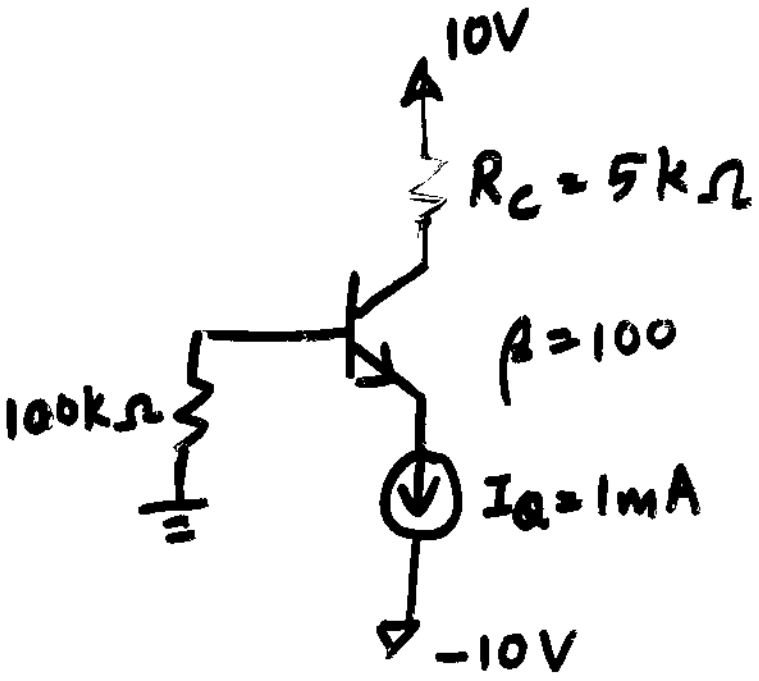
Circuit with current source (sink)



