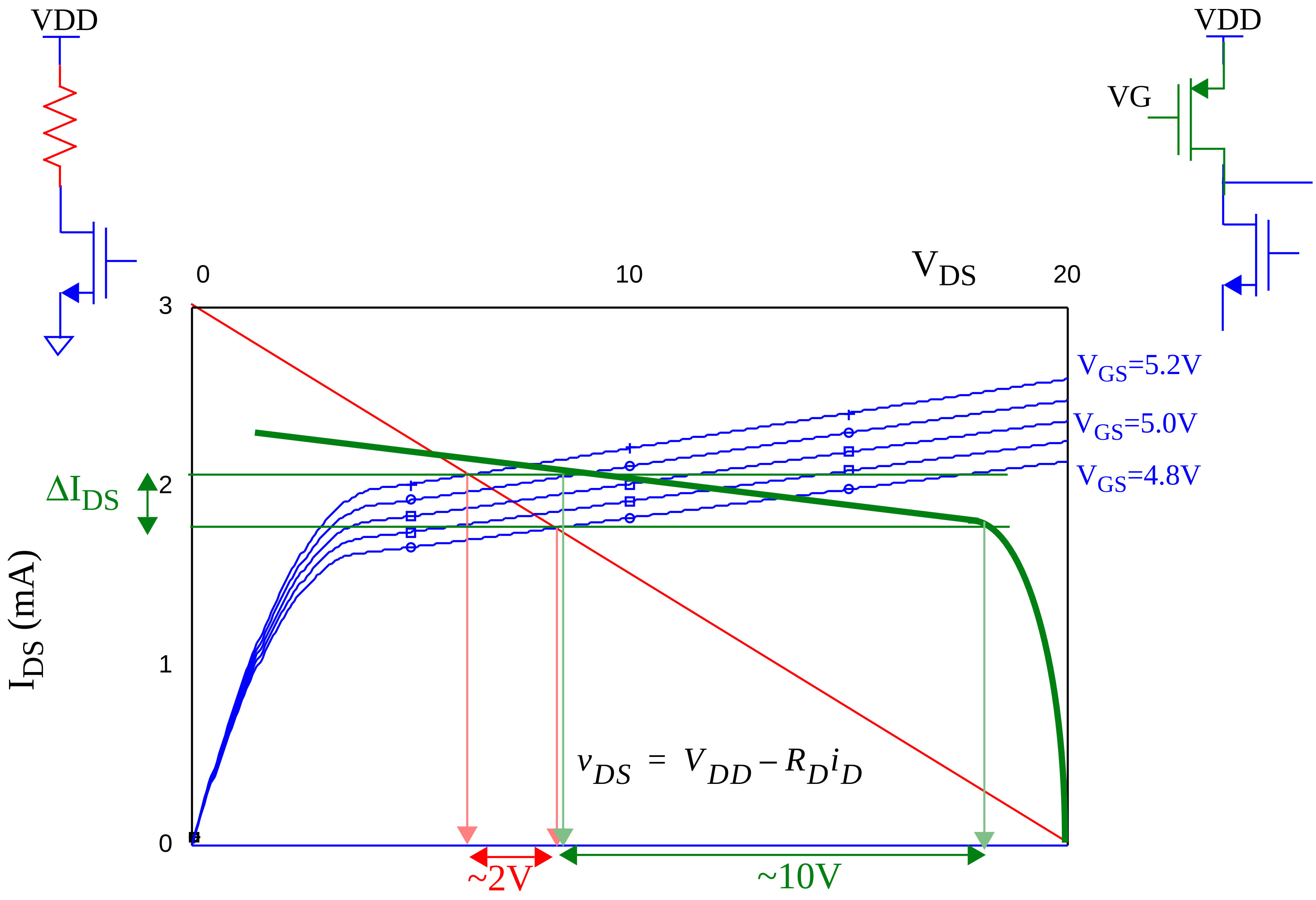
