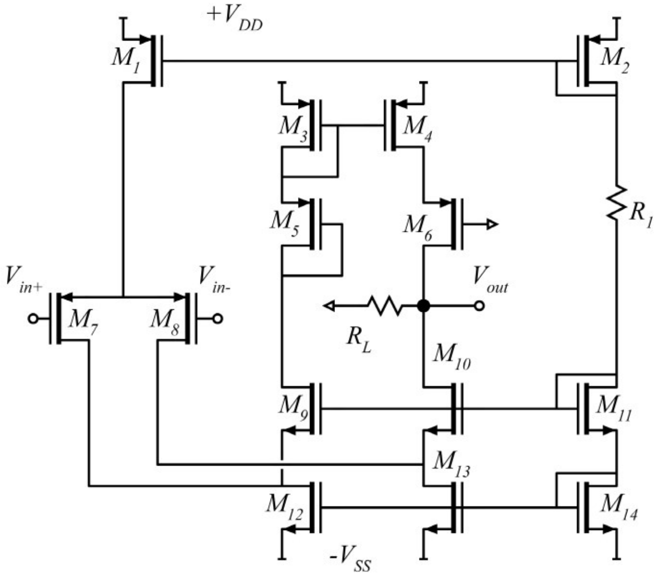
ECE137A Problem set #6



Problem 1:

$K_\mu = 10\text{mA/V}^2 \cdot (W_g / 1\mu\text{m})$

$K_v = 2.0\text{mA/V} \cdot (W_g / 1\mu\text{m})$,

$\Delta V = 0.10\text{V}$, $V_{th} = 0.3\text{V}$, $1/\lambda = 5\text{V}$

The PMOS have identical parameters, except, of course, V_{th} is negative.

V_{DD} = +0.8 V, $-V_{SS}$ = -0.8 V,

R_L=50kOhm

All transistors have $|V_{gs}|$=0.4V

M5,6,7,8,9,10,11 are biased at I_D=25 µA. Analyze under the assumption that the differential and common mode input voltages are at zero volts

a) Find the Gate widths, in µm, of M1, M7 (Note that, by using the mobility-limited formula $g_m = 2I_D / (V_{gs} - V_{th})$, we can solve the problem without calculating any of the FET widths. So, there's no reason to spend time calculating other FET widths.)

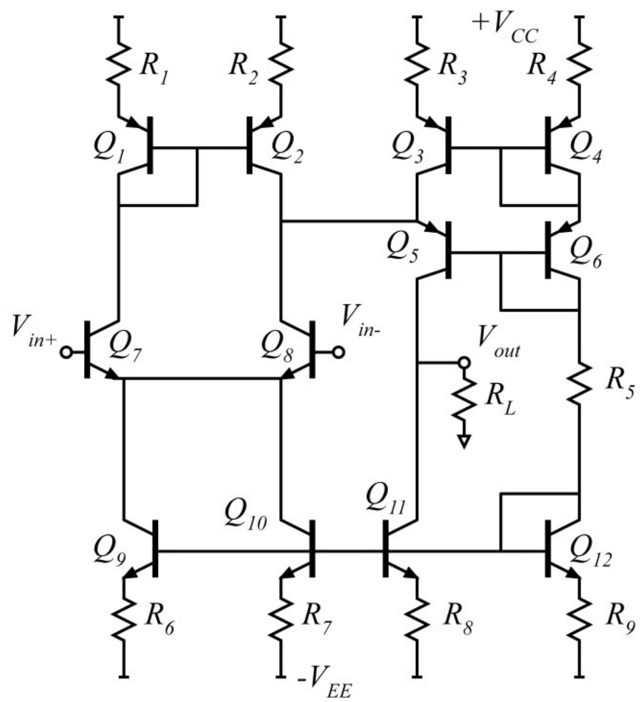
b) This amplifier has *two* signal paths between input and output. One is the path (M7 and M8, M9, M3, M4, M6, output). The other is the path (M7 and M8, M10, output). First find the gain $V_{out}/V_{in,differential}$ of the (M7 and M8, M9, M3, M4, M6, output) signal path.

c) Then find the gain $V_{out}/V_{in,differential}$ of the (M7 and M8, M10, output) signal path.

d) The overall gain is the sum of these two gains. Please find it.

e) find the maximum output swings dues to the knee voltage of M10, the knee voltage of M5, and cutoff of M7, M8, M10 and M9.

Note: Can you see that cutoff of M3,4,5,6,and M9 all occur under the same conditions ?



Problem 2: All the transistors have the same (matched) I_S, have β=infinity, and V_A=infinity volts.. $V_{CE(sat)} = 0.5\text{V}$. V_{be} is approximately 0.7 V, but use $V_{be} = (kT/q)\ln(I_E / I_S)$ when necessary or appropriate.

The supplies are +/-3V. All transistors are biased at Ic=0.1mA. The voltage drops across R1,2,3,4,6,7,8,9 are all 150mV. RL=10kOhm.

a) Find all DC node voltages and all resistor values. (b) Find the differential gain $V_{out} / (V_{in}^{+} - V_{in}^{-})$.