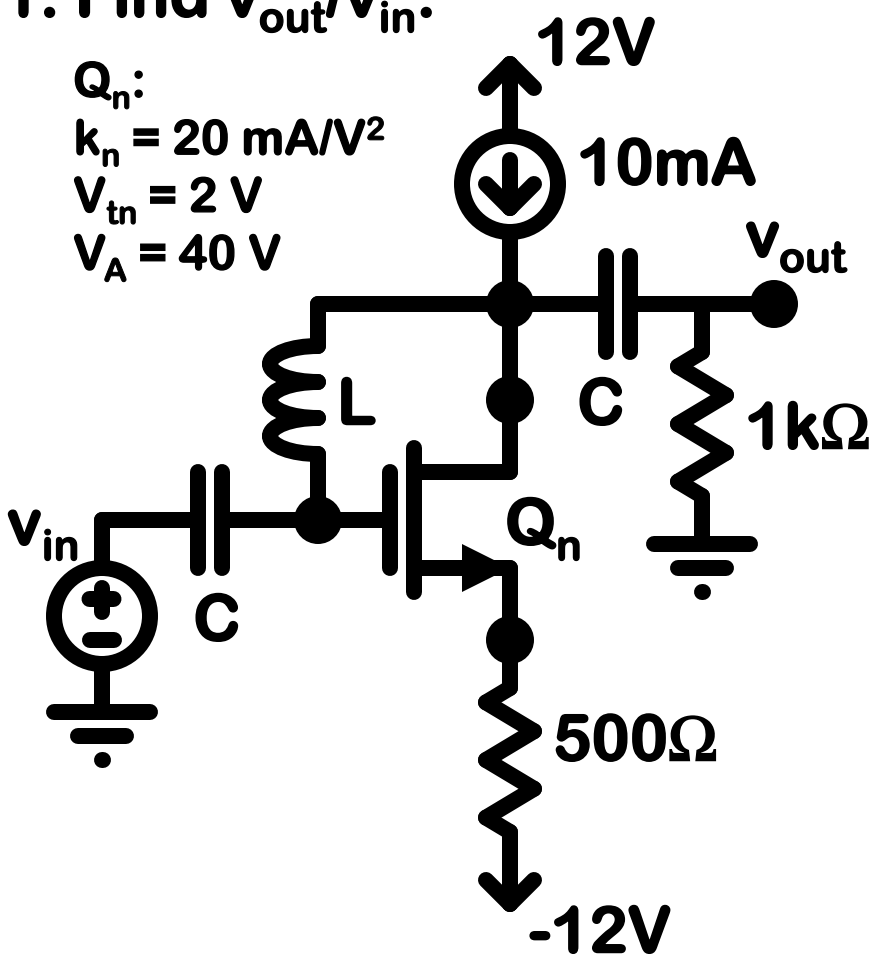
Perform Small Signal Anaysis on the Circuits.

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

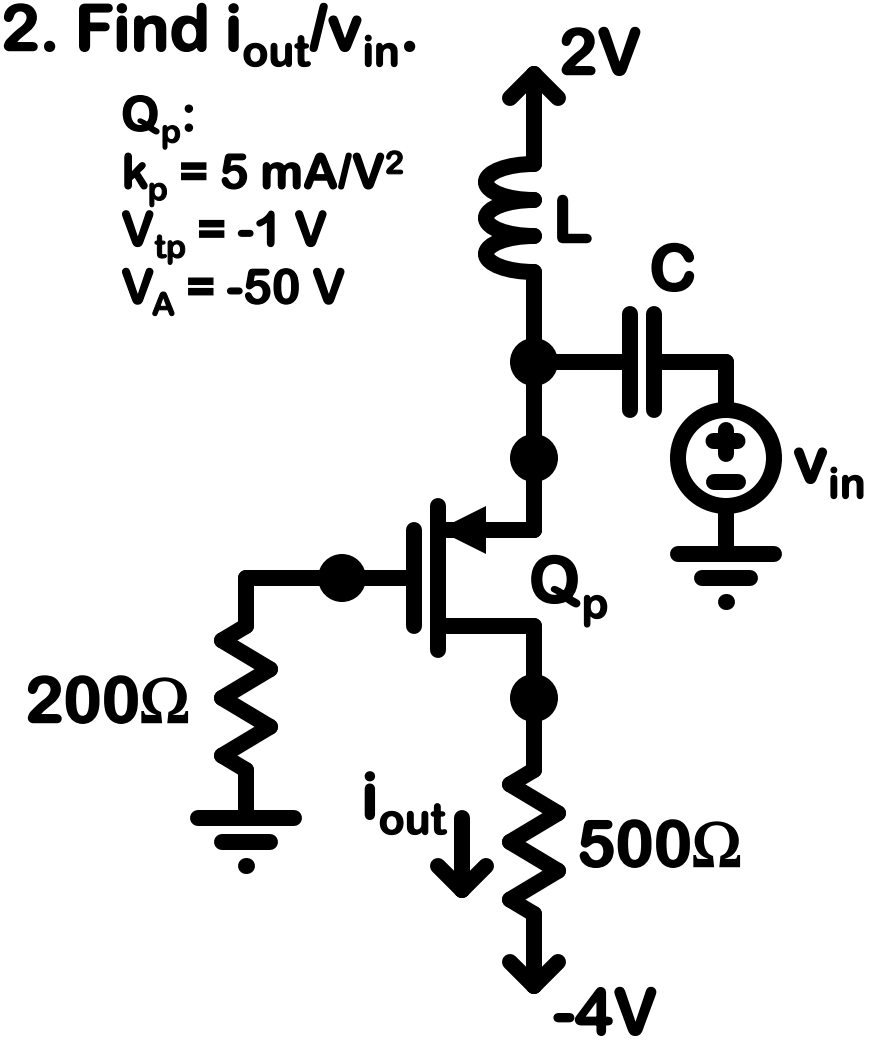
Q_n:
$k_n = 20\ mA/V^2$
$V_{tn} = 2\ V$
$V_A = 40\ V$



Draw the equivalent PMOS circuit.