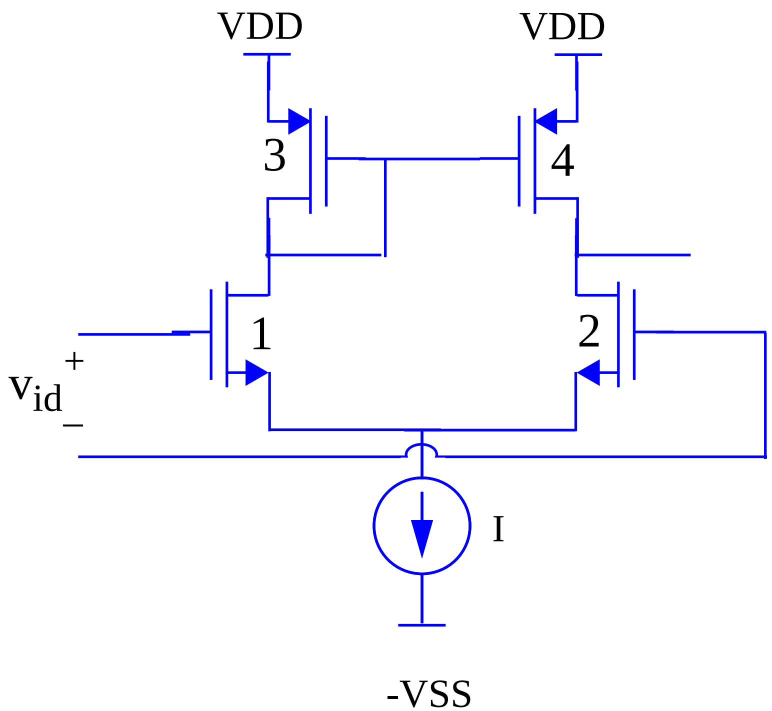
Passive Loads vs Active Loads

