

# Perform Small Signal Analysis on the Circuits.

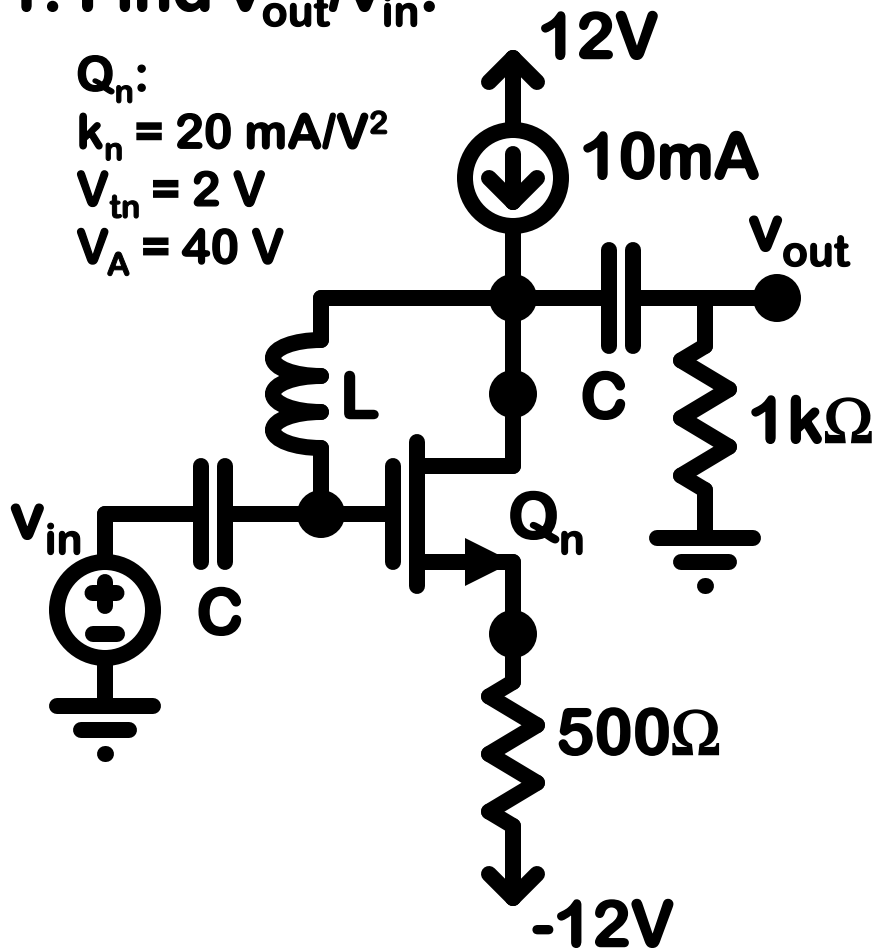
1. Find  $v_{out}/v_{in}$ .

$Q_n$ :

$$k_n = 20 \text{ mA/V}^2$$

$$V_{tn} = 2 \text{ V}$$

$$V_A = 40 \text{ V}$$



Draw the equivalent PMOS circuit.

