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PROBLEM SET #4

Issued: Tuesday, Feb.14, 2012

Due: Tuesday, Feb.21, 2012, 6:00 p.m. in the EE 140 homework box in 240 Cory

1. (a) For the two BJT current mirror circuits shown in Fig. PS4.11, calculate the ideal mirror ratio I_O/I_{REF} if (i) $V_A = \infty$ and $\beta_{FO} = \infty$. (ii) If $V_A = \infty$ and $\beta_{FO} = 75$. (iii) If $V_A = 60$ V, $\beta_{FO} = 75$, and $V_{BE} = 0.7$ V. The symbol "A" stands for the relative sizes of the emitters of the BJTs.

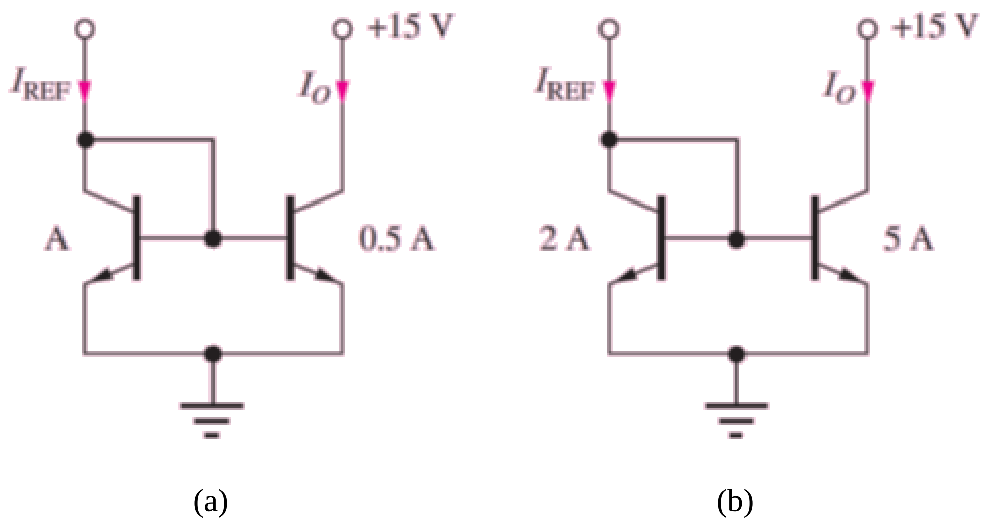

Fig. PS4.11

(b) Calculate the mirror ratio I_O/I_{REF} for the MOS current mirrors in the Fig PS4.12 for (i) λ=0; (ii) For $\lambda = 0.02\ V^{-1}$ if $V_{TN} = 1V$, $k' = 25\ \mu A/V^2$, and $I_{REF} = 50\ \mu A$.

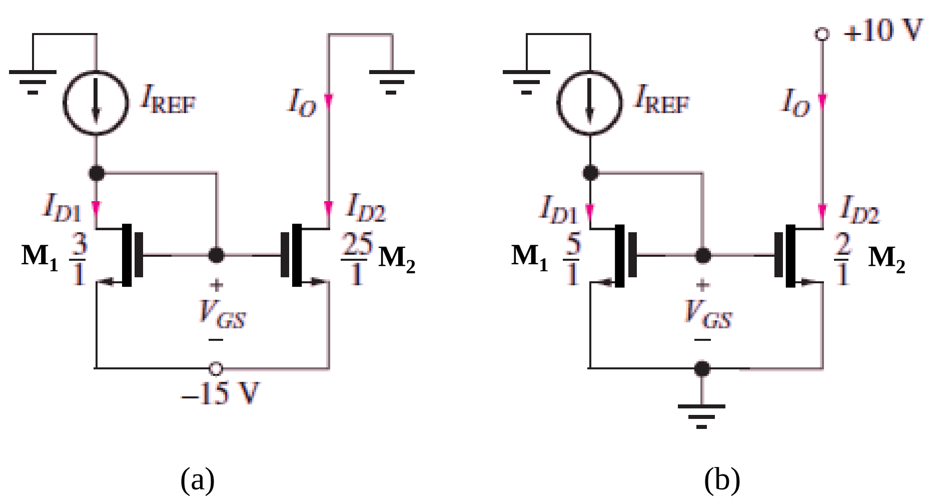

Fig PS4.12

(c) If a small ac voltage disturbance v_n is applied directly at the M_1 gate as shown below in Fig PS4.13, what is the output current disturbance i_n due to v_n for (i) λ=0; (ii) λ = 0.02 V^{-1} if V_{TN} = 1V, k' = 25 μA/V^2, and I_{REF} = 50 μA.