- MOS diff amp loads are generally transistors on ICs

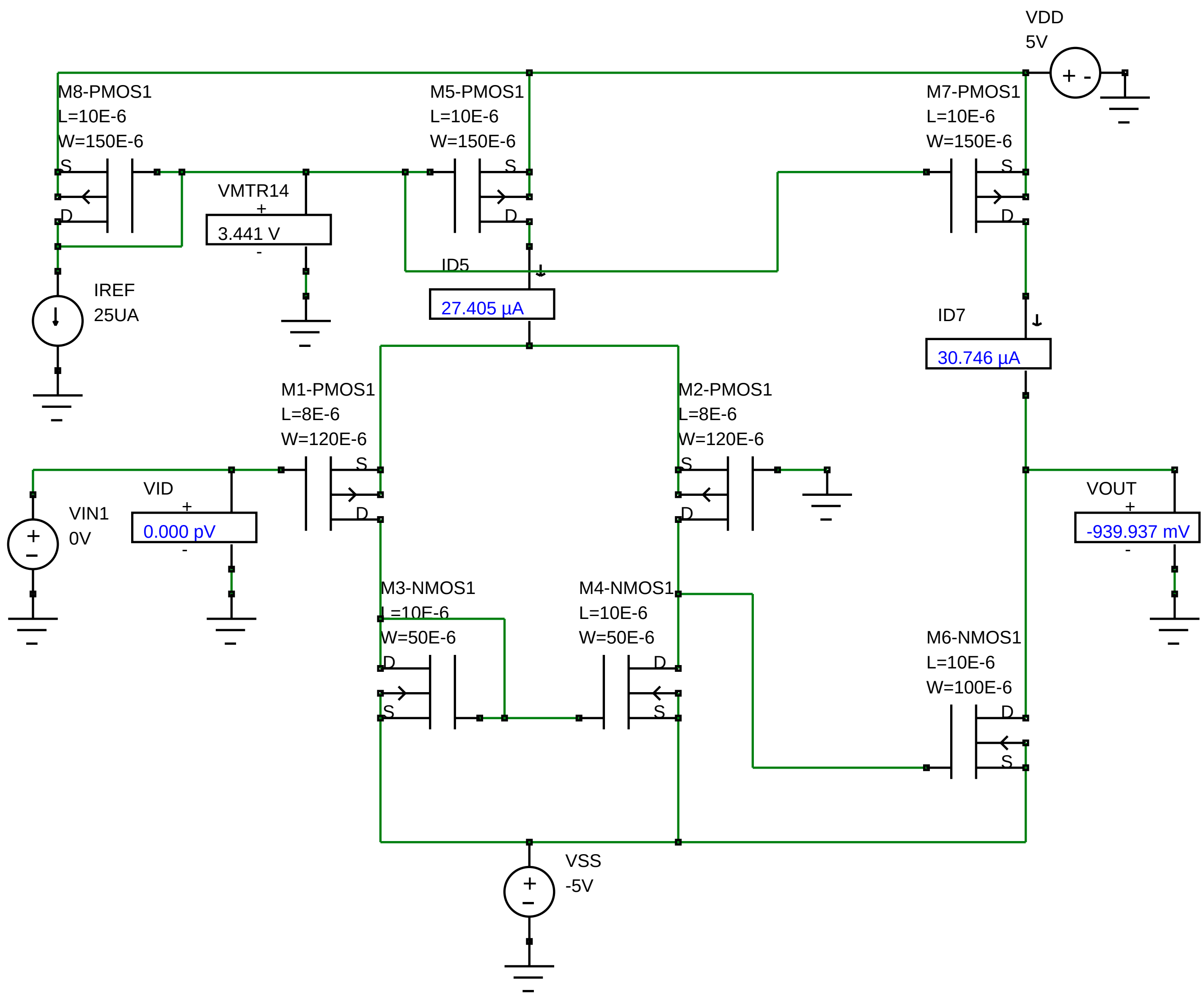


Active Loads

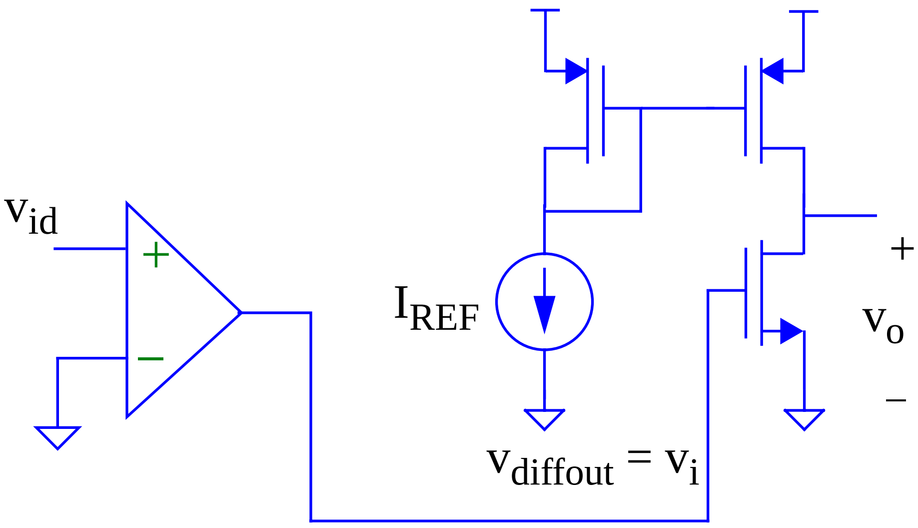
- MOS diff amp loads are generally transistors in ICs



