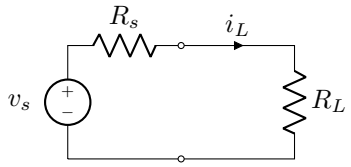
Lecture 20, Mar 4, 2022

Maximum Power Transfer



- Consider a voltage source connected to a resistor in series and then connected to a load; how do we extract maximum power from this voltage source? What R_L maximizes power?
  - $P_L = R_L i_L^2$
  - $i_L = \dfrac{v_s}{R_s + R_L} \implies P_L = \dfrac{R_L v_s^2}{(R_s + R_L)^2}$
  - To maximize P_L we differentiate it
  - $\dfrac{\mathrm{d}P_L}{\mathrm{d}R_L} = \dfrac{v_s^2(R_L + R_s)^2 - 2(R_L + R_s)R_L v_s^2}{(R_L + R_s)^4} = \dfrac{v_s^2((R_L + R_s) - 2R_L)}{(R_L + R_s)^3} = 0$
  - The only way for the derivative to equal zero is if $R_L + R_s = 2R_L \implies R_L = R_s$
  - Plugging in $R_L = R_s \implies P_{L_{max}} = \dfrac{v_s^2}{4R_s^2} = \dfrac{v_s^2}{4R_L}$
- For a voltage source and resistor, max power transfer is achieved when the load resistance equals the resistance attached to the voltage source, with max power being $\dfrac{v_s^2}{4R_s}$
  - For any complicated circuit we can find its Thevenin equivalent and turn it into a voltage source with resistor in series