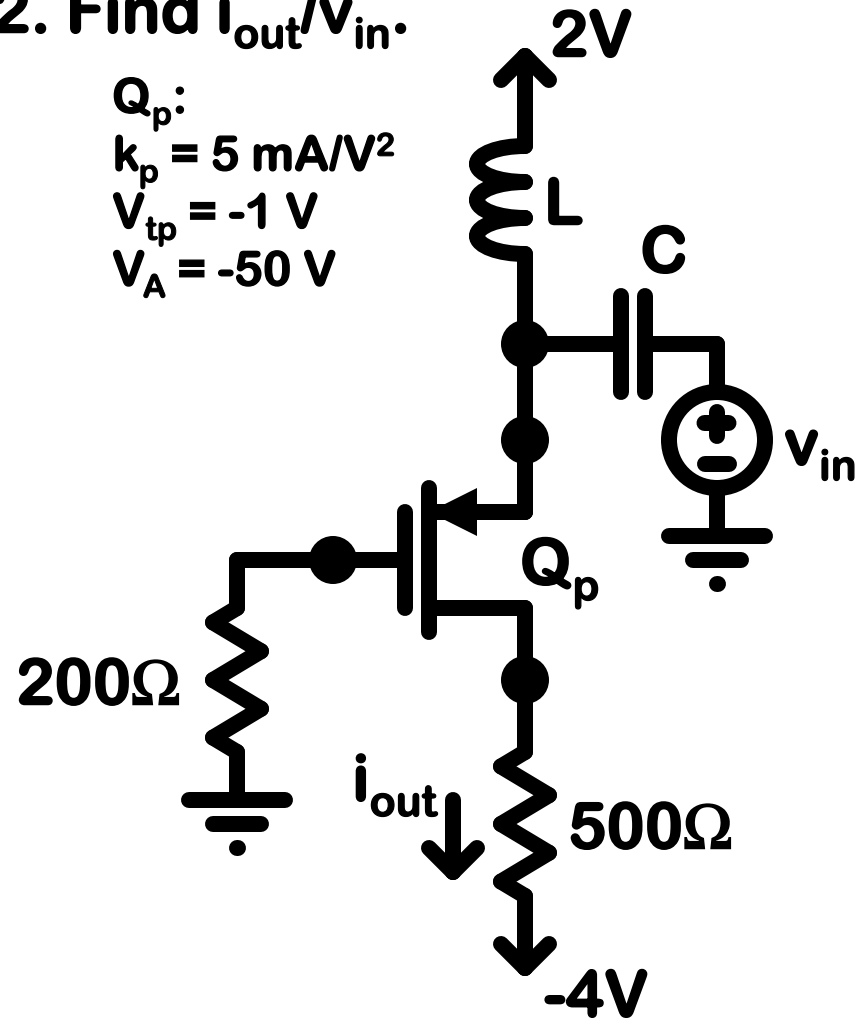
2. Find  $i_{out}/v_{in}$ .

$Q_p$ :