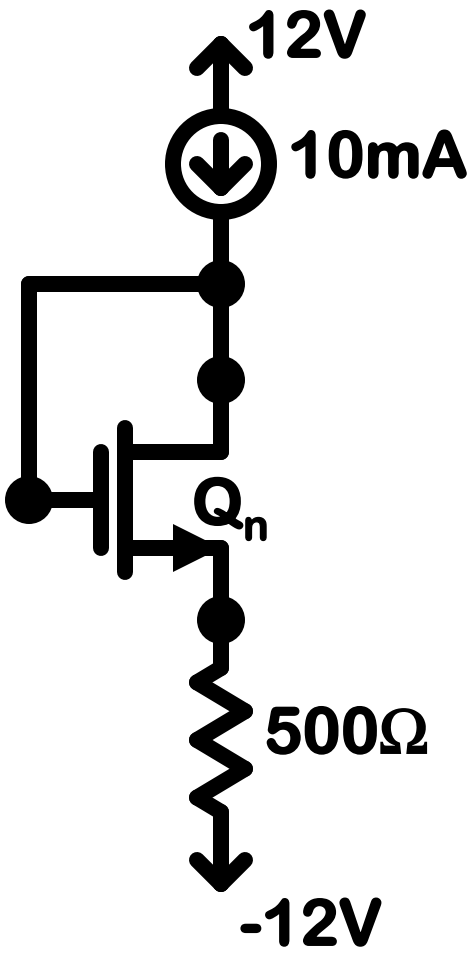
2. Find i_{out}/v_{in}.

Q_p:
$k_p = 5\ mA/V^2$
$V_{tp} = -1\ V$
$V_A = -50\ V$

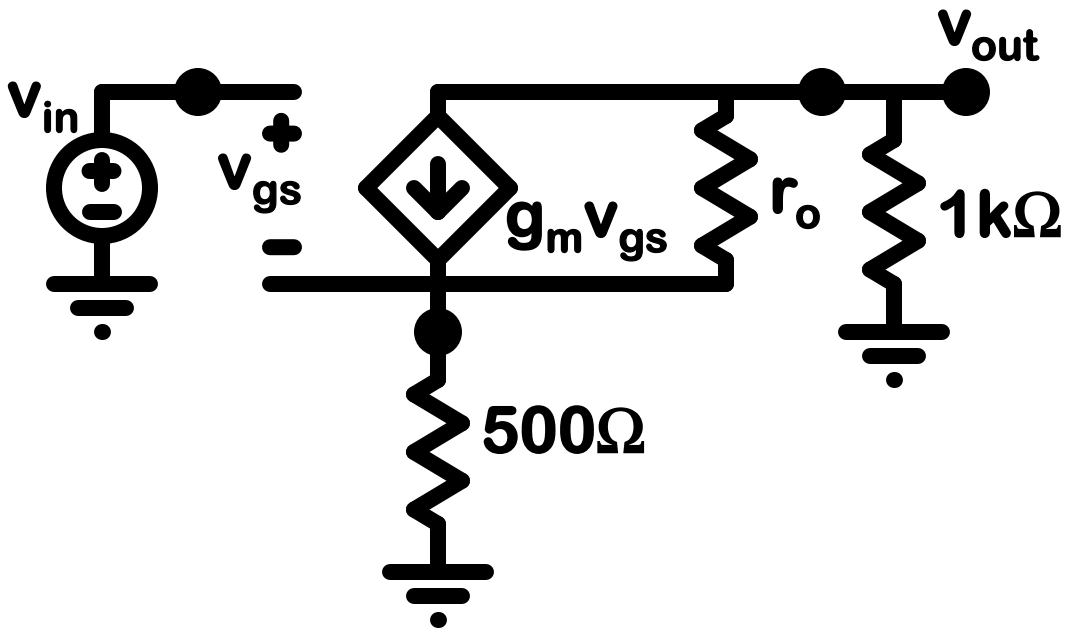


Draw the equivalent NMOS circuit.

Perform Small Signal Anaysis on the Circuits.