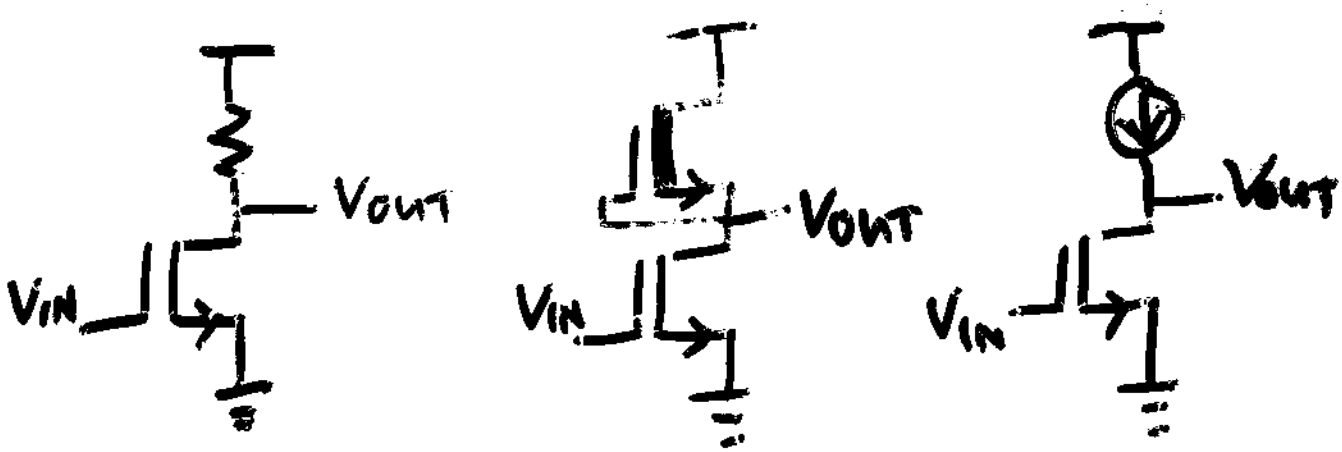
Find I_E, I_C, I_B

V_C, V_{CE}, V_B, V_E

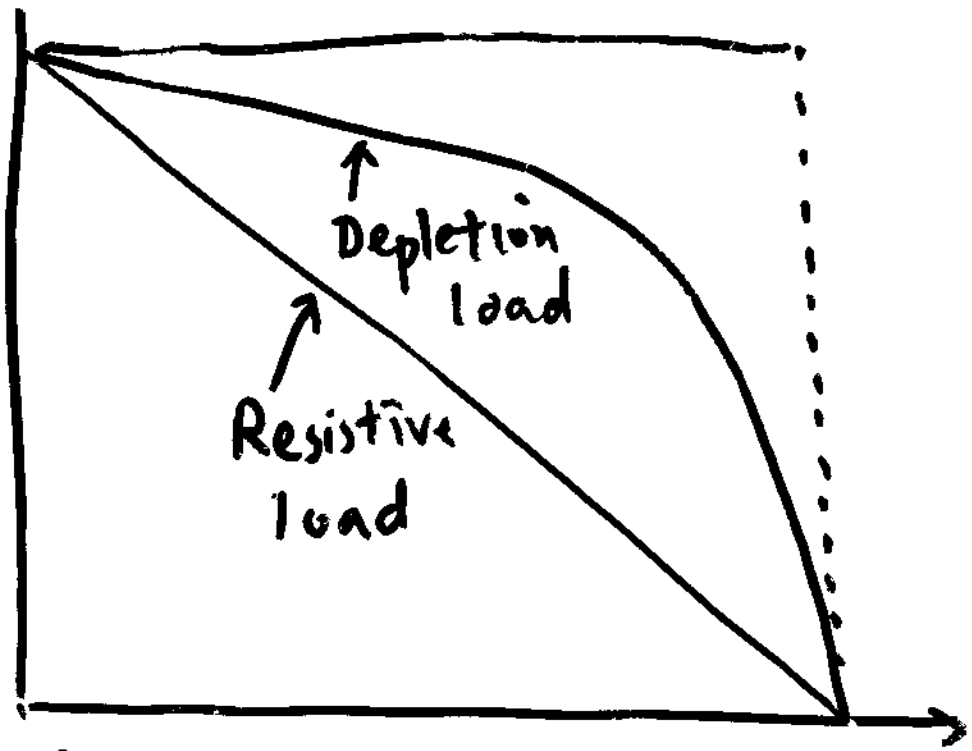
what if you change β?

Current as active load

Source



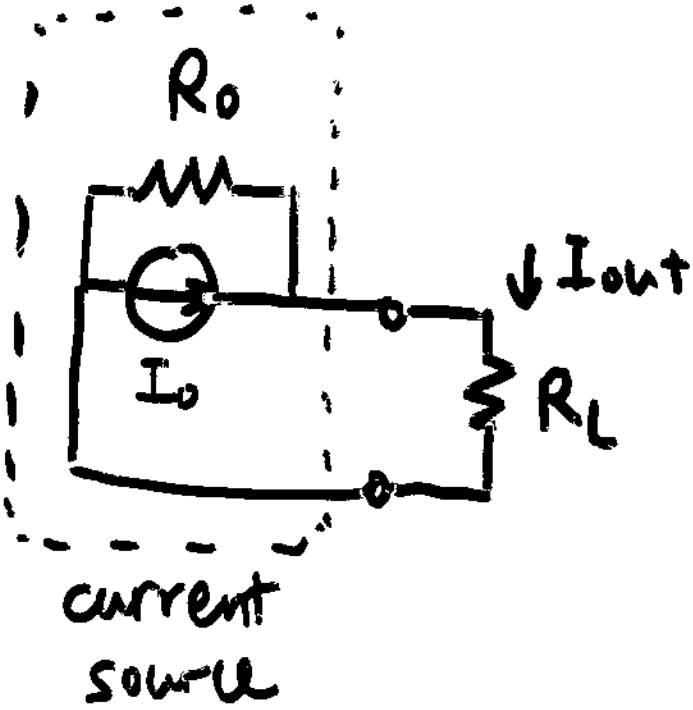
Load lines



Functions as a large resistor without restricting current flow.

