

$$= 10^{-15}\,A$$