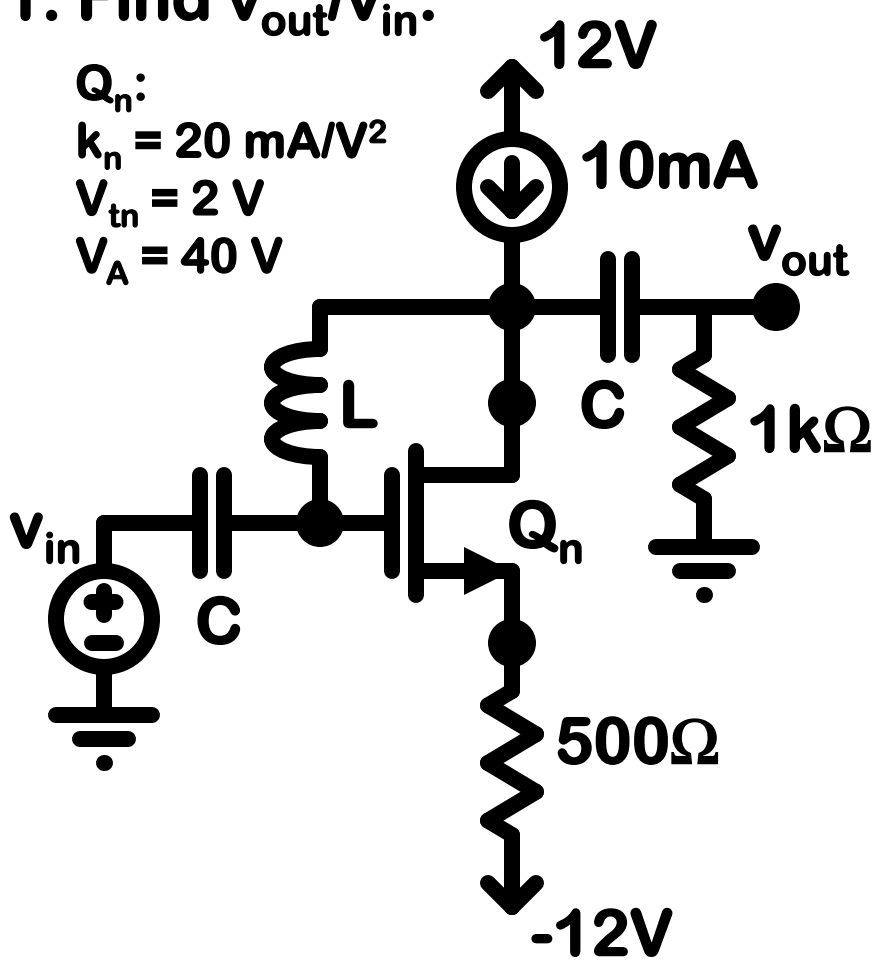
LSC



SSC

Perform Small Signal Anaysis on the Circuits.

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



1. LSC

2. $I_D = 10mA$
   $V_{GS} = sqrt(2*10/20)+2 = 3V$

3. $g_m = 20mA/V$
   $r_o = 40/.01 = 4k\Omega$

4. SSC

5. Solve

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

$-v_o/1k = 0.02(v_i-v_s) + (v_o-v_s)/4k$

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

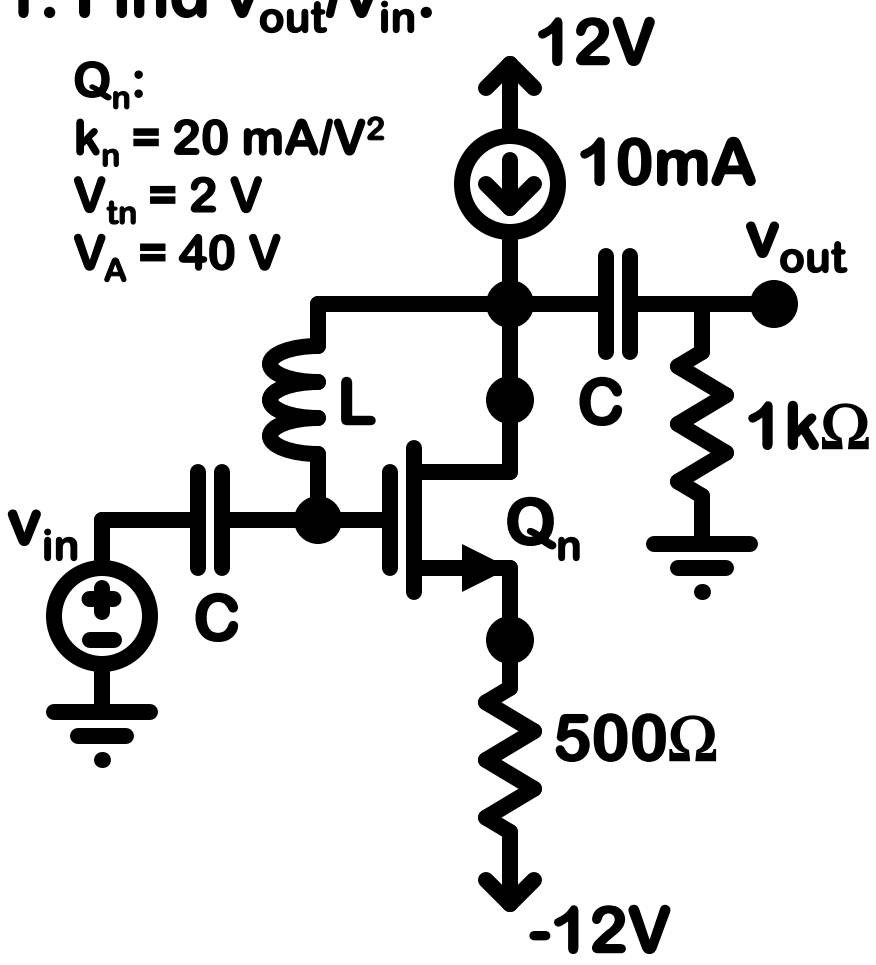
$v_o/v_i = -160/91\ (V/V)$

$v_o/v_i = -1.758\ (V/V)$

Perform Small Signal Anaysis on the Circuits.