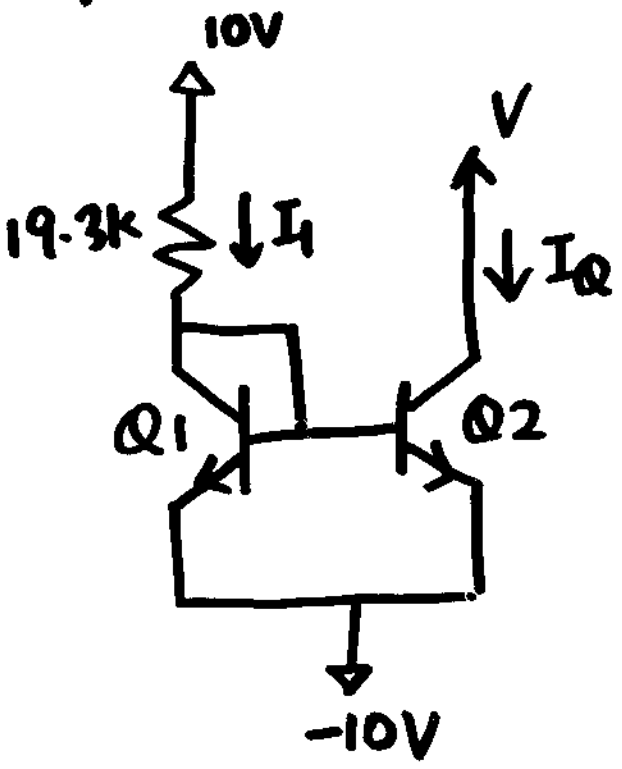
Current source

- sources or sinks the same amount of current, regardless of load conditions
- constant current over some range of load voltage
- Output compliance



$$I_{out} = \frac{I_O}{1 + \frac{R_L}{R_O}}$$

Implemention of Current Source



KVL:

