

Homework 2**1) MOS I/V Characteristics HSpice**

- a) Use HSpice to plot the I/V characteristics of an n-channel device ($W=6\mu\text{m}$, $L=1.2\mu\text{m}$) for three gate-source voltages of 1 V, 2 V and 3V, respectively. Use the **dc analysis** and sweep the drain voltage from 0 V to 5 V while the source remains grounded.
- b) Repeat the above exercise for a p-channel device of equal size.
- c) Use your plots to find the equivalent transconductance values g_m and output resistances r_o of the 2 devices under the various bias conditions.

2) MOS Model parameters

- a) Use the BSIM parameters listed on the next page to calculate I_d , g_m , g_{mb} , r_o and λ for the n-channel MOS transistor described in problem 1a).
- b) Repeat your calculations for the p-channel device described in problem 1b).
- c) Compare your results for g_m and r_o with the equivalent values derived from your HSpice plots. Comment on the differences.

3) Common-Source Gain Stage

An n-channel common-source amplifier with $W=6\mu\text{m}$ and $L=1.2\mu\text{m}$ is featuring a bias current of $I_{DQ}=50\mu\text{A}$.

- a) Find the load resistance so that you achieve a dc voltage gain of 50.
- b) Can you find a value for the dc current gain?
- c) How would you realize the load resistance computed above? Explain!

SPICE BSIM3 VERSION 3.1 PARAMETERS

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.MODEL nfet NMOS (
+VERSION = 3.1          TNOM = 27          LEVEL = 49
+XJ = 1.5E-7          NCH = 1.7E17        TOX = 1.39E-8
+K1 = 0.8857752      K2 = -0.0935679      VTH0 = 0.6398186
+K3B = -7.6711263   W0 = 1E-8          K3 = 22.1010569
+DVT0W = 0          DVT1W = 0          NLX = 1E-9
+DVT0 = 2.7950058   DVT1 = 0.4085592    DVT2W = 0
+U0 = 453.2010286   UA = 2.494433E-13  DVT2 = -0.1237812
+UC = 2.022743E-11 VSAT = 1.730467E5   UB = 1.488658E-18
+AGS = 0.1151449   B0 = 2.792031E-6   A0 = 0.5543744
+KETA = -1.371458E-3 A1 = 0          A2 = 5E-6
+RDSW = 1.319508E3 PRWG = 0.0381943   PRWB = 0.0141195
+WR = 1            WINT = 2.507126E-7  LINT = 2.304464E-8
+XL = 0           XW = 0          DWG = -1.755808E-8
+DWB = 4.946821E-8 VOFF = 0          NFACTOR = 0.7910748
+CIT = 0          CDSC = 2.4E-4       CDSCD = 0
+CDSCB = 0       ETA0 = 0.0051332    ETAB = -1.252309E-3
+DSUB = 0.1945608 PCLM = 2.253484    PDIBLC1 = -1
+PDIBLC2 = 2.440187E-3 PDIBLCB = -0.1294159 DROUT = 0.6751288
+PSCBE1 = 5.348212E8 PSCBE2 = 3.233314E-5 PVAG = 0
+DELTA = 0.01    RSH = 80.3        MOBMOD = 1
+PRT = 0         UTE = -1.5       KT1 = -0.11
+KT1L = 0       KT2 = 0.022      UA1 = 4.31E-9
+UB1 = -7.61E-18 UC1 = -5.6E-11    AT = 3.3E4
+WL = 0         WLN = 1          WW = 0
+WWN = 1        WWL = 0          LL = 0
+LLN = 1        LW = 0          LWN = 1
+LWL = 0        CAPMOD = 2       XPART = 0.5
+CGDO = 2.12E-10 CGSO = 2.12E-10    CGBO = 1E-9
+CJ = 4.279445E-4 PB = 0.9616445     MJ = 0.4374524
+CJSW = 3.492439E-10 PBSW = 0.1         MJSW = 0.1245165
+CJSWG = 1.64E-10 PBSWG = 0.1        MJSWG = 0.1245165
+CF = 0         PVTH0 = 0.0431719  PRDSW = -30.376525
+PK2 = -0.0350028 WKETA = -0.0230093  LKETA = 2.090253E-3)
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.MODEL pfet PMOS (
+VERSION = 3.1          TNOM = 27          LEVEL = 49
+XJ = 1.5E-7          NCH = 1.7E17        TOX = 1.39E-8
+K1 = 0.5429357      K2 = 9.433657E-3   VTH0 = -0.9488171
+K3B = -0.8567156   W0 = 1E-8          K3 = 3.2656684
+DVT0W = 0          DVT1W = 0          NLX = 1.48542E-8
+DVT0 = 2.530444    DVT1 = 0.5291909  DVT2W = 0
+U0 = 220.9301068   UA = 3.049951E-9  DVT2 = -0.1040273
+UC = -5.63429E-11 VSAT = 2E5         UB = 1E-21
+AGS = 0.1506017   B0 = 9.121548E-7  A0 = 0.9085767
+KETA = -2.819843E-3 A1 = 0          A2 = 5E-6
+RDSW = 3E3        PRWG = -0.0464229  PRWB = -0.0398483
+WR = 1            WINT = 2.90101E-7  LINT = 4.254314E-8
+XL = 0           XW = 0          DWG = -2.169468E-8
+DWB = 1.788287E-8 VOFF = -0.0659109 NFACTOR = 0.8188201
+CIT = 0          CDSC = 2.4E-4       CDSCD = 0
+CDSCB = 0       ETA0 = 1.380153E-3  ETAB = -0.0429727
+DSUB = 0.7658995 PCLM = 2.0797597  PDIBLC1 = 0.1113965
+PDIBLC2 = 4.521707E-3 PDIBLCB = -0.0437905 DROUT = 0.3065171
+PSCBE1 = 1.25116E10 PSCBE2 = 1.227353E-9 PVAG = 8.477076E-6
+DELTA = 0.01    RSH = 104.9       MOBMOD = 1
+PRT = 0         UTE = -1.5       KT1 = -0.11
+KT1L = 0       KT2 = 0.022      UA1 = 4.31E-9
+UB1 = -7.61E-18 UC1 = -5.6E-11    AT = 3.3E4
+WL = 0         WLN = 1          WW = 0
+WWN = 1        WWL = 0          LL = 0
+LLN = 1        LW = 0          LWN = 1
+LWL = 0        CAPMOD = 2       XPART = 0.5
+CGDO = 2.25E-10 CGSO = 2.25E-10    CGBO = 1E-9
+CJ = 7.308538E-4 PB = 0.9416073     MJ = 0.4948413
+CJSW = 2.852637E-10 PBSW = 0.99        MJSW = 0.3001719
+CJSWG = 6.4E-11  PBSWG = 0.99       MJSWG = 0.3001719
+CF = 0         PVTH0 = 5.98016E-3  PRDSW = 14.8598424
+PK2 = 3.73981E-3 WKETA = 4.127712E-3  LKETA = -2.567864E-3)

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