$$k_p = 5 \text{ mA/V}^2$$

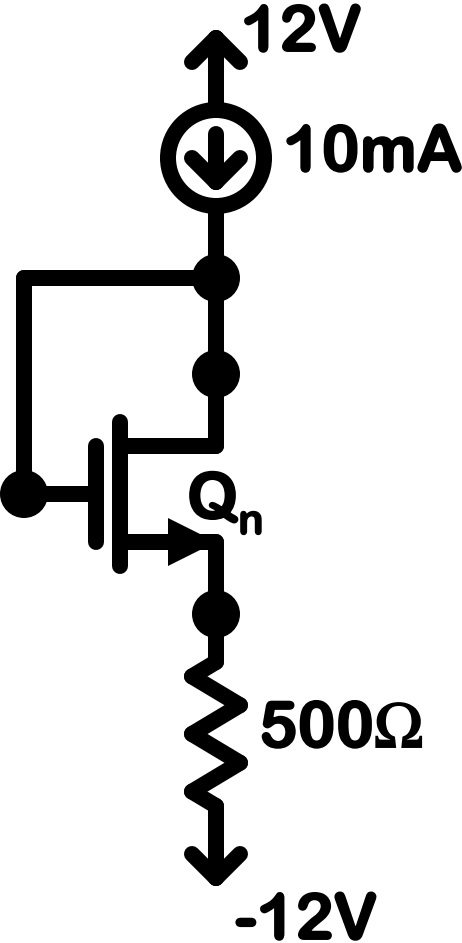
$$V_{tp} = -1 \text{ V}$$

$$V_A = -50 \text{ V}$$

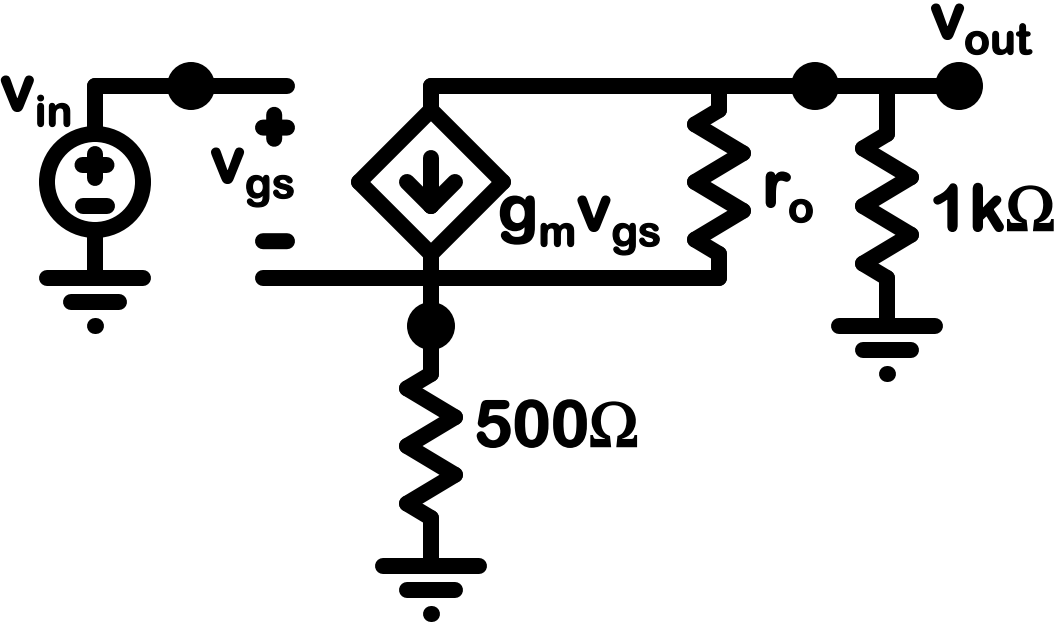


Draw the equivalent NMOS circuit.

# Perform Small Signal Analysis on the Circuits.



LSC



SSC

# Perform Small Signal Analysis on the Circuits.

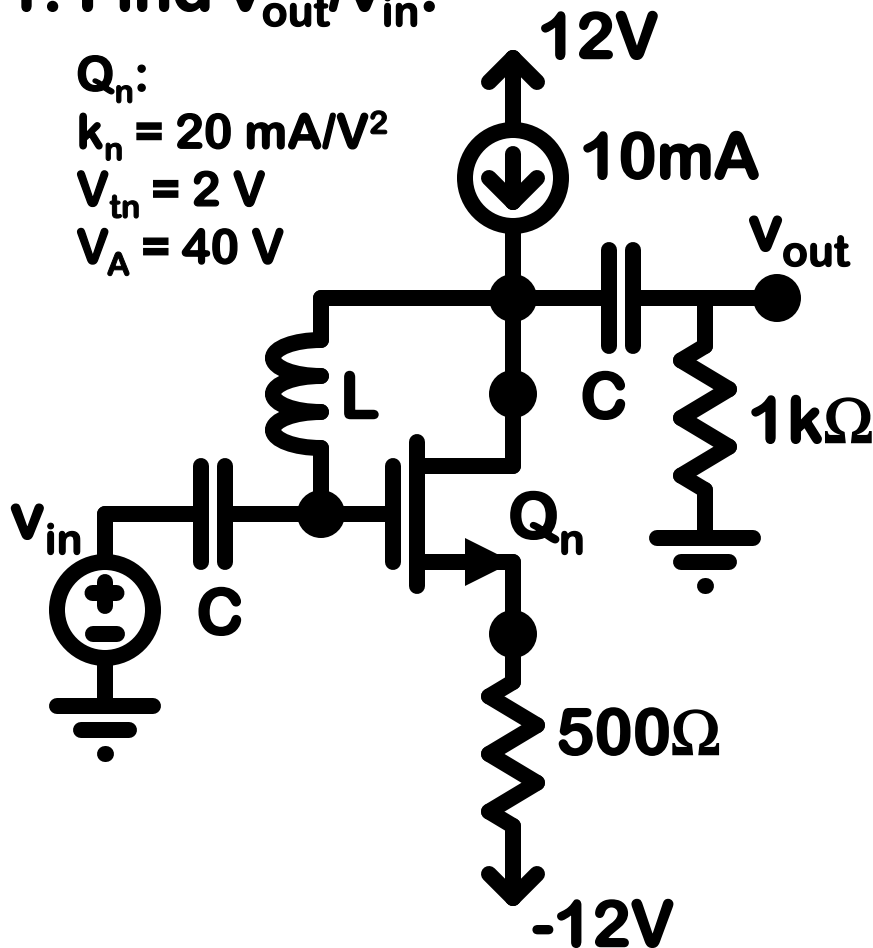
1. Find  $v_{out}/v_{in}$ .

