PROBLEM SET #8

Issued: Tuesday, Oct. 22nd, 2013

Due: Tuesday, Oct. 29th, 2013, 6:00 p.m. in the EE 140/240A homework box

1. Consider the circuit in Fig. PS8.1. Assume the tail current source is a simple current mirror, and the transistors have parameters $\lambda = 0.1V^{-1}$ and $\gamma = 0$. The transistors are nominally biased so that:

$I_{D\text{-}nom} = 2mA$, $g_{mTail} = 20mS$, $g_{m1,2} = 10mS$, $g_{m3,4,5,6} = 5mS$, $g_{m7,8} = 10mS$, $|V_{th}| = 0.5V$, $V_{DD} = 5V$.

(a) Determine the DC value of input and bias voltages V_{B1}, V_{B2} and V_{B3} for maximum output swing.

(b) Calculate the output slew rate when the amplifier is used as a unity-gain circuit and there is 1pF capacitor connected at the output node.

(c) Find the open-loop voltage gain $A=V_{out}/V_{in}$ for A_{dm}, A_{cm}, $A_{dm\text{-}cm}$, and $A_{cm\text{-}dm}$.

(d) Repeat part (c) assuming the amplifier is mismatched such that $(I_{D\text{-}M1,3,5,7}-I_{D\text{-}M2,4,6,8})/I_{D\text{-}nom} = 2\%$, and $(g_{m1,3,5,7}-g_{m2,4,6,8})/g_{m,nom} = 5\%$.

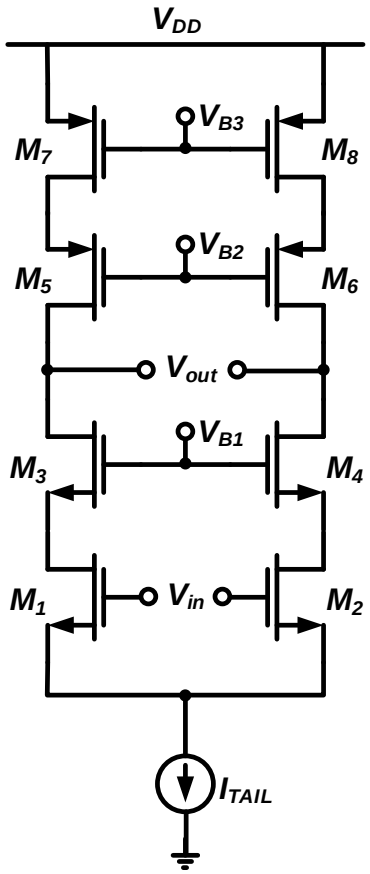


Fig. PS8.1

2. Write an expression for the common-mode input range of the op amp in Fig. PS8.2 in terms of V_{DD} and V_{SS}. Assume that the transistors have $|V_t| = 1$ V, and ignore the body effect. Also assume that the biasing is arranged so that $|V_{ov}| = 0.2$ V for each transistor except M_9. Finally, assume that M_1 and M_2 are biased at the edge of saturation by M_9 and I_C. If the common-mode input range is required to be no less than 0.2V, what is the minimum supply difference, V_{DD}-V_{SS}?

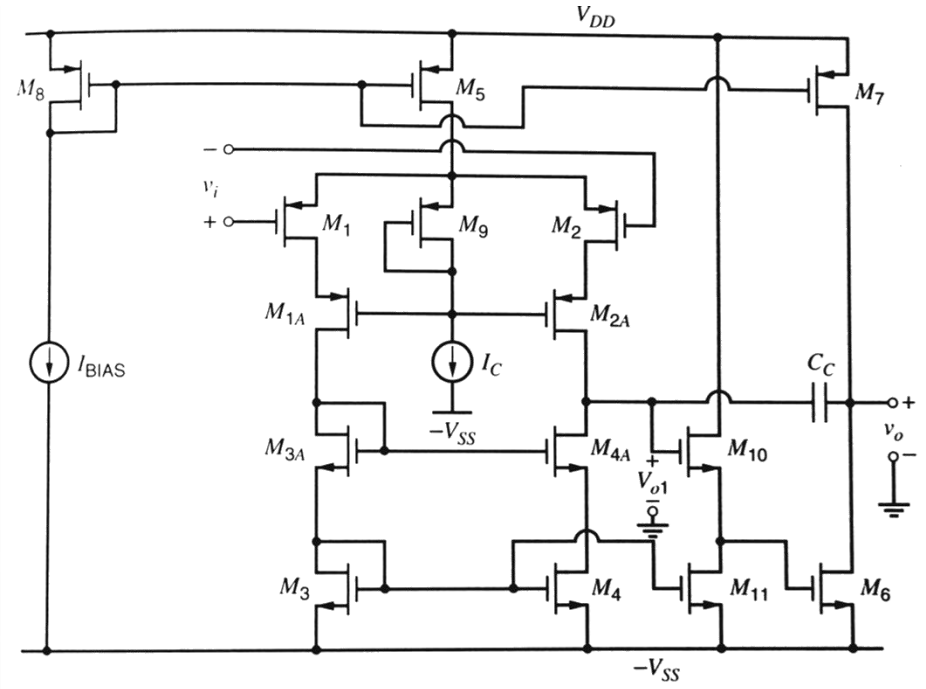


Fig. PS8.2

3. For the circuit in Fig. PS8.3(i):

a) Find the transfer function and sketch a Bode plot assuming the amplifier is ideal.

b) Find the transfer function and sketch a Bode plots if

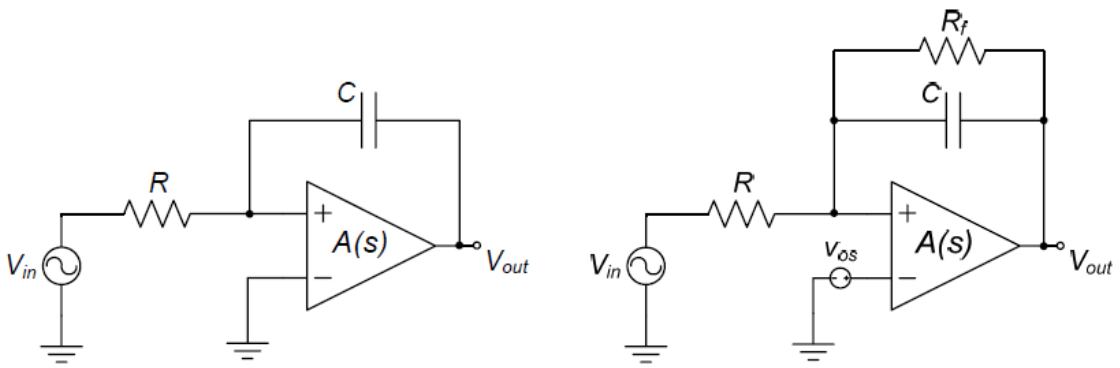
$$A(s) = \frac{A_0}{1 + \frac{s}{\omega_p}}$$

For the circuit in Fig. PS8.3(ii):

c) If the amplifier offset is V_{OS} =1mV, calculate the value of R_f such that $|V_{out}|$ = 0.5V when no input signal is applied.

d) Repeat b) with R_f included.

R = 1kΩ, C =1nF, A_0=105, ω_p=10 rad/s



(i) (ii)

Fig. PS8.2