Electronics Systems

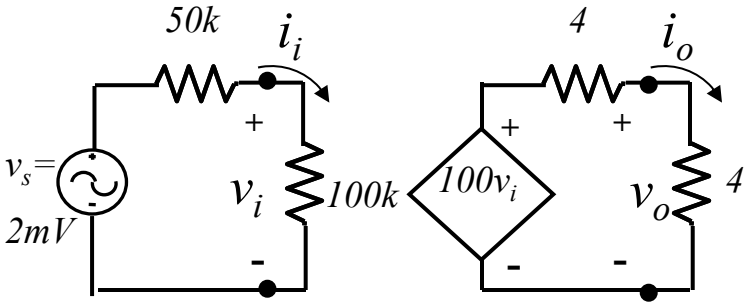
Lesson #3
Chapter 1

Homework

- Probs
  - 1.15 repeat using a load resistance of 8 Ω and then a load resistance of 2 Ω; describe what happens and why – prove it for extra credit.
  - 1.17 Use input resistance = 100Ω, input voltage 10*m* V rms and output voltage 10 V rms
  - 1.18,
  - 1.19 use load resistor of 100k Ω and source resistor of 500k Ω

Homework Answers #1

- Probs 1.15



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

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

$$i_o = \frac{100\times1.33mV}{8} = 16.7mA$$

$$v_o = 4\times16.7mA = 66.7mV$$

$$A_{vs} = \frac{v_o}{v_s} = \frac{66.7mV}{2mV} = 33.3$$

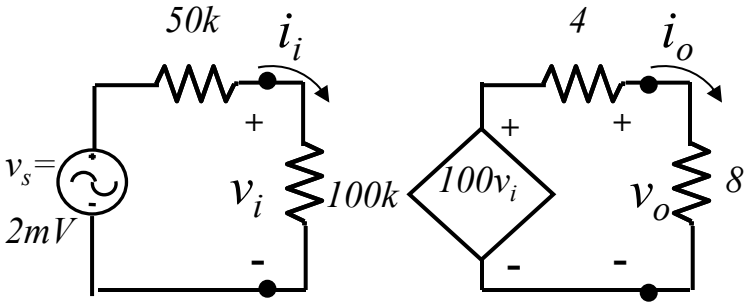
$$A_v = \frac{v_o}{v_i} = \frac{66.7mV}{1.33mV} = 50$$

$$A_i = \frac{i_o}{i_i} = \frac{16.7mA}{.013\mu A} = 1.25\times10^{6}$$

$$G = A_v \times A_i = 6.25\times10^{7}$$

Homework Answers #1

- Probs 1.15



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

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

$$i_o = \frac{100\times1.33mV}{12} = 11.1mA$$

$$v_o = 8\times11.1mA = 88.9mV$$

$$A_{vs} = \frac{v_o}{v_s} = \frac{88.9mV}{2mV} = 44.4$$

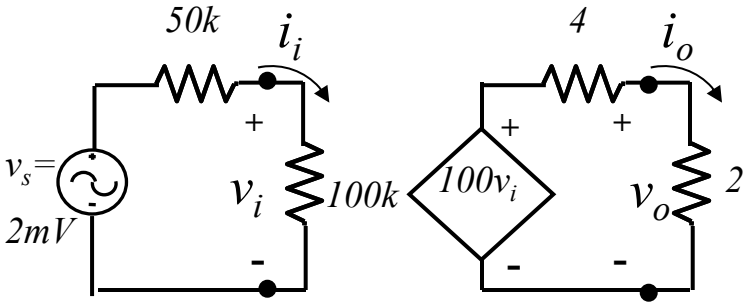
$$A_v = \frac{v_o}{v_i} = \frac{88.9mV}{1.33mV} = 66.7$$

$$A_i = \frac{i_o}{i_i} = \frac{16.7mA}{.013\mu A} = 0.83\times10^{6}$$

$$G = A_v \times A_i = 5.56\times10^{7}$$

Homework Answers #1

- Probs 1.15



$$i_i = \frac{2mV}{50k + 100k} = \frac{2 \times 10^{-3}}{150 \times 10^3} = .013\mu A$$