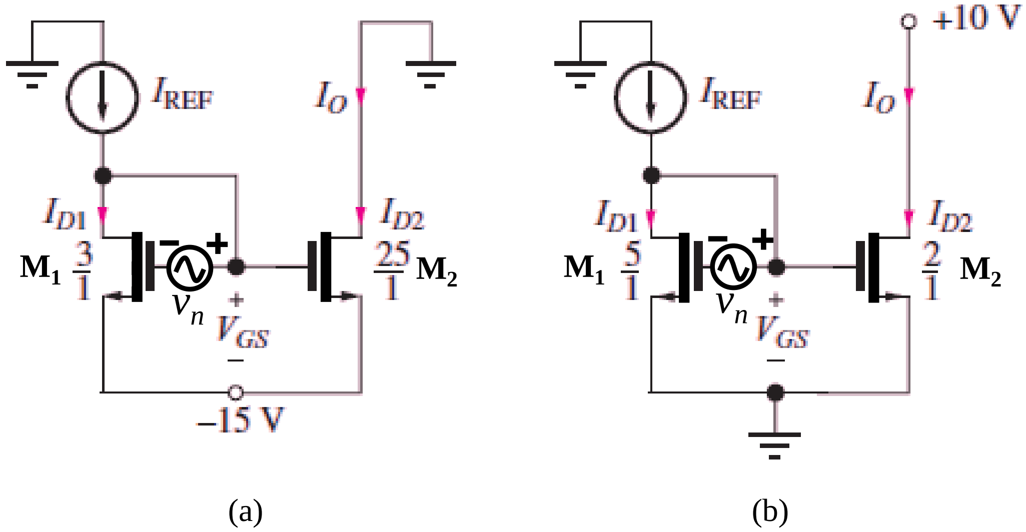

Fig. PS4.13

2. Calculate the gain of each circuit in Fig. PS4.2 at very low and very high frequencies. Neglect all other capacitances and assume λ=γ=0.

