

Summer-2019 UM-SJTU JI Ve311 Homework #8

Instructor: Dr. Chang-Ching Tu

Due: 10:00 am, August 01, 2019 (Thursday) in class

Note:

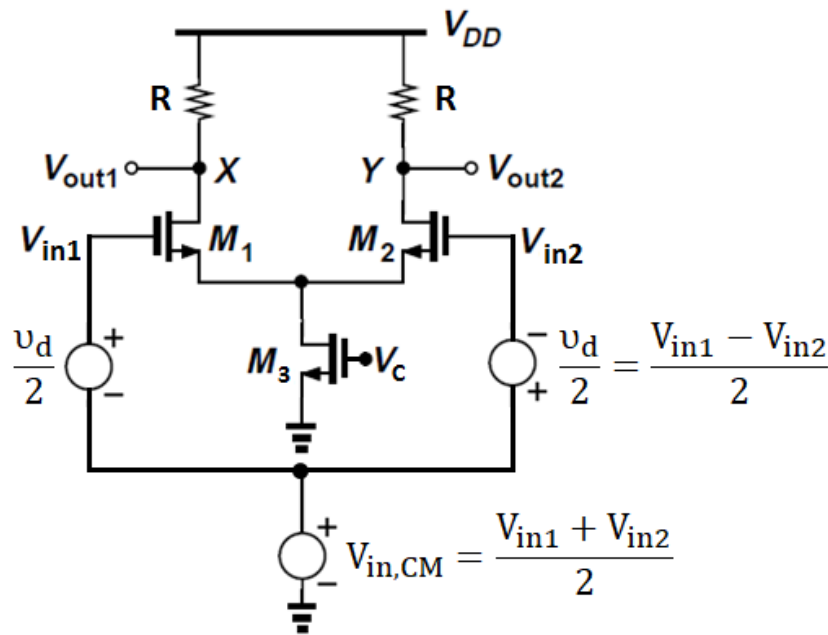
- (1) Please use A4 size papers.
- (2) Please use the SPICE model on page 2 for simulation and calculation.

1. [Differential Pair with Resistive Load]

(a) [40%] ($\lambda = 0$ and $\gamma = 0$) For $V_{DD} = 5$ V, $V_{in,CM} = 2.2$ V, $V_c = 1.2$ V, $R = 5$ k Ω , $(W/L)_1 = (W/L)_2 = 50$ $\mu\text{m} / 2$ μm , $(W/L)_3 = 100$ $\mu\text{m} / 2$ μm , what are the values for A_{DM} and A_{CM} for the circuit below?

(b) [30%] Plot $(V_{out1} - V_{out2})$ as a function of $(V_{in1} - V_{in2})$ (from -4 V to 4 V, i.e. $v_d/2$ increasing from -2 V to 2 V) using Pspice in DC sweep mode. Confirm whether the hand-calculated A_{DM} in (a) is consistent with the simulation result here.

(c) [30%] Plot $V_{out1,2}$ as a function of $V_{in,CM}$ (from 0 V to 5 V), while $v_d/2 = 0$ V, using Pspice in DC sweep mode. Confirm whether the hand-calculated A_{CM} in (a) is consistent with the simulation result here.



NMOS Model

LEVEL = 1	VTO = 0.7	GAMMA = 0.45	PHI = 0.9
NSUB = 9e+14	LD = 0.08e-6	UO = 350	LAMBDA = 0.1
TOX = 9e-9	PB = 0.9	CJ = 0.56e-3	CJSW = 0.35e-11
MJ = 0.45	MJSW = 0.2	CGDO = 0.4e-9	JS = 1.0e-8

PMOS Model

LEVEL = 1	VTO = -0.8	GAMMA = 0.4	PHI = 0.8
NSUB = 5e+14	LD = 0.09e-6	UO = 100	LAMBDA = 0.2
TOX = 9e-9	PB = 0.9	CJ = 0.94e-3	CJSW = 0.32e-11
MJ = 0.5	MJSW = 0.3	CGDO = 0.3e-9	JS = 0.5e-8

VTO: threshold voltage with zero V_{SB} (unit: V)

GAMMA: body effect coefficient (unit: $V^{1/2}$)

PHI: $2\Phi_F$ (unit: V)

TOX: gate oxide thickness (unit: m)

NSUB: substrate doping (unit: cm^{-3})

LD: source/drain side diffusion (unit: m)

UO: channel mobility (unit: $cm^2/V/s$)

LAMBDA: channel-length modulation coefficient (unit: V^{-1})

CJ: source/drain bottom-plate junction capacitance per unit area (unit: F/m^2)

CJSW: source/drain sidewall junction capacitance per unit length (unit: F/m)

PB: source/drain junction built-in potential (unit: V)

MJ: exponent in CJ equation (unitless)

MJSW: exponent in CJSW equation (unitless)

CGDO: gate-drain overlap capacitance per unit width (unit: F/m)

CGSO: gate-source overlap capacitance per unit width (unit: F/m)

JS: source/drain leakage current per unit area (unit: A/m^2)