$10 = 19.3k\Omega \cdot I_1 + V_{BE(ON)} - 10$

$I_1 = \frac{20 - V_{BE(ON)}}{19.3k\Omega}$

$= 1mA$

Assume $Q_1 = Q_2$

$\begin{cases} A_{E1} = A_{E2} \\ \beta_1 = \beta_2 \\ n_1 = n_2 \end{cases}$

$I_1 = I_{C_1} + I_{B1} + I_{B2}$

If $V_{BE1} = V_{BE2}$

$I_{B1} = I_{B2}$

$I_{C_1} = I_{C_1}$

$I_1 = I_{C_2} + 2I_{B2}$

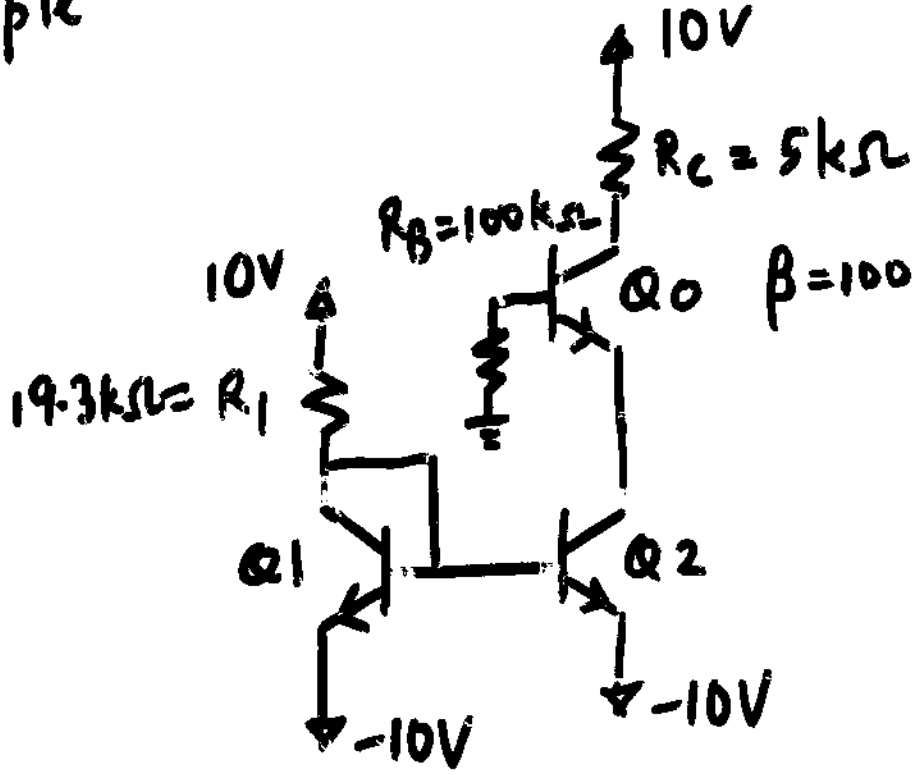
$= I_{C2} + 2\frac{I_{C2}}{\beta}$

$I_1 = (1 + \frac{2}{\beta}) I_{C2} \Rightarrow$ $\boxed{I_{C2} = \frac{I_1}{1 + 2/\beta}}$

Current in Q_1 almost mirrored in Q_2

↓ Current mirror

Example



Computed: $I_{CO} \doteq 1\,mA$

$I_{BO} = 0.01\,mA$

$V_{BO} \doteq -1V$

$V_{EO} = V_{C2} \doteq -1.7V$

$\therefore V_{CE2} = -1.7 - (-10V) = 8.3V$

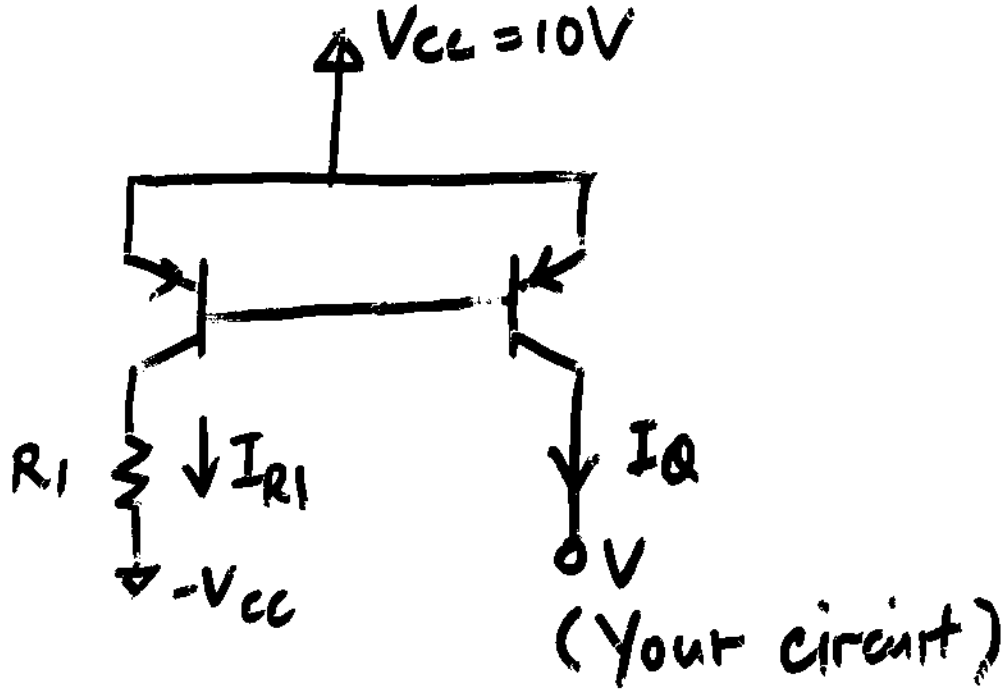
$V_{B2} = (-10) - (-0.7) = -9.3V$ } Right

$V_{B1} = V_{C1} = 10 - I_{R_1} R_1$

$= 10 - 19.3 = -9.3V$ } Left

Same operating point

PNP Current Source



Design for $I_Q = 2mA$

given $\beta = 25$

$$I_Q = \frac{I_{R1}}{1 + 2/\beta} \Rightarrow$$

KVL on Left