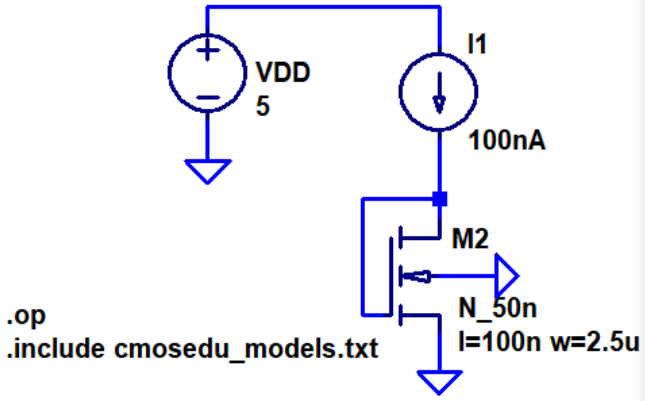
H.W. #6 EE 420/ECG 620 Spring 2019

Show your work for credit and put a box around each of your answers (follow the hw guidelines!) Unless otherwise indicated use the book's long-channel (1 um) process.

1. Examine the simulations seen below noting that a short-channel device from the book is used. This operating point simulation can be used with the menu items View -> SPICE Error log to show the small-signal parameters of the MOSFET (remember this, it's useful!). Below Gm is the transconductance of the MOSFET and Gds (= $1/r_{on}$) is the output conductance of the MOSFET. By changing the value of the biasing current, seen below 100 nA, and simulating, hand plot the open circuit gain of the MOSFET as a function of bias current and compare to Fig. 9.35 of the book (e.g., set the current to 10 nA on the x-axis and divide Gm by Gds to get open-circuit gain), then change to bias current 50 nA repeat, then 100 nA, etc.). Note that the Level=3 long channel models found in the cmosedu_models.txt file do not model subthreshold current hence why we are using the BSIM4 models, level=54 in LTspice, below. (4 points)

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SPICE Error Log: C:\Users\rjacobbaker\Google Drive\Work\Courses\e
Circuit: * C:\Users\rjacobbaker\Google Drive\Work

Direct Newton iteration for .op point succeeded.
Semiconductor Device Operating Points:
                              --- BSIM4 MOSFETS ---
Name:       m2
Model:    n_50n
Id:       1.00e-07
Vgs:      1.55e-01
Vds:      1.55e-01
Vbs:      0.00e+00
Vth:      3.62e-01
Vdsat:    3.93e-02
Gm:       2.68e-06
Gds:      1.10e-07
Gmb       7.00e-07
Cbd:      2.38e-15
Cbs:      2.50e-15


Date: Tue Feb 05 18:04:42 2019
Total elapsed time: 0.093 seconds.
```

2. In general, what happens to the small-signal output resistance as V_{DS} is increased? (0.5 points)
3. In general, what happens to the small-signal transconductance as V_{GS} is increased? (0.5 points)
4. In general, what happens to the open-circuit gain as V_{GS} is increased? and the transition frequency? (1 points)