

Homework 8

Due: Friday Oct. 31, 2014 1pm

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

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

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

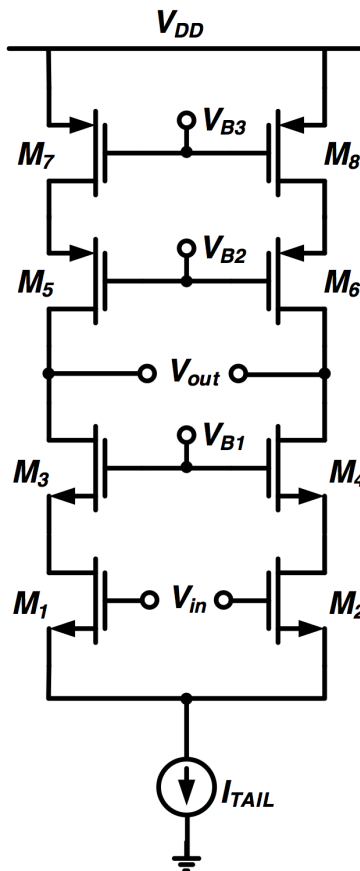


Fig. PS8.1

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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, $V_{DD} - V_{SS}$?

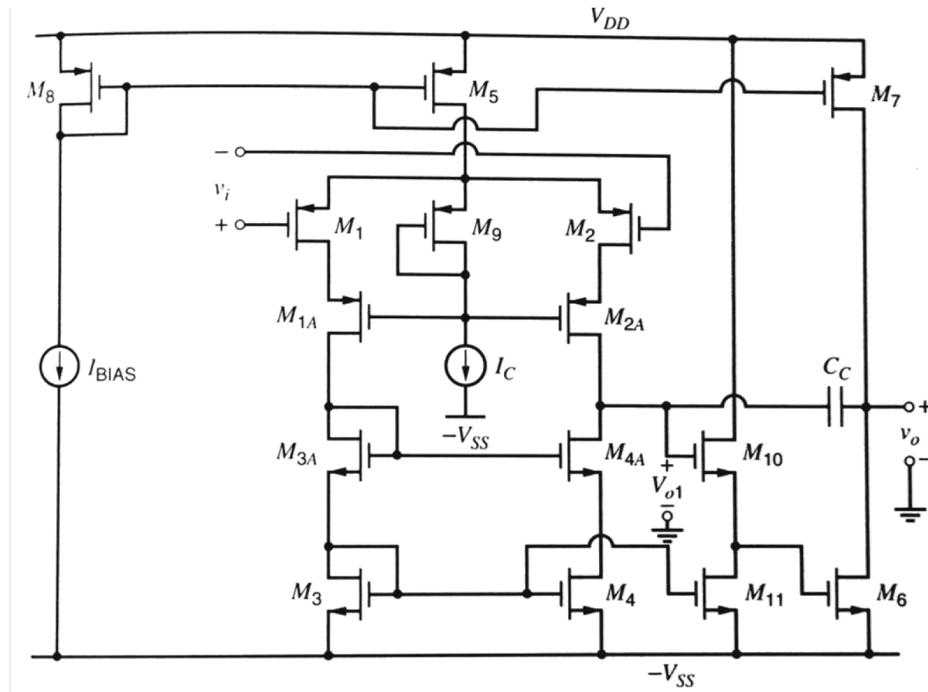


Fig. PS8.2

3. For the circuit in Fig. PS8.3(i):
- Find the transfer function and sketch a Bode plot assuming the amplifier is ideal.
 - 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):

- If the amplifier offset is $V_{OS} = 1\text{mV}$, calculate the value of R_f such that $|V_{out}| = 0.5\text{V}$ when no input signal is applied.
- Repeat b) with R_f included.

$$R = 1\text{k}\Omega, C = 1\text{nF}, A_0 = 105, \omega_p = 10 \text{ rad/s}$$

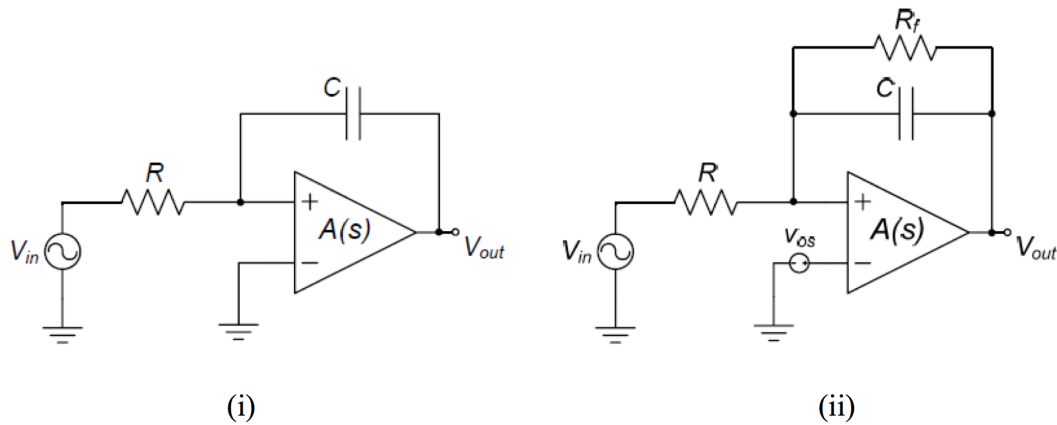


Fig. PS8.2