

EE3235 Analog Integrated Circuit Analysis and Design I

Homework 2

Elementary Gain Stages

Due date: 2023.10.25 (Wed.) 23:30 (upload to eeclass system)

Suppose $V_{DD}=1.8V$, temperature=25°C, TT corner in this homework.

Please note that:

1. **No delay allowed.**
2. Please hand in your report using eeclass system.
3. Please generate your report with **pdf** format, name your report as [HWX_studentID_name.pdf](#).
4. Please hand in the spice code file (.sp) for each work. Do not include output file.
5. Please print waveform with [white background](#), and make sure the X, and Y labels are clear.
6. Please do not zip your report.

Part I – Common Source Amplifier

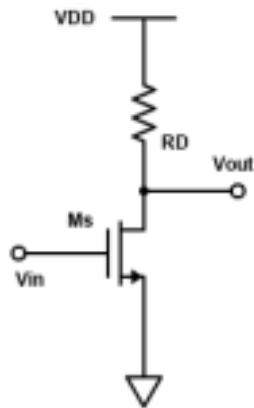


Fig. 1. Common source amplifier.

In part I, as shown in Fig. 1, you are to run HSPICE and design a common source amplifier with the SPEC shown in Tab. I. Note that V_{out} is required to be biased at 0.8V (only $\pm 10mV$ V_{out} error is permitted).

TABLE I
COMMON SOURCE PERFORMANCE TABLE

Working Item	SPEC	Your Design	Hand Calculation
V_{DD}	1.8V	1.8V	1.8V
$V_{in,DC}$	0.8V	0.8V	0.8V
$V_{out,DC}$	0.8V	_____	_____
Gain A_V	> 3.2(V/V)	_____	_____
R_D	< 90K Ω	_____	-
I_D	< 30 μ A	_____	-
M_S W/L	-	_____	-

(1) DC Swee

Please probe V_{out} v.s. V_{in} and measure the derivative of V_{out} when V_{in} is 0.8V.

(2) TF Analysis

Please run the following command in HSPICE to measure the I/O impedance and DC gain A_V . Is A_V close to the result in (1)? Why?

.tf V(V_{out}) V_{in}

(3) Hand Calculation and Discussion

Show your operating point list in the report.

Calculate the **DC gain**, $V_{out,DC}$, and **output impedance** R_{out} , finish Tab. I and compare the simulation result with your hand calculation.

How do you design your common source amplifier to meet the SPEC? Describe your design considerations.

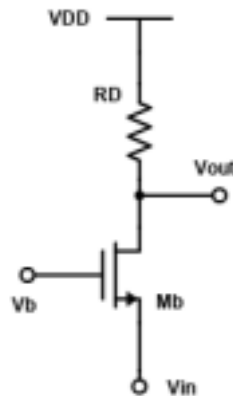
Part II – Common Gate

Fig. 2. Common gate.

In part II, as shown in Fig. 2, you are to run HSPICE and design a common gate stage with the SPEC shown in Tab. II. Note that V_{out} is required to be biased at 0.9V (only $\pm 10\text{mV}$ V_{out} error is permitted).

TABLE II
COMMON GATE PERFORMANCE TABLE

Working Item	SPEC	Your Design	Hand Calculation
V_{DD}	1.8V	1.8V	1.8V
$V_{in,DC}$	0.16V	0.16V	0.16V
$V_{out,DC}$	0.9V	_____	_____
Gain A_V	> 10(V/V)	_____	_____
R_D	< 90K Ω	_____	-
I_D	< 30 μA	_____	-
V_b	-	_____	-
M_b W/L	-	_____	-

(1) DC Sweep

Please probe V_{out} v.s. V_{in} and measure the derivative of V_{out} when V_{in} is 0.16V.

(2) TF Analysis

Please run .tf analysis in HSPICE to measure the I/O impedance and DC gain A_V . Is A_V close to the result in (1)? Why?

(3) Hand Calculation and Discussion

Show your operating point list in the report.

Calculate the **DC gain**, $V_{out,DC}$, and **I/O impedance** R_{in} , R_{out} , finish Tab. II and compare the simulation result with your hand calculation.

How do you design your common gate stage to meet the SPEC? Describe your design considerations.

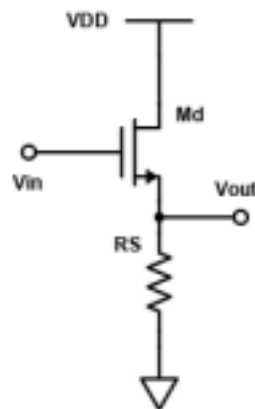
Part III – Source Follower

Fig. 3. Source follower.

In part III, as shown in Fig. 3, you are to run HSPICE and design a source follower with the SPEC shown in Tab. III. Note that V_{out} is required to be biased at 0.8V (only $\pm 10\text{mV}$ V_{out} error is permitted).

TABLE III

SOURCE FOLLOWER PERFORMANCE TABLE

Working Item	SPEC	Your Design	Hand Calculation
V_{DD}	1.8V	1.8V	1.8V
$V_{in,DC}$	1.6V	1.6V	1.6V
$V_{out,DC}$	0.8V	_____	_____
Gain A_V	>0.75(V/V)	_____	_____
R_S	< 90K Ω	_____	-
I_D	< 30 μA	_____	-
M_d W/L	-	_____	-

(1) DC Sweep

Please probe $\partial V_{\text{out}} / \partial V_{\text{in}}$ v.s. V_{in} and describe your observation.

(2) TF Analysis

Please run .tf analysis in HSPICE to measure the I/O impedance and DC gain A_v .

(3) Hand Calculation and Discussion

Show your operating point list in the report.

Calculate the **DC gain**, $V_{\text{out,DC}}$, and **Output impedance** R_{out} , finish Tab. III and compare the simulation result with your hand calculation.

How do you design your source follower to meet the SPEC? Describe your design considerations.