# PROBLEM SET #9

*Issued: Thursday, Apr. 4, 2013*

*Due (at 8 a.m.): Tuesday, Apr. 12, 2013*, in the EE 140/240A HW box near 125 Cory.

**1.** Consider the class AB output stage depicted in Fig. PS9.1. Assume that the DC value of the input signal has been adjusted such that output DC voltage is set at zero.

**(a)** Find the DC biasing points of the circuit at rest (when there is no signal at the input).

From now on, assume the circuit is in the steady state with $v_{in}\,sin(2\pi\,f_0\,t)$ *as* the input signal and $v_m\,sin(2\pi\,f_0\,t)$ as the output signal.

**(b)** Find the maximum value of $v_m$ for $R_L$ = 100Ω and $R_L$ = 50Ω, such that there is no clipping in the output waveform.

**(c)** Find the maximum output power delivered to 100Ω and 50Ω loads and calculate the efficiency of the output stage in each case (include all the elements).

**(d)** Find the maximum average power dissipated in transistors $Q_{1,\,2}$.

**(e)** Find the optimum value of $R_L$ that maximizes the efficiency of the output stage.

BJT parameters:

$Q_{1\text{-}2}$: $I_{S1} = I_{S2} = 1\times10^{-13}$A, $\beta_{npn} = 50$, $\beta_{pnp} = 30$, $V_A = 50$V, $V_{CE\,(sat)} = 0.2$V,

$Q_{3\text{-}4}$: $I_{S3} = I_{S4} = 5\times10^{-14}$A,

$Q_{5\text{-}7}$: $V_{BE\,(on)} = 0.7$V, $\beta = 100$, $V_A = 50$V, $V_{CE\,(sat)} = 0.2$V,

$V_{CC} = 10$V, $V_T = 25$mV.

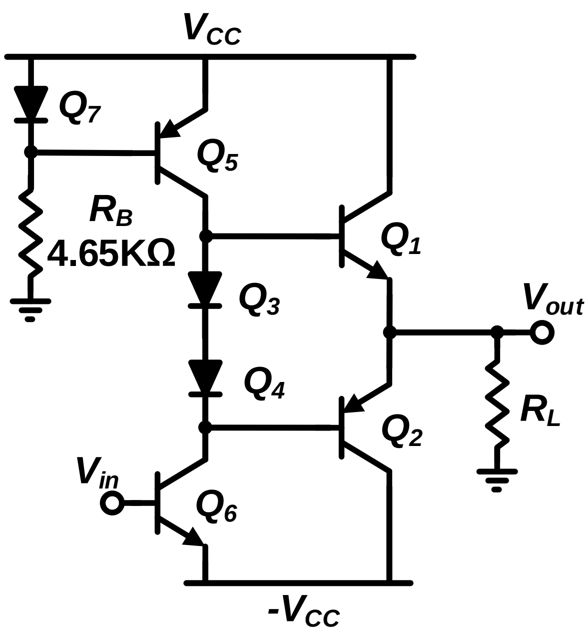


**Fig. PS9.1**

**2.** An amplifier has a forward gain of $A_0$ = 1000 and two poles at $\omega_{p1}$ and $\omega_{p2}$. For $\omega_{p1} = 10^6$ rad/s, calculate the phase margin of a unity-gain feedback loop if:

**(a)** $\omega_{p2} = 3\omega_{p1}$

**(b)** $\omega_{p2} = 15\omega_{p1}$

**(c)** Compute the maximum amplitude due to frequency peaking for both (a) and (b).

**3.** An amplifier has a low-frequency forward gain of 40,000, and its transfer function has three poles at 2 kHz, 400 kHz, and 4 MHz

**(a)** If this amplifier is connected in a feedback loop with a constant feedback factor $\beta$, resulting in a low-frequency gain $A_0$ = 600, estimate the phase margin and sketch the amplifier's frequency response in terms of both magnitude and phase.

**(b)** Repeat (a) if $A_0$ = 300.