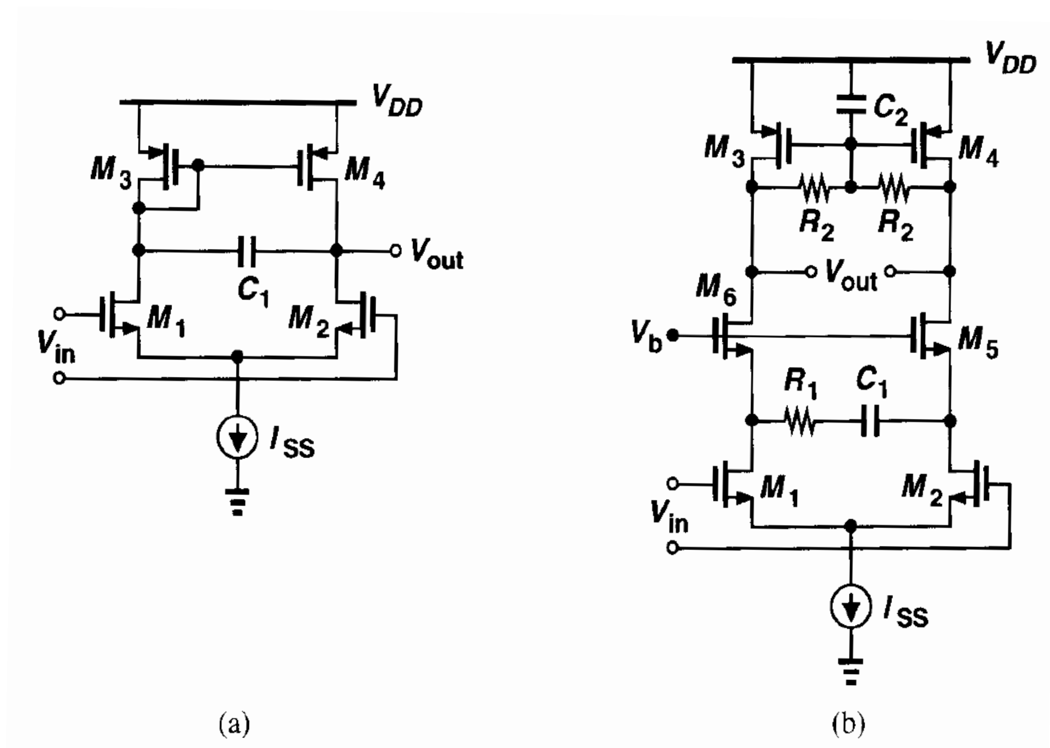

Fig. PS4.2

3. For the BJT Wildar current source shown in Fig. PS4.3, assume V_{cc}= 5V, R_1 = 4.3kΩ, $V_{BE(on)}$ = 0.7V.
   (a) Determine the proper value of R_2 to give I_{out} = 5mA, assume β_F = 100
   (b) What is the output resistance of the current source, assume V_A=80V, β_F=100.
   (c) Determine the sensitivity of I_{out} to the power-supply voltage $S_{V_{CC}}^{I_{OUT}}$. ($S_{V_{CC}}^{I_{OUT}} = \frac{V_{CC}}{I_{OUT}}\frac{\partial I_{OUT}}{\partial V_{CC}}$)

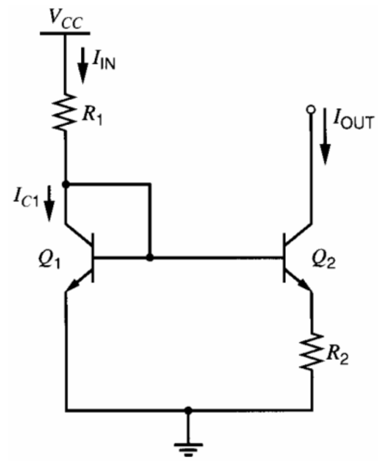

Fig. PS4.3

4. Calculate the mid-band small-signal gain and -3dB frequency of the circuit in Fig. PS4.4. Assume: R_S= 1 kΩ, R_E = 75 Ω, R_3 = 4 kΩ, R_L = 1 kΩ, R_I = 4 kΩ , R_2 = l0kΩ, and V_{CC} = V_{EE} = 10V. Device data are β = 200, $V_{BE(on)}$ =0.7 V, τ_F = 0.25 ns, r_b = 200 Ω, r_c (active region) = 150 Ω, C_{jeo} = 1.3 pF, $C_{\mu 0}$ =0.6 pF, ψ_{0c}= 0.6 V, C_{cs0} = 2pF, ψ_{0s} = 0.58 V, and n_s = 0.5. Also you can assume C_{je} in forward active region equals $2C_{je0}$.

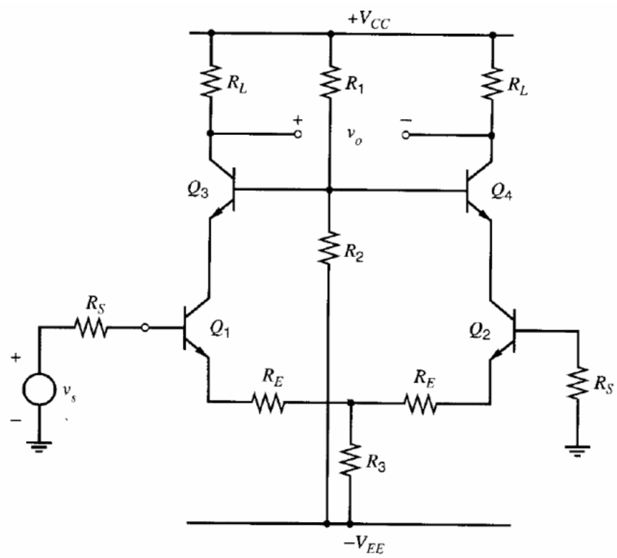

Fig. PS4.4