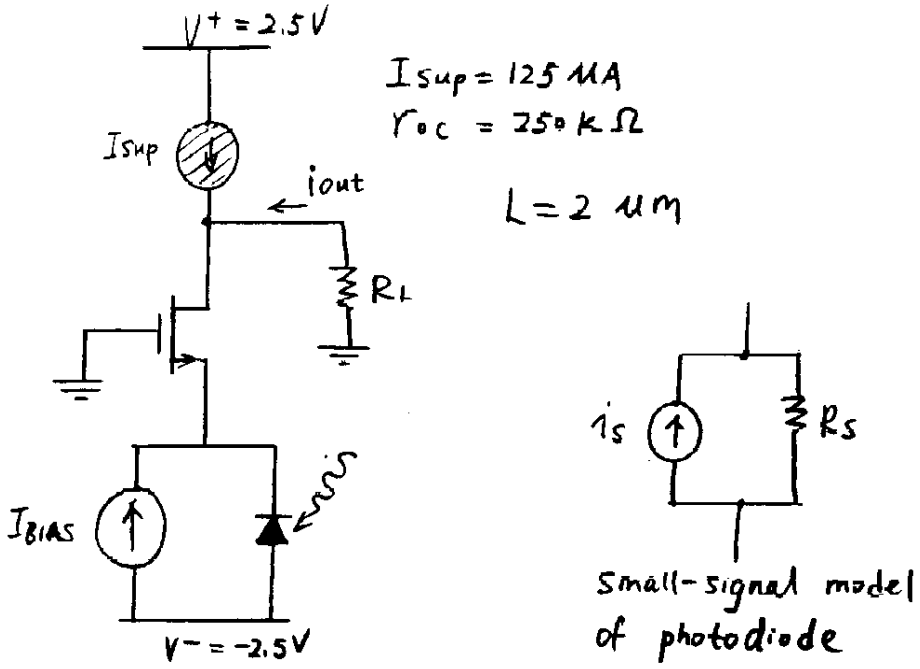
University of California
College of Engineering
Department of Electrical Engineering and Computer Sciences

Problem Set #12
Review Problems - Not Due

EECS105 **FALL, 1998**

1. P8.8

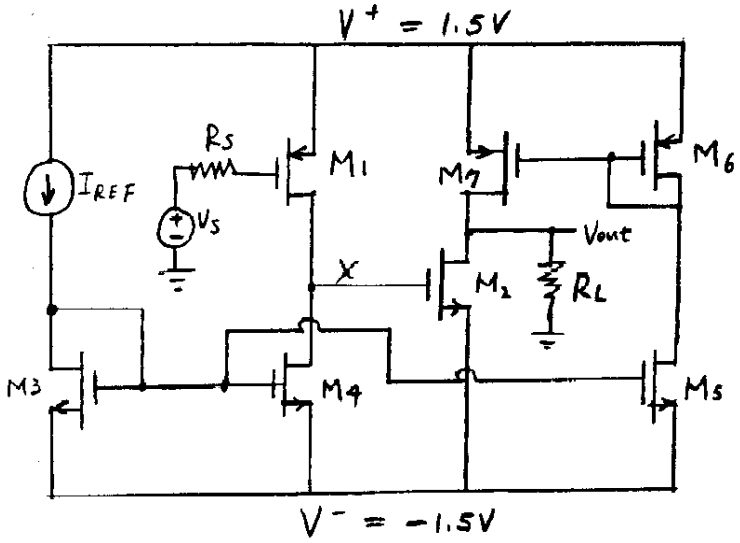
2. This circuit buffers the small-signal current from a photodiode. The small-signal model for the photodiode is shown. I_{sup} = 125 μA, r_{oc} = 250 kΩ, and L = 2 μm. Use the MOSFET parameters from p. 319. (Note the typo in the channel length modulation parameters. $\lambda n = 0.067\ V^{-1}$.)
   (a) Given that I_{out} = 0 A and I_{BIAS} = -125 μA. Select the width W of the NMOS such that the DC bias on the photodiode is V_D = -1.25 V.
   (b) Draw the two-port small-signal model for this amplifier (with source and load).
   (c) Find the numerical value of the input resistance R_{in} of this amplifier.
   (d) Find the numerical value of the output resistance R_{out} of this amplifier.
   (e) Find the overall current gain i_{out}/i_S for this amplifier for the case where R_S = 50 kΩ and R_L = 100 kΩ.



