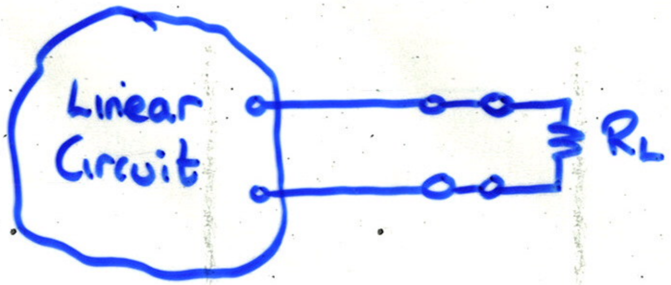
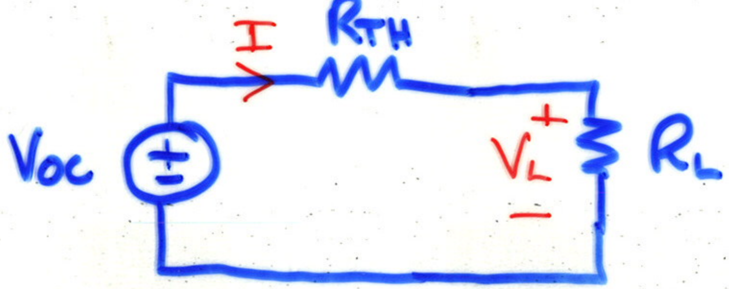
Maximum Power Transfer



What value of R_L should we choose in order to maximize the power in this load?

Where to start?

How about Thevenin equivalent?



Power in load $= V_L \cdot I_L$

$$= I^2 R_L$$

$$= \left(\frac{V_{oc}}{R_{TH}+R_L}\right)^2 R_L$$

How to maximize?

First determine stationary points

$$\frac{dP_L}{dR_L} = \frac{(R_{TH}+R_L)^2 V_{oc}^2 - 2V_{oc}^2 R_L (R_{TH}+R_L)}{(R_{TH}+R_L)^4}$$

Denominator is positive (assuming $R_{TH} > 0$)

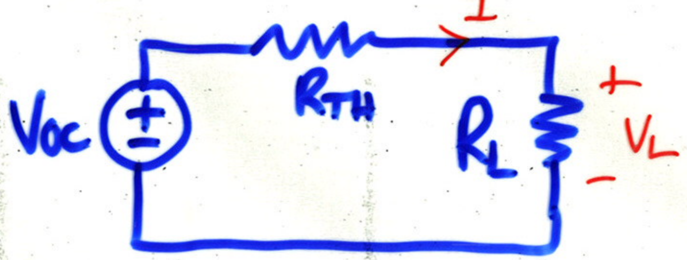
⇒ STATIONARY POINT IS $R_L = R_{TH}$

⇒ Max. Power Transfer when

$$R_L = R_{TH}$$

- Efficiency?

WHAT ABOUT OTHER LOAD-MATCHING OBJECTIVES



$$I = \frac{V_{OC}}{R_{TH} + R_L}$$ → decreases with R_L

$$V_L = \frac{R_L V_{OC}}{R_{TH} + R_L} = \frac{V_{OC}}{1 + R_{TH}/R_L}$$ → Increases with R_L towards V_{OC}

$$P_L = V_L I = \frac{V_{OC}^2}{R_L \left(1 + R_{TH}/R_L\right)^2}$$

for small R_L, $R_L \ll R_{TH}$

$$P_L \approx \frac{V_{OC}^2}{R_L \left(R_{TH}/R_L\right)^2} = \frac{R_L V_{OC}^2}{R_{TH}^2}$$

→ Increases with R_L

for large R_L, $R_L \gg R_{TH}$

$$P_L \approx \frac{V_{OC}^2}{R_L}$$ → Decreases with R_L

Turning point? $R_L = R_{TH}$

What about efficiency $\frac{P_L}{P_{S,gen}}$

$$P_L = \frac{V_{OC}^2}{R_L\left(1+ R_{TH}/R_L\right)^2}$$

$$P_{S,gen} = V_{OC} I = \frac{V_{OC}^2}{R_L + R_{TH}} = \frac{V_{OC}^2}{R_L\left(1+ R_{TH}/R_L\right)}$$

$$\Rightarrow \text{Efficiency} = \frac{1}{1+\frac{R_{TH}}{R_L}}$$

What is efficiency at max power transfer?