Two Stage OpAmp

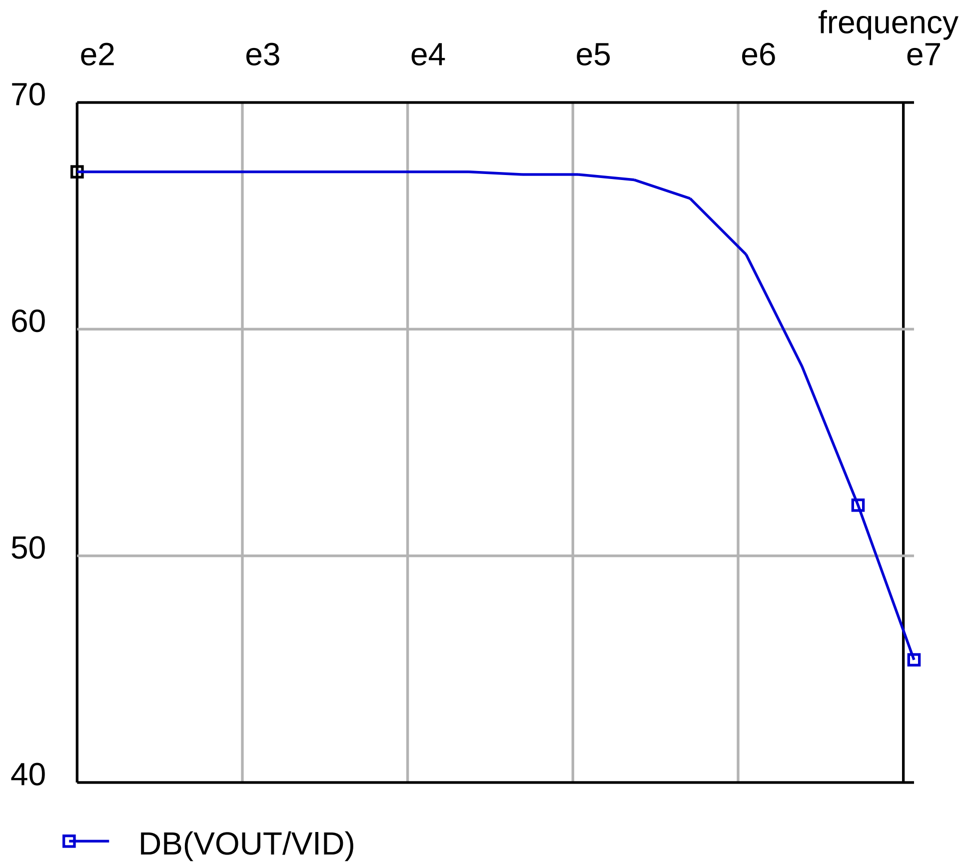


Two Gain Stages

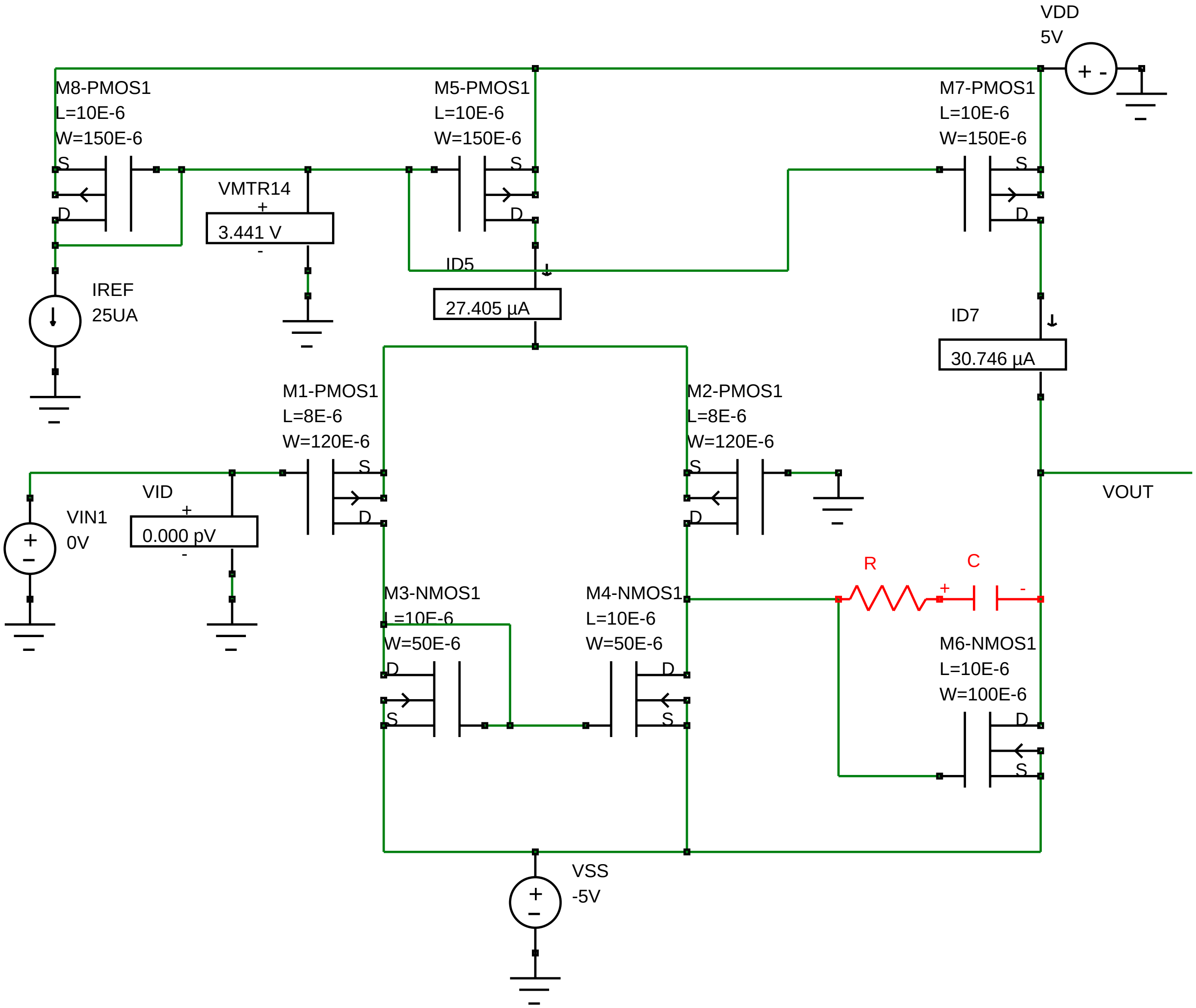


Two Stage OpAmp

- The overall gain is the product of the two stage gains

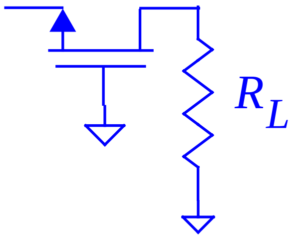


Compensation



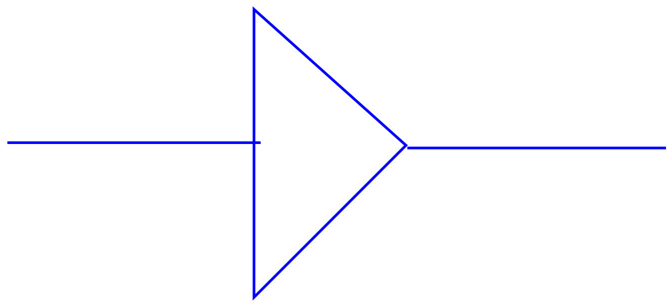
Common Gate Configuration

$r_{in} =$

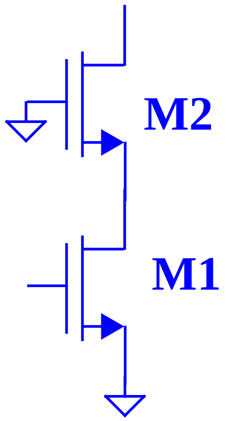


