EECS 105 – Microelectronic Devices and Circuits

Spring 2001, **Prof. A. R. Neureuther**
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Course Web Site http://www-inst.EECS.Berkeley.EDU/~ee105/

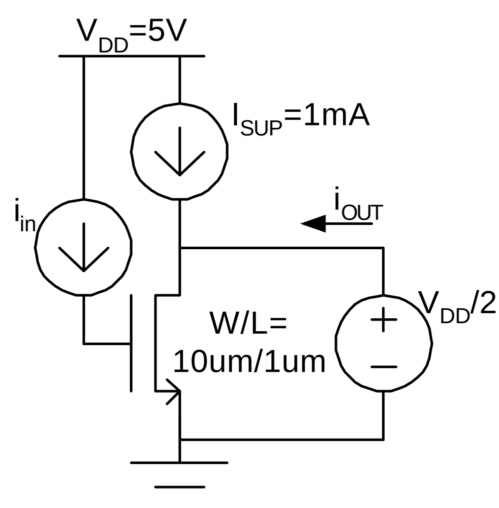
Homework Assignment # 7, Due March 9, 2001

Use the following parameters for all MOSFET devices.

NMOS	PMOS
ì $_n C_{ox}$=50ìA/V ^{2}	ì $_p C_{ox}$=25ìA/V ^{2}
V_{T0n}=1.0V	V_{T0p}=-1.0V
γ_n=0.6V$^{1/2}$	γ_p=0.6V$^{1/2}$
ë$_n$=(0.1/L)V^{-1} L in ìm	ë$_p$=(0.1/L)V^{-1} L in ìm
ϕ_p=-0.42 (N_a=10^{17}/cm^3)	ϕ_n=0.42 (N_d=10^{17}/cm^3)
C_{OV}=0.2fF/ìm	C_{OV}=0.2fF/ìm

7.1) **MOSFET f_t**

Consider the following circuit:



a) Find the symbolic expression for the small signal current gain (i_{out}/i_{in}) for this circuit. The only capacitances you need to consider are C_{gs} and C_{gd}.

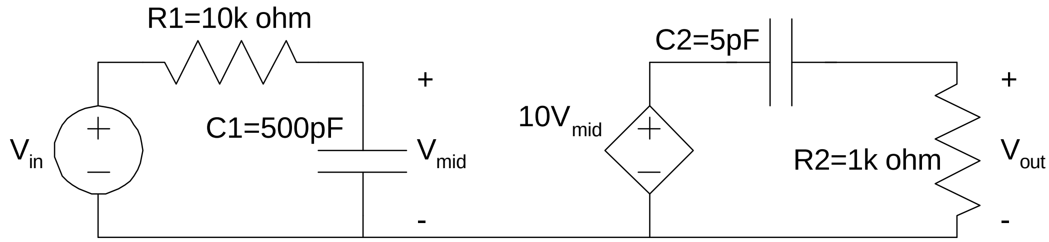
b) Set the magnitude of the expression from part a equal to 1 and solve for the radian frequency.

c) Plug in the circuit values into your answer for part b to determine the frequency (in Hz) where the small signal current gain has a magnitude of 1.

d) A newer technology can make transistors with 0.6um gate lengths, however the power supply voltages must also be reduced by 40% because of maximum electric field constraints. If this circuit was scaled to the new process (W/L=6um/0.6um, V_{DD}=3V) what will happen to its small signal current gain?

7.2) **Frequency Response**

Consider the following circuit:



a) Draw the approximate (straight lines only) magnitude Bode plot of voltage gain for this circuit. Use radian/sec for the horizontal axis, not Hertz. Label all important values.

b) Draw the approximate (straight lines only) phase Bode plot of voltage gain for this circuit. Use radian/sec for the horizontal axis, not Hertz. Label all important values.

7.3) **Law of the junction**

Consider a PN junction with $N_d = 10^{16}/cm^3$, $N_a=10^{18}/cm^3$ and $n_i^2=10^{20}/cm^3$.

a) For an applied voltage of 0V, find the hole and electron concentrations on each side of the depletion region.

b) Repeat for 0.1V applied forward voltage.

7.4) **Junction currents**

Consider a PN junction with $N_d = 10^{16}/cm^3$, $N_a=10^{18}/cm^3$, $n_i^2=10^{20}/cm^3$, Wn=1um, Wp=0.5um and a 2um by 2um cross-section.

a) Find the current for an applied voltage of 0V.

b) Determine what applied voltage that will cause 1mA current.

c) Plot the majority and minority carriers vs. position in the diode for the non-depleted sections of the diode with the applied voltage found in part b. Label all important concentrations.

d) Plot hole, electron and total currents vs. position. Label the majority electron current, majority hole current, minority electron current, minority hole current and total current. Label all important values.

Student instructor office hours

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