UNIVERSITY OF CALIFORNIA AT BERKELEY
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1. Figure 1 shows the measured I_D-V_{DS} curves of a 5um/0.15um (W/L) NMOS transistor. (the data file is attached)

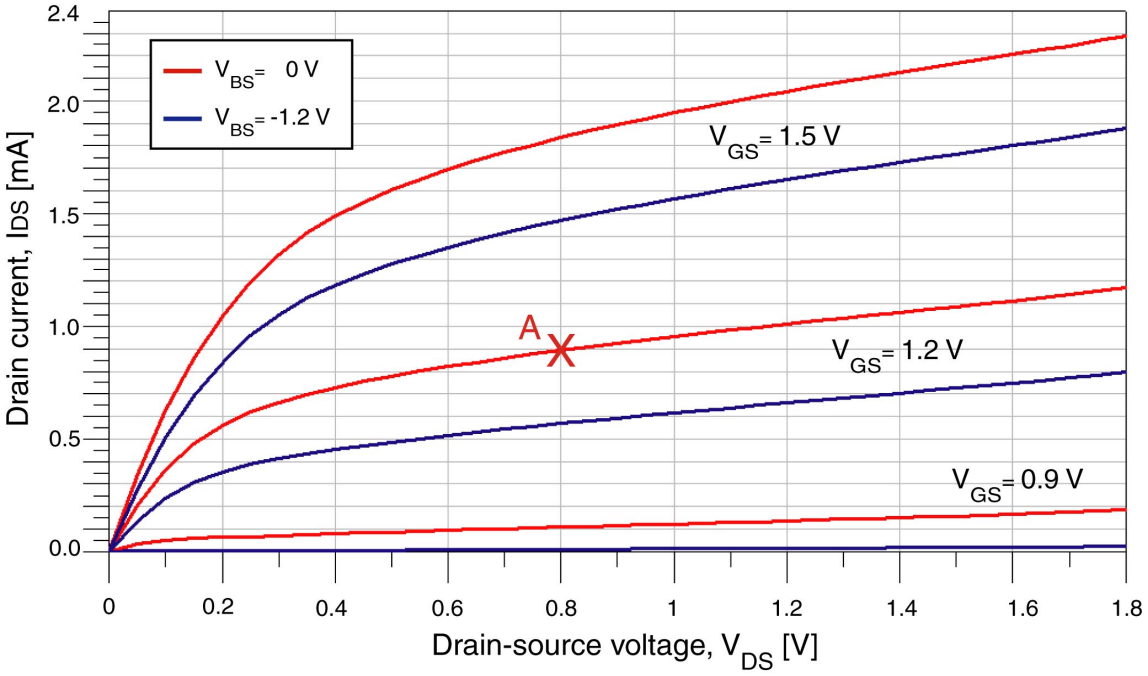

Figure 1

a) Estimate the model parameters (Level 1) V_{T0}, γ, k', and λ of this transistor. (Assume φ_f = 0.3 V)

b) Calculate the small signal parameters (g_m, g_{mb}, and r_o) at the operating point A. (V_{GS} = 1.2 V, V_{BS} = 0, V_{DS} = 0.8 V)

c) Use the results of part (a) to complete the **.model** statement of the following HSPICE netlist to simulate the I_D-V_{DS} curves of figure 1. (the red curves, since V_{BS} = 0)

```
.option nomod post

.model xtor nmos level=1 vt0=xxx gamma=xxx lambda=xxx kp=xxx capop=0

m1 d g 0 0 xtor w=5u l=0.15u
vds d 0 dc=0.8
vgs g 0 dc=1.2
```

```
.probe dc id=i1(m1)
.dc vds start=0 stop=1.8 step=0.01 vgs 0.9 1.5 0.3

.end
```

d) Copy the netlist file (xxx.sp) to your working directory and execute HSPICE and Awaves:

```
c199.> hspice xxx.sp >! xxx.lis
>info:      *****hspice job concluded
c199.> awaves &
```

e) View the results from Awaves and print out the I_D-V_{DS} curves. Compare the measured and simulated curves and comment on the results.
(Load the design from **Design→Open**, and choose the waveform by the **Results Browser**)

f) Modify the netlist (to provide V_{BS} = -1.2 V) and repeat part (d) and (e) for the blue curves of figure 1.

2. Figure 2 shows the measured log(I_D) –V_{GS} curves of the same NMOS transistor. (the data file is attached)

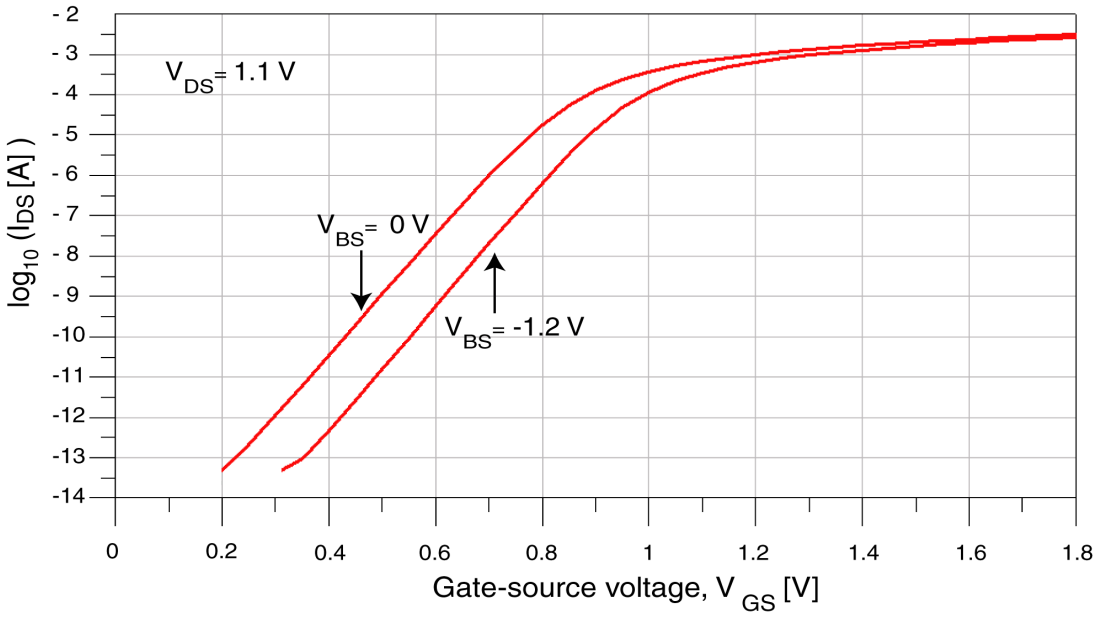

Figure 2

a) Assume the sub-threshold current can be approximated with $I_d = I_0 e^{\frac{(V_{GS}-V_{th})}{nV_T}}$, where V_T = 26mV. Estimate the value of n for this transistor.

b) Use the extracted model and procedure of problem 1 to simulate and print out the curves shown in figure 2 (log(I_D) –V_{GS}) and normal I_D –V_{GS} curves. Comment on the accuracy of the simulation results for different regions of operation.