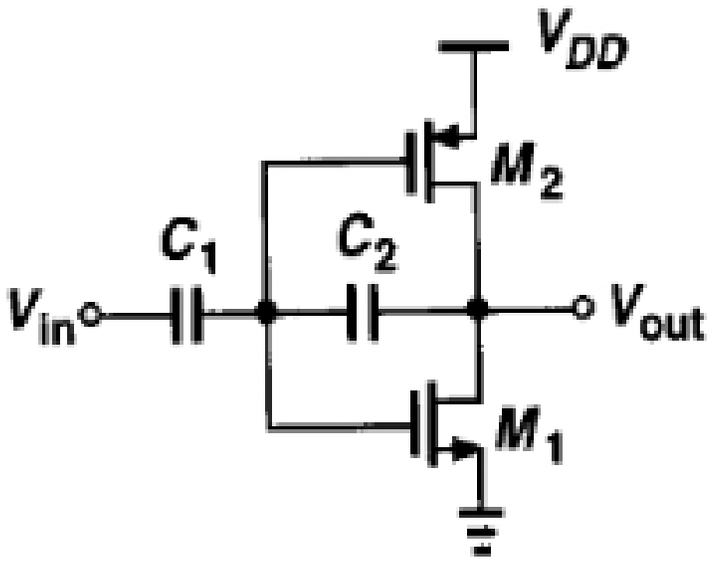
PROBLEM SET #4

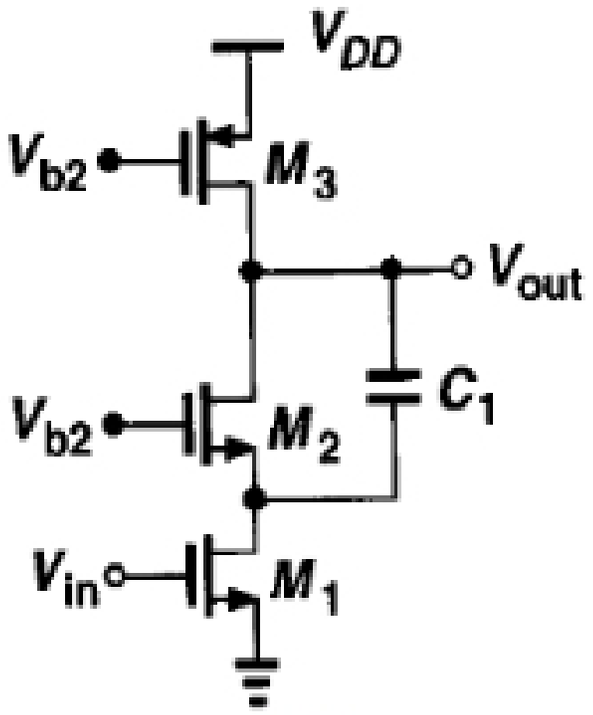
Issued: Tuesday, Feb.15, 2011

Due: Tuesday, Feb.22, 2011, 5:00 p.m. in the EE 140 homework box in 240 Cory

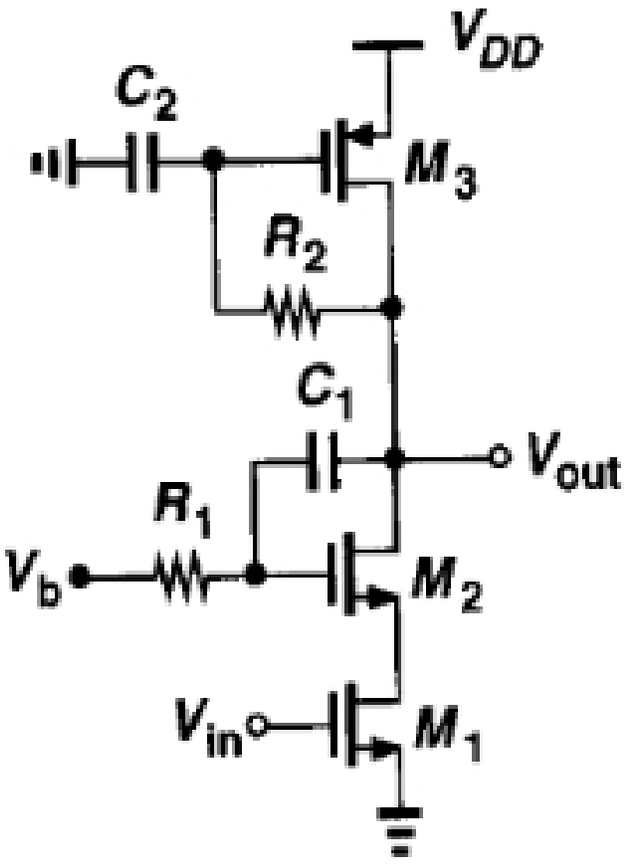
1. Write the expressions for the gain of each circuit in Fig. PS4.1 at very low and very high frequencies. Neglect other capacitances and assume $\lambda = 0$ for circuits (a) and (b) and $\gamma = 0$ for all of the circuits. The expressions should be in terms of the given elements and parameters of the small-signal equivalent circuits (i.e., g_m, r_o, etc.) for the transistors used.



