NAME: KEY

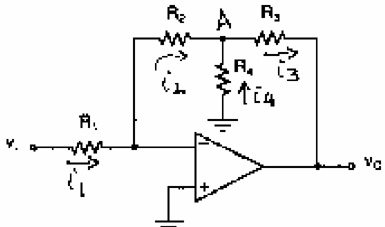
STUDENT NO.:

University of Puerto Rico
Electrical and Computer Engineering Department
INEL 4202 - Electronics II - Fall 2002 - Exam 2a - Prof. M. Toledo
THERE ARE THREE PROBLEMS - BE CLEAR OR LOOSE POINTS

1. For the amplifier shown below, assume an ideal opamp.

   (a) Derive an expression for $A_v = v_o/v_i$ in terms of R_1, R_2, R_3 and R_4: (25 points)

   (b) Find $A_v = v_o/v_i$ if $R_1 = R_3 = 1k\Omega$, $R_2 = 10k\Omega$ and $R_4 = 20k\Omega$: (5 points)



(a) $i_1 = i_2 = \frac{v_i}{R_1} \Rightarrow V_A = -i_2 R_2 = -\frac{R_2}{R_1} v_i$

$i_4 = -V_A/R_4 = +\frac{R_2}{R_1}\frac{v_i}{R_4}$

$i_3 = i_2 + i_4 = +\frac{v_i}{R_1} + \frac{R_2}{R_1}\frac{v_i}{R_4} = \frac{v_i}{R_1}\left(1+\frac{R_2}{R_4}\right)$

$v_o = V_A - R_3 i_3 = -\frac{R_2}{R_1} v_i - v_i \frac{R_3}{R_1}\left(1+\frac{R_2}{R_4}\right)$

$$\frac{v_o}{v_i} = -\frac{R_2}{R_1}\left[+1+\frac{R_3}{R_2}\left(1+\frac{R_2}{R_4}\right)\right]$$

(b) $\frac{v_o}{v_i} = -\frac{10k}{1k}\left[1+\frac{1}{10}\left(1+\frac{10}{20}\right)\right] = -11.5\ V/V$

I switched R_3 & R_4 in the diagram by mistake. You can see that if $R_3 = 20k$ and $R_4 = 1k$ you get $A_v = -10\left(1+\frac{20}{10}[1+10]\right) = -230 V/V$ with moderate resistance values (less thermal noise).

Ex 2a

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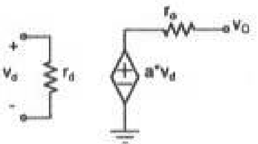
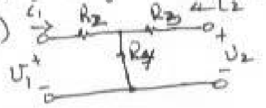
2. For the amplifier shown in problem 1, assume that the opamp can be represented with the model shown below, with $r_d = 10k\Omega$, $a = 10^4 V/V$ and $r_o = 100\Omega$.
   (a) Identify the type of feedback being used. (10 points)
   (b) Draw a diagram of the feedback network. (10 points)
   (c) Find the feedback network's R_{11}, R_{22} and β as defined in lecture. (10 points)
   (d) Draw a diagram of the non-feedback amplifier that must be analyzed to properly use the feedback method discussed in lecture. (10 points)
   (e) Find the non-feedback amplifier gain that must be used in the feedback method discussed in lecture. (10 points)



(a) voltage-sampling, current-mixing

(b)



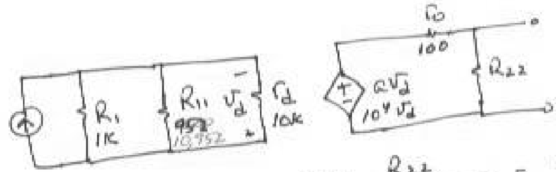
(c) $R_{11} = v_1/i_1|_{v_2=0} = R_2 + \frac{R_3R_4}{R_4+R_4} = 9525\Omega$ ||10k → 10,952Ω

$R_{22} = v_2/i_2|_{v_1=0} = R_3 + R_2||R_4 = 7.67K\Omega$

$\beta = i_1/v_2|_{v_1=0} = \frac{-1}{R_{22}} \cdot \frac{R_4}{R_2+R_4} = \frac{-1}{11.5K\Omega}$

-8.7×10^{-5} ℧

(d)



(e) $A = \frac{v_o}{i_i} = R_M \Rightarrow v_o = 10^4 v_d \frac{R_{22}}{R_{22}+r_o} = 9871\, v_d$

$v_d = -i_i(R_1||R_{11}||r_d) = -465\Omega \times i_i$ (839)

$\therefore v_o = -i_i \times 4.59M\Omega$ (8.3MΩ) $\Rightarrow$ $R_M = -4.59M\Omega$ (−8.3MΩ)

Prob. 3 – See solutions to exam 2b.