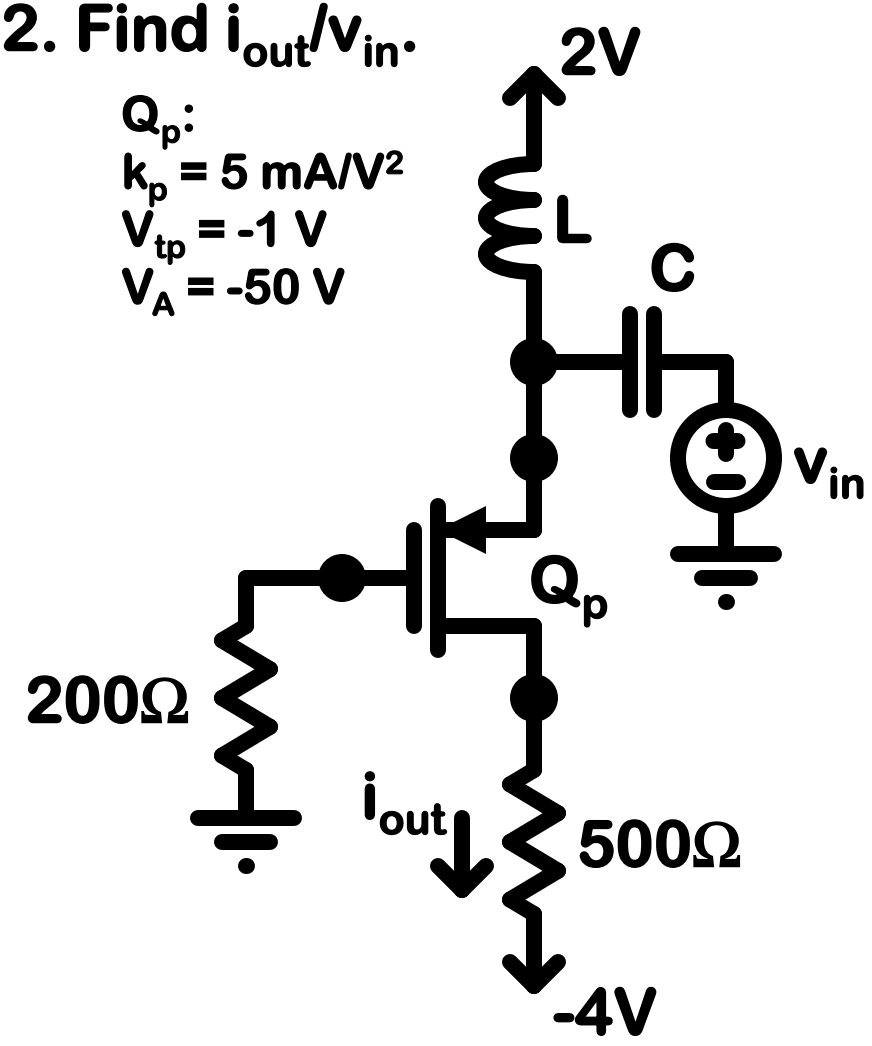
1. Find v_{out}/v_{in}.

