- ***Parameters***:
  - ***Output Current I_0***
    - ***As per specification***
  - ***Output Resistance R_0***
    - $R_0 = \Delta V_0/\Delta I_0 = dV_0/dI_0 = v_0/i_0$ (***ac***)
    - ***As large as possible*** - ***ideally infinite***
  - ***Minimum Allowed Output Voltage $V_{0,min}$***
    - ***As small as possible*** - ***ideally zero***
    - ***Dictated by***:
      - ***For BJT***: $V_{CE}(\text{min}) = V_{CE}(\text{SS}) = 0.2$ V
      - ***For MOSFET***: $V_{DS}(\text{min}) = V_{GT}(\text{min}) = 80$ mV

- ***I_0 should be independent of power supply and temperature***
  - ***Temperature and Supply Independent Biasing***
- ***Should use minimum number of circuit elements***
  - ***Economization of space***
- ***Should not affect frequency response***

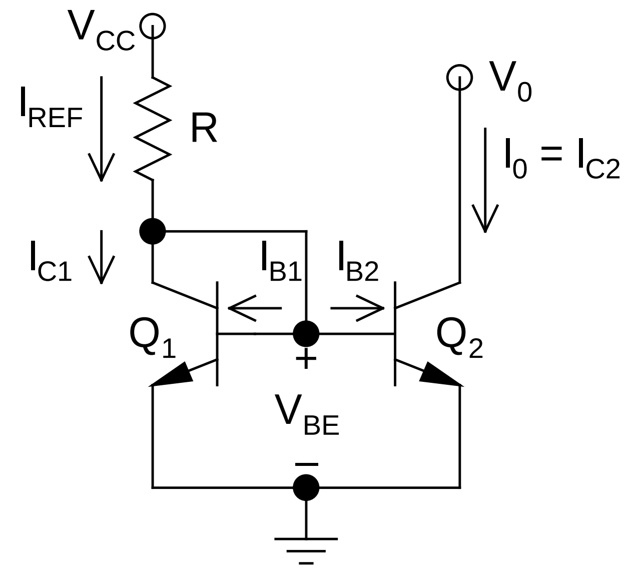
- It is ***almost impossible to satisfy all these constraints simultaneously***
  - ***Look for optimization***

Current Sources/Sinks

- Also known as ***Current Mirrors*** (CM)
- Can be used for ***biasing*** as well as ***load elements*** (known as ***active load***)
- Designed based on ***required specifications***
- ***Two sources of errors***:
  - ***Systematic***: ***Even when devices are matched***
  - ***Random***: ***When there is a random mismatch between devices***

- ***Simple npn CM***:
  - Q_1 has its ***B and C shorted***
    - ***Can never saturate*** ($V_{BC} = 0$)
    - Known as ***diode-connected BJT***
  - Q_1 and Q_2 have ***same*** V_{BE}
  - I_{REF} = ***Reference Current***

    $= (V_{CC} - V_{BE})/R$
  - I_0 = ***Output Current*** = I_{C2}
  - V_0 = ***Output Voltage***
    - ***Variable***, ***depends on the load connected to it***



- ***General Analysis***:

$$I_{REF} = I_{C1} + I_{B1} + I_{B2} = I_{C1}\left(1 + \frac{1}{\beta_1}\right) + \frac{I_{C2}}{\beta_2}$$

- Now:

$$V_{BE} = V_T \ln\left(\frac{I_{C2}}{I_{S2}}\right) = V_T \ln\left(\frac{I_{C1}}{I_{S1}}\right)$$

$$\Rightarrow I_{C2} = KI_{C1} \quad \left(K = I_{S2}/I_{S1}\right)$$

- Thus:

$$I_{REF} = I_{C2}\left[\frac{1}{\beta_2} + \frac{1}{K}\left(1 + \frac{1}{\beta_1}\right)\right]$$