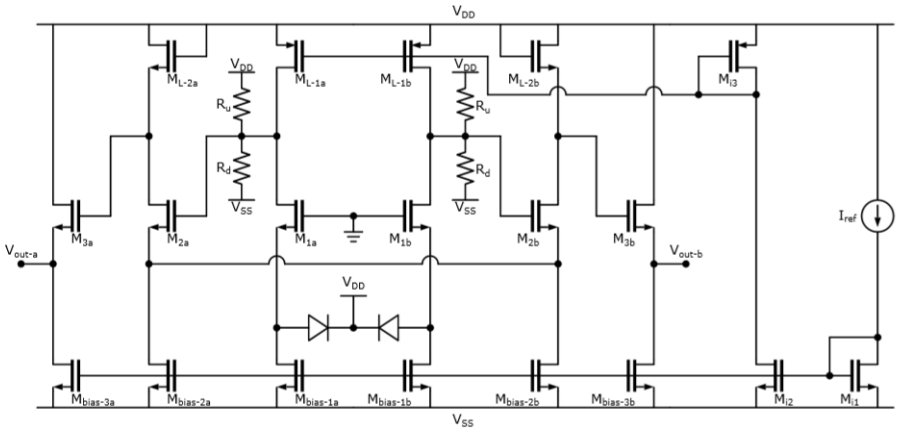
EE214A Design Project

November 10, 2019

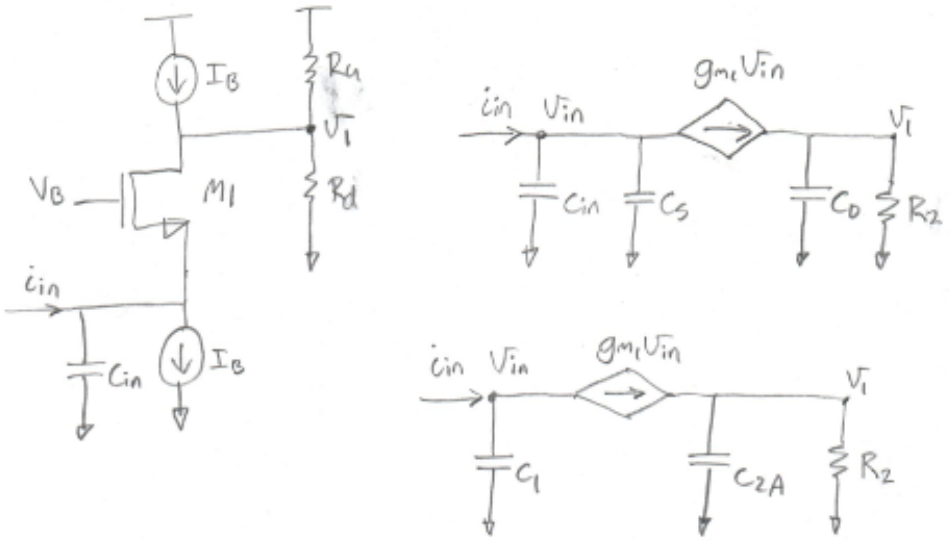


The amplifier under evaluation has 3 stages: Common Gate (CG), Common Source (CS), and Common Drain (CD). In order to analyze, the circuit is broken down into its 3 stages and key parameters are summarized.

The following assumptions are used throughout to simplify analysis.

Simplification of Parasitic Capacitance	
Cdb / Cgs	0.33
Cgd / Cgs	0.25
gm / gm'	0.84

Common Gate:



$$C_{in} = 100fF \tag{1}$$

$$C_S = C_{gs1} + C_{sb1} = cstot(Hspice) \tag{2}$$

$$C_D = C_{gd1} + C_{db1} = cdtot(Hspice) \approx 0.58 * C_{gs1} = 0.58 * (2/3) * (W/L)_1 * C_{ox} \tag{3}$$