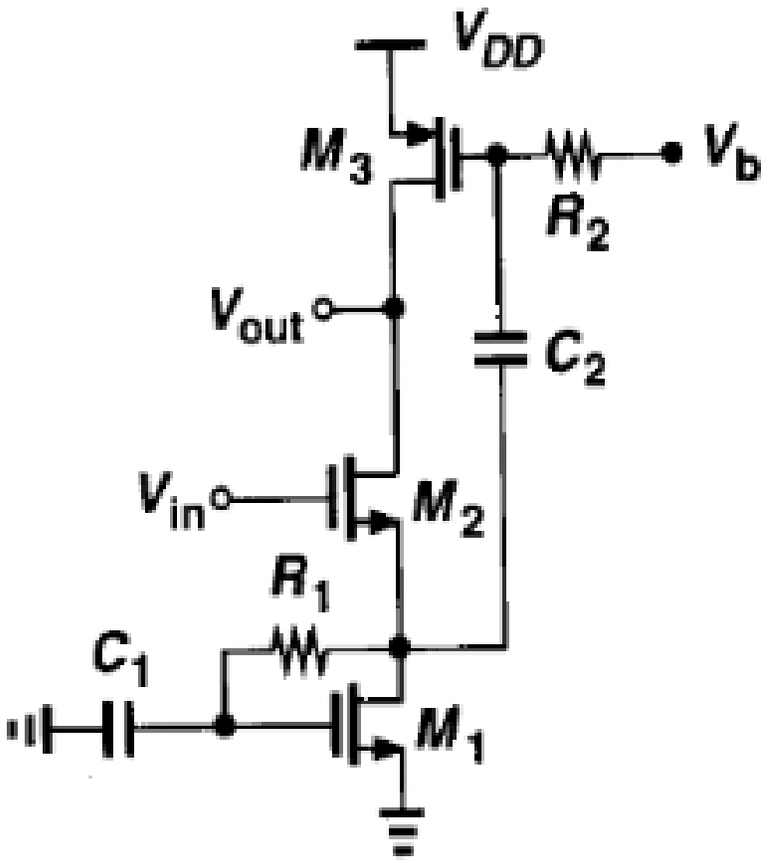
(a)



(b)



(c)



(d)

Fig. PS4.1

2. The circuit of Fig. PS4.2 produces a supply insensitive current. Calculate the ratio of small-signal variations in I_{BIAS} to small-signal variations in V_{DD} at low frequencies. Ignore the body effect but include finite transistor r_o in this calculation.

