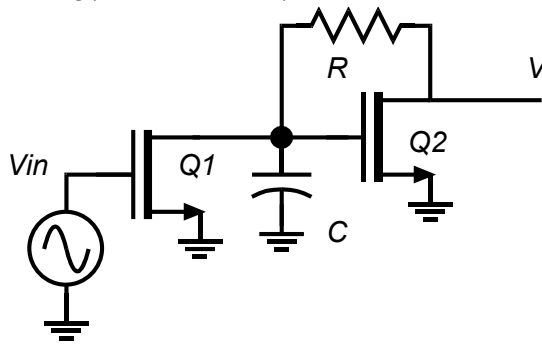
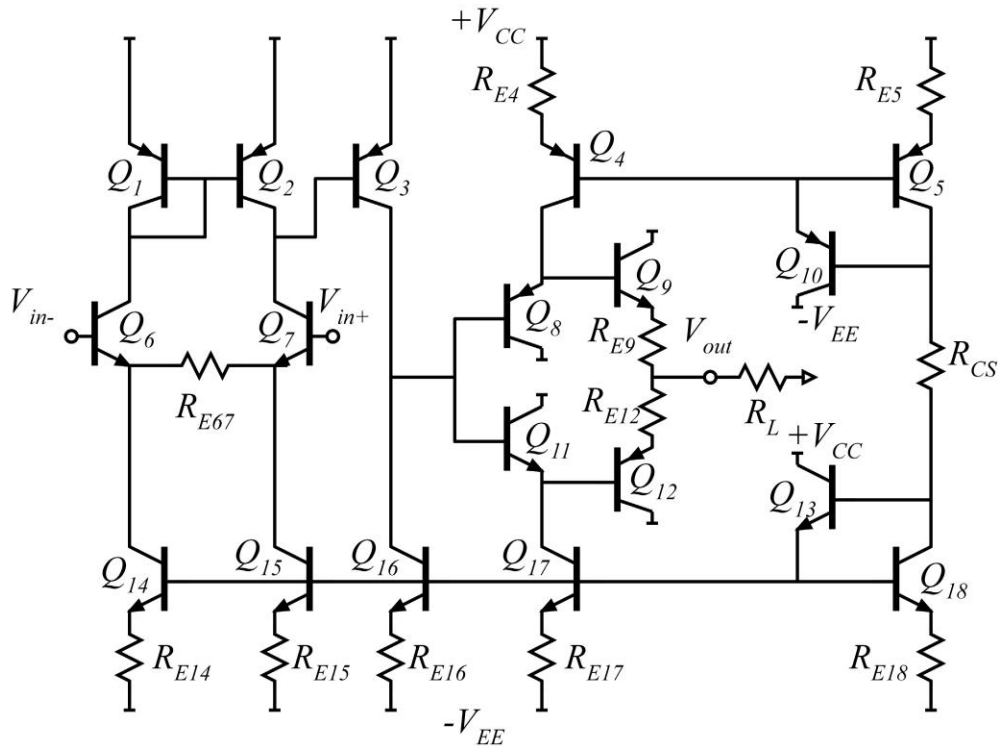