Q_n:
$k_n = 20\ mA/V^2$
$V_{tn} = 2\ V$
$V_A = 40\ V$

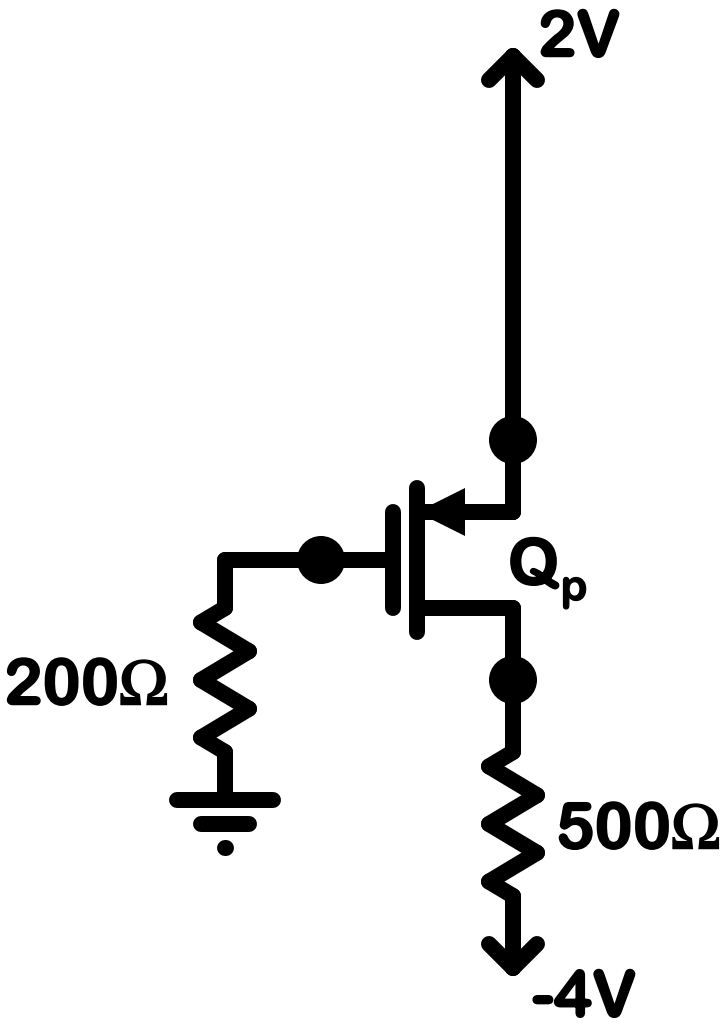


2. Find i_{out}/v_{in}.

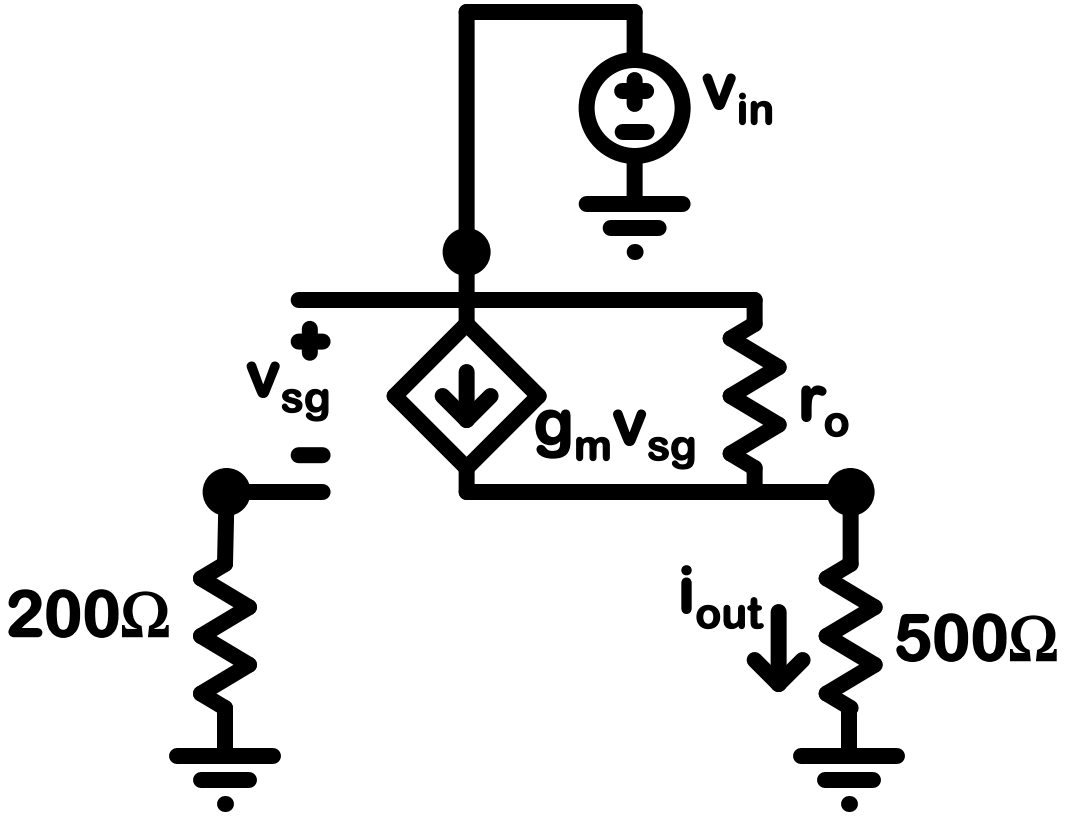
Q_p:
$k_p = 5\ mA/V^2$
$V_{tp} = -1\ V$
$V_A = -50\ V$



Perform Small Signal Anaysis on the Circuits.



LSC



SSC

Perform Small Signal Anaysis on the Circuits.

1. LSC

2. $V_{SG} = 2V$
   $I_D = 0.0025(2-1)^2 = 2.5mA$

3. $g_m = 5mA/V$
   $r_o = 50/.0025 = 20k\Omega$

4. SSC

5. Solve

$v_{sg} = v_i$

$.005v_i = (v_i - v_o)/20k = v_o/.5k$

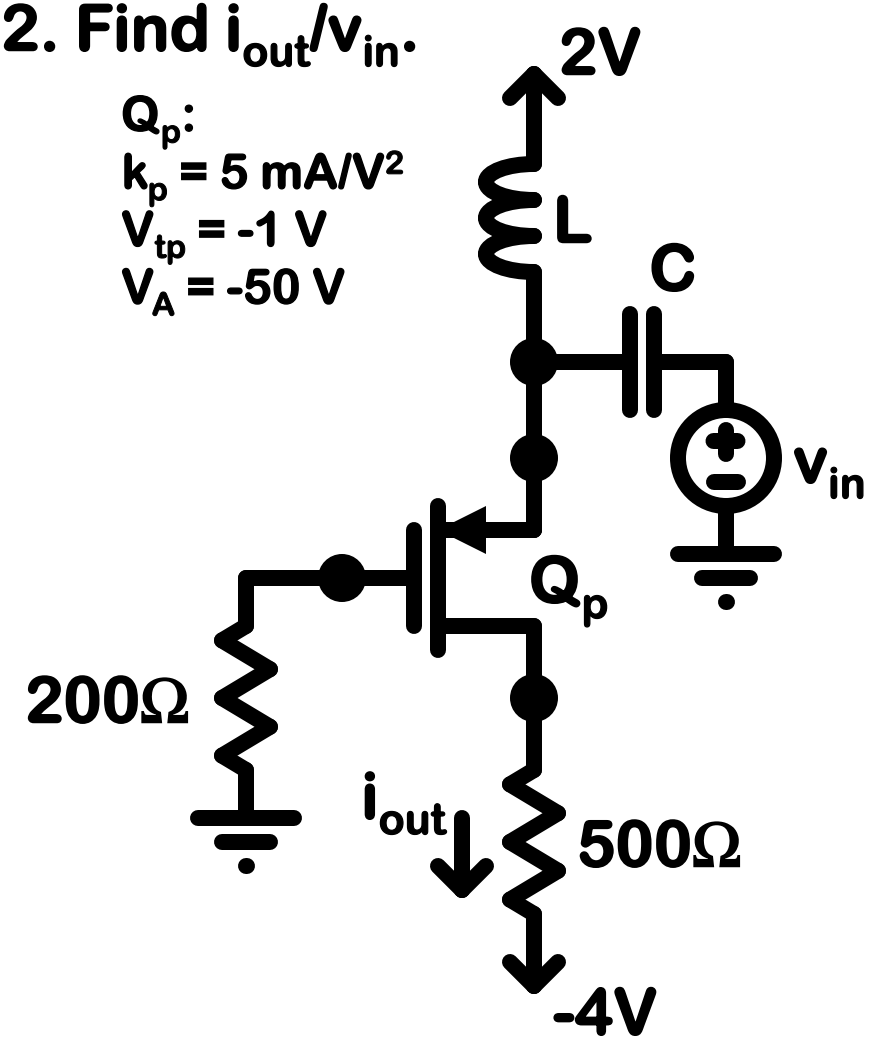
$100v_i = v_i - v_o = 40v_o$

$v_o/v_i = 101/41$ (V/V)