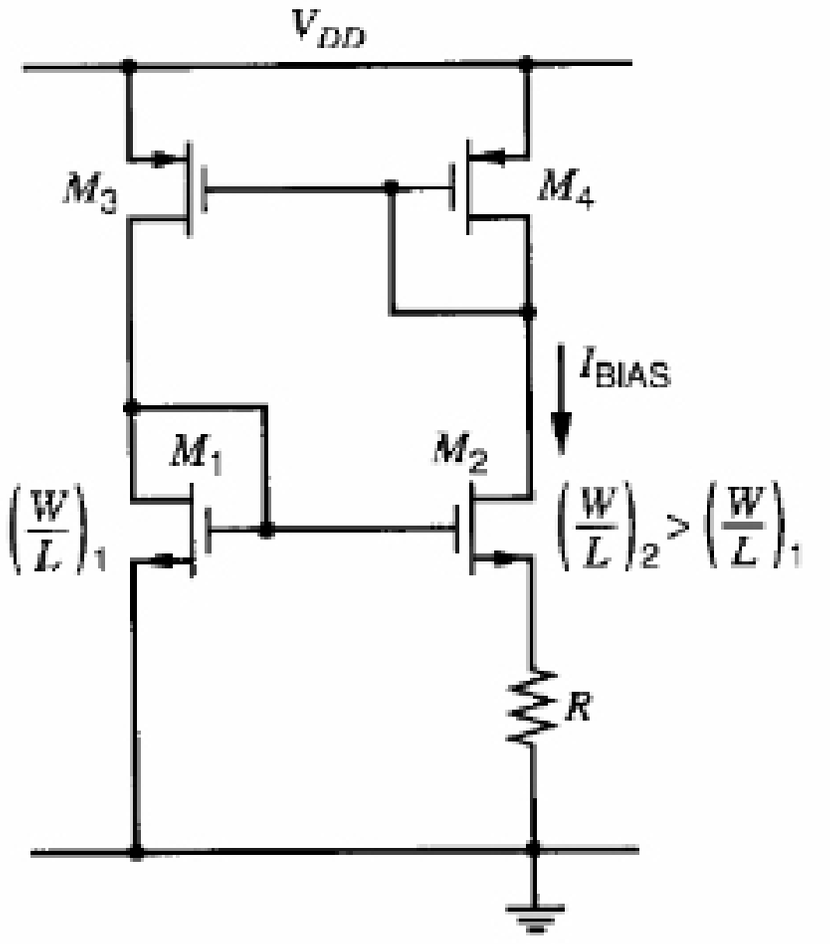


Fig. PS4.2

3. Consider the circuit of Fig. PS4.3, assuming $(W/L)_{1-3} = 40/0.5$, $I_{REF} = 0.3\text{mA}$, and $\gamma = 0$.

   Use the following parameters for your calculation if necessary:

   $V_{th0} = 0.7\text{V}$, $2\Phi_F = 0.9\text{V}$, $L_D = 0.08\mu\text{m}$, $\mu_{no} = 350\text{cm}^2/\text{Vs}$, $\lambda = 0.1\text{V}^{-1}$, $t_{ox} = 9\text{nm}$

   a. Determine V_b such that $V_X = V_Y$;

   b. If V_b deviates from the value calculated in part a by 100mV, what is the mismatch between I_{out} and I_{REF};

   c. If the circuit fed by the cascode current source changes V_P by 1V, how much does V_Y change.

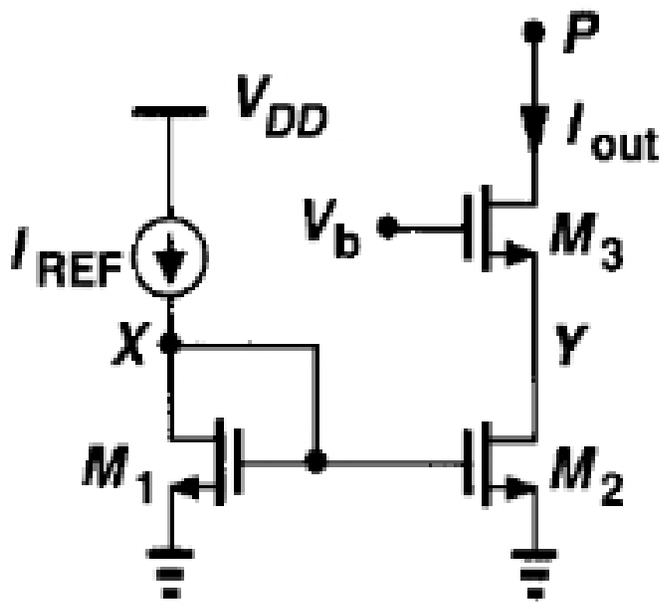


Fig. PS4.3

4. A BICMOS amplifier is shown in Fig. PS4.4. Calculate the small-signal voltage gain v_o/v_i. Assume $I_S = 10^{-16}$ A, $\beta_F = 100$, $r_b = 0$, $V_A \rightarrow \infty$, $\mu_n C_{ox} = 200$uA/V, $V_t = 0.6$V, and $\lambda = 0$.

