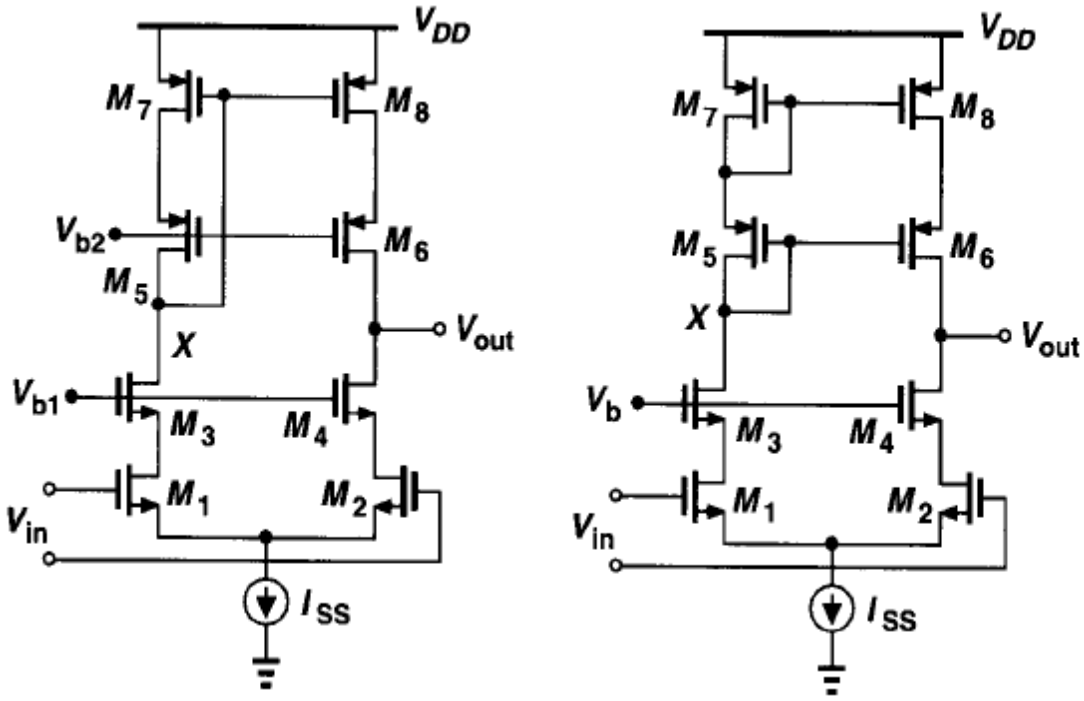
Problem Set #3: Operational Amplifiers

Problem (1)



(a) (b)

Compare between the two operational amplifier circuits in terms of:

1- DC-gain
2- GBW (assume a load capacitance C_L)
3- Slew rate
4- Maximum available output swing
5- Input common-mode range (assume $V_b = V_{b1} = V_{TH}+4V_{eff}$)
6- Noise & Offset