Common Gate Configuration

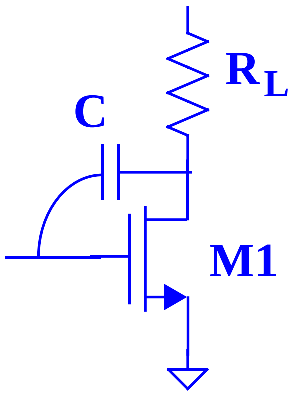
- Common gate configutation acts as a current buffer (just like common base)

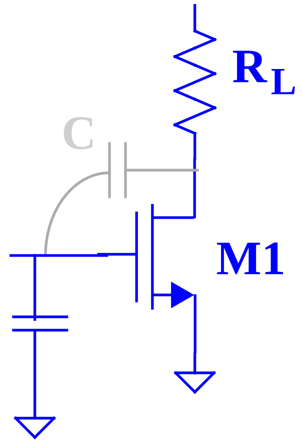


Cascode

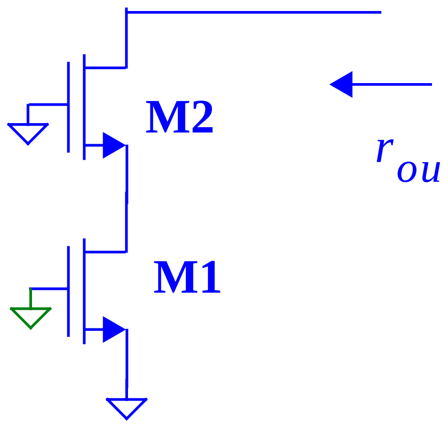


- Cascade of common source and common gate stages.
- Broader frequency band than common source
- Higher output impedance than common source



