NAME	
ID#	

ECSE 330

INTRODUCTION TO ELECTRONICS

(Winter 2008)

Quiz 2 Set A

Monday March 10, 2008

Time Allowed: 45 Minutes

Total Marks: 20 Marks

Instructions:

- Answer all questions on the question sheets provided.
- Show all your work to receive full credits.
- Feel free to request additional blank paper if needed.

Mark
/20

In the following problem consider CLM for AC analysis. For DC analysis you may ignore CLM.

Consider the current mirror in Fig.1. Assume V_{DD} = 5 V, $\mu_n C_{OX}$ = 100 $\mu A/V^2$, V_{tn} = 1 V $\lambda = 0.025\ V^{-1}$ and $(W/L)_1 = (W/L)_2 = (W/L)_3 = 10$.

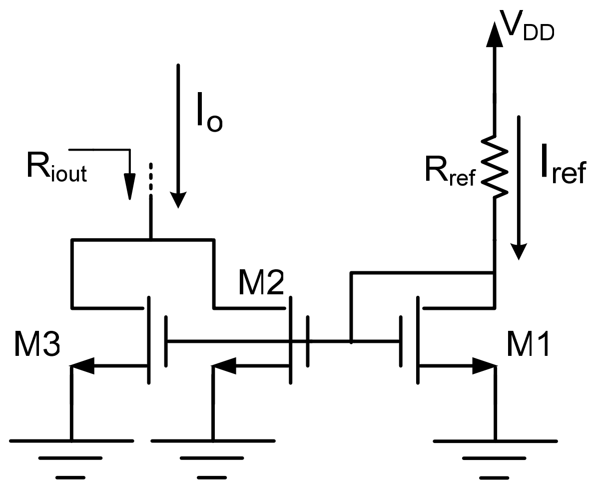

Fig. 1.

i) What is the value of I_{ref} if I_o= 1mA?
ii) Find the value of R_{ref} such that I_o= 1mA.
iii) Calculate the small-signal output impedance of the current mirror (R_{iout}).

The current mirror of Fig. 1 is now used to bias the CS amplifier of Fig. 2. Assume $\mu_p C_{OX}$ =50 $\mu A/V^2$, $|V_{tp}|$ = 1 V, $|\lambda|$= 0.025 V^{-1}, $(W/L)_4$=40, and R_{sig}=50Ω.

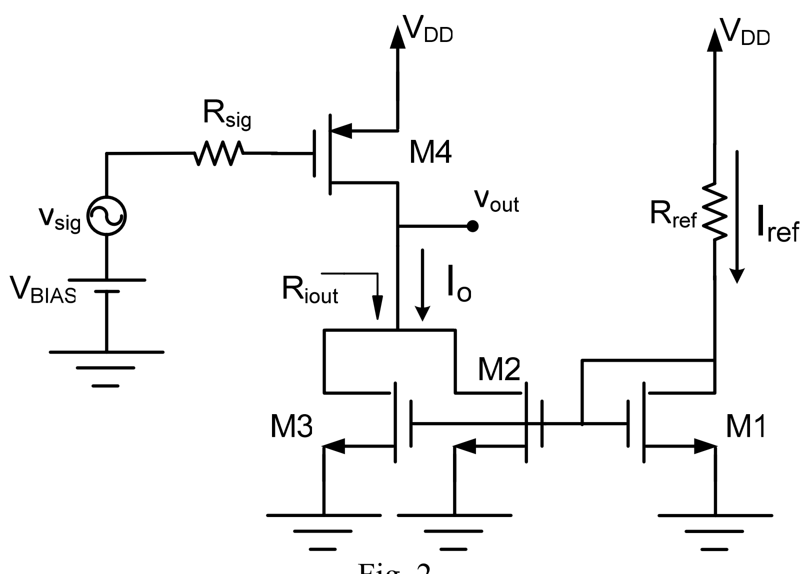

Fig. 2.

iv) Find the required value of the DC bias at the gate of M_4 (V_{BIAS}) for I_o= 1mA. Assume that the magnitude of v_{sig} (small-signal source) is small and does not affect the DC operating point. (Parts (iv) and (v) are on the next page)

v) Draw the small-signal equivalent circuit of the amplifier (You may replace the current mirror with its output impedance. If you haven't solved part (iii) assume an output resistance of 50KΩ).
vi) Calculate the small-signal gain of the circuit (v_{out}/v_{sig}).

NMOS:

Saturation:

$$V_{GS} > V_t$$
$$V_{DS} > V_{GS} - V_t$$

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_t)^2(1 + \lambda V_{DS})$$

Body effect:

$$V_t = V_{t0} + \gamma(\sqrt{2\phi_f + V_{SB}} - \sqrt{2\phi_f})$$

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Small-Signal:

$$g_m = \frac{2I_D}{V_{GS} - V_t}$$
$$g_m = \mu C_{ox}\frac{W}{L}(V_{GS} - V_t)(1 + \lambda V_{DS})$$
$$g_m = \sqrt{2\mu C_{ox}}\sqrt{\frac{W}{L}}\sqrt{(1 + \lambda V_{DS})}\sqrt{I_D}$$
$$r_o = \frac{1}{\lambda I_D}$$
$$g_{mb} = \chi g_m$$