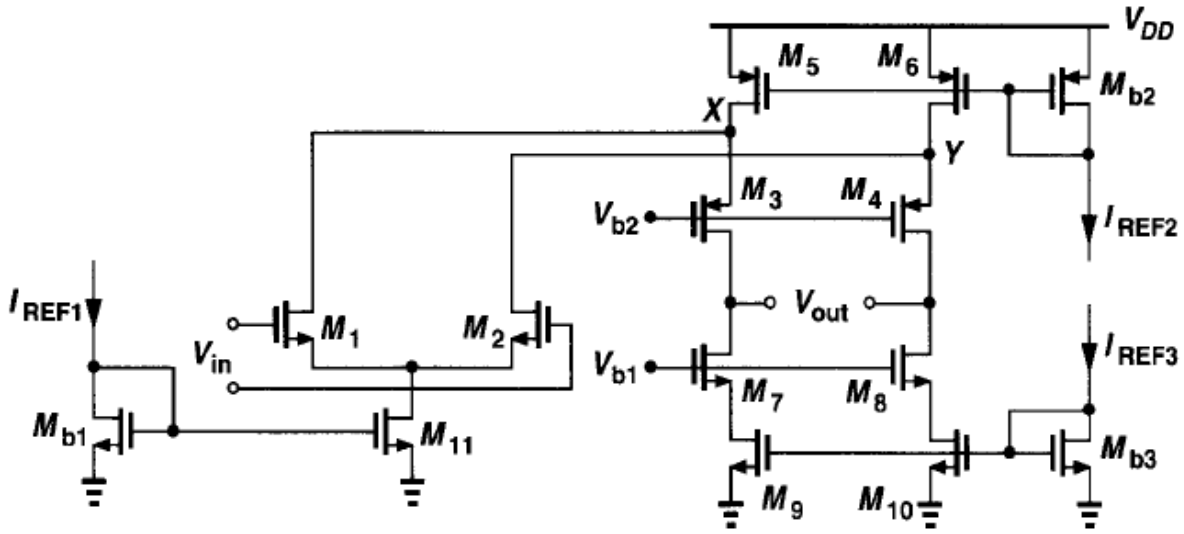
Show that the noise & offset of the cascode devices are neglected.

Explain why the transfer function $A(s) = \frac{V_{out}}{V_{in}}(s)$ will have LHP zeroes.

Problem (2)

Study the stability of the self-regulated current source in the previous sheet of current mirrors (problem #3) considering only the capacitors shown in the figure.

Problem (3)

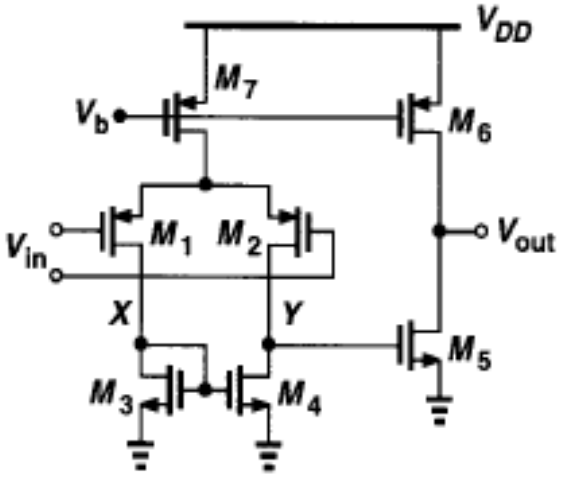


For the shown operational amplifier:

1- What is the type of this op-amp?
2- Find the relation between I_{REF1}, I_{REF2} and I_{REF3}.
3- Find an expression for the poles in this op-amp in terms of the circuit parameters (Consider C_{gs} only).
4- Assume output load capacitance C_L at V_{out}, find an expression of the Gain-Bandwidth product (GBW) in terms of the circuit parameters. Find an expression for the Slew rate (SR).
5- Find the maximum output range as a function of V_{b1} and V_{b2}.
6- Find the values of V_{b1} and V_{b2} for maximum output swing. Find an expression for the maximum output swing in this case.

Problem (4)

For the two-stage op-amp shown: V_{DD}=2.5V, $\mu_n C_{ox}$=100μA/V, $\mu_p C_{ox}$=50μA/V, $\lambda_n=\lambda_p$=0.01V^{-1}, and $V_{thn}=|V_{thp}|$=0.6V. For a total power consumption of 6mW, find the maximum GBW for C_L=1pF such that the non-dominant pole is double GBW. Calculate the DC-gain and the maximum output swing. What is the optimum value for $\mathbf{V_{eff5}}$? Assume: Compensation capacitor = C_L / 2, and $V_{eff5}=V_{eff6}$ and $V_{eff1}=V_{eff3}$
If the amplifier is placed in a unity feedback configuration, calculate the closed loop gain and BW. What is the fractional gain error (FGE) and settling time?



Problem (5)

For the following op-amp circuit:

1- Find the DC gain.
2- Find the locations and expressions of the poles.
3- Is there a zero in the transfer function? Find its location.