EE2002 Assignment 2

AY 2013/14 S2

Consider the current mirror in Fig. 1. All the BJT transistors are biased at activate region, and they have the same emitter area. Given the below parameters:

VDD=3.3V

R=20KΩ

β=60

VA= ∞.

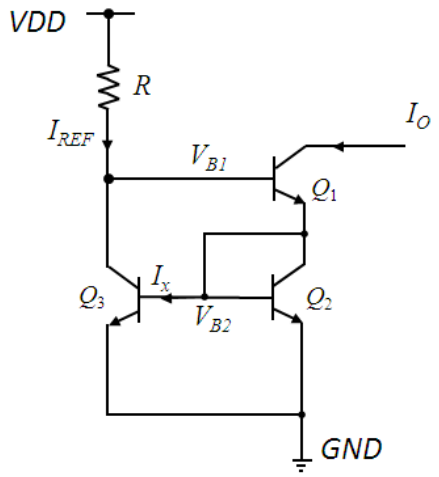

Fig. 1

A) For active mode BJT, we always start from an assumption that V_{BE} = 0.7V. With this, please calculate the input current to the mirror, I_{REF}

(30 Marks)

Answer:

We can find out:

$V_{B2}=V_{BE3}=0.7$

$V_{B1}= V_{B2}+V_{BE1}=1.4$

Hence, voltage drop across R is:

$V_R=VDD-V_{B1}=1.9$

Finally, the input current is:

$I_{REF}=V_R/R=95uA$

B) In order to find out the mirror ratio, we need to find out the relationship between all the current branches. If we assume the base current of Q_3 is I_x, please find out the emitter current of Q_1 and Q2, respectively.

(40 Marks)

Answer:

$$I_{B3} = I_X$$
$$=> I_{B2} = I_X$$
$$=> I_{C2} = I_{C3} = \beta I_X$$
$$=> I_{E1} = I_{B3} + I_{B2} + I_{C2} = (2+\beta) I_X$$
$$=> I_{E2} = (1+\beta) I_{B2} = (1+\beta) I_X$$

C) With the above analysis, further derive the mirror ration of this circuit is:

$$MR = \frac{I_O}{I_{REF}} = \frac{\beta(\beta+2)}{\beta^2+2\beta+2}$$

(40 Marks)

Answer:

$$I_{B1} = \frac{I_{E1}}{1+\beta} = \frac{2+\beta}{1+\beta} I_X$$
$$I_O = I_{B1}\beta = \frac{(2+\beta)\beta}{1+\beta} I_X$$
$$I_{REF} = I_{B1} + I_{C3} = \frac{\beta^2+2\beta+2}{1+\beta} I_X$$
$$=> MR = \frac{I_O}{I_{REF}} = \frac{\beta(\beta+2)}{\beta^2+2\beta+2}$$