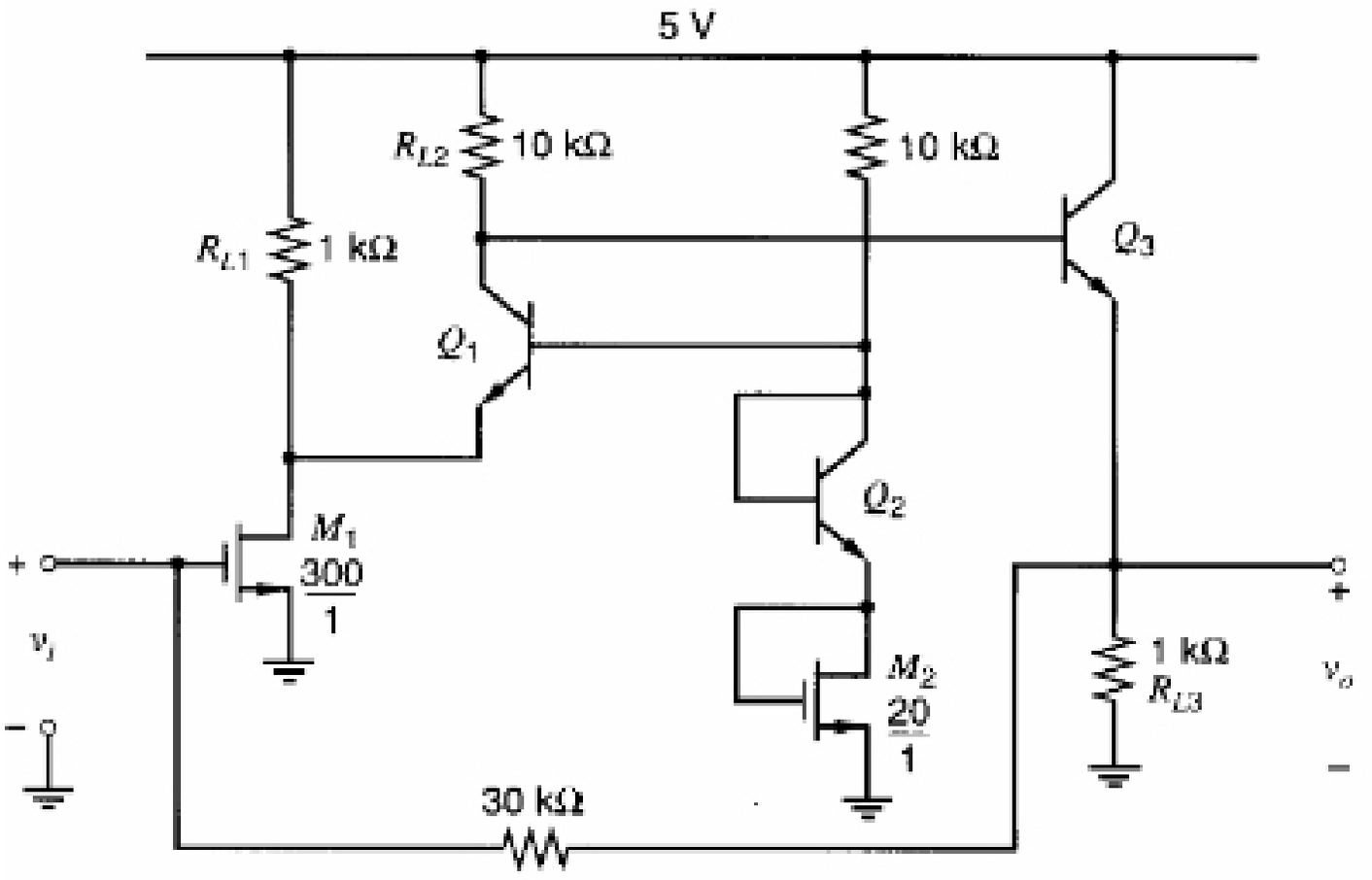


Fig. PS4.4