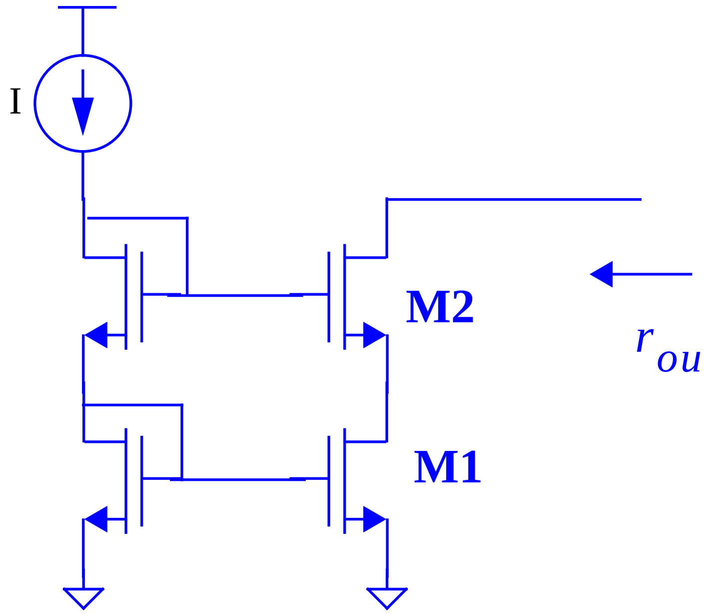


Cascode - increased output impedance



$r_{out} =$

Cascode current source - increased output impedance

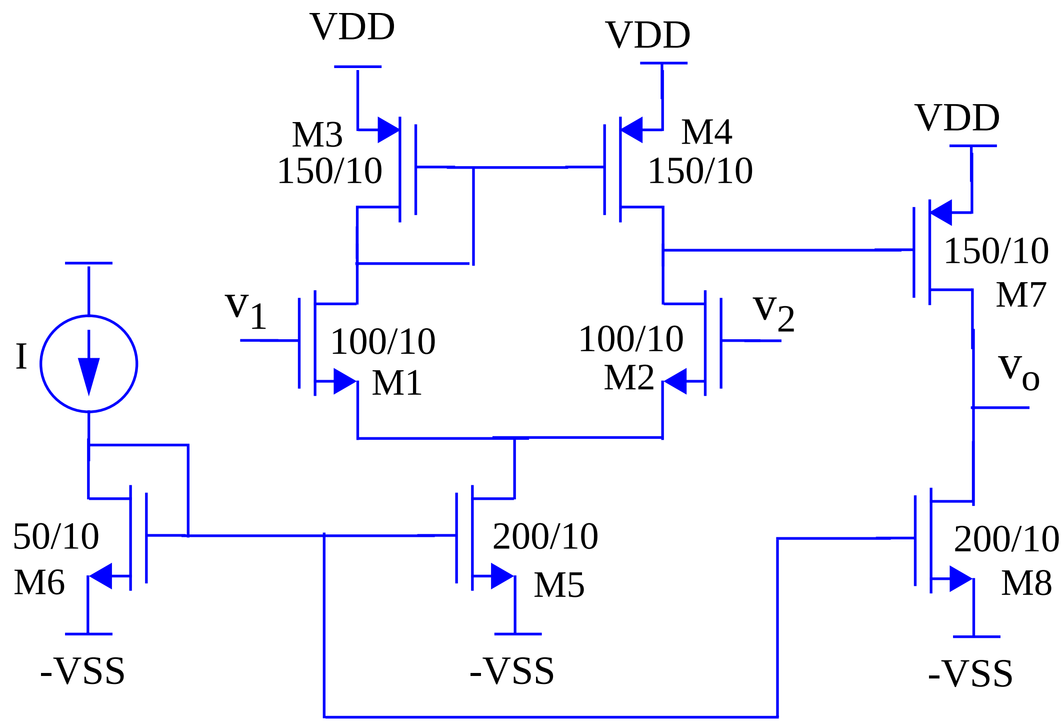


$r_{out} =$

Problem from previous year's exam#3

Calculate the midband gain ($v_o/(v_1-v_2)$) as a function of I (the reference current) for the two-stage CMOS opamp shown below. Assume that all of the biasing is working properly. Show all of your work!

