EE539: Analog Integrated Circuit Design

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COMPARISON OF COMMON SOURCE , CASCODE AND CASCADE STAGES.

PARAMETER	COMMON SOURCE	CASCODE	CASCADE
Transconductance	g_{m1}	g_{m1}	$\frac{g_{m1}}{g_{ds1}} g_{m2}$
Output impedance	$\frac{1}{g_{ds1}}$	$\frac{g_{m2}}{g_{ds1} g_{ds2}} + \frac{1}{g_{ds1}} + \frac{1}{g_{ds2}}$	$\frac{1}{g_{ds2}}$
DC gain	$\frac{g_{m1}}{g_{ds1}}$	$\frac{g_{m1} g_{m2}}{g_{ds1} g_{ds2}} + \frac{g_{m1}}{g_{ds1}} + \frac{g_{m2}}{g_{ds2}}$	$\frac{g_{m1}}{g_{ds1}} \frac{g_{m2}}{g_{ds2}}$

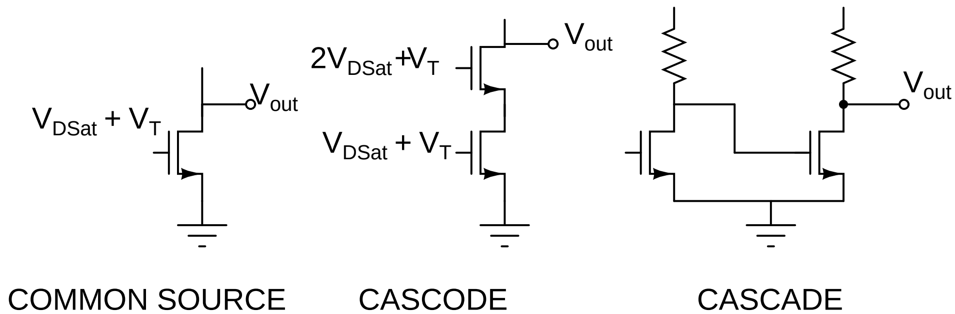


Figure 1: COMMON SOURCE, CASCODE AND CASCADE STAGES

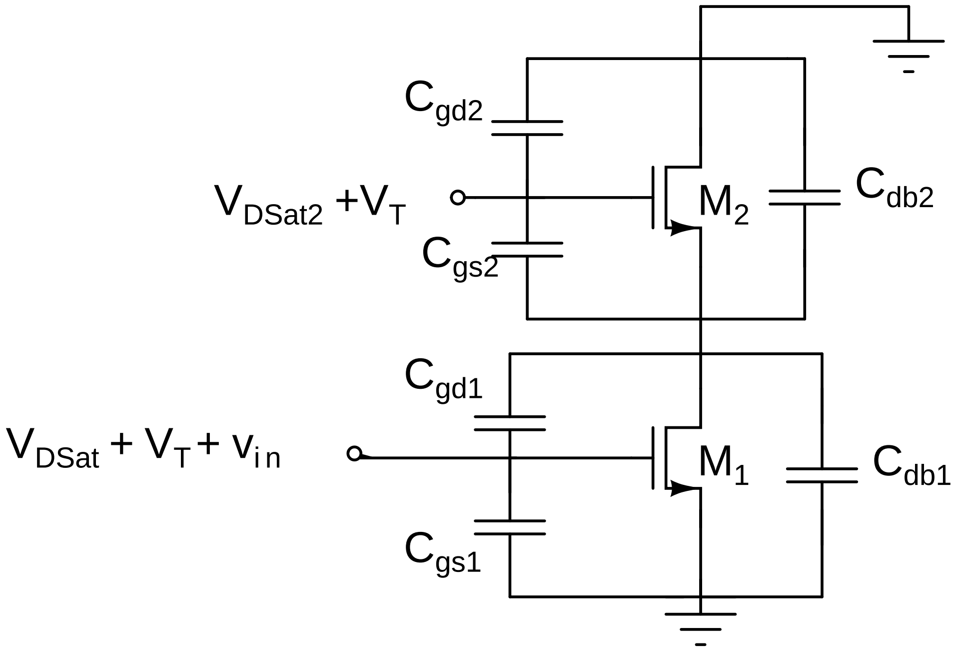


Figure 2: CASCODE

FREQUENCY RESPONSE OF CASCODE

We consider the case when drain of the transistor is shorted,the result holds true if R_L is small