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

$$i_o = \frac{100 \times 1.33mV}{6} = 22.2mA$$

$$v_o = 2 \times 22.2mA = 44.4mV$$

$$A_{vs} = \frac{v_o}{v_s} = \frac{44.4mV}{2mV} = 22.2$$

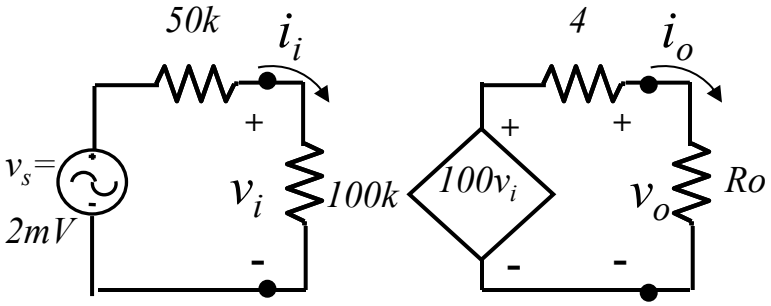
$$A_v = \frac{v_o}{v_i} = \frac{44.4mV}{1.33mV} = 33.3$$

$$A_i = \frac{i_o}{i_i} = \frac{22.2mA}{.013\mu A} = 1.67 \times 10^6$$

$$G = A_v \times A_i = 5.56 \times 10^7$$

Homework Answers #1

- Probs 1.15

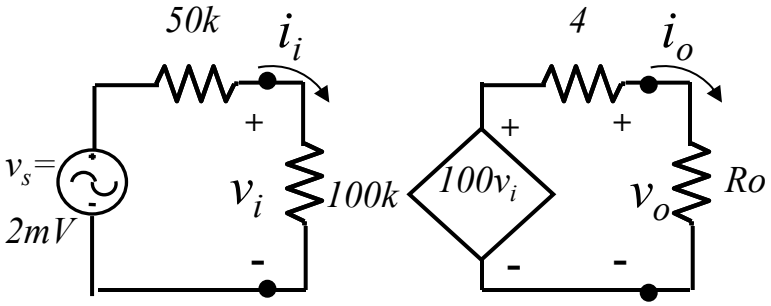


Ro	Avs	Av	Ai	Gp
4	3.33E+01	5.00E+01	1.25E+06	6.25E+07
8	4.44E+01	6.67E+01	8.33E+05	5.56E+07
2	2.22E+01	3.33E+01	1.67E+06	5.56E+07

When $R_o = 4\ \Omega$, we have maximum power transferred.

Homework Answers #1

- Probs 1.15



$$V_o = A_{vo} V_i \frac{R_L}{R_L + R_o} \Rightarrow A_v = \frac{V_o}{V_i} = A_{vo} \frac{R_L}{R_L + R_o}$$

$$I_o = A_{vo} V_i \frac{1}{R_L + R_o} = A_{vo} I_i R_i \frac{1}{R_L + R_o}; \Rightarrow A_i = \frac{I_o}{I_i} = A_{vo} \frac{R_i}{R_L + R_o}$$

$$G_p = (A_{vo})^2 \frac{R_L R_i}{(R_L + R_o)^2}$$

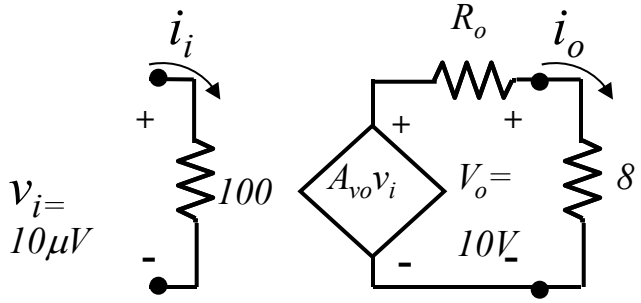
Maximum Power Transferred when $\frac{dG_p}{dR_L} = 0$

$$\frac{dG_p}{dR_L} = (A_{vo})^2 [\frac{R_i}{(R_L + R_o)^2} - \frac{2R_L R_i}{(R_L + R_o)^3}] = (A_{vo})^2 R_i [\frac{R_L + R_o}{(R_L + R_o)^3} - \frac{2R_L}{(R_L + R_o)^3}]$$

$$= (A_{vo})^2 R_i [\frac{R_L + R_o}{(R_L + R_o)^3} - \frac{2R_L}{(R_L + R_o)^3} = 0 \Rightarrow R_L = R_o$$

