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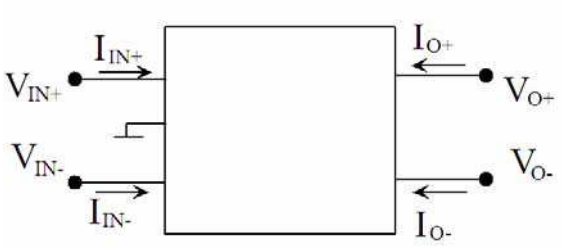
ELE509E
Current-Mode Analog Circuit Design
Final Project

Design a current operational amplifier using n-well 0.5μm CMOS technology. The circuit symbol of the current operational amplifier is illustrated in Figure 1.



Figurel-1

The definition equations are given by

$$\begin{bmatrix} V_{IN+} \\ V_{IN-} \\ I_{O+} \\ I_{O-} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ K & -K & 0 & 0 \\ -K & K & 0 & 0 \end{bmatrix} \begin{bmatrix} I_{IN+} \\ I_{IN-} \\ V_{O+} \\ V_{O-} \end{bmatrix}$$

where K is the open-loop gain; V_{IN+}, V_{IN-} I_{IN+}, I_{IN-} are the voltages and currents of the input terminals,, V_{O+}, V_{O-} I_{O+}, I_{O-} denote the voltages and currents of the output terminals. The current operational amplifier to be designed must provide the following properties given in Table 1.

Table 1

Open-loop gain (dB)	> 80
Unity gain bandwidth (MHz)	>50
İnput resistance (k. Ohm)	< 1
Output resistance (M.Ohm)	>10
Supply voltages	±2.5V

Design a current operational amplifier providing the above mentioned properties with n-well 0.5μm CMOS technology.

a- Determine the dimensions and biasing currents of the transistors.
Using SPICE simulations :
b- Plot the DC transfer characteristic of the circuit; I_{O+}= f(I_{IN+}-I_{IN-}), I_{O-}= f(I_{IN+}-I_{IN-}).
c- Plot the open-loop frequency response the current gain{$i_{o+}/(i_{in+}-i_{in-})$, $i_{o-}/(i_{in+}-i_{in-})$} without applying any compensation, determine the poles of the transfer function.
d- Compensate the frequency response to obtain a slope of -20dB/dec. Investigate the stability of the circuit.

e- Investigate the DC transfer characteristics V_{O+} =f(I_{IN+}-I_{IN-}), V_{O-} = f(I_{IN+}-I_{IN-}) for several load resistance values,
f- Investigate the frequency response of input and output impedances.
h- Summarize the performance parameters of the current operational amplifier in a Table.
i- Evaluate your design and your results.

Explanations: The current operational amplifier can be realized by the use of the blocks illustrated in Figure 2. (DO-CCII structure designed in a previous homework can be also used for the output stage).

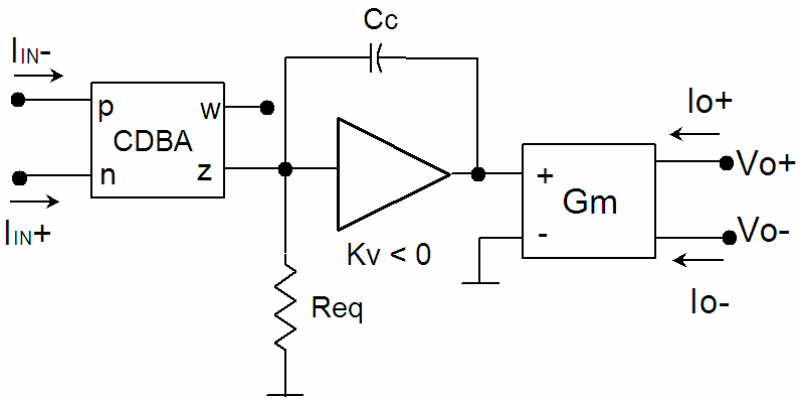


Figure-2

References:

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[4] N. Tarım, H. Kuntman, "A High Performance Current Differencing Buffered Amplifier", Proceedings of the 13th International Conference on Microelectronics (ICM'2001), pp.153-156, Rabat, Morocco, October 29-31, 2001.
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