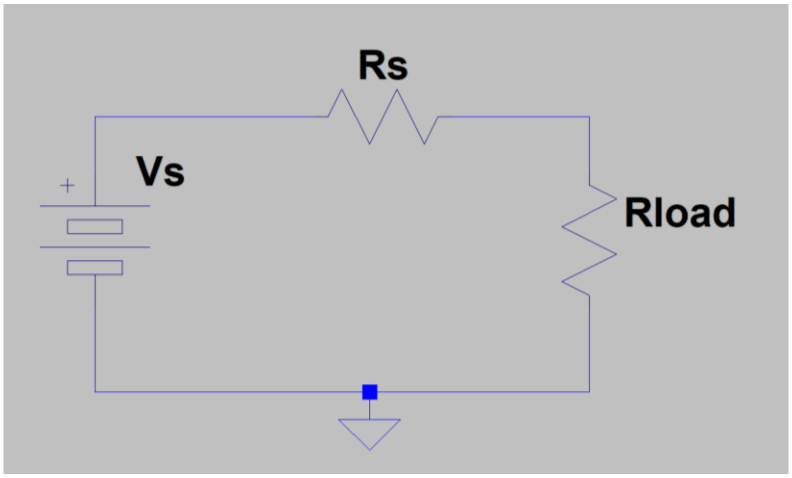
Maximum Power Theorem

Lets look at a simple circuit with a voltage supply, a source resistance and a load resistor all connected in series.



Note that this is a Thevenin Equivalent source with a load resistor.

The voltage across R_{load} is:

$Vs * \frac{Rload}{Rs+Rload}$

and the current through Rload is:

$I = \frac{Vs}{Rs+Rload}$

so the power is:

$$Pload = V_{Rload} * I_{Rload} = Vs * \frac{Rload}{Rs + Rload} * \frac{Vs}{Rs + Rload} = \frac{\boldsymbol{Vs^2}}{(\boldsymbol{Rs} + \boldsymbol{Rload})^2}$$

If R_{load} = 0 there is no voltage across R_{load} so the power is zero

If $R_{load} = \infty$ there is no current so the power is zero

Therefore there must be a maximum power somewhere between $0 < R_{load} < \infty$

If you do the calculus (take the partial derivative WRT R_{load}, set it to zero and solve for R_{load}) you find that the maximum power is when R_{load} = Rs. This is the Maximum Power Theorem. The derivation is on pages 148-149 in edition 7 of Alexander-Sadiku.

Notes:

1. If Rs is actually a complex number (it happens in AC circuits), then the result is that the load must be the complex conjugate of the source "impedance".
2. The source power is then equally divide between the source resistance (impedance) and the load resistance (impedance).