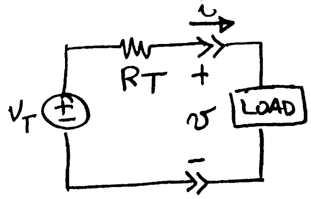
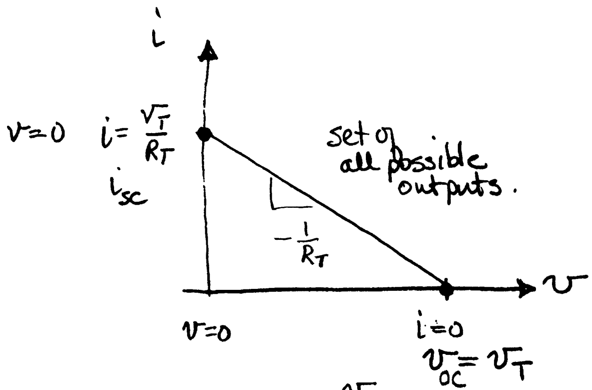
Application to non-linear loads

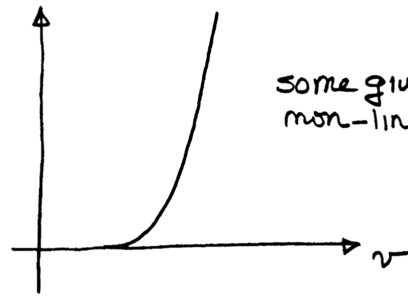
Thevenin



$$i = \frac{v_T - v}{R_T}$$

$$i = -\frac{1}{R_T} v + \frac{v_T}{R_T}$$

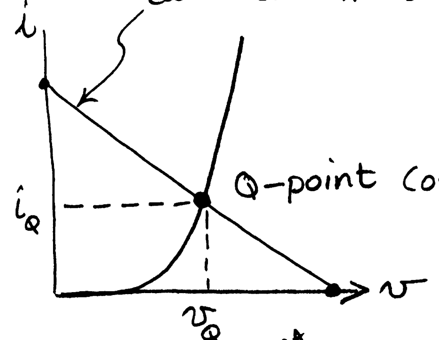




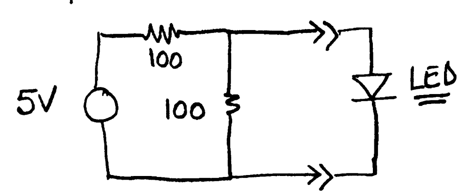
some given non-linear devices

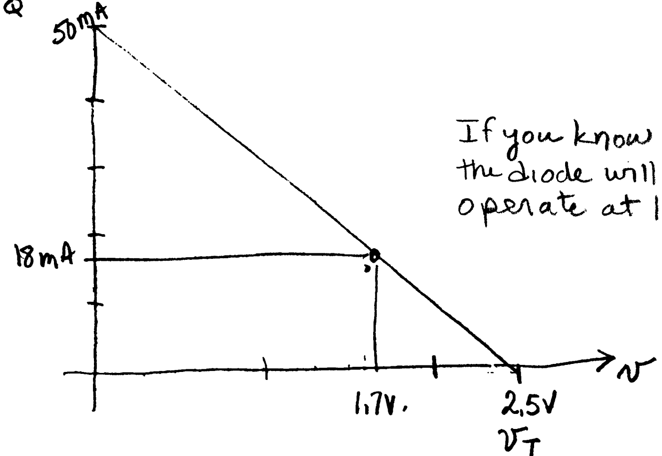
$$i = -\frac{1}{R_T} v + \frac{v_T}{R_T}$$

called a load line but really is a source line



Example 3-18





If you know the diode will operate at 1.7 volts.

