MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.301 Solid State Circuits

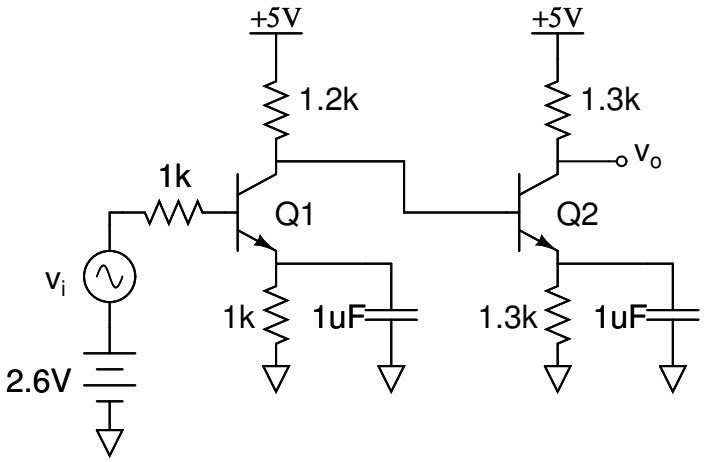
Fall Term 2010 — Issued : Sept. 17, 2010
Problem Set 3 — Due : Friday, Sept. 24, 2010

Suggested Reading: Read as many of the following as you can. All of the recommended references are on reserve at Barker Library.

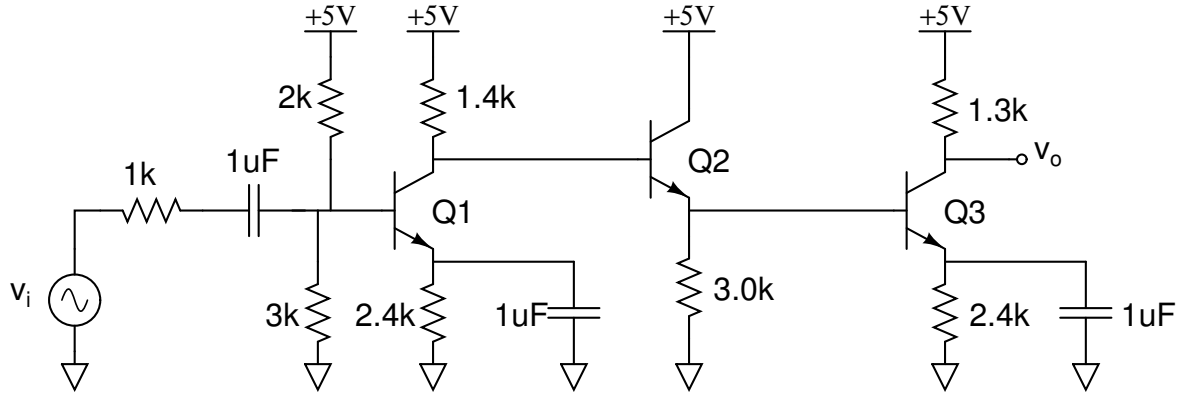
1. Lundberg sections 4 and 5.
2. Grebene section 5.1.
3. Gray and Meyer section 3.5.

Problem 1: Find the mid-band gain for each circuit below. Assume that $\beta = 400$, $V_{\mathrm{BE,ON}} = 0.6\mathrm{V}$, and ignore r_o.