$Q_n$ :

$$k_n = 20 \text{ mA/V}^2$$

$$V_{tn} = 2 \text{ V}$$

$$V_A = 40 \text{ V}$$



1. LSC

2.  $I_D = 10\text{mA}$

$$V_{GS} = \text{sqrt}(2 \cdot 10 / 20) + 2 = 3\text{V}$$

3.  $g_m = 20\text{mA/V}$

$$r_o = 40 / 0.01 = 4\text{k}\Omega$$

4. SSC

5. Solve

$$v_o / 1000 = -v_s / 500, v_s = -v_o / 2$$

$$-v_o / 1\text{k} = 0.02(v_i - v_s) + (v_o - v_s) / 4\text{k}$$

$$-8v_o = 160(v_i + v_o / 2) + 2(v_o + v_o / 2)$$

$$v_o / v_i = -160 / 91 \text{ (V/V)}$$

$$v_o / v_i = -1.758 \text{ (V/V)}$$

# Perform Small Signal Analysis on the Circuits.

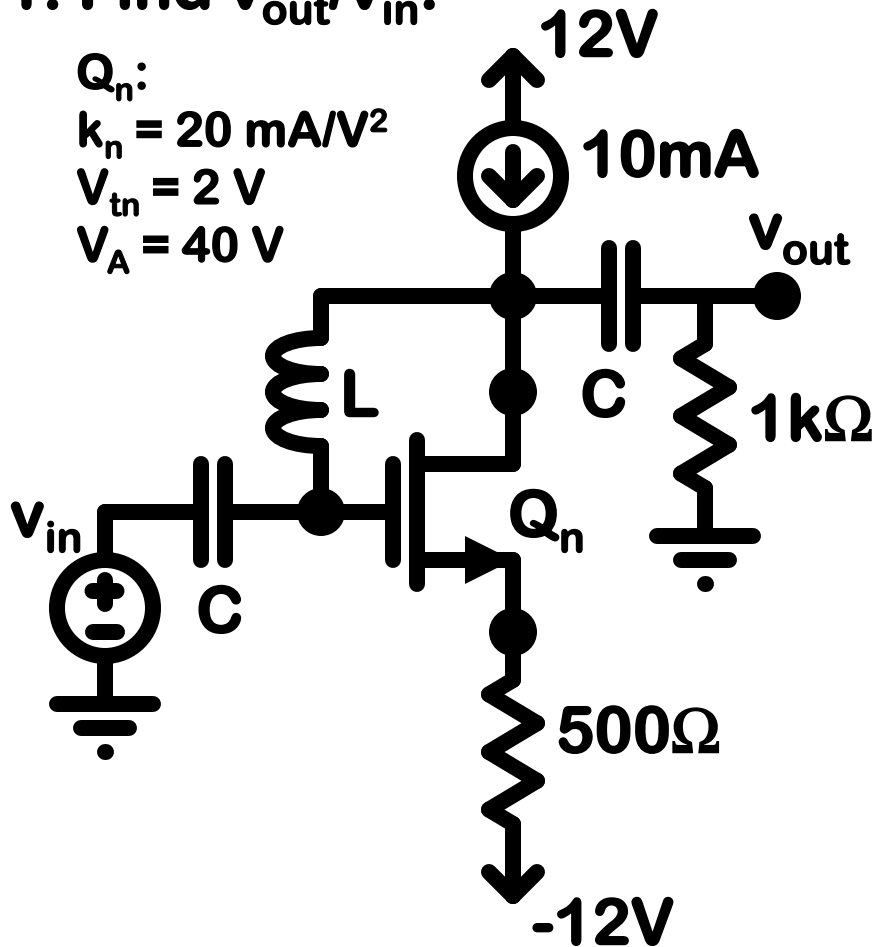
1. Find  $v_{out}/v_{in}$ .

$Q_n$ :

