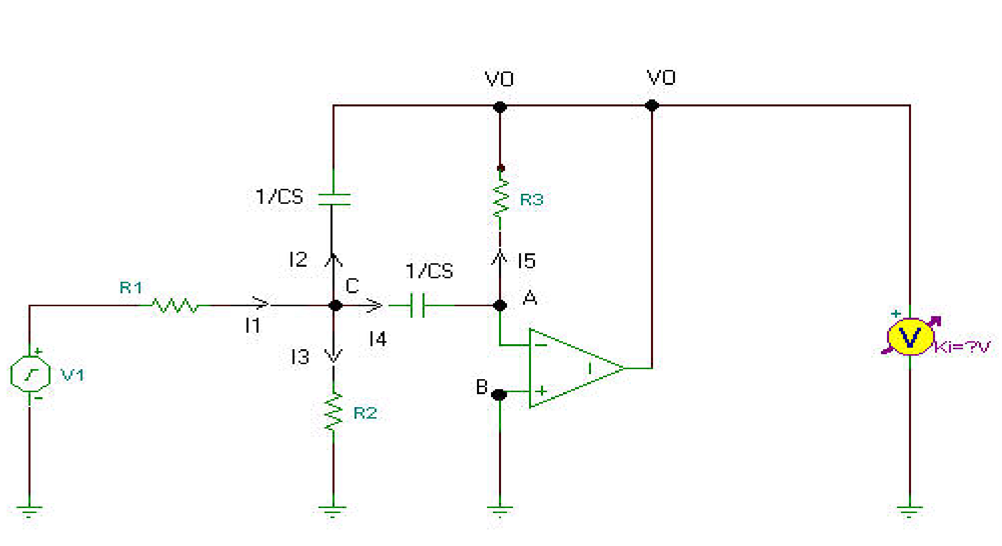
TINA'S STUDENT CONTEST

KELIRIS SOTIRIS SOLUTION: I permit designsoftware to publish my solution on their website.

Using the laplace transform we have the circuit below:



The nodes of the circuit are A,B,C and V_0 .(V_0 is V_{OUT})
The AC transfer function of the circuit is given by the formula $W(s)=V_o/V1$

From the ideal opamp(operational amplifier) we know that $V_A=V_B$

$V_B=0$ => $\underline{\mathbf{V_A=0\ \ (1)}}$

If we use Ohm's law in node A we get :

$$I_4=I_5 \Rightarrow \frac{(V_C-V_A)}{(1/CS)} = \frac{(V_A - V_0)}{R_3}$$

But V_A is 0 (relationship (1)) so we get :

$$\frac{\mathbf{V_C}}{\mathbf{(1/CS)}} = \frac{\mathbf{-V_0}}{\mathbf{R_3}} \quad \mathbf{(2)} \qquad \textbf{and} \qquad \mathbf{V_C = \frac{-V_0}{R_3CS}} \quad \mathbf{(3)}$$

If we use Ohm's law in node C we get :

$$I_1=I_2+I_3+I_4 \Rightarrow \frac{\mathbf{(V_1-V_C)}}{\mathbf{R_1}} = \frac{\mathbf{(V_C-V_0)}}{\mathbf{1/CS}} + \frac{\mathbf{V_C}}{\mathbf{R_2}} + \frac{\mathbf{V_C}}{\mathbf{1/CS}} \quad \mathbf{(4)}$$

Now all we have to in order to find the transfer function is to substitude relationships (2) and (3) into relationship (4)

Thereby $\Rightarrow \quad \dfrac{V_1}{R_1} + \dfrac{V_0}{R_1R_3CS} = -V_0CS - \dfrac{V_0CS}{R_3CS} - \dfrac{V_0CS}{R_2R_3CS} - \dfrac{V_0CS}{R_3CS}$

$$\Rightarrow \quad \frac{V_1}{R_1} = -\frac{V_0}{R_1R_3CS} - V_0CS - \frac{2V_0CS}{R_3CS} - \frac{V_0CS}{R_2R_3CS}$$

$$\Rightarrow \quad \frac{V_1}{R_1} = -\frac{(V_0R_2 + V_0R_1 + 2V_0CSR_1R_2 + V_0CSR_1R_2R_3CS)}{R1R_2R3CS}$$

$$V_1 = -\frac{V_0(R_2 + R_1 + 2CSR_1R_2 + V_0R_1R_2R_3\, C^{2}S^{2})}{R_2R3CS}$$ (C^2S^2=C*C*S*S)

Finally $\quad W(S) = \dfrac{-R_2R_3CS}{(R_1 + R_2 + 2CSR_1R_2 + R_1R_2R_3\, C^{2}S^{2})}$

and it is the same result as TINA's Analysis/Symbolic Analysis/AC Transfer/ returned to us as shown below.