Question 2

3. P9.17

4. Default MOS transistor parameters: note that λ depends on L!
   NMOS: $\mu_n C_{ox} = 100\ \mu A/V^2$, $\lambda_n = [0.1/L]\ V^{-1}$ (L in μm), $V_{Tn} = 1V$
   PMOS: $\mu_p C_{ox} = 50\ \mu A/V^2$, $\lambda_p = [0.1/L]\ V^{-1}$ (L in μm), $V_{Tp} = -1V$
   (a) Determine the width of transistor M_7 in μm so that $V_x = 0$ V.
   (b) Redraw the circuit with symbolic current supplies replacing the transistor current supplies. Give the numerical value of the DC supply currents; there is no need to calculate the source resistance of this supplies.
   (c) Draw the two-port small-signal model for this two-stage amplifier. There is no need to substitute numerical values for the elements.
   (d) Find the numerical value of the output resistance R_{out} of this amplifier.
   (e) Find the numerical value of the open-circuit voltage gain A_v of this amplifier in dB.



$L = 2\ \mu m$ for all MOSFETs

$(W/L)_1 = (W/L)_2 = \frac{20\ \mu m}{2\ \mu m}$

$(W/L)_3 = \frac{10\ \mu m}{2\ \mu m}$

$(W/L)_4 = (W/L)_5 = \frac{20\ \mu m}{2\ \mu m}$

$(W/L)_6 = \frac{10\ \mu m}{2\ \mu m}$

$I_{REF} = 25\ \mu A$

$R_S = 5\ k\Omega$

$R_L = 100\ k\Omega$

Question 4

5. E5.9

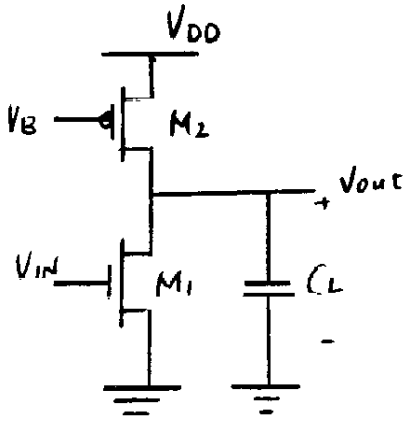
6. An NMOS inverter with current source pull-up shown in the figure has $(W/L)_n$ = 6/1.5 and $(W/L)_p$ = 3/6, V_{DD} = 3 V and V_B = 0 V. Use the simplified hand calculation method shown in sections 5.4.1 and 5.4.3. Assume devices are in their constant current region. For this problem, use $\lambda_n = [0.1/L_n]\ V^{-1}$ (L_n in μm) and $\lambda_p = [0.1/L_p]\ V^{-1}$ (L_p in μm); $\varepsilon_0 = 8.85 \times 10^{-14}$ F/cm. Refer to p. 319 for other MOS transistor parameters.

(b) Two identical inverters are located 1000 μm from the driving inverter. The connecting wire is 2 μm wide aluminum and lies on a deposited glass and field oxide layer. The total thickness of the dielectric layer is 1.0 μm and you can assume it behaves like a parallel capacitor. The permittivity of the dielectric is $3.9\varepsilon_0$. Calculate the propagation delay t_p.

(c) What is the static power consumed by this circuit?

(d) Calculate the device widths such that C_{DB} = 100 fF while maintaining the same V_M.

(e) What is t_p for the device sizes calculated in (d)?



Question 6.