Homework Answers #2

- Probs 1.17



$$i_i = \frac{10\mu V}{100} = \frac{10\times10^{-6}}{100} = 0.1\mu A$$

$$i_o = \frac{10V}{8} = 1.25A$$

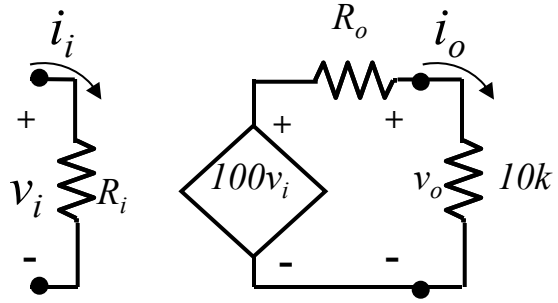
$$A_v = \frac{v_o}{v_i} = \frac{10V}{10\mu V} = 10^6$$

$$A_i = \frac{i_o}{i_i} = \frac{1.25A}{0.1\mu A} = 1.25\times10^7$$

$$G = A_v \times A_i = 1.25\times10^{13}$$

Homework Answers #3

- Probs 1.18



$$A_v = \frac{v_o}{v_i}$$

$$v_o = \frac{R_L}{R_L + R_O} A_{vo} v_i$$

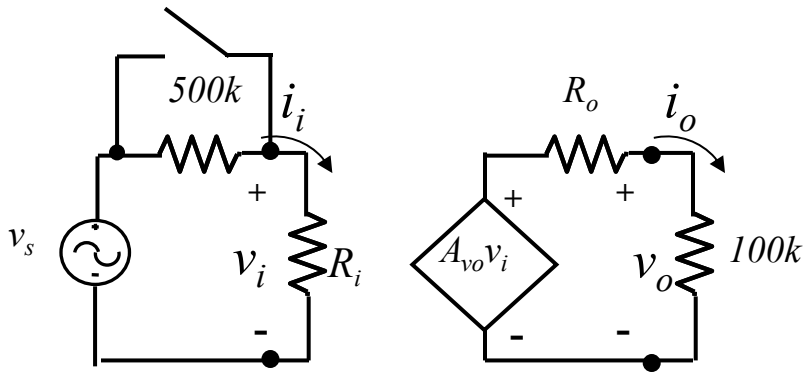
$$A_v = \frac{v_o}{v_i} = \frac{R_L}{R_L + R_O} A_{vo}$$

$$= \frac{10k}{10k + R_O} 100 = 90$$

$$R_O = \frac{10k(100 - 90)}{90} = 1.11k\Omega$$

Homework Answers #4

- Probs 1.19



$$v_i = \frac{R_i}{R_s + R_i} v_s$$

$$v_o = \frac{R_L}{R_L + R_o} A_{vo} v_i = A_{vo} \frac{R_L}{R_L + R_o} \times \frac{R_i}{R_s + R_i} v_s$$

With switch closed , $R_s = 0$

$$v_o = A_{vo} \frac{10k}{10k + R_o} \times \frac{R_i}{0 + R_i} v_s = A_{vo} \frac{10k}{10k + R_o} v_s = 100mV$$

With switch open , $R_s = 1M$

$$v_o = A_{vo} \frac{10k}{10k + R_o} \times \frac{R_i}{0.5 \times 10^6 + R_i} v_s = 50mV$$

$$\frac{R_i}{0.5 \times 10^6 + R_i} = .5$$

$$R_i = 500k\Omega$$