MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Stuff

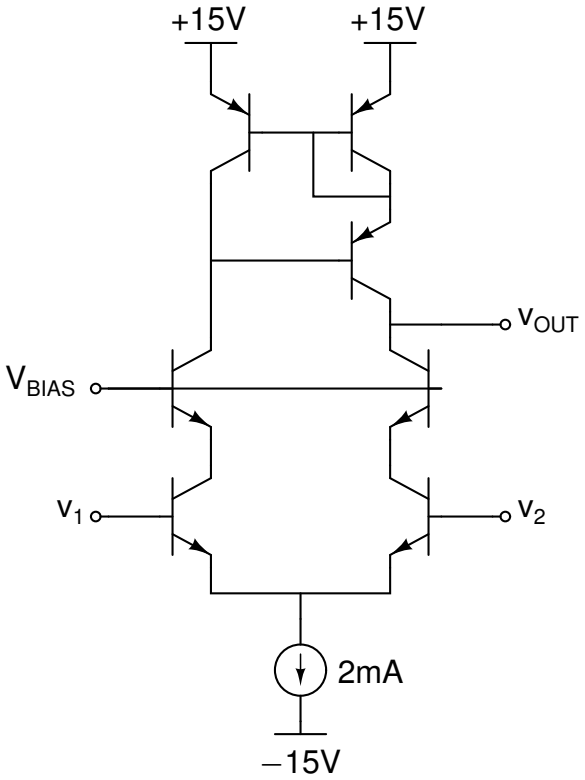
6.301 Solid State Circuits

Fall Term 2010 — Issued : Oct. 29, 2010
Problem Set 6 — Due : Friday, Nov. 6, 2010

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

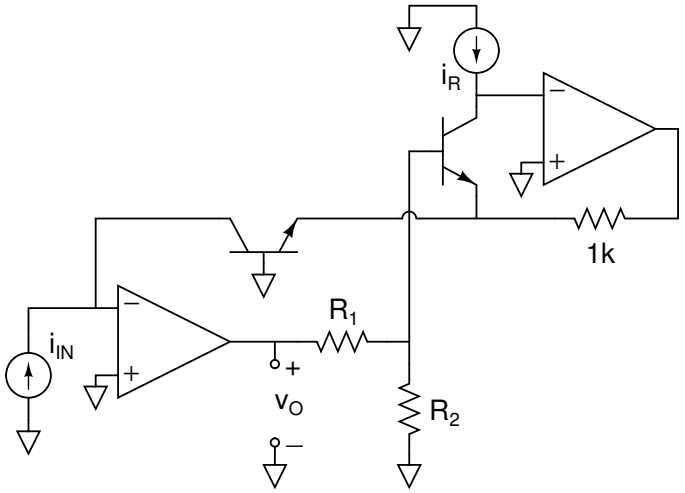
1. Lundberg sections 21–24 and 27.
2. Grebene section 7.
3. Gray and Meyer sections 4.3, 7.4 and 8.

Problem 1: Actively Loaded Differential Pair



Find $\frac{v_{out}}{v_1 - v_2}$ at midband, assuming β_{npn}=200, β_{pnp}=50, $V_{A,npn}$=100V, $V_{A,pnp}$=50V, Common-Mode Voltage V_{CM}=0 and V_{BIAS}=4V.

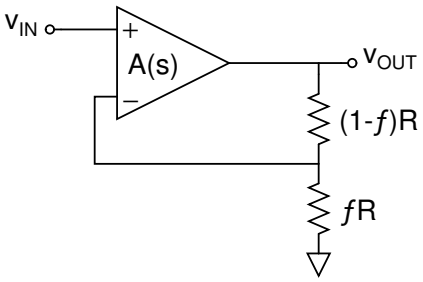
Problem 2: Op Amp Log Circuit Assume that the following circuit is operated at room temperature ($T = 300K$).



(a) When R_1=15.7R_2, v_O is of the form v_O=$A\ log_{10}(x)$. Find A and x.

(b) Solve for R_1 in terms of R_2 such that v_O exhibits a $log_2(x)$ behavior.

Problem 3: Op Amp Frequency Response Assume that the following op amp has a finite gain with frequency response $A(s)$=$\frac{a_o}{\tau s+1}$ (where a_o=10^6 and τ=10^{-6}) and that f=[1 0.1 0.01 0.001].



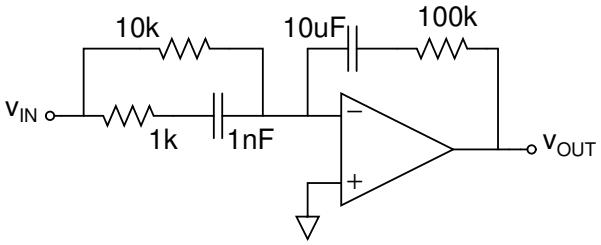
(a) Solve for the closed-loop DC gain and upper -3dB Frequency for each value of f.

(b) Sketch the Bode plot (magnitude only) of $\frac{v_{OUT}}{v_{IN}}(s)$ for each value of f.

(c) Sketch the unit step response of $v_{OUT}(t)$ for each value of f.

Make sure to label important features in your sketches including magnitudes, slopes, breakpoint frequencies, and times.

Problem 4: Lead-Lag Op Amp Configuration



Sketch the Bode plot (magnitude and phase) of $\frac{v_{OUT}}{v_{IN}}(s)$. Make sure to label the magnitudes of each asymptote and its breakpoint frequency. Assume the op amp is ideal.

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