(a) Circuit a

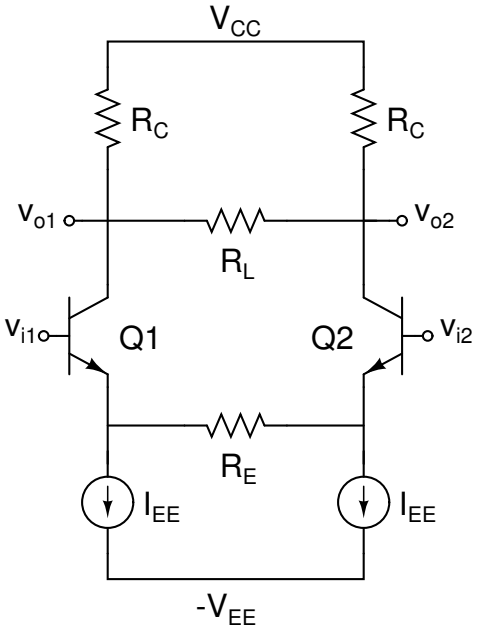


(b) Circuit b



Problem 2: Simulate the CE-EF-CE amplifier in Circuit 1b (above) with HSPICE. Use the following data for your simulations: $I_S = 10^{-15}$A, $\beta_F = 200$, V_A=100, $\tau_F = 0.1$ns, $c_{jeo} = 10$pF, and $c_{jco} = 2$pF. Turn in your HSPICE input file, and an Awaves plot showing the low and high frequency roll-offs.

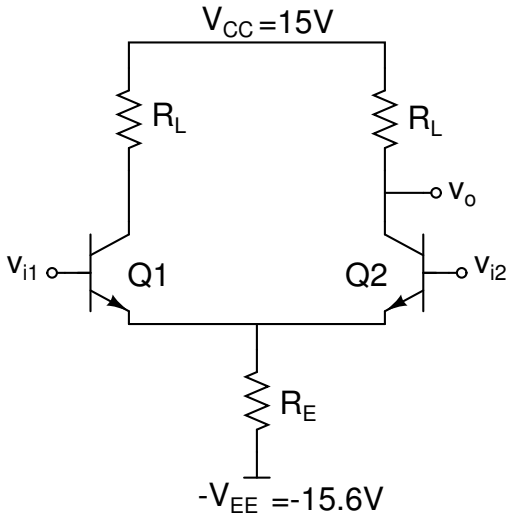
Problem 3: For the differential amplifier shown below:



(a) Find the differential voltage gain a_{vd} and the common mode voltage gain a_{vc}.

(b) Find both the differential and common mode input and output resistances ($R_{\text{in,d}}$, $R_{\text{in,c}}$, $R_{\text{out,d}}$, and $R_{\text{out,c}}$).

Problem 4: For the single-ended differential amplifier shown below, assume that $\beta = 200$ and $V_{\text{BE,ON}} = 0.6\text{V}$ for both transistors, and that the DC common mode input voltage is zero. Neglect r_o for this problem.



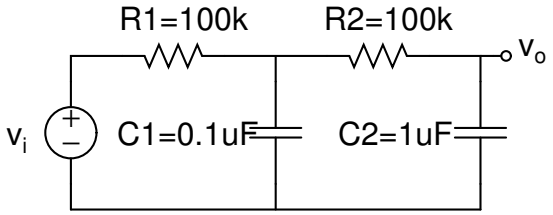
(a) Express the differential voltage gain a_{vd} as a function of the voltage drop V_L across R_L.

(b) If $V_{\text{CE,SAT}} = 0.3\text{V}$, what is the maximum a_{vd} possible?

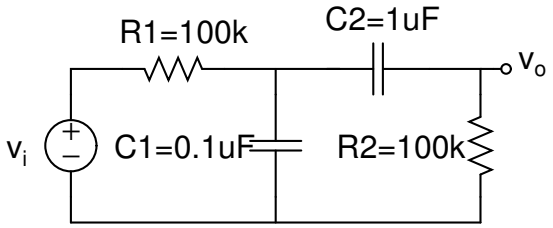
(c) Select R_L and R_E so that $R_{\text{in,d}} = 1\text{M}\Omega$ and $a_{vd} = 300$. What is the common mode rejection ratio (CMRR)?

Problem 5: For each circuit below, find the transfer function v_o/v_i, and draw the Bode plot (magnitude and phase).

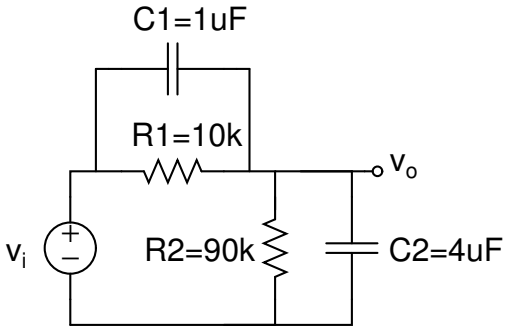
(a) Circuit a



(b) Circuit b



(c) Circuit c



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