$$v_T = v_{oc} = \frac{100}{100+100} \cdot 5 = 2.5V$$

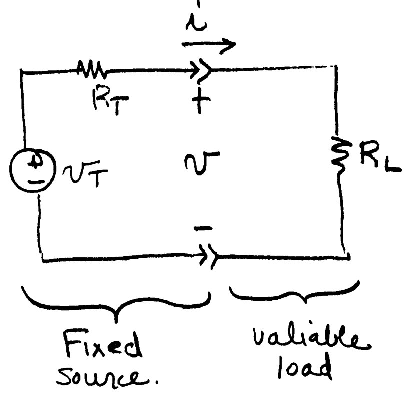
$$R_T = 100 \| 100 = 50$$

$$i_N = i_{sc} = \frac{V_T}{R_T} = \frac{2.5}{50}$$

$$= 50mA$$

$$P_D = vi = (1.7)(.018) = 30.6mW$$

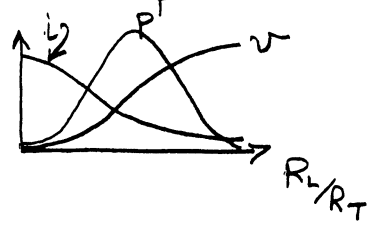
3.5 Maximum signal transfer



max output voltage when $R_L = \infty$

max output current when $R_L = 0$

Where is maximum power?



Consider the power being delivered to the load.

At the interface

$$v = \frac{R_L}{R_L + R_T} v_T$$

$$i = \frac{v_T}{R_L + R_T}$$

$$P = vi = \frac{R_L v_T}{R_L + R_T} \cdot \frac{v_T}{R_L + R_T} = \frac{R_L v_T^2}{(R_L + R_T)^2}$$

When do we get maximum power to the load, i.e., the value of R_L

$$\frac{\partial P}{\partial R_L} = \frac{v_T^2}{(R_L + R_T)^2} + \frac{R_L v_T^2 (-2)}{(R_L + R_T)^{+3}} = 0.$$

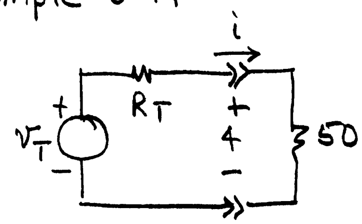
$$\frac{(R_L + R_T) - 2R_L}{(R_L + R_T)^3} v_T^2 = 0$$

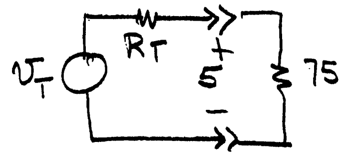
$$R_L + R_T - 2R_L = 0$$

$$R_T - R_L = 0$$

Example 3-19

given measurements find max output.





$$4 = \frac{50}{50+R_T} v_T \qquad 5 = \frac{75}{75+R_T} v_T$$

$$\frac{200+4R_T}{50} = v_T \qquad v_T = \frac{375+5R_T}{75}.$$

$$\frac{200+4R_T}{50} = \frac{375+5R_T}{75}$$

$$(200)(75) + (75)(4)R_T = (375)(50) + (50)(5R_T)$$

$$(75)(4)R_T - (50)(5)R_T = (375)(50) - (200)(75)$$

$$300R_T - 250R_T = 18750 - 15000$$

$$50R_T = 3750$$

$$R_T = 75\Omega.$$

$$4 = \frac{50}{50+75} v_T$$

$$\frac{(125)(4)}{50} = v_T = 10.$$

max voltage out $= v_{oc} = 10$ volts

max current out $= i_{sc} = \frac{10V}{75\Omega} = 133mA$

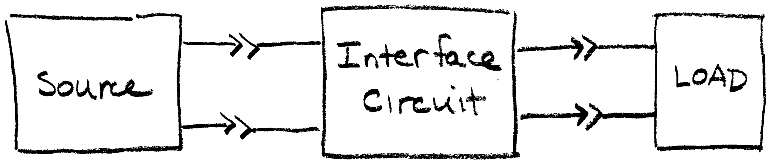
max power out occurs at $R_L = 75\Omega$.

@ $R_L = 75\Omega$

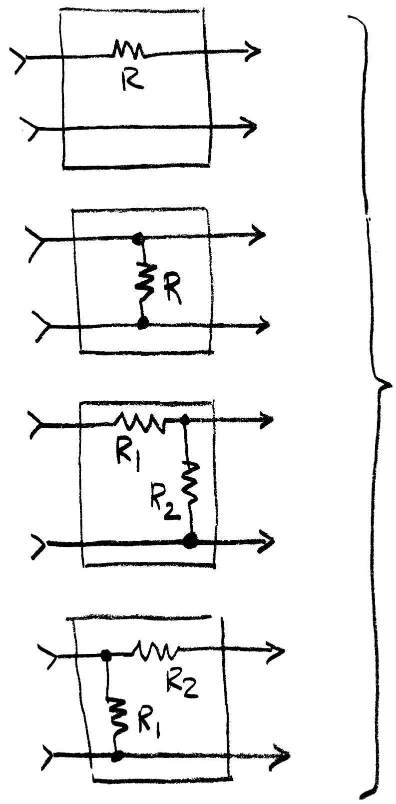
$$V_{OUT} = \frac{75}{75+75} \cdot 10 = 5 \text{ volts}.$$

$$P_{OUT} = \frac{(V_{OUT})^2}{R_L} = \frac{(5)^2}{75} = \frac{25}{75} = 333mW.$$

