ELE509E
Current-Mode Analog Circuit Design
Homework 1 (22.10.2004)

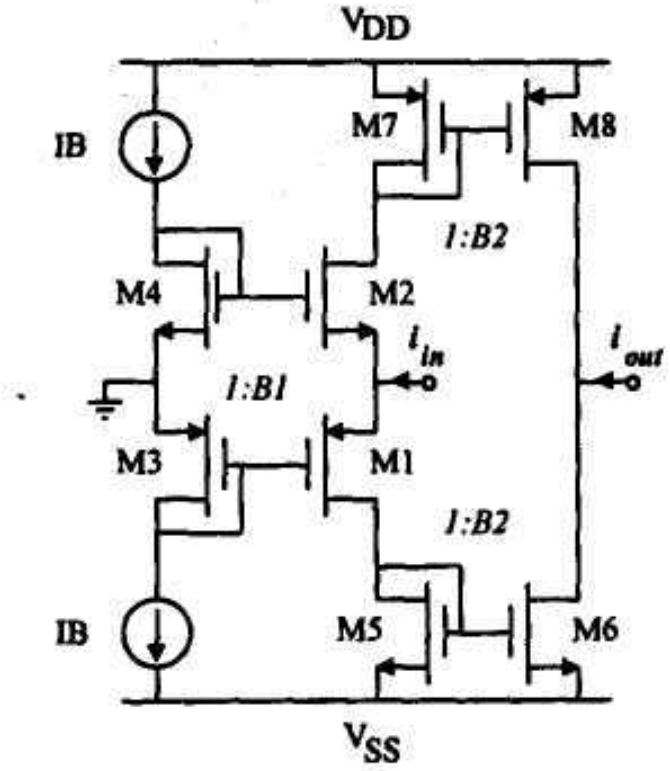

Figure 1

A CMOS current amplifier is shown in Figure 1. The supply voltages and the biasing currents are given as V_{DD} =2.5V, $-V_{SS}$ = -2.5V, I_B = 50μA. The dimensions for M1, M2, M3 and M4 are illustrated in Table 1 and the model parameters of the MOS transistors are given in Table 2.

a) Realize the current sources I_B providing a biasing current of 50μA, determine the transistor dimensions.
b) Determine the dimensions for M5, M6, M7 and M8 to provide a current gain of 3.

Using SPICE simulation results

c) draw the the plot of I_{OUT} against I_{IN},
d) specify the limits of the input current I_{IN} and the output current I_{OUT},
e) draw the frequency response of the current gain and determine the bandwidth of the amplifier,
f) draw the plot of the input impedance against the frequency,

g) draw the plot of the output impedance against the frequency,
h) investigate the large signal behaviour of the amplifier by applying a sinusoidal input current in the passband of the amplifier and observing the total harmonic distortion THD at the output for different input levels; draw the plot of THD against i_{in},
i) investigate the dependence of the output voltage upon the load resistance R_L keeping the input level constant, observe the harmonic distortion THD at the output for each load resistance value; draw the plot of V_O against R_L,
j) Give a detailed evaluation of your results.

Table 1. Transistor dimensions

Transistor	L [μm]	W [μm]
M1	1	10
M2	1	10
M3	1	10
M4	1	10

Table 2. Transistor parameters of 0.5μm CMOS process

.MODEL NT NMOS LEVEL=3

+UO=460.5 TOX=1.0E-8 TPG=1 VTO=.62 JS=1.8E-6 XJ=.15E-6 RS=417 RSH=2.73

LD=0.04E-6 ETA=0 +VMAX=130E3 NSUB=1.71E17 PB=.761 PHI=0.905

THETA=0.129 GAMMA=0.69 KAPPA=0.1 AF=1 +WD=.11E-6 CJ=76.4E-5 MJ=0.357

CJSW=5.68E-10 MJSW=.302 CGSO=1.38E-10 CGDO=1.38E-10 +CGBO=3.45E-10

KF=3.07E-28 DELTA=0.42 NFS=1.2E11

.MODEL PT PMOS LEVEL=3

+UO=100 TOX=1E-8 TPG=1 VTO=-.58 JS=.38E-6 XJ=0.1E-6 RS=886 RSH=1.81
LD=0.03E-6 ETA=0 +VMAX=113E3 NSUB=2.08E17 PB=.911 PHI=0.905
THETA=0.120 GAMMA=0.76 KAPPA=2 AF=1 +WD=.14E-6 CJ=85E-5 MJ=0.429
CJSW=4.67E-10 MJSW=.631 CGSO=1.38E-10 CGDO=1.38E-10 +CGBO=3.45E-10
KF=1.08E-29 DELTA=0.81 NFS=0.52E11