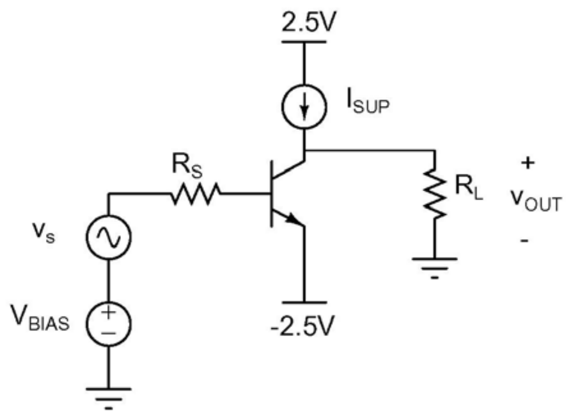
Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.012 Microelectronic Devices and Circuits
Spring 2007

Homework #8 – Due May 11, 2007

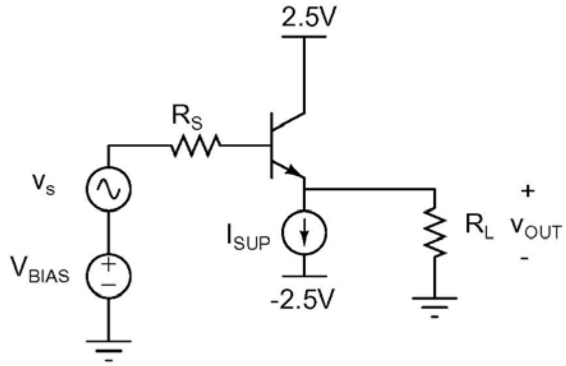
Problem 1:



Device Parameters	
I_{SUP}=100uA	$I_S=10^{-15}$A
R_S=5kΩ	$\beta_F=\beta_o=100$
R_L=10kΩ	V_A=100V
$r_{oc}=\infty$	f_T=1GHz @ I_C=100uA
	C_μ=0.1pF

a.) Calculate V_{BIAS} such that V_{OUT}=0V.
b.) Calculate the low frequency loaded voltage gain v_{out}/v_s.
c.) Calculate C_π from the device data.
d.) Use the Miller approximation to calculate ω_{3db}.
e.) Use the open-circuit time constant method to calculate ω_{3db}.

Problem 2:

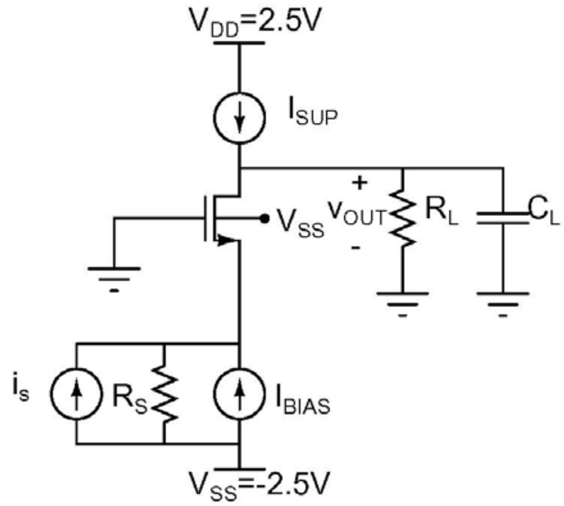


Device Parameters	
R_L=25kΩ	C_{je0}=100fF
R_S=5kΩ	τ_F=100ps
$I_S=10^{-15}$A	$C_{\mu 0}$=200fF
$\beta_F=\beta_o$=100	$r_{oc}=\infty$
V_A=100V	Φ_{Bc}=0.75V

In the previous problem, the high source resistance lowered ω_{3db}. One method of improving the frequency response is to precede the common emitter stage with an emitter-follower stage.

a.) Find I_{SUP} for the emitter follower such that its R_{out} equals 100Ω.
b.) Calculate V_{BIAS} such that V_{OUT}=0V.
c.) Calculate C_π and C_μ from the device data for the emitter-follower.
d.) Use the open-circuit time constant method to calculate ω_{3db} for the emitter-follower.

Problem 3:



Device Parameters	
R_S=100kΩ	$\mu_n C_{ox}$=50uA/V^2
R_L=1kΩ	C_{ox}=2.3fF/um^2
$r_{oc}=\infty$	C_{Jn}=0.1fF/um^2
V_{Tn}=1V	C_{JSWn}=0.5fF/um
λ_n=0.05V^{-1}	L_{diffn}=6um
C_L=0.5pF	C_{ov}=0.5fF/um

The frequency response of the NMOS common-gate amplifier depends on g_m, C_{gs}, C_{gd}, and C_L. One method of increasing g_m is to increase the bias current. Another method of increasing g_m is to increase the W of the device. However, as the width of the device is increased, the parasitic capacitances also increase. For this problem, include C_{db}, but neglect the backgate effect. Assume that the amplifier is biased such that V_{OUT}=0V.

a.) Use the open-circuit time constant method to derive an expression for ω_{3db} for the common-gate amplifier including C_L.
b.) Use Matlab or Excel to plot ω_{3db} vs. I_{SUP} for 50uA < I_{SUP} < 500uA. Use W/L=50um/2um.
c.) What is the effect of increasing I_{SUP} (for a constant W) on the frequency response of this amplifier? What are some potential drawbacks of this approach?