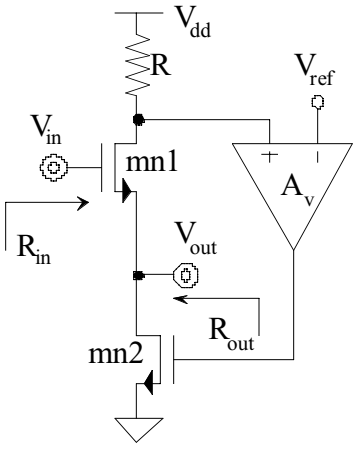
EXAMINATION NO. 3

NAME_____SCORE_____/100

INSTRUCTIONS: This exam is closed book with one sheet of notes permitted. The exam consists of 4 questions for a total of 100 points. Please show your work leading to your answers so that maximum partial credit may be given where appropriate. Be sure to turn in your exam with the problems in numerical order, firmly attached together.

Problem 1 - (25 points)

Referring to the feedback circuit shown on the right, answer and/or fill in the blanks of the following questions:



a. What kind of mixing is being employed?

b. What kind of sampling is being employed?

c. What type of amplifier is the feedback circuit?

d. $R_{in} = R_{in\_open\_loop}$ * _____

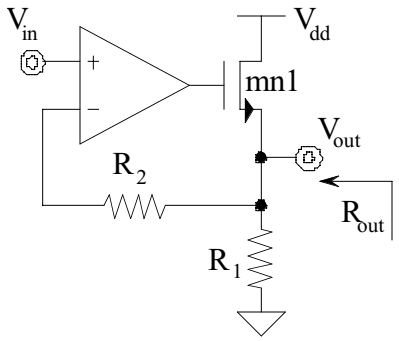
e. $R_{out} = R_{out\_open\_loop}$ * _____

f. Calculate the loop gain of this circuit (assume $r_{ds} \rightarrow \infty$ and derive the relationship as a function of small-signal parameters, R, and A_v) –hint: break the loop somewhere and compute the transfer function–.

Problem 2 - (25 points)

Referring to the circuit shown, determine the closed-loop output resistance R_{out} using Return-Ratio (RR) and Blackman's formula:

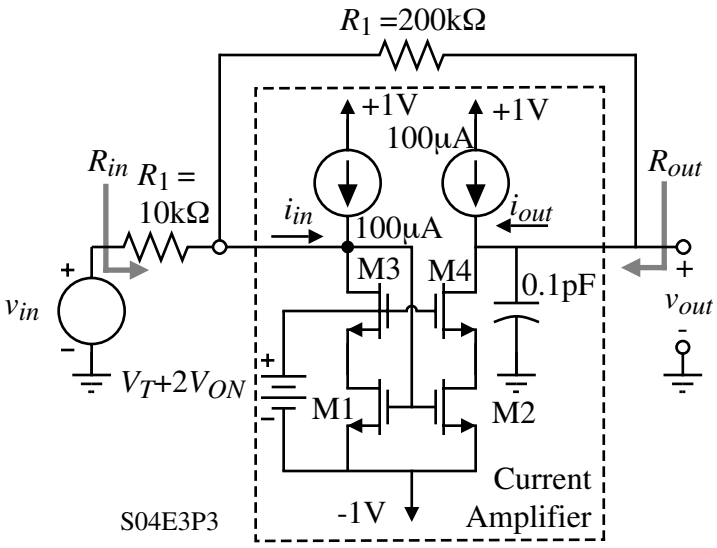
$$R_{out} = \frac{R_{out\text{—(Controlled Source Gain=0)}}}{(1 + RR_{output\ port\ open})} \cdot (1 + RR_{output\ port\ shorted})$$



(Assume $r_{ds} \rightarrow \infty$, R_i, R_O, and A_v are the input resistance, output resistance, and gain of the differential amplifier. Derive the relationship as a function of small-signal parameters, R_1, R_2, and A_v.)

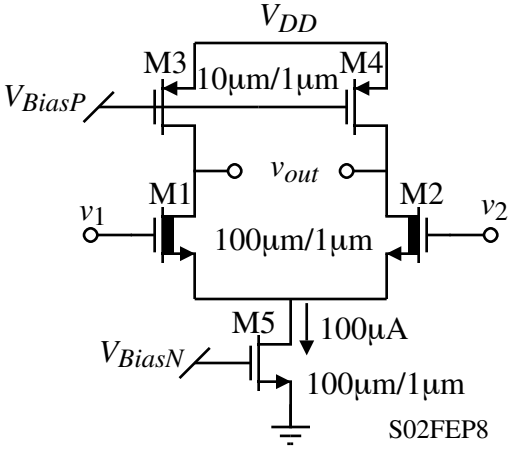
Problem 3 - (25 points)

A voltage amplifier using feedback around a current amplifier is shown. In this problem assume all of the NMOS transistors are identical. Assume that R_1 is greater than the transistor transconductance and find the input resistance, R_{in}, the output resistance, R_{out}, the voltage gain, v_{out}/v_{in}, and the gainbandwidth (GB) in Hz.



Problem 4 - (25 points)

A differential CMOS amplifier using depletion mode input devices is shown. Assume that the normal MOSFETs parameters are $K_N' = 110\text{V}/\mu\text{A}^2$, $V_{TN} = 0.7\text{V}$, $\lambda_N = 0.04\text{V}^{-1}$ and for the PMOS transistors are $K_P' = 110\text{V}/\mu\text{A}^2$, $V_{TP} = 0.7\text{V}$, $\lambda_P = 0.04\text{V}^{-1}$. For the depletion mode NMOS transistors, the parameters are the same as the normal NMOS except that $V_{TN} = -0.5\text{V}$. (a.) What is the maximum input common-mode voltage, $V_{icm}^{+}(\text{max})$? (b.) What is the minimum input common-mode voltage, $V_{icm}^{-}(\text{min})$? (c.) What value of V_{DD} gives an $ICMR = 0.5V_{DD}$?



Extra Sheet