Condensed

$$C_1 = 100fF + C_S \tag{4}$$

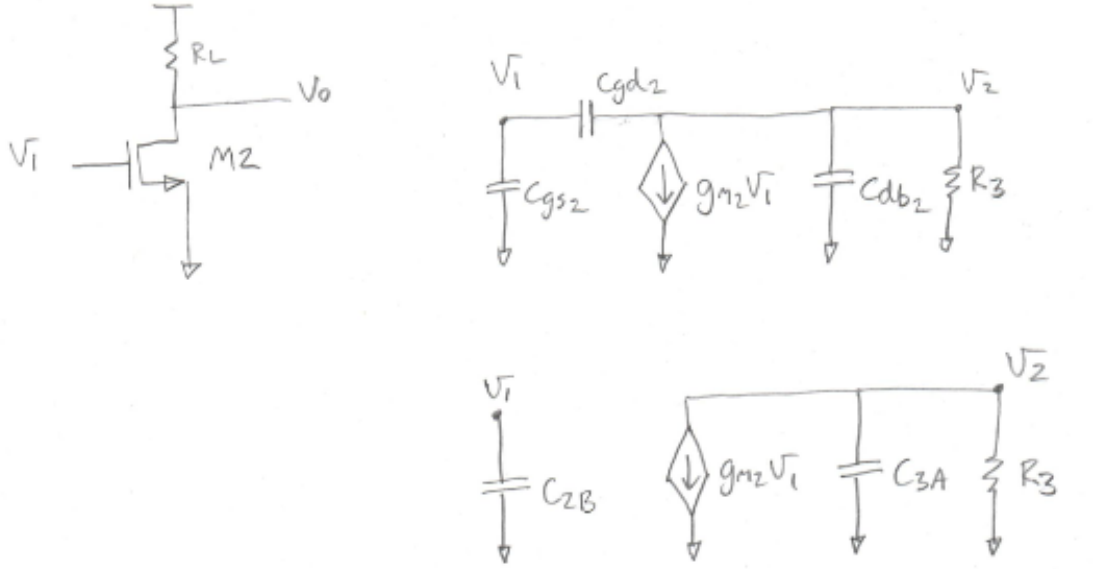
$$C_{2A} = C_D \tag{5}$$

Setting $R_u = R_d = R$

$$R_{L1} = 2 * R \tag{6}$$

Low Frequency Characteristics	
Transimpedance	R_{L1}
Rin	1/gm1
Rout	ro

Common Source:
The source of the common source stage is referenced to virtual, small-signal ground in the DM half circuit, so parasitic capacitances to base can be neglected.



Using Miller Approximation:

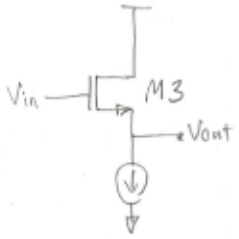
$$A = g_{m2} * R_{L2} \tag{7}$$

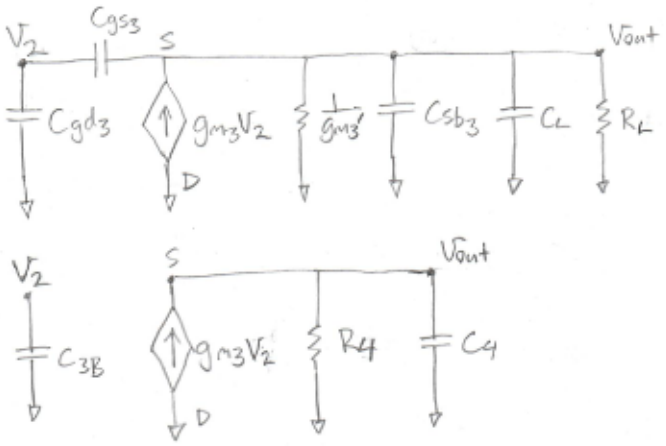
$$C_{2B} = C_{gs2} + (1 + A) * C_{gd2} \tag{8}$$

$$C_{3A} = C_{db2} + (1 + 1/A) * C_{gd2} \tag{9}$$

Low Frequency Characteristics	
Av	-gm2*R_{L2}
Rin	inf
Rout	R_{L2}

Common Drain:





$$C_L = 250fF \tag{10}$$

$$R_L = 20k\Omega \tag{11}$$

Using Miller Approximation:

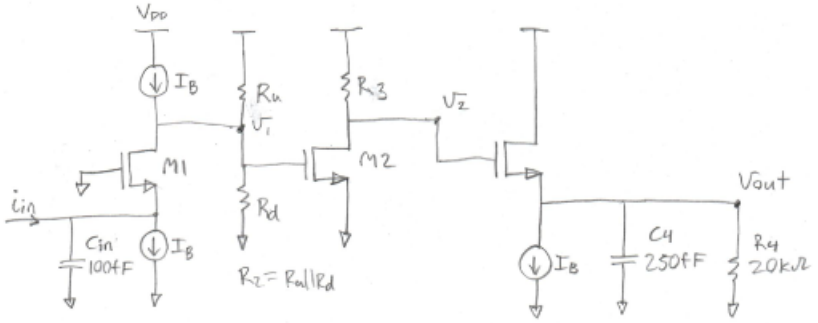
$$A \approx -\frac{g_{m3}}{g'_{m3}} \approx -0.84 \tag{12}$$

$$C_{3B} = C_{db3} + 0.14 * C_{gs3} \tag{13}$$

$$C_4 = -0.2 * C_{gs3} + C_{sb3} + C_L \tag{14}$$

$$R_L = 20k\Omega \tag{15}$$

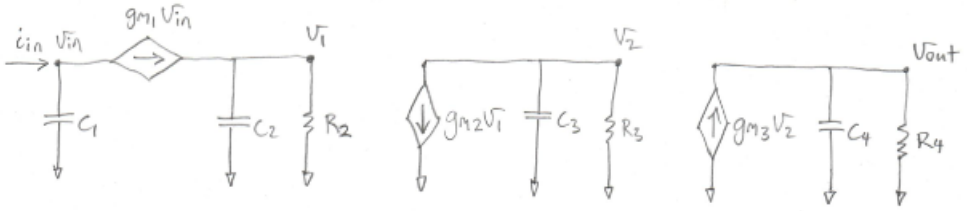
Full Schematic



Low frequency gain:

$$Av = -0.84 * g_{m1} * g_{m2} * R_2 * R_3 \tag{16}$$

Full Small-Signal Model



ZVTC bandwidth (conservative approximation)

$$b1 = \frac{1}{g_{m1}} * C_1 + R_2 * C_2 + R_3 * C_3 + R_4 * C_4 \tag{17}$$

where

$$C_1 = 100fF + C_{gs1} + C_{sb1} \tag{18}$$

$$R_2 = variable \tag{19}$$

$$C_2 = C_{gd1} + C_{db1} + C_{gs2} + (1 + A) * C_{gd2} \tag{20}$$

$$R_3 = variable \tag{21}$$

$$C_3 = C_{db2} + (1 + 1/A) * C_{gd2} + C_{db3} + 0.14 * C_{gs3} \tag{22}$$

$$R_4 = 20k\Omega \tag{23}$$

$$C_4 = -0.2 * C_{gs3} + C_{sb3} + 250fF \tag{24}$$