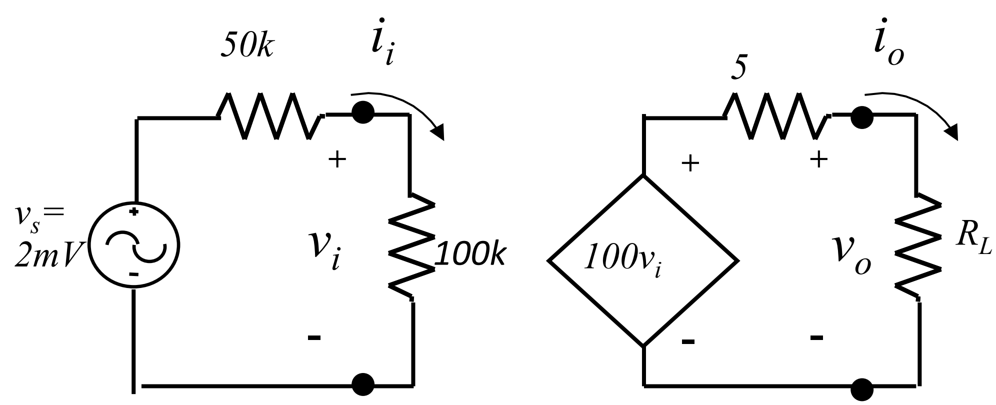
# BME 301

10-Amplifiers and Feedback

# Homework

1. For the following circuit, determine the value of $R_L$ to maximize the power gain for this circuit. Provide a proof. Which value of $R_L$ makes the better design and why?



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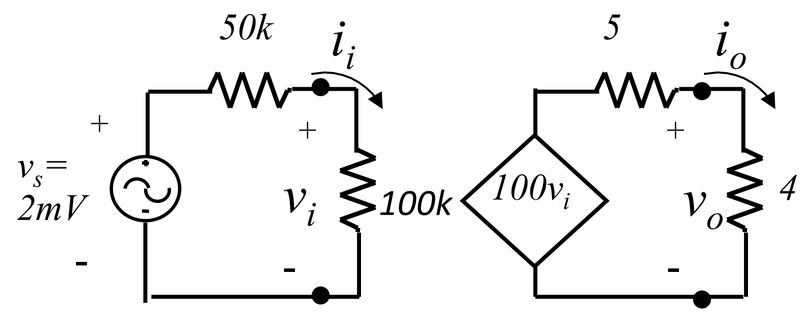



To determine the best value of $R_L$, calculate the power gain,

$$G = \frac{v_o i_o}{v_i i_i} = \frac{v_o}{v_i} \times \frac{i_o}{i_i} = A_v A_i$$

$$= \frac{\frac{R_L}{R_L + r_o} A v_i}{v_i} \times \frac{\frac{A v_i}{R_L + r_o}}{\frac{v_i}{r_i}} = \frac{R_L}{(R_L + r_o)^2} r_i A^2$$

take the derivative of it with respect to $R_L$ and set it equal to zero:

$$\frac{dG}{dR_L} = \frac{1}{(R_L + r_o)^2} r_i A^2 - 2\frac{R_L}{(R_L + r_o)^3} r_i A^2 = 0$$

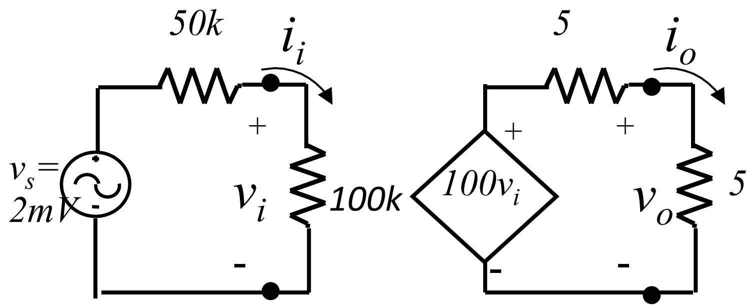
Now solve for $R_L$

$$R_L + r_o = 2R_L \Rightarrow R_L = r_o$$

That is, make $R_L$ = to the output impedance, $r_o$, and the power gain will be maximized. In this case $R_L = 5\Omega$.

# Homework

1. For the following circuit, calculation the gains $A_v$, $A_{vs}$, $A_i$, and power gain for $R_L$ =2, 4, 6 ohms. Which value of $R_L$ makes the better design and why?




$$i_i = \frac{2mV}{50k+100k} = \frac{2\times10^{-3}}{150\times10^{3}} = .013\mu A$$

$$v_i = i_i 100k = 1.33mV$$

$$i_o = \frac{100\times1.33mV}{5} = 26.6mA$$

$$v_o = 2\times26.6mA = 53.3mV$$

$$A_{vs} = \frac{v_o}{v_s} = \frac{53.3mV}{2mV} = 26.6$$

$$A_v = \frac{v_o}{v_i} = \frac{53.3mV}{1.33mV} = 37$$

$$A_i = \frac{i_o}{i_i} = \frac{26.6mA}{.013\mu A} = 2.05\times10^{6}$$

$$G = A_v \times A_i = 7.6\times10^{7}$$

# Homework

2. What are the benefits of negative feedback?
   - Stabilization of Gain
   - Reduction of Nonlinear Distortion
   - Reduction of noise
   - Control of input and output impedances
   - Extension of Bandwidth
3. What are the problems with positive feedback?
   - In stability unless instability is desired (e.g., timer)

# Homework

4. HONORS STUDENTS ADD THE FOLLOWING

Name 3 types of negative feedback applications.

Timers − In computer circuits

Schmitt Triggers − Level Detection

Oscillators − signal generation of sinusoids and square waves, for example.