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Pre-lab #9

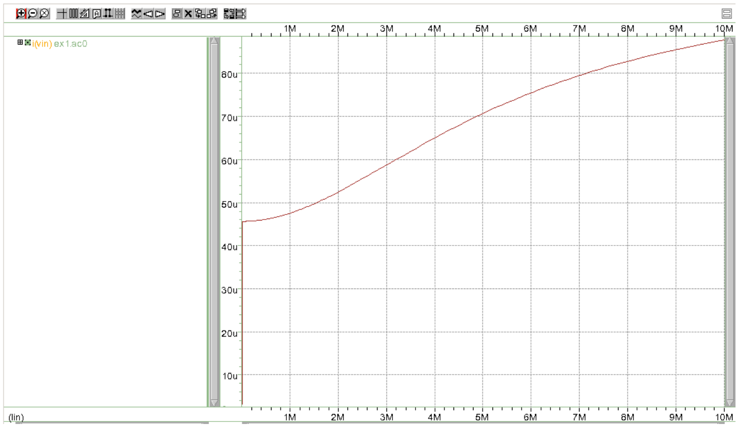
1.

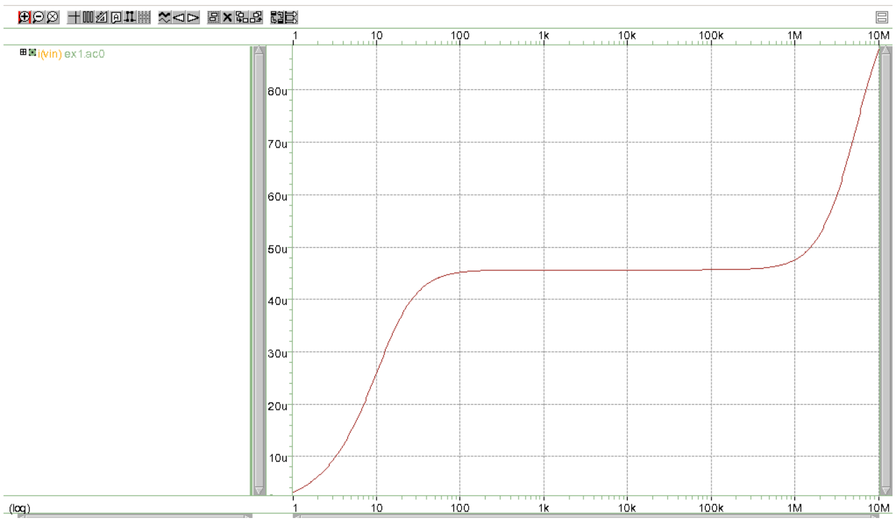
ex1.sp

```
Exercise 1
.opt post
.MODEL nmos2N7000   NMOS (LEVEL=3   RS=0.205          NSUB=1.0E15
+DELTA=0.1      KAPPA=0.0506    TPG=1             CGDO=3.1716E-9
+RD=0.239       VTO=1.000       VMAX=1.0E7        ETA=0.0223089
+NFS=6.6E10     TOX=1.0E-7      LD=1.698E-9       UO=862.425
+XJ=6.4666E-7   THETA=1.0E-5    CGSO=9.09E-9)

Vdd 1 0 10V
Rb1 2 0 10k
Rss 5 0 500
Rd 3 1 18.94k
m1 3 2 5 0 nmos2N7000 W = 0.8E-2 L=2.5E-6
C1 2 0 10uF
C2 3 0 10uF

.probe
.plotI(m1)
.end
```

ex2.sp | ex1.sp | ex1.sp

```
Exercise 2
.opt post

.MODEL nmos2N7000   NMOS (LEVEL=3   RS=0.205          NSUB=1.0E15
+DELTA=0.1      KAPPA=0.0506    TPG=1             CGDO=3.1716E-9
+RD=0.239       VTO=1.000       VMAX=1.0E7        ETA=0.0223089
+NFS=6.6E10     TOX=1.0E-7      LD=1.698E-9       UO=862.425
+XJ=6.4666E-7   THETA=1.0E-5    CGSO=9.09E-9)

Rb1 vdd gate 10k
Rb2 gate 0 1.23k
Rss source 0 500
RL out 0 rLpar
Rd vdd drain 18.94k
m1 drain gate soure  source nmos2N7000 W = 0.8E-2 L=2.5E-6
C1 in gate 10u
C2 drain out 10u

.param rLpar = 1e6
.param rLpar = 100k
.param rLpar = 10k

vdd vdd 0 10V
vin in 0 AC(50mV 0)

.temp=27

.probe ac gaindB=par('20*log10(v(out))')
.plot v(out)
.ac dec 100 1 1e7 sweep r1par poi 3 1e6 100k 10k
.op
```





2.
3. Given the equation: $\frac{V_{dd}}{2} = \frac{A{g_m}^2 * R_L(1+g_m R_{ss})}{2K_n \frac{W}{L}[g_m R_L - A(1+g_m R_{ss})]}$

*In the above equation, K_n = 250*10^-6 (A/V^2) and (W/L) = 3200

We are designing our circuit with A= 28dB = 10^(28/20) = 25.12 (V/V)

V_{dd} = 10V

R_{ss} = 200Ω

We will be ranging R_L from 100Ω to 100kΩ, but we want the circuit to support a minimum R_L of 10kΩ, so we will be using R_L=10kΩ for the equations above.

Plugging the values above into the equation yields:

$$5(V) = \frac{25.12{g_m}^2(10(k\Omega) + 2(k\Omega^2)g_m)}{1.6\left(\frac{A}{V^2}\right) * [10(k\Omega)\mathrm{g_m} - (25.12 + 5.023(\Omega) * \mathrm{g_m})]}$$

Solving for g_m yields the following solutions (in units of 1/Ω):

g_m = -.0328 (This answer can be thrown out because a negative g_m has no physical interpretation)

g_m = .00544

g_m = .0224

Using the equation: $I_D = \frac{{g_m}^2}{2K_n\frac{W}{L}}$

Plugging in g_m = .00544 (1/Ω) yields I_D = 18.477μA, which is below the threshold 100 μA, so g_m = .00544 (1/Ω) can be thrown out.

Plugging in g_m = .0224 (1/Ω) yields I_D = 313.664μA, which is above the threshold 100 μA, so g_m = .0224(1/Ω) is a good result for our circuit.

Using this g_m value, we will solve for $R_D = \frac{AR_L(1+g_mR_{SS})}{g_mR_L-A(1+g_mR_{SS})}$ = 15.85kΩ