3-6 Interface Circuit Design



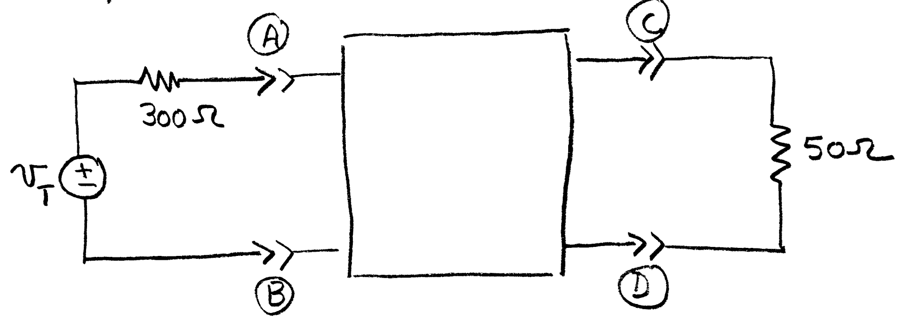
At this point resistors are the only elements we can use to design interface circuits.



Examples of interface circuits.

These are often called two-port circuits.

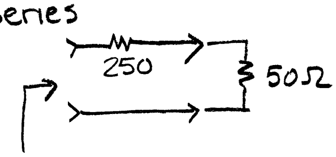
Design Example 3-23



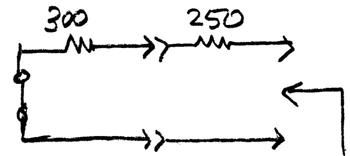
Design the two-port interface circuit so the load "sees" a Thevenin resistance of 50Ω between terminals Ⓒ and Ⓓ, while simultaneously the source "sees" a load resistance of 300Ω between Ⓐ and Ⓑ

<u>Design</u> We can try different interface circuits

Series

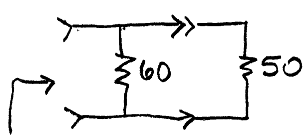


$R_T = 300\Omega$ <u>OK</u>

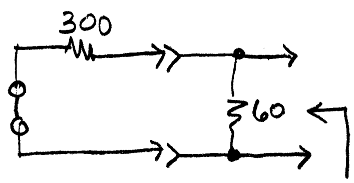


$R_T = 550 \gg 50$ <u>NOT OK</u>

Parallel

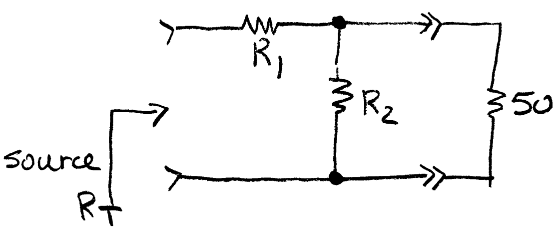


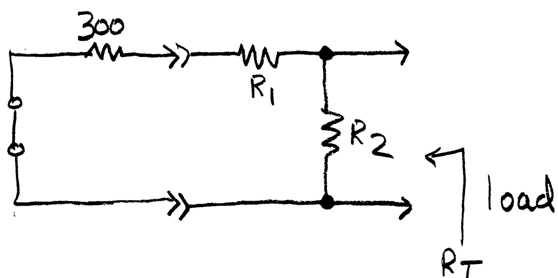
$R_T \ll 50$ <u>NOT OK</u>



$R_T = 60 \| 300 = 50$ <u>OK</u>

Try two resistor circuits





Want source to see larger resistance than 50 so this requires a series R.

Want load to see a R_T smallel than source so there has to be a parallel resistance.

Design $\quad R_1 + \dfrac{50 R_2}{R_2 + 50} = 300 \qquad \dfrac{(R_1 + 300) R_2}{R_1 + 300 + R_2} = 50$

Non-linear equations with solutions $R_1 = 273.9$ and $R_2 = 54.8\ \Omega$.