

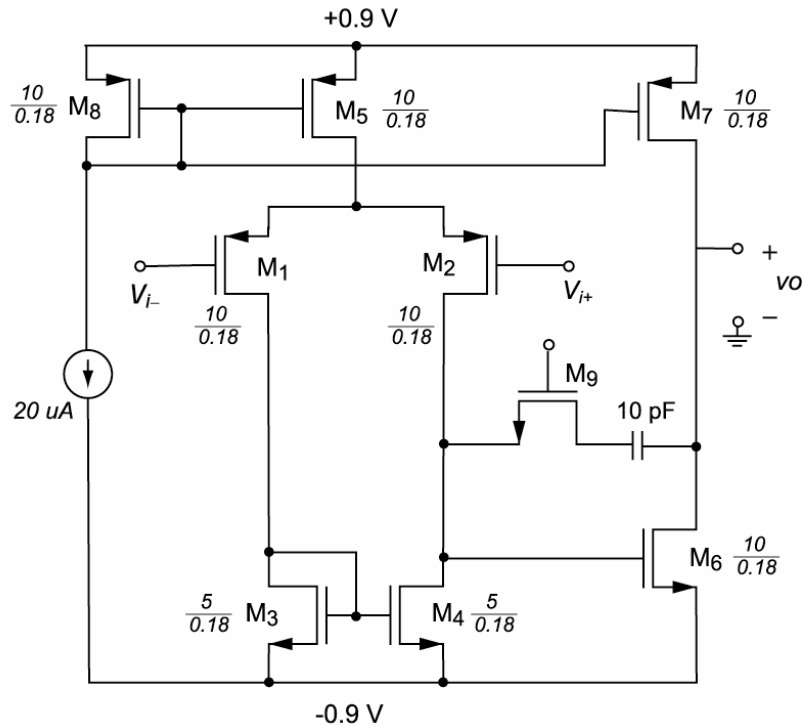
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Homework #7

EECS140
Fall 2004

1. For the operational amplifier shown below:



- (a) Calculate the open-loop differential-mode voltage gain.
- (b) Calculate the unity-gain bandwidth.
- (c) Calculate the slew rate
- (d) Compare your results of (a)-(c) with HSPICE simulation results. Comment on the phase characteristics and close-loop stability of the amplifier.

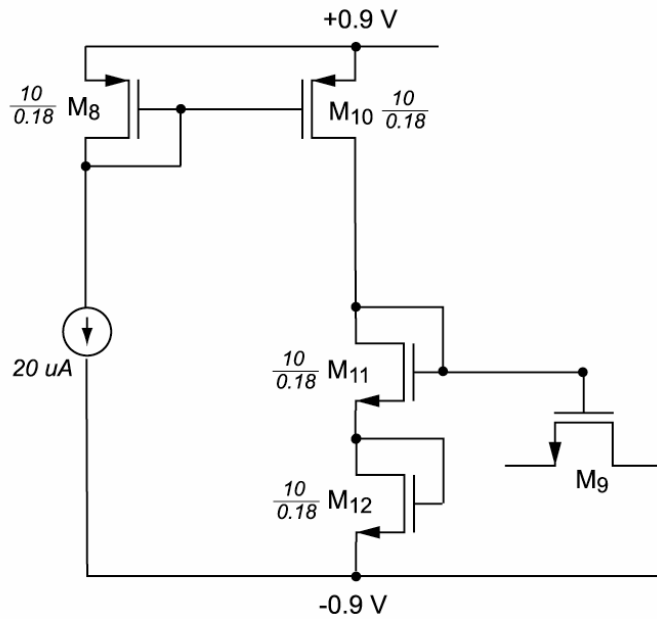
Assume that the gate of M_9 is connected to the positive power supply, its bulk is tied to the negative power supply, and the W/L of M_9 has been chosen to cancel the right-half-plane zero. Bulk terminal of all other transistors are connected to their respective source terminal. The input sources have no dc voltage ($V_{IC} = 0 V$.) and referred to the ground.

Use the following SPICE models. For any unspecified parameters, use the default values from HSPICE. Assume the lambda for layout rules is $0.09 \mu\text{m}$, and include the area and perimeter information for all transistors.

```
.model nch nmos level=1 tox=2.5n 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=2.5n 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
```

2. If the circuit below is used to generate the voltage to be applied to the gate of transistor M_9 of the operational amplifier of problem 1, calculate the W/L of M_9 required to move the right-half-plane zero to infinity. Compare your results with HSPICE simulation results. Use the SPICE models of P#1 and tie the bulk of transistor M_{11} to the negative power supply.



3. Razavi 8.18 (page 288)

4. Razavi 8.19 (page 288)