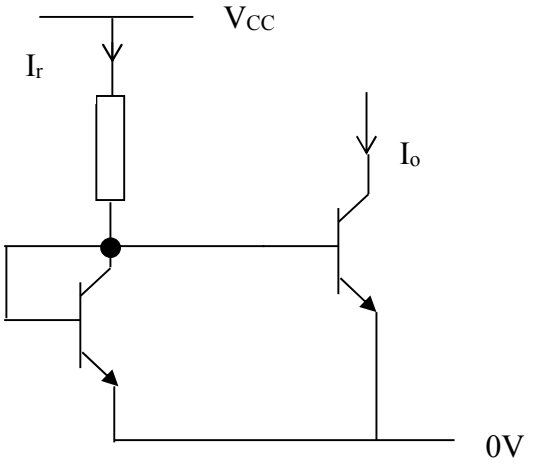
Current mirror problems

For the simple current mirror shown below, show that

$$\frac{I_o}{I_r} = \frac{1}{1+2/\beta} = 1 - \frac{2}{\beta+2}$$

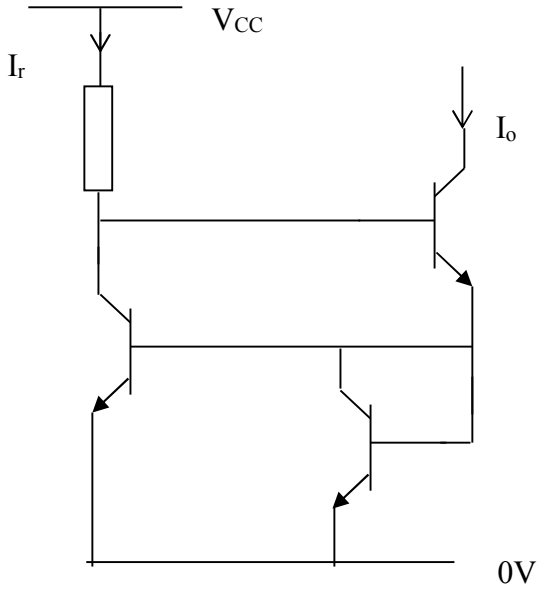


where $\beta = I_C/I_B$.

Assume identical transistors.

Similarly show that for the Wilson current mirror below,

$$\frac{I_o}{I_r} = 1 - \frac{2}{\beta(\beta+2)+2}$$



Calculate the percentage change in I_o/I_r for each circuit if β varies from 5 to 100. Hence show that the second circuit is approximately six times superior to the first in maintaining I_o constant.

Hint: recall that the relationship between collector and emitter currents can be written as

$$I_E = \frac{\beta+1}{\beta} I_C$$