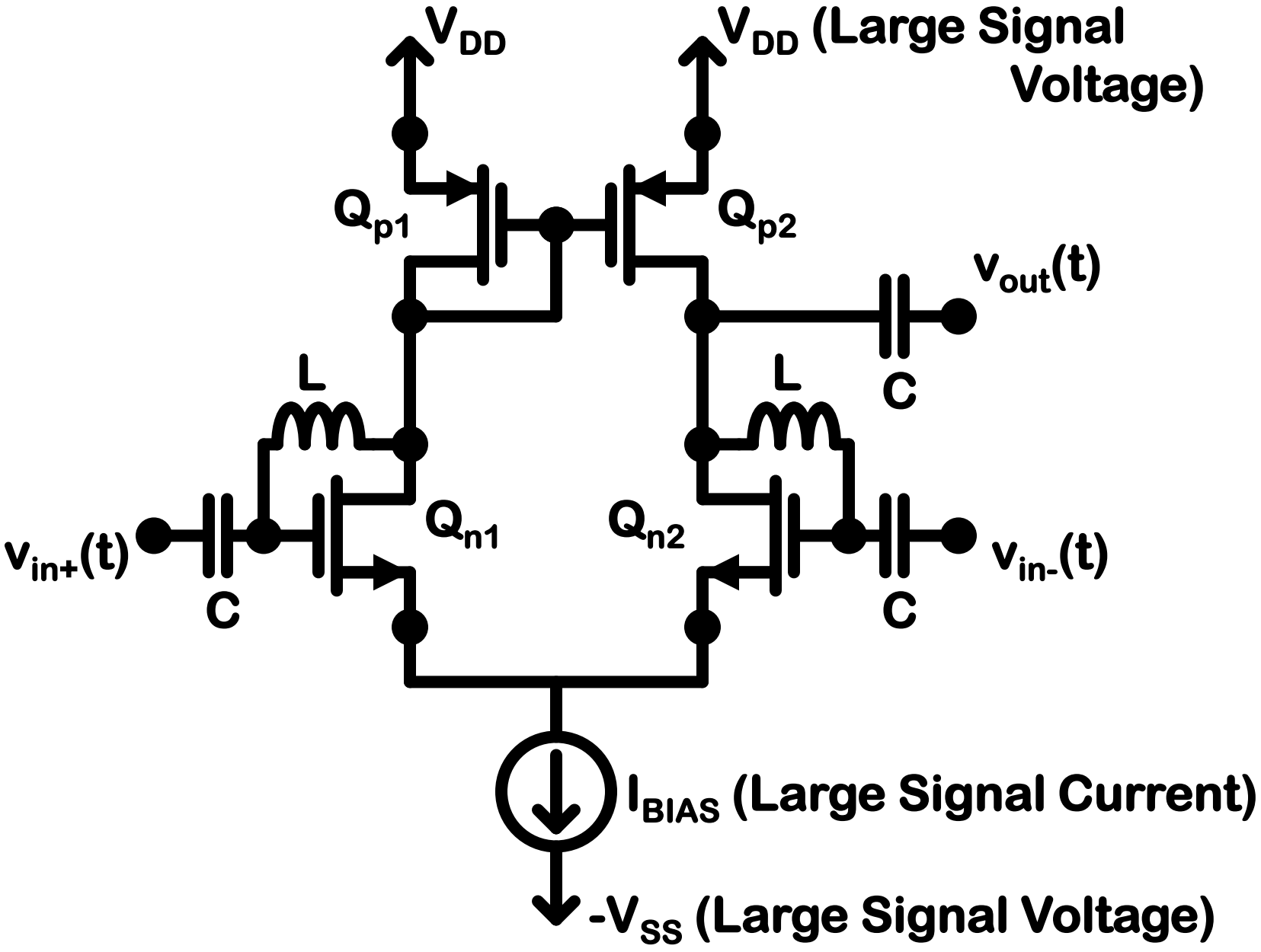
$i_o/v_i = (101/41)/500$ (1/Ω) = 4.93 mA/V

