

UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering
and Computer Sciences

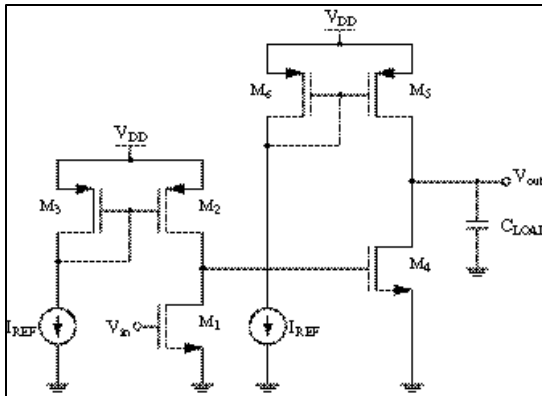
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EECS 140
Fall 2004

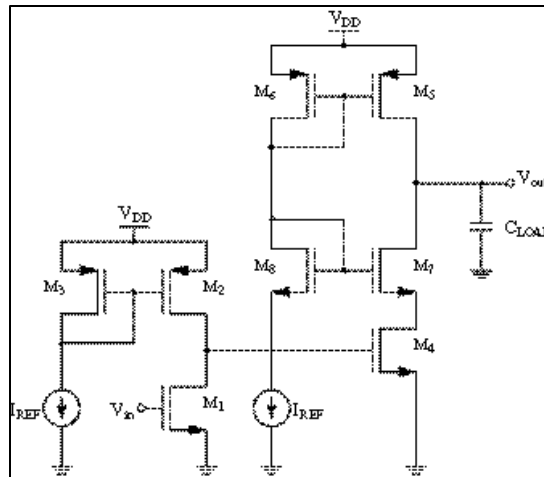
PROBLEM SET #5

(Due 10/27/04)

Now due 10/29/04



(i)



(ii)

All $W/L=2/0.18$, $V_{DD}=1.8$ V, $I_{REF}=10$ μ A. Assume the wells of all devices are tied to their respective sources. Set the DC voltage at V_{IN} so that the output is at 0.9 V.

Problem 1

- a) For circuit (i), calculate the two lowest pole frequencies and compare with SPICE using the pole-zero analysis option (.pz v(vout) vin), explaining any differences. Assume that $C_{LOAD}=0$ pF.
- b) Use SPICE to produce the Bode plots for phase and magnitude using the .ac analysis option. Draw by hand the piece-wise linear approximations on these same plots, using the pole and zero locations obtained from the .pz analysis in part (a).
- c) Repeat (a) and (b) when $C_{LOAD}=10$ pF.

Problem 2

Repeat problem 1 for circuit (ii).

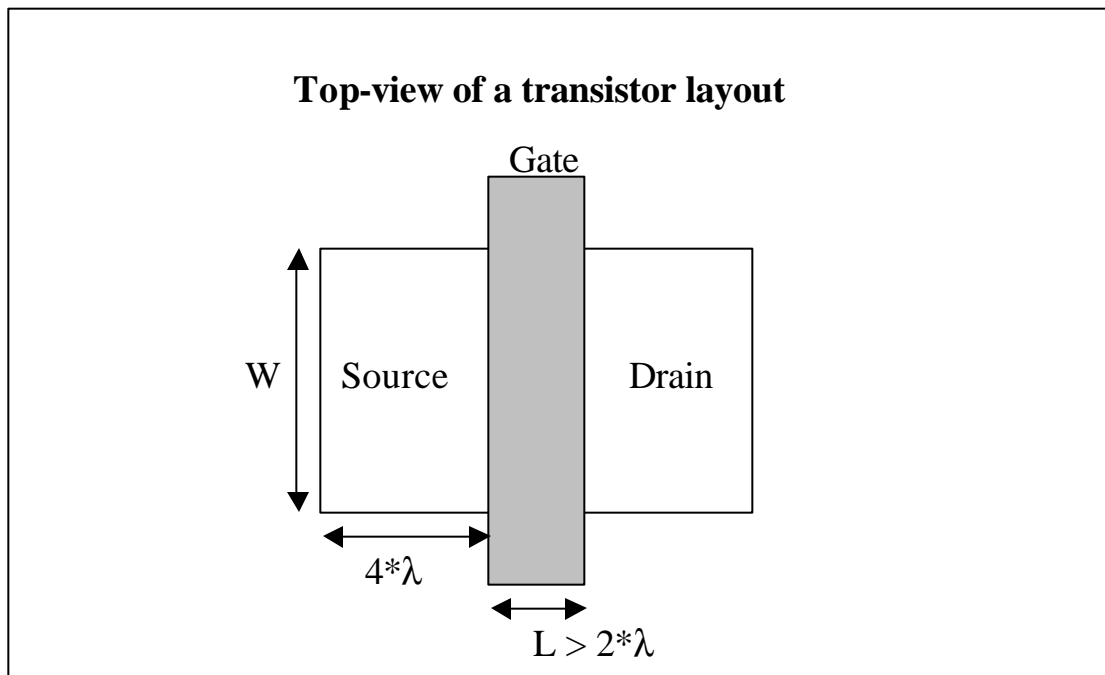
For problems 1 and 2, use the following SPICE models and the default values from HSPICE for any unspecified parameters. Assume the lambda for layout rules is 0.09 μm, and include the area and perimeter information for all transistors.

```
.model nch nmos level=1 tox=2.5e-9 vto=0.5 kp=140e-6 lambda=0.1
+ gamma=0.5 phi=0.6 capop=0 cgso=5e-10 cgdo=5e-10 cgbo=4e-10
+ cj=6e-4 cjsw=2e-10
```

```
.model pch pmos level=1 tox=2.5e-9 vto=-0.5 kp=65e-6 lambda=0.15
+ gamma=0.5 phi=0.6 capop=0 cgso=5e-10 cgdo=5e-10 cgbo=4e-10
+ cj=6e-4 cjsw=2e-10
```

Note: We are using the constant “lambda” in two different contexts here. They are:

1. Lambda as a measure of device output resistance, where $r_o = (\lambda \cdot I_{DS})^{-1}$. The units here are 1/volts
2. Lambda as a design rule parameter. Lambda specifies the minimum dimensions of your devices. The minimum gate length is typically $2 \cdot \lambda$. See the figure below. Here, lambda is in units of length, and as specified about, the lambda for layout rules is 0.09 μm. From the figure below, we can see that the area of the source/drain is equal to $4 \cdot \lambda \cdot W$ and the perimeter of the source/drain is $8 \cdot \lambda + W$



Problem 3: Razavi problem 6.6.