ECE4902 Lecture 7

Common Source with Active Load
Design Example

Bandwidth (6.2)
Miller Effect

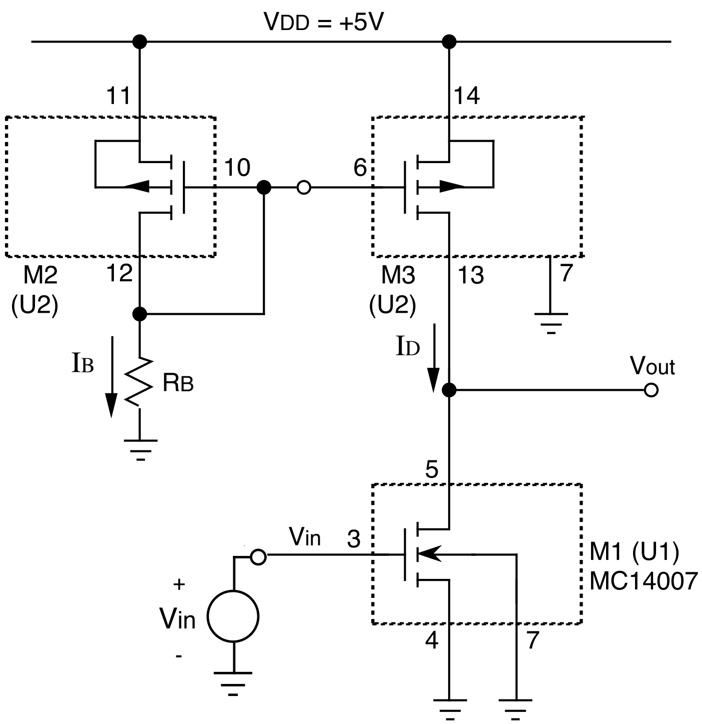
Differential Pair

Hand In:
HW 3

Handouts:
Design Example
Transfer Function: Poles & Nodes
Miller Effect
3 Cases of Differential Pair
Bartlett's Bisection Theorem
Lab 7 Differential Pair Circuits

Design example: common source amplifier with active load

Determine input DC bias and value of R_B required for V_{OUT} DC bias of 2.5V and DC drain current of 100μA



Example process parameters		NMOS	PMOS	Units
Threshold voltage	V_t	+1.50	-1.50	V
Mobility- C_{ox} product	μC_{ox}	7.0 E-6	2.5 E-6	A/V^2
Channel length modulation	λ	0.03	0.05	V^{-1}

Transfer function: Poles associated with circuit nodes

Cascade of noninteracting blocks

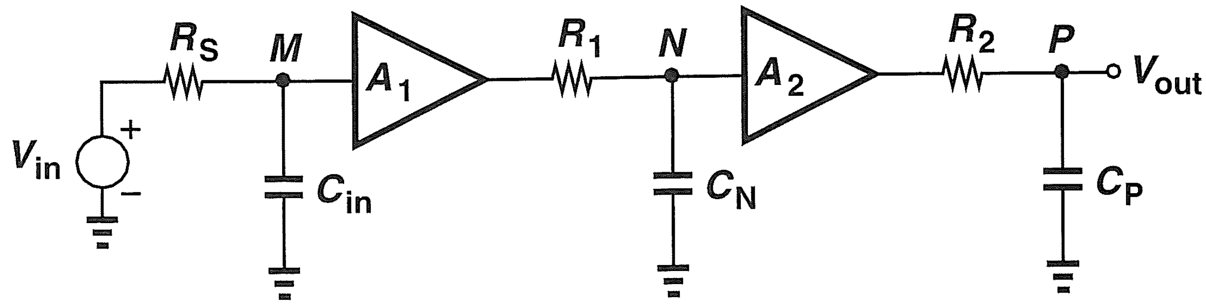
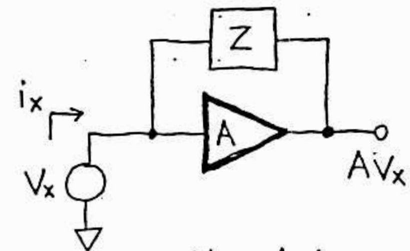


Figure 6.6 Cascade of amplifiers.

Miller effect

EE4902 MILLER EFFECT

Consider any amplifier (not necessarily an op-amp) with gain A, and some impedance Z from input to output: what impedance does it "look like"?