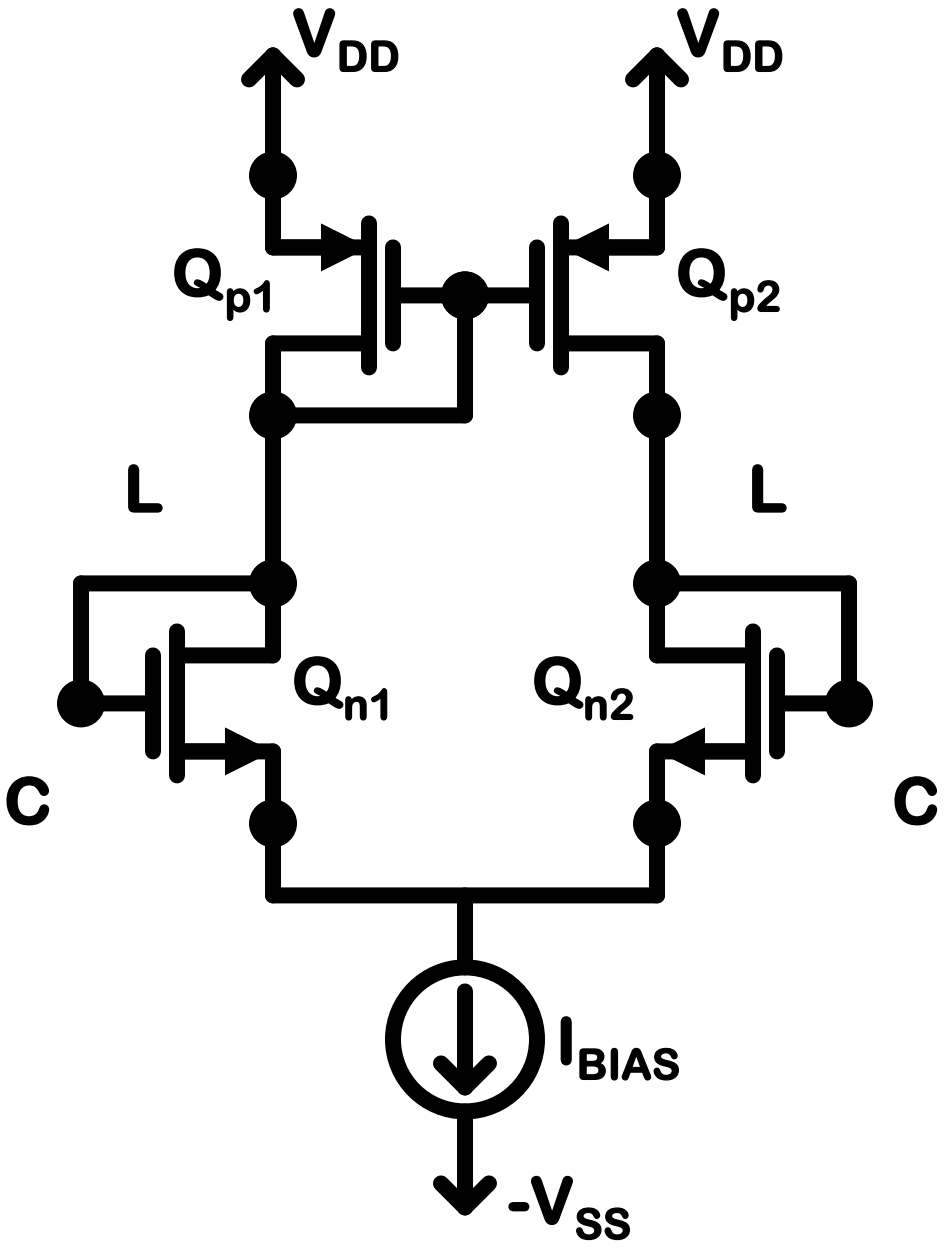
2. Find i_{out}/v_{in}.

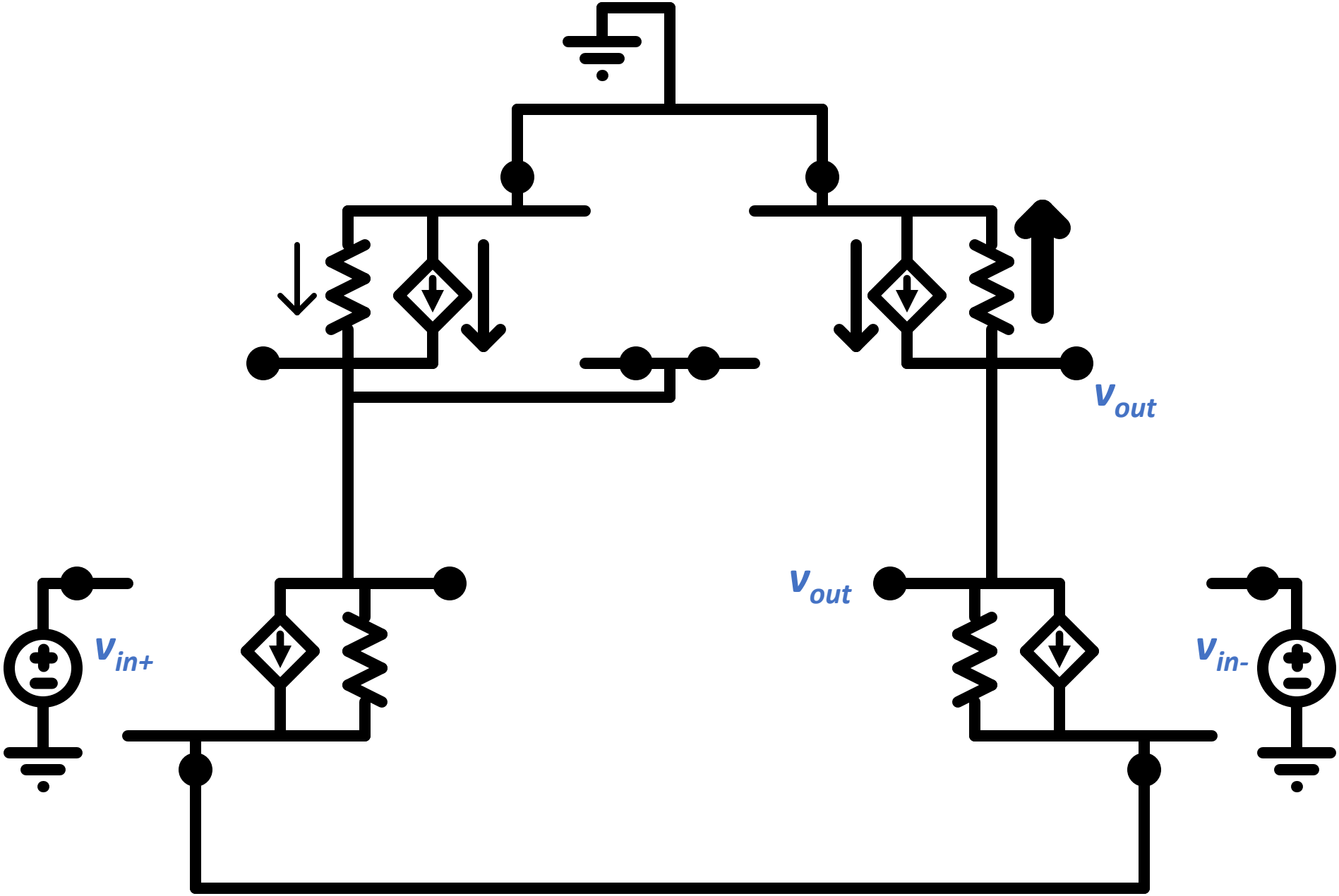
Q_p:
$k_p = 5$ mA/V^2
$V_{tp} = -1$ V
$V_A = -50$ V