ECE137A Problem set 7



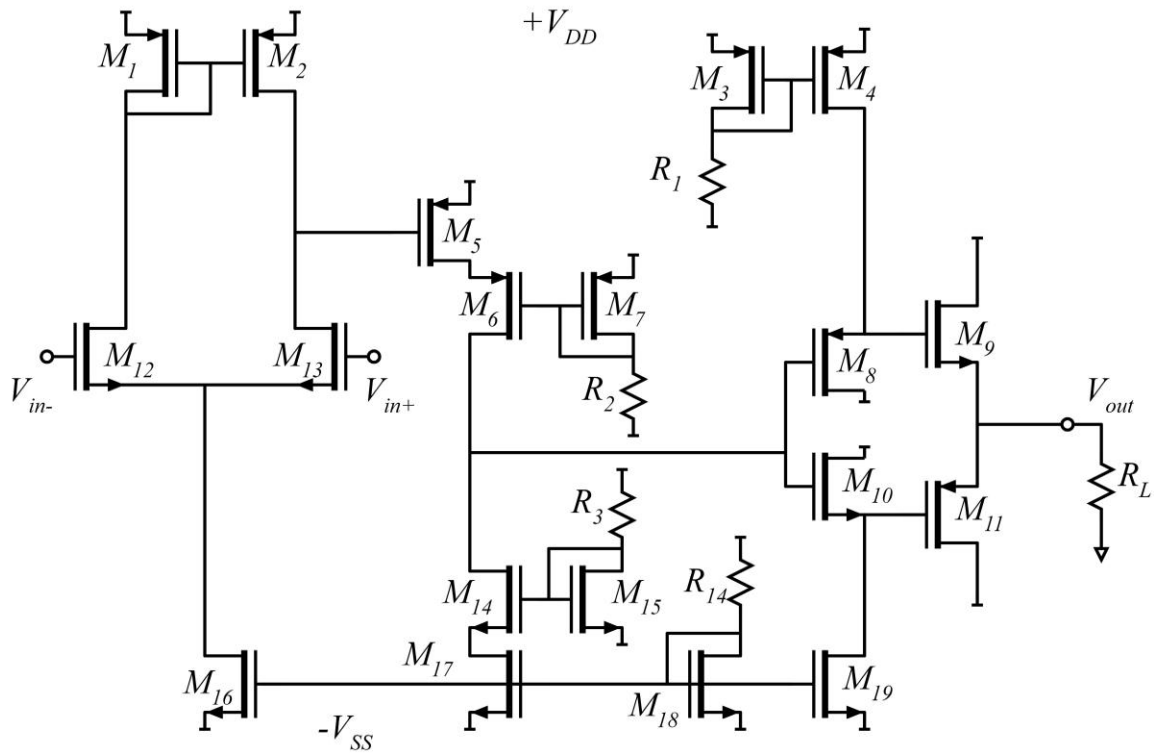
Problem 1: Nodal Analysis exercise: a transconductance-transimpedance amplifier. Ignore DC bias analysis. You don't need it. The two transistors have transconductance g_{m1} and g_{m2} respectively. Their output resistances R_{ds1} and R_{ds2} are both infinity. The capacitor C has value= zero Farads. (a) Find, by nodal analysis, a small-signal expression for V_{out}/V_{in} . (b) $G_{m1}=20$ mS. $G_{m2}=10$ mS. $R=1$ kOhm. Again find V_{out}/V_{in} .

Problem 2:



This is an Op-Amp---analyze the bias under the assumption that DC output voltage is zero volts, that the positive input V_{i+} is zero volts, and that we must determine the DC value of the negative input voltage (V_{i-}) necessary to obtain this. All the transistors have the same (matched) I_S , have $\beta=250$, and $V_A = \text{infinity}$ Volts. $V_{CE(sat)}=0.3$ 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 +5 Volts and -5 Volts. All transistors have the same I_S . The resistors R_{E5} and R_{E18} have a 150mV DC voltage drop across them. $R_{E67}=75$ Ohms, $R_L=500$ Ohms. DC bias currents: $I_{C6}=I_{C7}=I_{C9}=I_{C12}=I_{C18}=250$ μ A. $I_{C3}=I_{C8}=I_{C11}=0.5$ mA. (a) find all resistor values, (b) Find the overall differential gain $V_{out} / (V_{in}^+ - V_{in}^-)$. (c) Find the maximum output voltage swings due to saturation of Q3,4,8, and 9.

Problem 3:



This is an Op-Amp---analyze the bias under the assumption that DC output voltage is zero volts, that the positive input V_{i+} is zero volts, and that we must determine the DC value of the negative input voltage (V_{i-}) necessary to obtain this. The NMOSFETs have $K_{\mu} = 10\text{mA/V}^2 \cdot (W_g / 1\mu\text{m})$, $K_v = 2.0\text{mA/V} \cdot (W_g / 1\mu\text{m})$, $\Delta V = 100\text{mV}$, $1/\lambda = 5$ Volts, and a 0.25 V threshold. The PMOS FETs are the same, except have -0.25 V threshold. The PMOS have identical parameters, except, of course, V_{th} is negative. $V_{DD} = +1\text{ V}$, $-V_{SS} = -1\text{ V}$, $R_L = 30\text{ k}\Omega$. All transistors have $|V_{gs}| = 0.30\text{V}$, **except for M7 and M15**, which have $|V_{gs}| = 0.35\text{V}$. M12,13 are biased at $I_D = 20\text{ }\mu\text{A}$. M5,7,15 are biased at $I_D = 50\text{ }\mu\text{A}$. M3,18,8,9,10,11 are biased at $I_D = 300\text{ }\mu\text{A}$. (a) Find all FET gate widths (b) find the DC voltages at each circuit node. (c) Find the overall differential gain $V_{out} / (V_{in}^+ - V_{in}^-)$. (d) Find the maximum output voltage swings due to the knee voltages of M8,9,4, and 6.