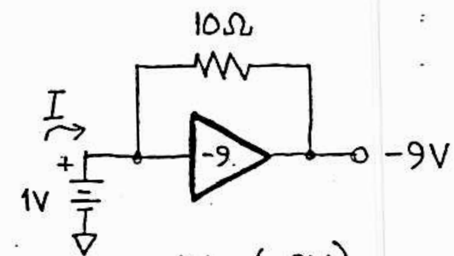
$$i_x = \frac{V_x - AV_x}{Z}$$

$$\boxed{\frac{V_x}{i_x} = \frac{Z}{(1-A)}}$$

Impedance is reduced by factor (1-A)

EXAMPLE: $Z = 10\Omega$ resistor

$A = -9$; $V_x = 1V$



$$I = \frac{1V - (-9V)}{10\Omega} = 1A$$

Applying 1V causes 1A to flow: source "sees" a 1Ω resistor!

$1\Omega = 10\Omega / (1 - [-9])$

WHEN Z IS A CAPACITANCE: $Z = \frac{1}{j\omega C}$

$$\frac{V_x}{i_x} = \frac{1}{j\omega \underbrace{(1-A)C}}$$

APPARENT VALUE OF C MULTIPLIED BY (1-A) !

LARGE INCREASE WHEN A IS INVERTING GAIN

Miller effect in common source stage

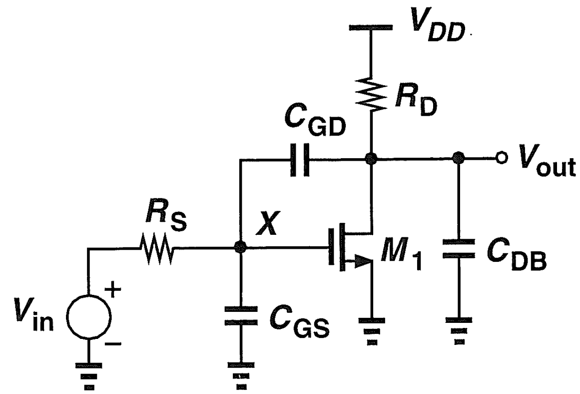
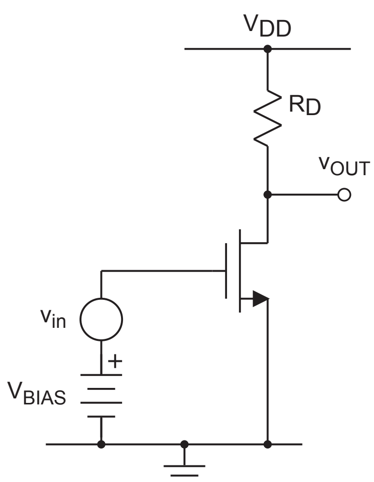


Figure 6.10 High-frequency model of a common-source stage.

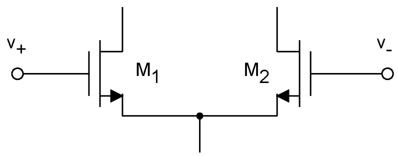
Differential pair motivation:

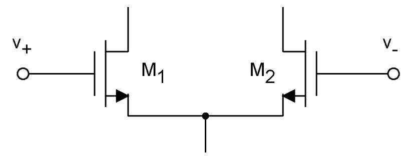
1) Op-amp input

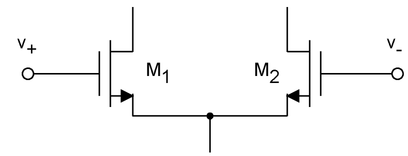
2) DC bias of common source amplifier

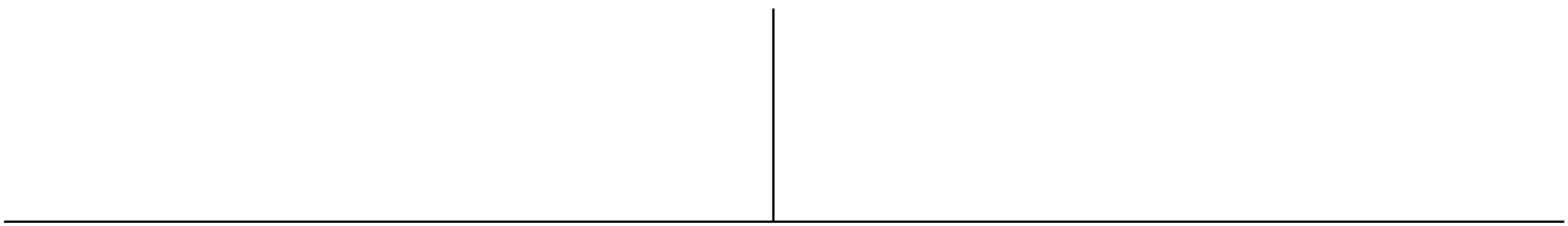


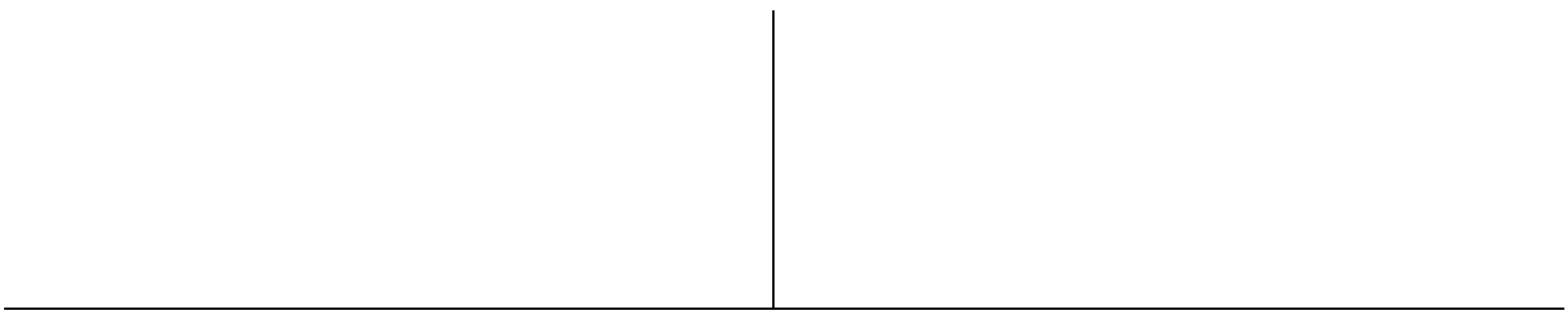
Building up differential amplifier characteristic

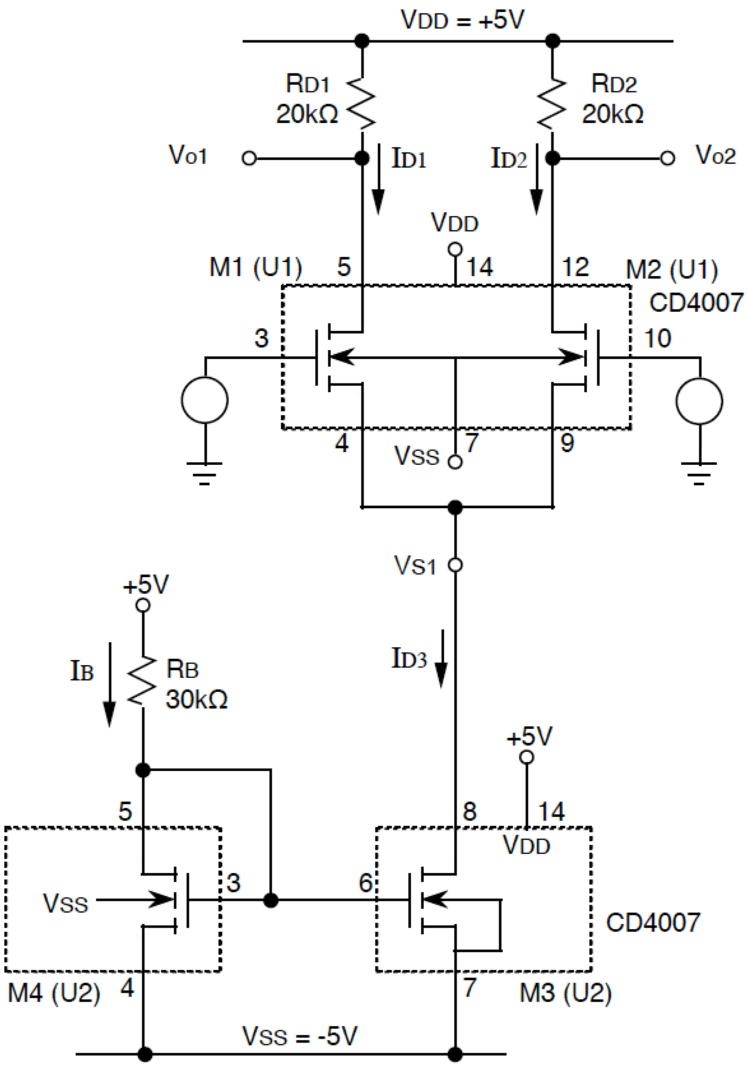











VDD = +5V
RD1
20kΩ
RD2
20kΩ
Vo1
ID1
ID2
Vo2
VDD
M1 (U1)
5
14
12
M2 (U1)
CD4007
3
10
4
VSS
7
9
VS1
+5V
IB
RB
30kΩ
ID3
+5V
5
8
14
VDD
VSS
3
6
CD4007
M4 (U2)
4
7
M3 (U2)
VSS = -5V