$$k_n = 20 \text{ mA/V}^2$$

$$V_{tn} = 2 \text{ V}$$

$$V_A = 40 \text{ V}$$



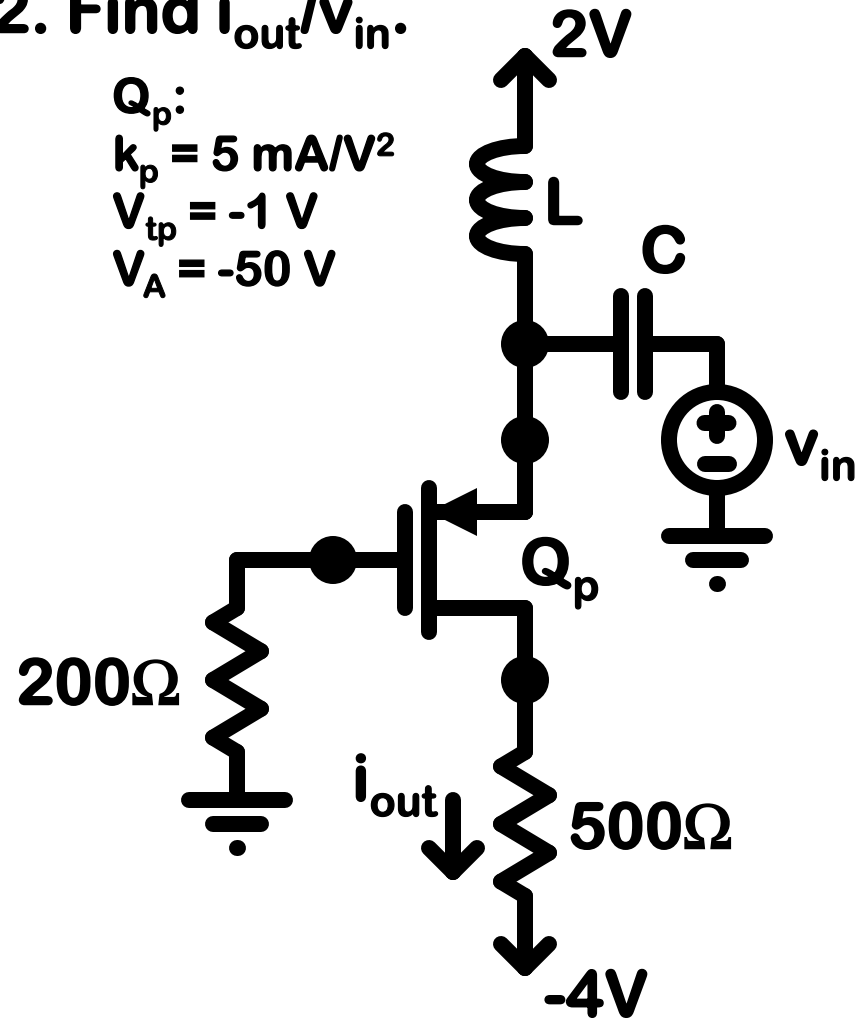
2. Find  $i_{out}/v_{in}$ .

$Q_p$ :

