## Problem Set 3C - MultiStage

Question 1

It is desired to create a voltage output from a small current source input (say from a photodetector). Shown below, the small current source input and its output impedance is shown as i_i and R_i, respectively. The figure below shows 2 circuits. Circuit (a) does not make use of a transistor while circuit (b) makes use of one transistor. V_B is a dc bias voltage. Also, assume the current source I_B is ideal.

(a)   (b)
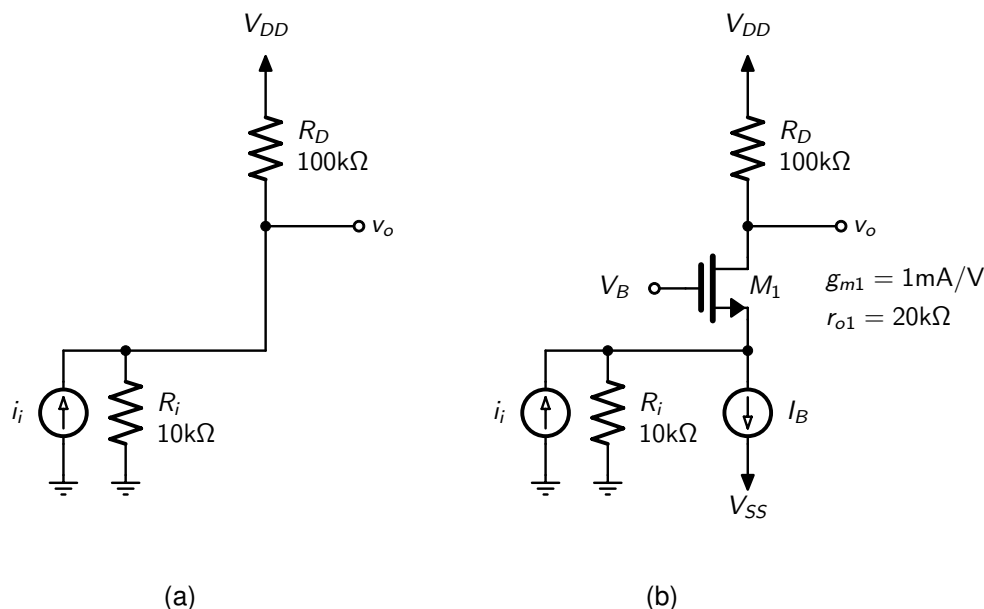
(a) For circuit (a), find the small-signal gain, v_o/i_i. Next, find the change in v_o when $i_{i,max} = 10\mu A$.

(b) For circuit (b), find the small-signal gain, v_o/i_i. Next, find the change in v_o when $i_{i,max} = 10\mu A$

(c) What is the small-signal gain improvement for circuit (b) over circuit (a)?

Answer
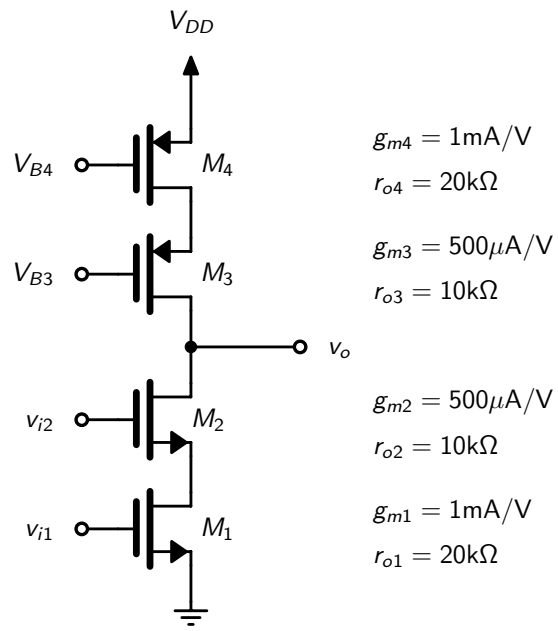
(a) $(v_o/i_i)_a = 9.091 k\Omega$; $v_{o,max} = 90.91 mV$ (b) $(v_o/i_i)_b = 63.64 k\Omega$; $v_{o,max} = 0.6364 V$ (c) $k = 7$

Question 2

V_{DD}

V_{B4} ⟶ M_4

$g_{m4} = 1\text{mA/V}$
$r_{o4} = 20\text{k}\Omega$

V_{B3} ⟶ M_3

$g_{m3} = 500\mu\text{A/V}$
$r_{o3} = 10\text{k}\Omega$

v_o

v_{i2} ⟶ M_2

$g_{m2} = 500\mu\text{A/V}$
$r_{o2} = 10\text{k}\Omega$

v_{i1} ⟶ M_1

$g_{m1} = 1\text{mA/V}$
$r_{o1} = 20\text{k}\Omega$

For the circuit above

(a) Find v_o/v_{i1} assuming v_{i2} is a dc bias voltage.

(b) Find v_o/v_{i2} assuming v_{i1} is a dc bias voltage.

Answer

(a) $v_o/v_{i1} = -60\text{V/V}$ (b) $v_o/v_{i2} = -2.5\text{V/V}$