

EE 338 L Analog Integrated Circuit Design

MIDTERM 3/20/07

NAME _____

For all problems use the following parameters

$$V_{tn} = 0.5V$$

$$|V_{tp}| = 0.5V$$

$$K'_n = 160 \mu A/V^2$$

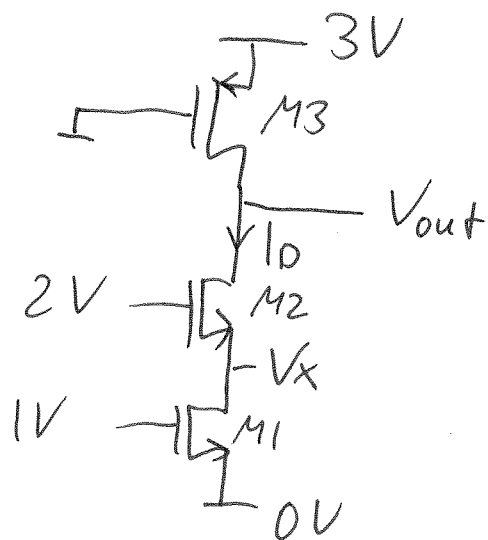
$$K'_p = 50 \mu A/V^2$$

$$\lambda_n = 0.01$$

$$\lambda_p = 0.02$$

① Large Signal Analysis

Determine operating regions of the devices and calculate node voltages and current. Ignore λ and the v_{os}^2 term in the ohmic equation

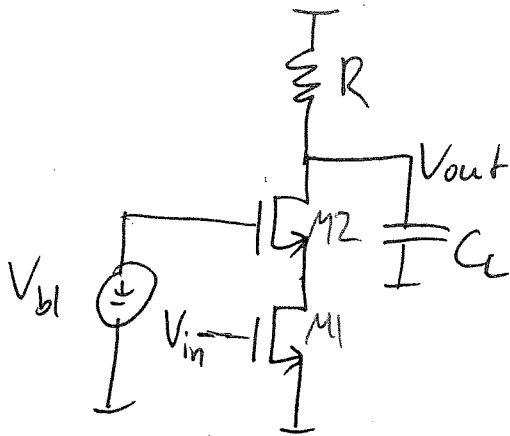


$$\left(\frac{W}{L}\right)_1 = 4$$

$$\left(\frac{W}{L}\right)_2 = 8$$

$$\left(\frac{W}{L}\right)_3 = 16$$

② Small Signal Analysis



ignore C_{dg} , g_{mb}

ignore g_{ds2}

What is the transfer function

$$\frac{V_{out}}{V_{in}} \text{ vs. frequency}$$

Include C_{gs} , C_{sb} , C_{db} in your equations

DC gain

location of first pole

location of second pole

③ Design of a common source amplifier

We know

$$V_n^2 = \frac{8}{3} kT \frac{1}{g_{min}} \left(1 + \frac{g_{mload}}{g_{min}} \right) \leq (4 nV/\sqrt{Hz})^2$$

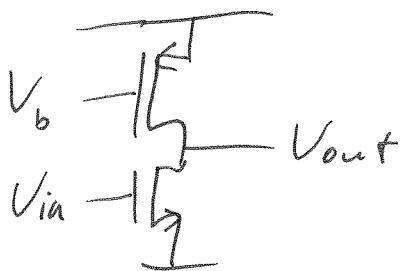
$$V_{outmax} = V_{DD} - V_{ovload} \leq 2.5V$$

$$V_{outmin} = V_{inmin} \geq 0.5V$$

Minimize I_D to meet these spec's.

Hint 1: Choose $\frac{g_{min}}{I_D} = 20$ (good choice to avoid subthreshold)

Hint 2: Ignore V_{outmin} during the design, check it later.