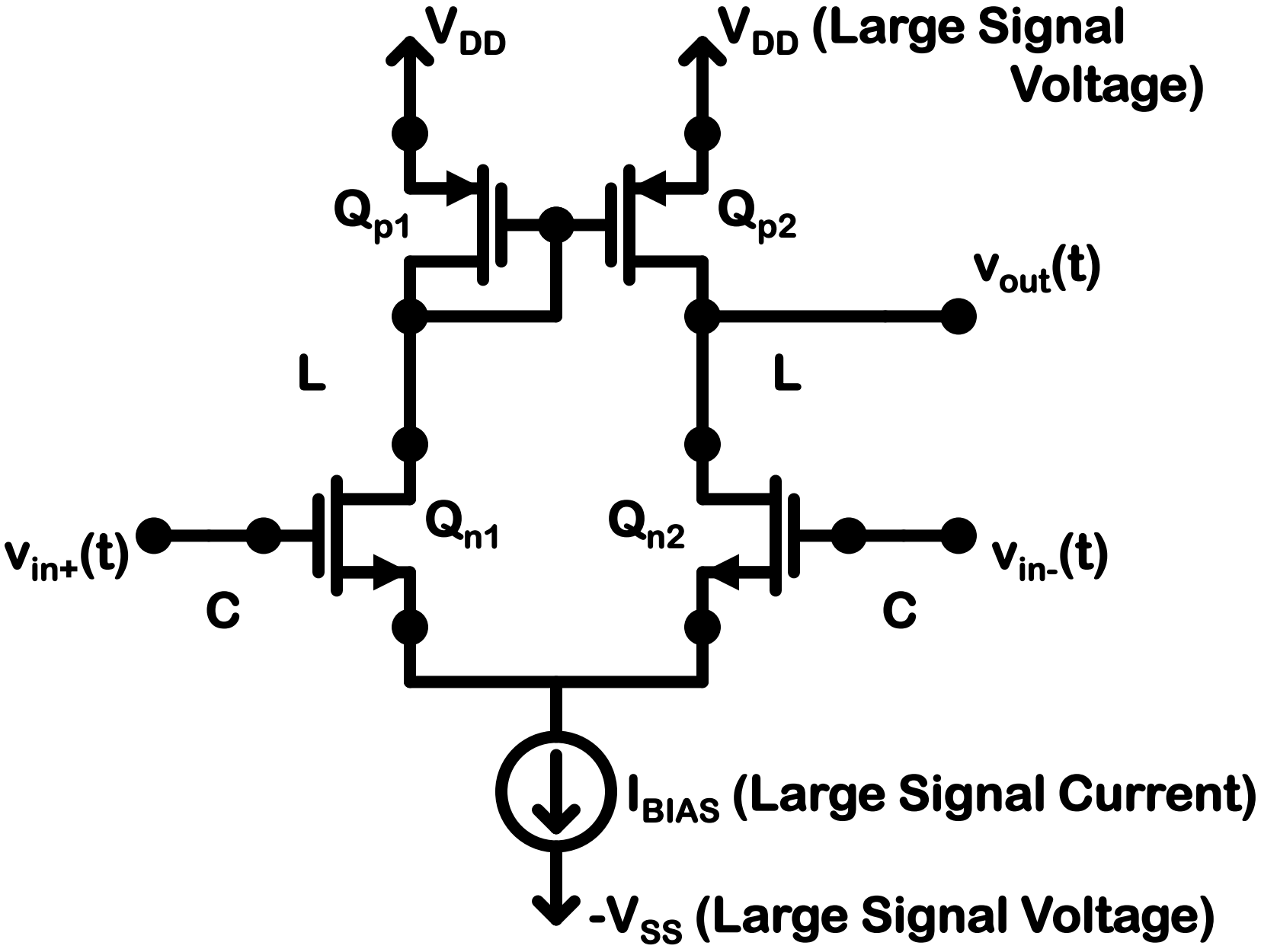
Draw the Large and Small Signal Circuits.
Include r_o in the Small Signal Circuit.




V_{DD}
V_{DD}
Q_{p1}
Q_{p2}
L
L
Q_{n1}
Q_{n2}
C
C
I_{BIAS}
$-V_{SS}$


v_{out}
v_{out}
v_{in+}
v_{in-}

Draw the Large and Small Signal Circuits.
Include r_o in the Small Signal Circuit.



Find:

V_{OH}	3.6+1.1 = 4.7
V_{OL}	1.2-0.7+(-1/6)*(5-3.8) = 0.3
V_{IH}	3.8-0.7*sqrt(2)/2 = 3.3
V_{IL}	1.9+1.1*sqrt(2)/2 = 2.68
NM_L	2.68-0.3 = 2.38
NM_H	4.7-3.3 = 1.4
NM	1.4