- Only if source impedance is present,then C_{gs1} will contribute to poles.
- The voltage gain at output of M_1 is $\frac{g_{m1}}{g_{m2}+g_{mbs2}}$, so miller multiplication for C_{gd1} is small.
- The transfer function should look like a first order LPF , as at high frequencies $C_{db1} + C_{gs2}$ will be a short.
- The voltage transfer function will have two poles.
  - The High frequency pole at $P_2 = \frac{g_{m2}+g_{ds1}}{C_{db1}+C_{gs2}}$.
  - The Low frequency pole at $P_1 = \frac{1}{R_L(C_{db2}+C_{gd2})}$.

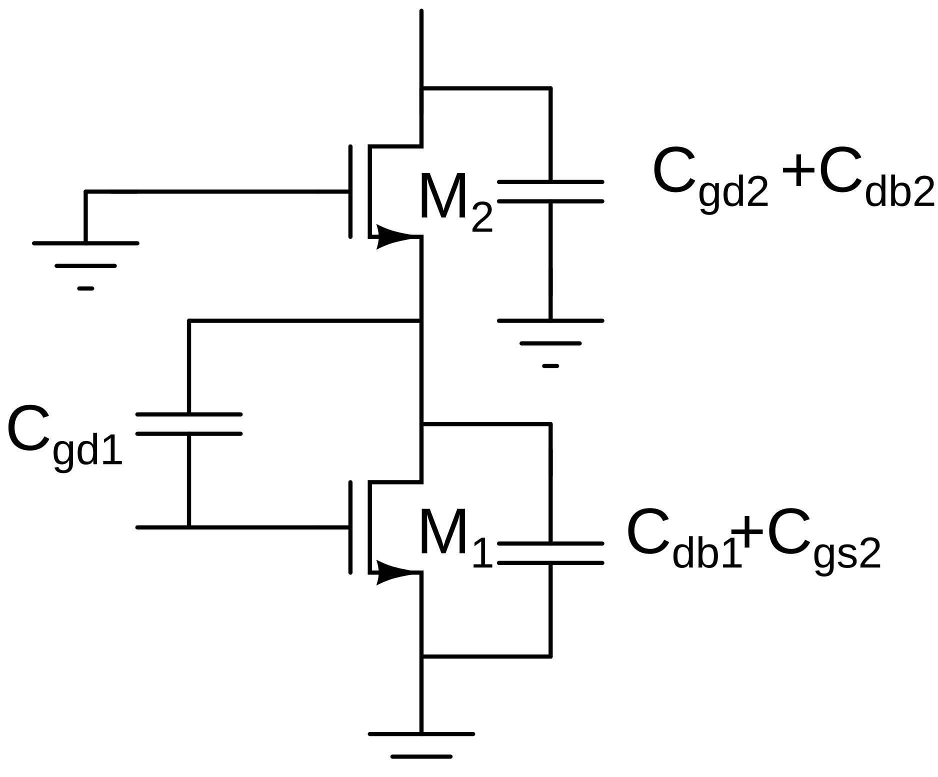


Figure 3: CASCODE

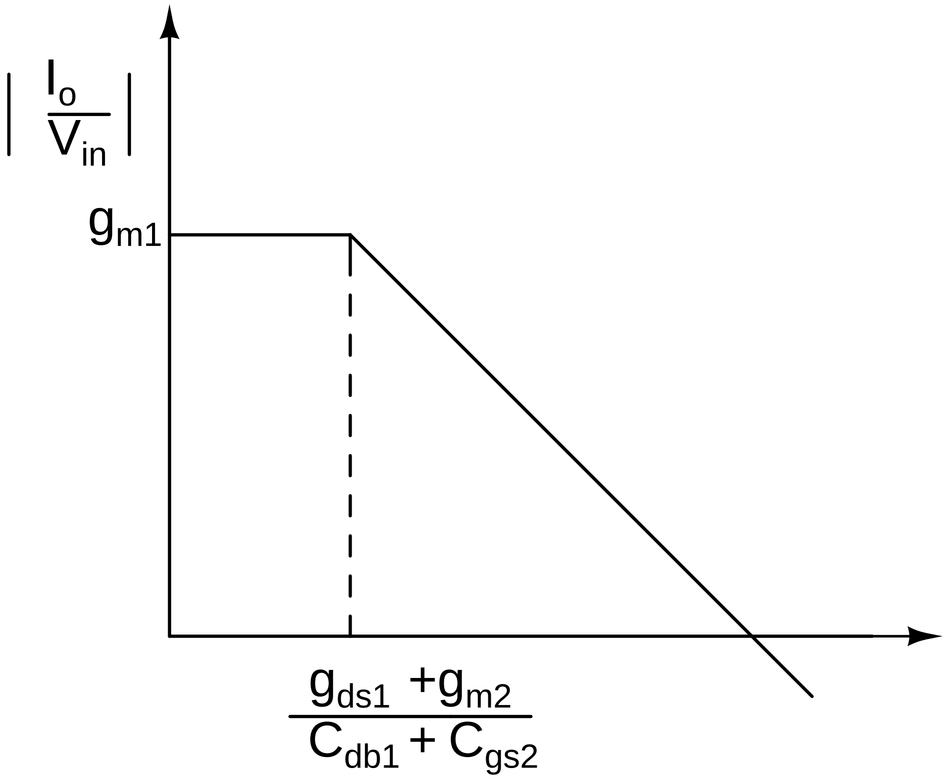


Figure 4: FREQUENCY RESPONSE OF CASCODE

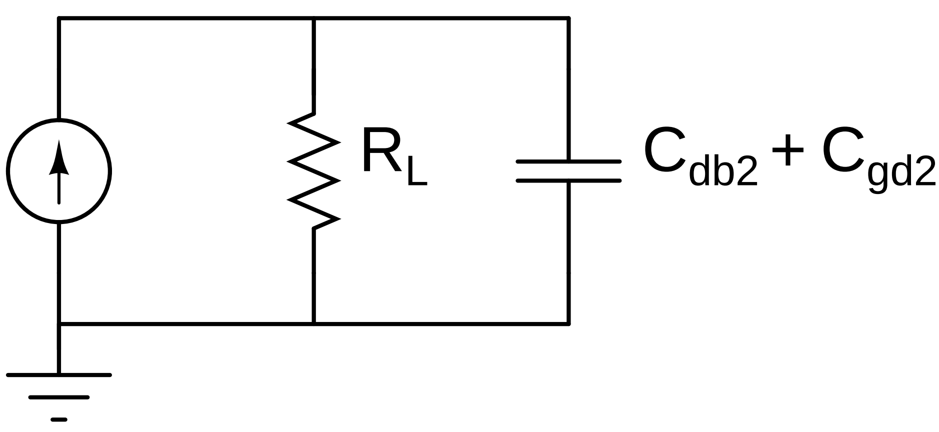


Figure 5: FREQUENCY RESPONSE OF CASCODE

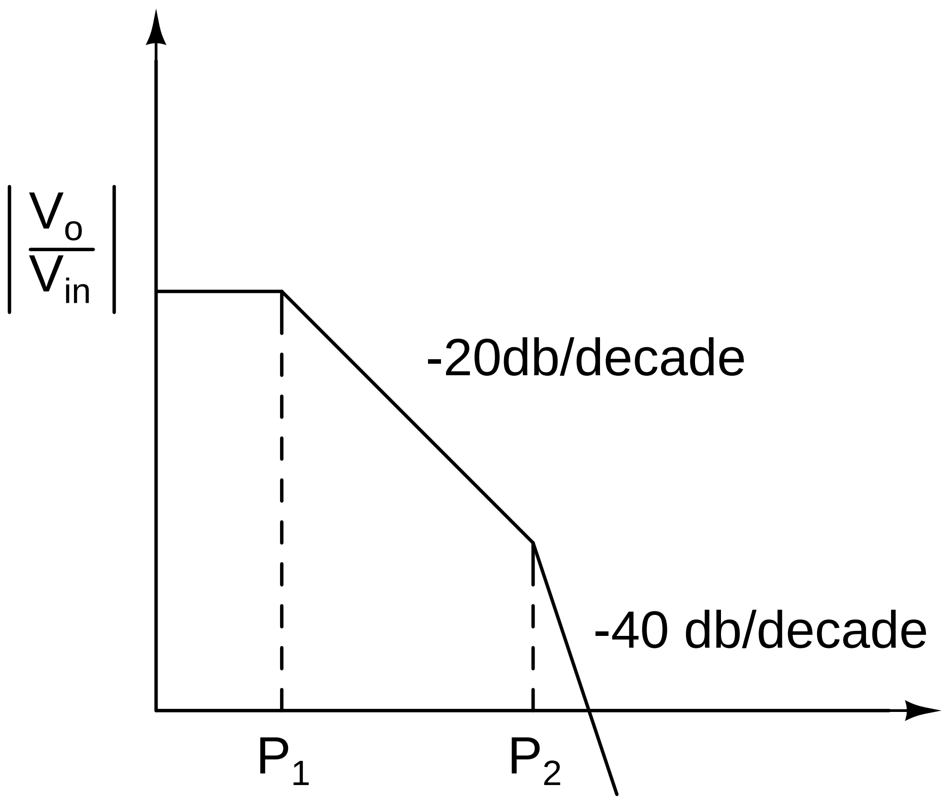
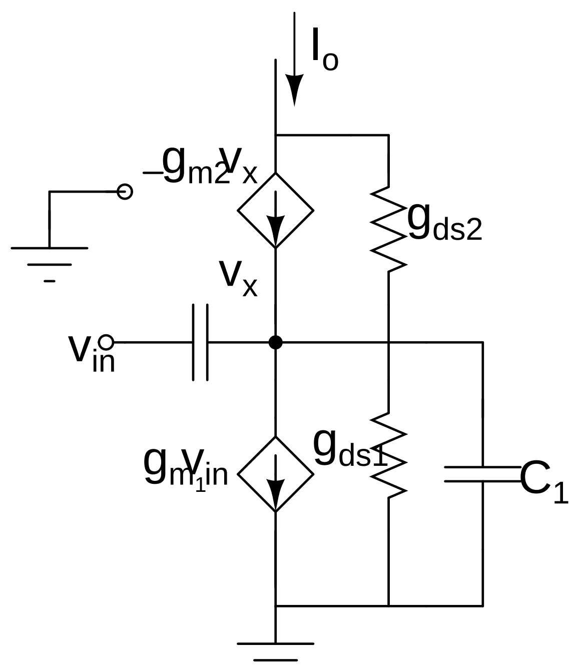


Figure 6: FREQUENCY RESPONSE OF CASCODE



I o
g m2 v x
g ds2
v x
v in
g ds1
g m1 v in
C 1

Let $C_1 = C_{db1} + C_{gs2}$

$$I_o = g_{m1}V_{in} + V_x s(C_1 + C_{gd1}) - V_{in}sC_{gd1} + V_x g_{ds1} \quad (1)$$

$$I_o = -(g_{m2} + g_{ds2})V_x \quad (2)$$

$$\frac{I_o}{V_{in}} = \frac{g_{m1} - sC_{gd1}}{1 + s(\frac{C_1+C_{gd1}}{g_{m2}+g_{ds2}}) + \frac{g_{ds1}}{g_{m2}+g_{ds2}}} \quad (3)$$

☛ Note that there is a difference in DC gain between approximate and actual analysis.This difference is due to the current flowing through g_{ds1}, which was neglected in approximate analysis.The DC gain in approximate analysis was g_{m1} and in actual analysis is $\frac{g_{m1}}{1+\frac{g_{ds1}}{g_{m2}+g_{ds2}}}$