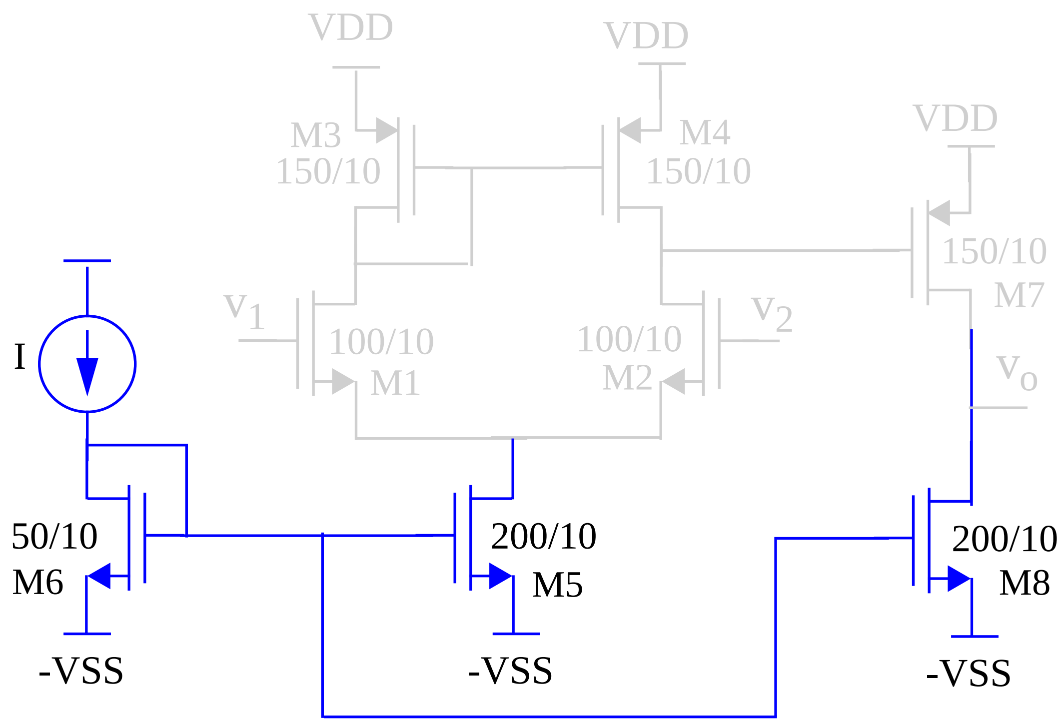
$$\lambda_p = 0.02$$
$$\lambda_n = 0.01$$
$$\mu_p C_{ox} = 20\mu A/V^2$$
$$\mu_n C_{ox} = 20\mu A/V^2$$



1. Calculate currents of M5 and M8

Calculate the midband gain ($v_o/(v_1-v_2)$) as a function of I (the reference current) for the two-stage CMOS opamp shown below. Assume that all of the biasing is working properly. Show all of your work!

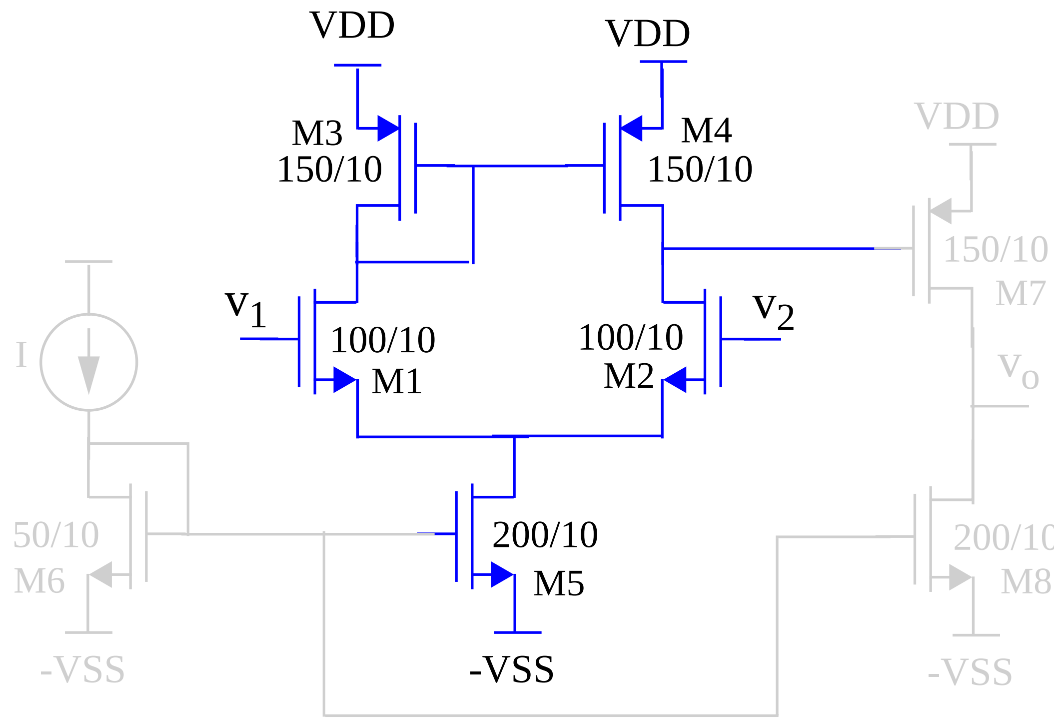
$$\lambda_p = 0.02$$
$$\lambda_n = 0.01$$
$$\mu_p C_{ox} = 20\mu A/V^2$$
$$\mu_n C_{ox} = 20\mu A/V^2$$