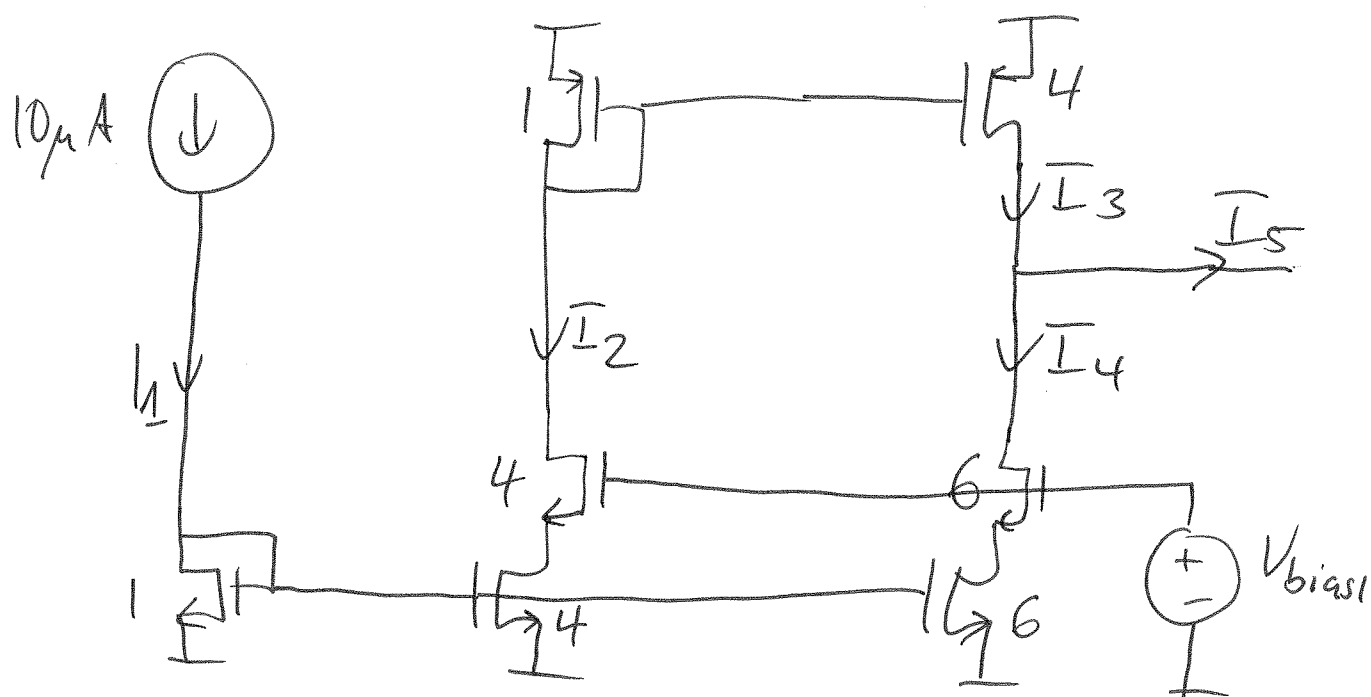
$L_n = L_p = 1\mu m$, choose W_n, W_p, I_D

④

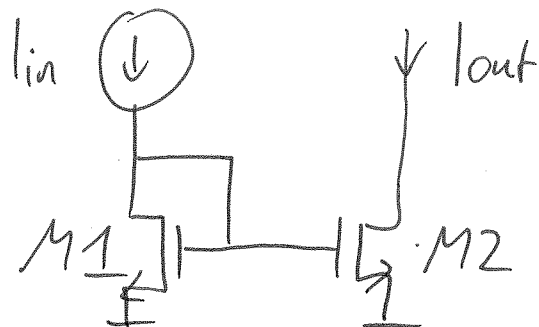
What are the following currents?

All Devices are in saturation

All Devices: $L = 1\mu m$, W is noted



⑤ Current Mirror



$$\left(\frac{W}{L}\right)_1 = \left(\frac{W}{L}\right)_2 = 10$$

Assume that due to mismatch

$$V_{TM1} = V_{TM2} + 40\text{mV} = 0.54\text{V}$$

Biasing:

$$V_{DS2} = 2\text{V}$$

$$V_{DS1} = V_{GS1} = 1\text{V}$$

What is I_{in} , What is I_{out}

What causes a bigger error in output current, V_{DS} mismatch or V_T mismatch?