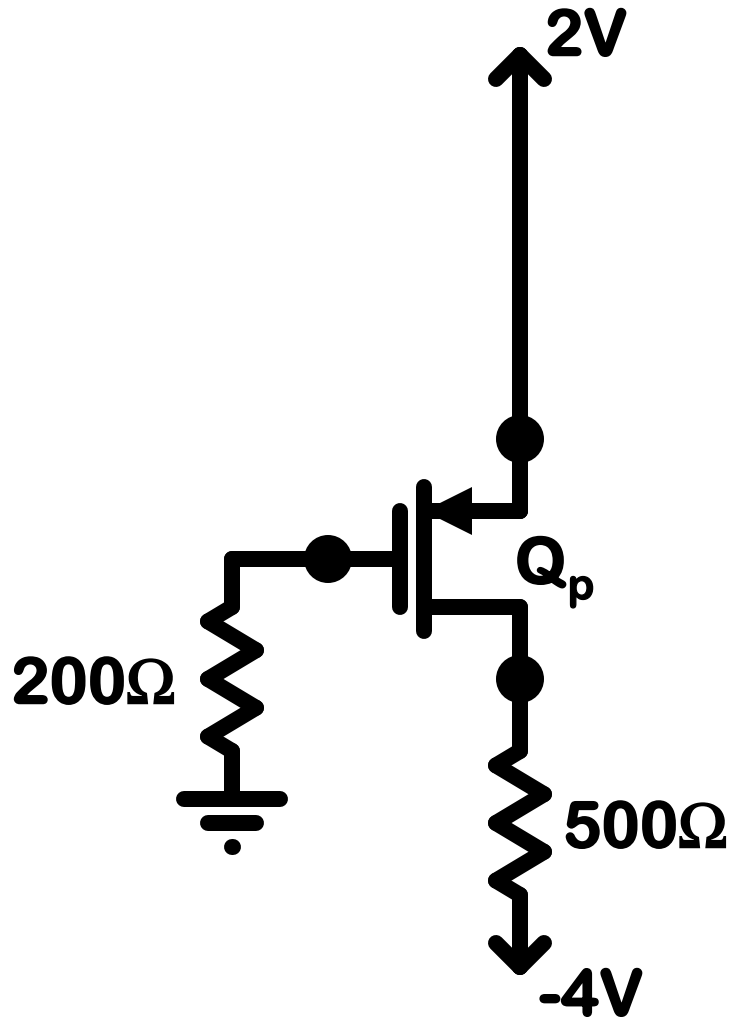
$$k_p = 5 \text{ mA/V}^2$$

$$V_{tp} = -1 \text{ V}$$

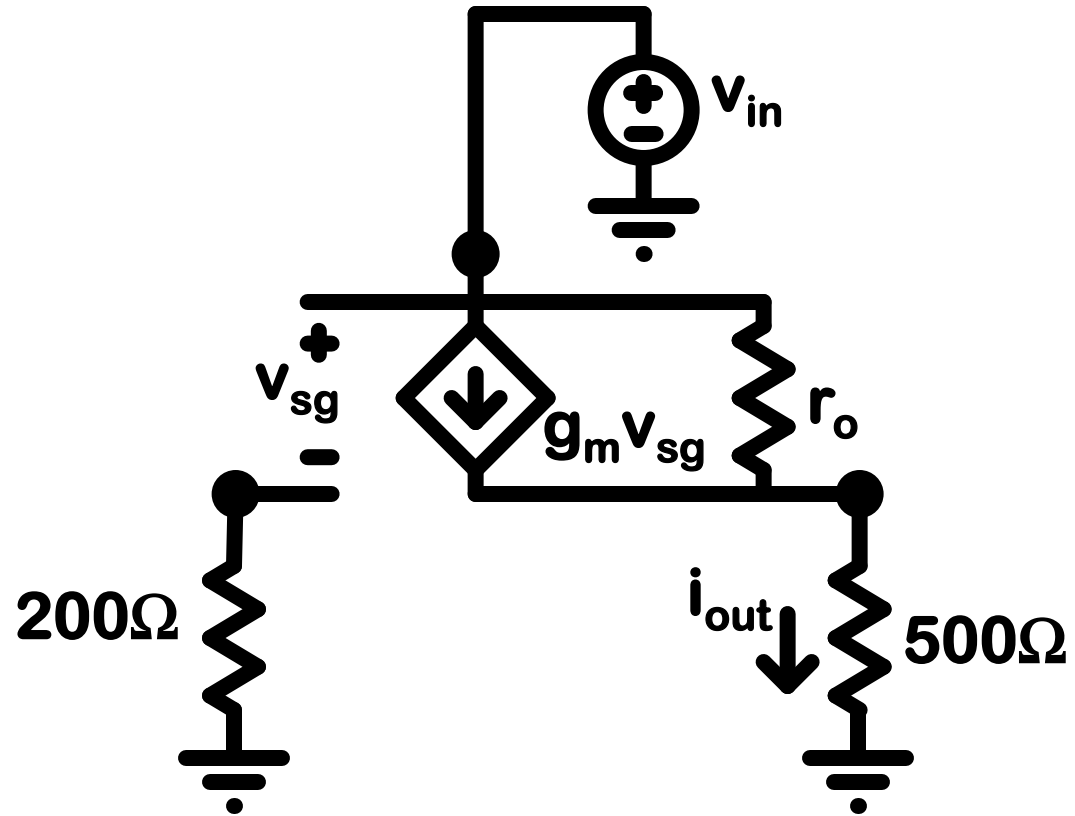
$$V_A = -50 \text{ V}$$



# Perform Small Signal Analysis on the Circuits.



LSC



SSC

# Perform Small Signal Analysis on the Circuits.

1. LSC

2.  $V_{SG} = 2V$

$$I_D = 0.0025(2-1)^2 = 2.5\text{mA}$$

3.  $g_m = 5\text{mA/V}$

$$r_o = 50/0.0025 = 20\text{k}\Omega$$

4. SSC

5. Solve

$$v_{sg} = v_i$$

$$.005v_i + (v_i - v_o)/20\text{k} = v_o/.5\text{k}$$

$$100v_i + v_i - v_o = 40v_o$$

$$v_o/v_i = 101/41 \text{ (V/V)}$$

$$i_o/v_i = (101/41)/500 \text{ (1/\Omega)} = 4.93 \text{ mA/V}$$

2. Find  $i_{out}/v_{in}$ .

$Q_p$ :

$$k_p = 5 \text{ mA/V}^2$$

$$V_{tp} = -1 \text{ V}$$

$$V_A = -50 \text{ V}$$

