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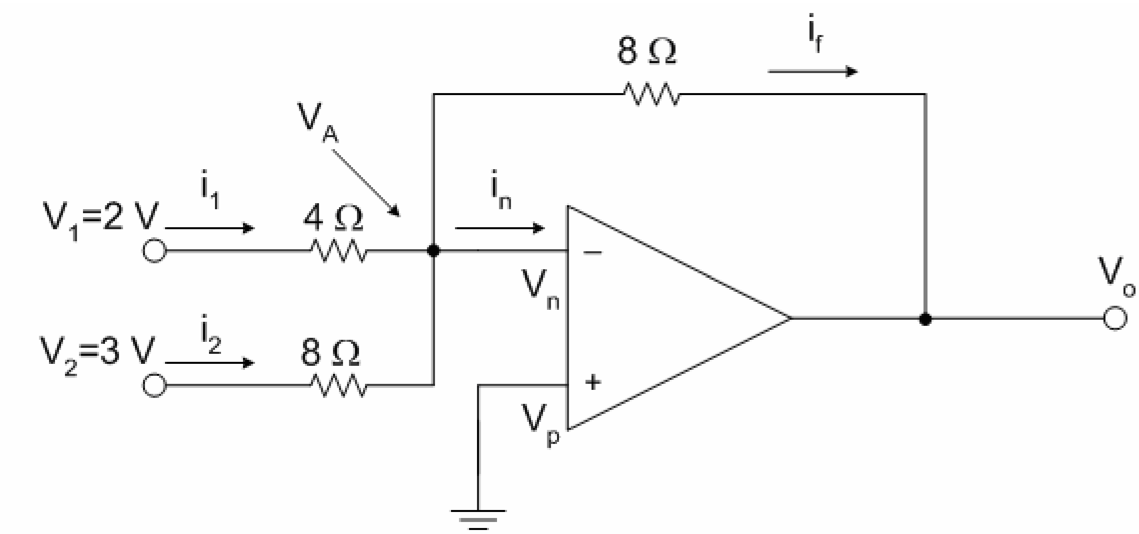
CASE WESTERN RESERVE UNIVERSITY
Case School of Engineering
Department of Electrical Engineering and Computer Science
ENGR 210. Introduction to Circuits and Instruments (4)

Quiz No. 7 3/5/04

PUT ANSWERS IN THE SPACE PROVIDED AND SHOW YOUR WORK IF APPROPRIATE
BE SURE TO STATE ALL ASSUMPTIONS

Problem 1 (10 points)



(a) What is V_A? 0 (2 points)
The IV relationships of the ideal model of the OPAMP are:
$V_p=V_n$ and $i_n=i_p=0$; detailed analysis can be found in p.164.
As noted, $V_p=0$. So $V_n=V_A=0$

(b) What is i_n? 0 (2 points)
$I_n=i_p=0$

(c) What is i_f? 0.875 A (3 points)
KCL at node A: $i_1+i_2=i_f+i_n$ and $i_n=0$, so $i_1+i_2=i_f$
And we know $V_n=0$, so $i_1=(V_1-V_A)/4\Omega=V1/4\Omega=2V/4\Omega=0.5$ A
$i_2=(V_2-V_A)/8\Omega=V_2/8\Omega=3V/8\Omega=0.375$ A
$i_f=i_1+i_2=0.875$ A

(d) What is V_o? -7 V (3 points)
$V_o=V_A-i_f*8\Omega=0-0.875A*8\Omega=-7$ V

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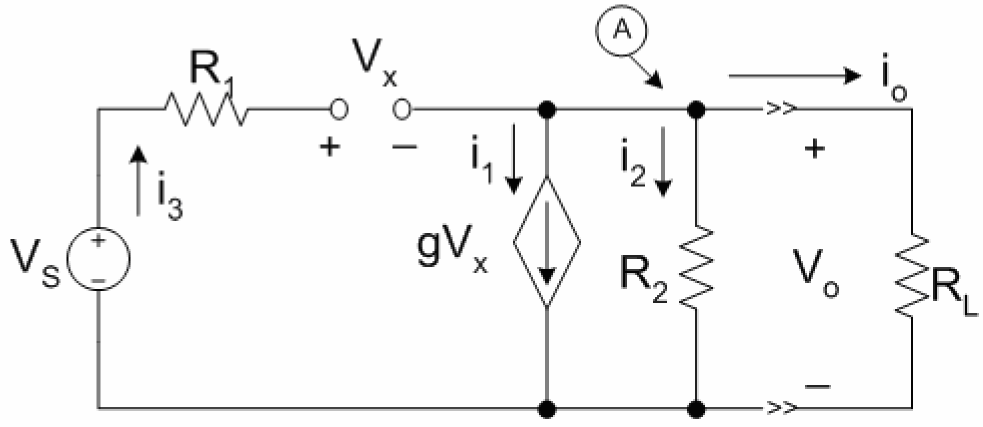
Problem 2 (10 points)



(a) Determine an expression for the voltage V_x in terms of circuit constants (i.e., V_s, R_1, g and R2). Note that gV_x is a voltage-controlled current source, not a voltage source.
Write KVL equation: $-V_s+i_3*R_1+V_x+V_o=0$ and $i_3=0$
So $V_x=V_s-V_o$
Write KCL at node A: $i_1+i_2+i_o=0$
So $i_2+i_o=-i_1=-gV_x$
And we know $V_o=-gV_x*(R_2//R_L)=-gV_x*R_2R_L/(R_2+R_L)$
In all, $V_x=V_s-V_o=V_s-[-gV_x*R_2R_L/(R_2+R_L)\}=V_s+gV_x*R_2R_L/(R_2+R_L)$

And solve for $V_x = V_s + gV_x \dfrac{R_2R_L}{R_2+R_L}$

$$=> V_x(1-g\frac{R_2R_L}{R_2+R_L}) = V_s$$

$$=> V_x = V_s/(1-g\frac{R_2R_L}{R_2+R_L})$$ (3 points)

(b) Determine the open circuit output voltage V_{oc}, i.e., V_o for $R_L=\infty$.
If $R_L=\infty$, then $V_o = -gV_x\cdot(R_2//\infty) = -gV_xR_2$

So $V_x = V_s + gV_xR_2$

$$=> V_x(1-gR_2) = V_s$$

$$=> V_x = \frac{V_s}{1-gR_2}$$

$$=> V_o = -\frac{gV_sR_2}{1-gR_2}$$ (3 points)

(c) Determine the short circuit output current i_{sc}, i.e., i_o for $R_L=0$.

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If $R_L = 0$, then $i_o = -gV_x$ and $V_o = 0$

So $V_x = V_s$

$$=> i_o = -gV_s$$ (2 points)

(d) What is the Thevenin output resistance R_T of the circuit?

$$R_T = \frac{V_o}{i_o} = \frac{-\frac{gV_sR_2}{1-gR_2}}{-gV_s} = \frac{R_2}{1-gR_2}$$ (2 points)