Homework 6

Please clearly organize and present your solutions.

Due: Dec. 13

* If V_{DD} is not specified, V_{DD} is set to 1 V. You should use real components in your simulation. For DC voltage source, please use “vdc” in analoglib.

*Please attach your schematic and simulation results, and ensure that the background is inverted to white.

* Plagiarism is strictly prohibited. If you are found guilty, you will receive a score of 0.

1. Problems 9.18 in the textbook.

9.18. In this problem, we design a two-stage op amp based on the topology shown in Fig. 9.90. Assume a power budget of 6 mW, a required output swing of 2.5 V, and $L_{eff} = 0.5\ \mu$m for all devices.

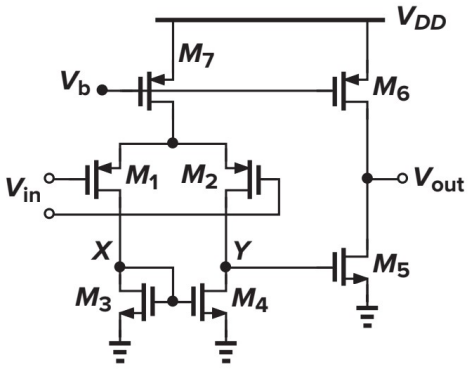

Figure 9.90

(a) Allocating a current of 1 mA to the output stage and roughly equal overdrive voltages to M_5 and M_6, determine $(W/L)_5$ and $(W/L)_6$. Note that the gate-source capacitance of M_5 is in the signal path, whereas that of M_6 is not. Thus, M_6 can be quite a lot larger than M_5.

(b) Calculate the small-signal gain of the output stage.

(c) With the remaining 1 mA flowing through M_7, determine the aspect ratio of M_3 (and M_4) such that $V_{GS3} = V_{GS5}$. This is to guarantee that if $V_{in} = 0$ and hence $V_X = V_Y$, then M_5 carries the expected current.

(d) Calculate the aspect ratios of M_1 and M_2 such that the overall voltage gain of the op amp is equal to 500.

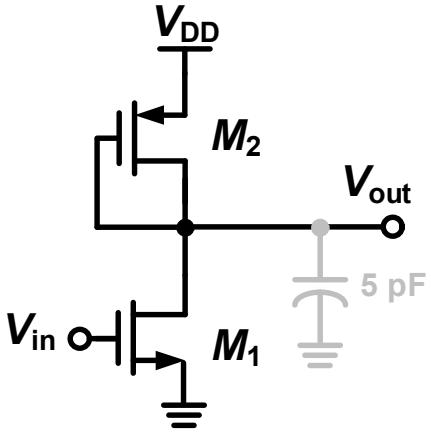

Fig. 1

Transistor	M_1	M_2
Finger number	10	
Fin number (multipler)	20	
Length	16 nm	240 nm
Source M1 width/ Drain M1 width	50 nm	

Table 1

2. In this problem, consider a CS amplifier with a diode connected load as shown in Fig. 1. Transistors parameters are provided in Table 1. V_{in} is realized by "vsin" in analoglib with 10 mV_{p-p} and a DC voltage of 500 mV to ensure the bias conditions of M_1 and M_2 unchanged. Perform "noise" simulation and answer the following questions.
   (1) Specify the frequency range to be 1 kHz~1 THz. Plot output noise (V^2/Hz) in dB versus frequency in log scale.
   (2) The plot above can be divided into several regions based on the slope of the plot. Look into "Noise Summary…" and specify the dominating noise contributor (including the name of the component and the type of noise) at each region.
   (3) Specify the temperature as 60℃ and repeat (1), (2).
   (Hint: Temperature setting can be found somewhere in ADE.)