2. Calculate gain A_{diff} of the differential stage M5-M1-M2-M3--M4

Calculate the midband gain ($v_o/(v_1-v_2)$) as a function of I (the reference current) for the two-stage CMOS opamp shown below. Assume that all of the biasing is working properly. Show all of your work!

$$\lambda_p = 0.02$$
$$\lambda_n = 0.01$$
$$\mu_p C_{ox} = 20\mu A/V^2$$
$$\mu_n C_{ox} = 20\mu A/V^2$$

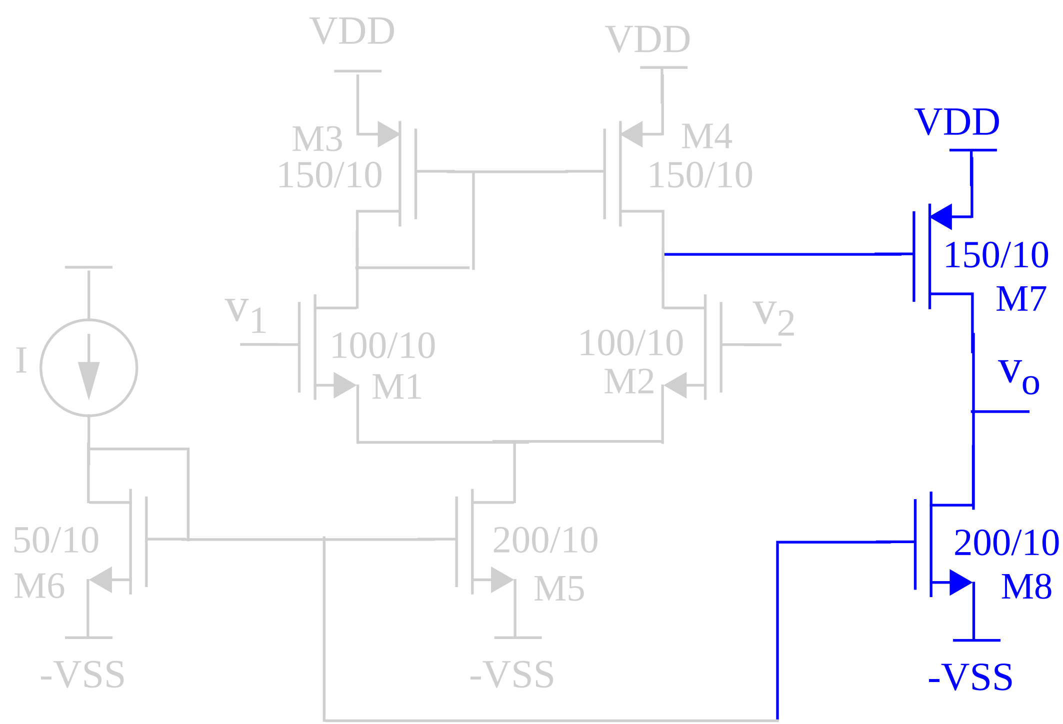


$$g_m = \sqrt{2\mu_n C_{ox}}\sqrt{\frac{W}{L}}\sqrt{I_D}$$

3. Calculate gain of the second stage

Calculate the midband gain ($v_o/(v_1-v_2)$) as a function of I (the reference current) for the two-stage CMOS opamp shown below. Assume that all of the biasing is working properly. Show all of your work!

$$\lambda_p = 0.02$$
$$\lambda_n = 0.01$$
$$\mu_p C_{ox} = 20\mu A/V^2$$
$$\mu_n C_{ox} = 20\mu A/V^2$$



4. Combine gain of both stages

Calculate the midband gain ($v_o/(v_1-v_2)$) as a function of I (the reference current) for the two-stage CMOS opamp shown below. Assume that all of the biasing is working properly. Show all of your work!

$$\lambda_p = 0.02$$
$$\lambda_n = 0.01$$
$$\mu_p C_{ox} = 20\mu A/V^2$$
$$\mu_n C_{ox} = 20\mu A/V^2$$