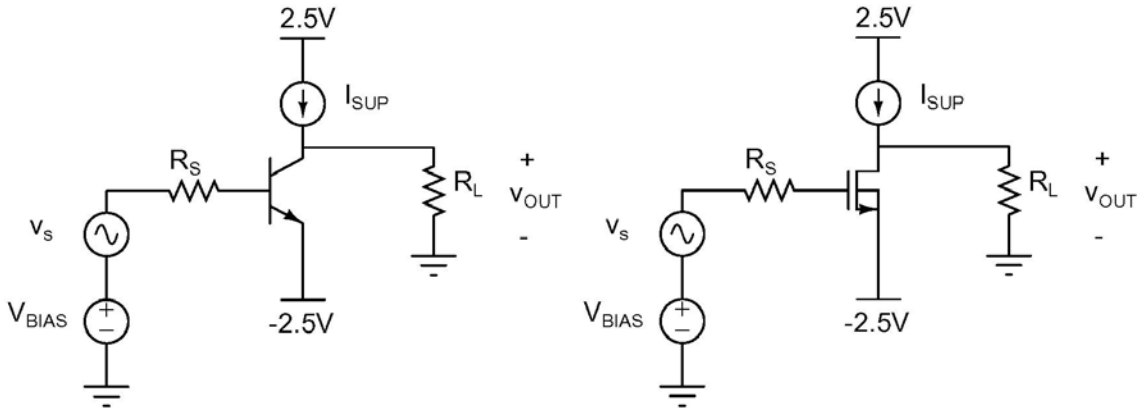
Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.012 Microelectronic Devices and Circuits
Spring 2007

Homework #7 – Due May 4, 2007

Problem 1:



Common-Emitter	**Common-Source**
I_{SUP}=100uA	I_{SUP}=100uA
R_S=1kΩ	R_S=1kΩ
R_L=10kΩ	R_L=10kΩ
$I_S=10^{-15}$A	V_{Tn}=1V
$\beta_F=\beta_o$=100	$\mu_n C_{ox}$=50uA/V^2
V_A=25V	λ_n=0.1V^{-1}@L=1.5um
$r_{oc}=\infty$	$r_{oc}=\infty$

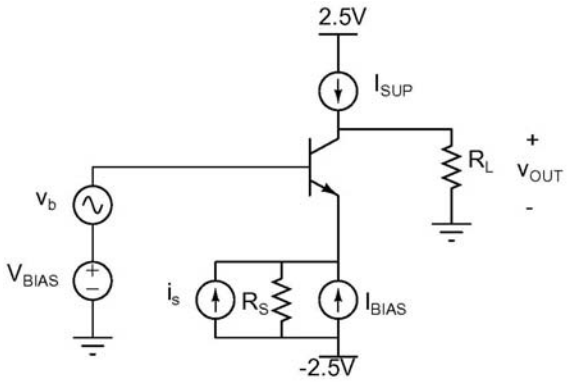
For the Common-Emitter Amplifier:

a.) Find V_{BIAS} such that V_{OUT}=0V
b.) Find the input resistance R_{in}.
c.) Find the unloaded voltage gain A_v.
d.) Find the output resistance R_{out}.
e.) Draw the two-port model and find the loaded voltage gain v_{out}/v_s.

For the Common-Source Amplifier:

f.) Choose the length L for the NMOS such that the Common-Source Amplifier has the same output resistance as the Common-Emitter Amplifier.
g.) Choose the width W for the NMOS such that the Common-Source Amplifier has the same loaded voltage gain as the Common-Emitter Amplifier.
h.) Find V_{BIAS} such that V_{OUT}=0V for the Common-Source Amplifier designed in parts f and g.

Problem 2:

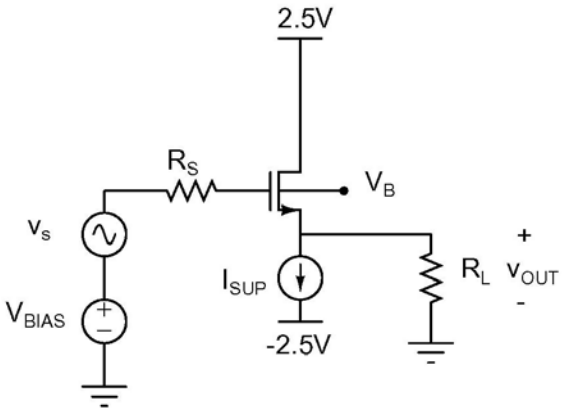


Device Parameters	$I_S=10^{-15}A$
$I_{SUP}=200uA$	$\beta_F=\beta_o=100$
$R_S=5k\Omega$	$V_A=25V$
$R_L=50k\Omega$	$r_{oc}=\infty$

The DC voltage supply at the base of the npn transistor has a small-signal component added to it which represents feedthrough from other signal lines.

a.) Find i_{out}/i_s for $v_b=0V$.
b.) Find i_{out}/v_b for $i_s=0A$.
c.) Let i_{out1} be the portion of i_{out} due to the signal source i_s. Let i_{out2} be the portion of i_{out} due to the signal source v_b. Find the ratio i_{out1}/i_{out2}.
d.) State whether the value for I_{SUP}, R_S, and R_L should increase, decrease, or stay the same to increase the ratio calculated in part c.

Problem 3:



Device Parameters	
I_{SUP}=200uA	W/L=100/2
R_S=1kΩ	$\mu_n C_{ox}$=50uA/V^2
R_L=100kΩ	γ_n=0.5V$^{1/2}$
r_{oc}=∞	V_{T0n}=0.7V
$2\Phi_p$=-0.8V	λ_n=0.05V^{-1}

In this problem, we want to compare the small-signal performance and output voltage swing of an NMOS CD amplifier when the backgate terminal is shorted to the source (V_{BS}=0V) and when it is tied to the most negative supply (V_B=-2.5V).

a.) Given I_{SUP}=200uA and V_B=-2.5V, find V_{BIAS} such that V_{OUT}=0V.
b.) What is the maximum and minimum V_{OUT} possible while still keeping the NMOS device in the constant-current region? Assume the current source supply requires at least 0.5V across it.
c.) What is the overall voltage gain, v_{out}/v_s including the effect of R_L?
d.) Repeat (a)-(c) for V_{BS}=0V.