Mock Final Examination

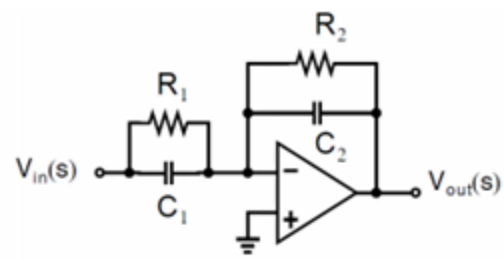
ECE 580

December 1, 2021

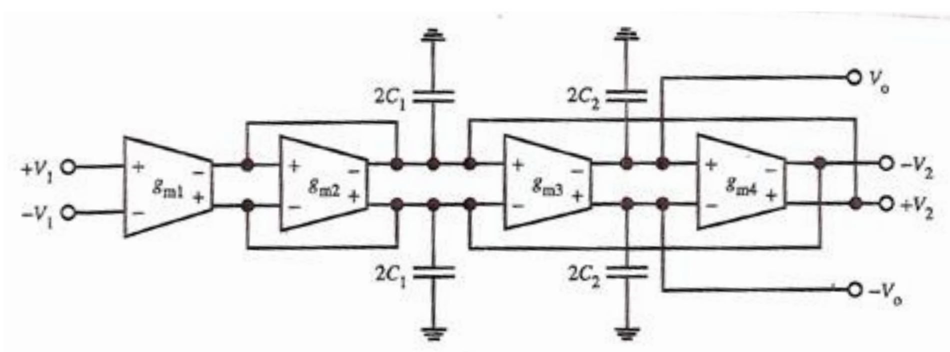
1. Find the transfer function for the bilinear filter stage shown below:

(a) For ideal opamp;

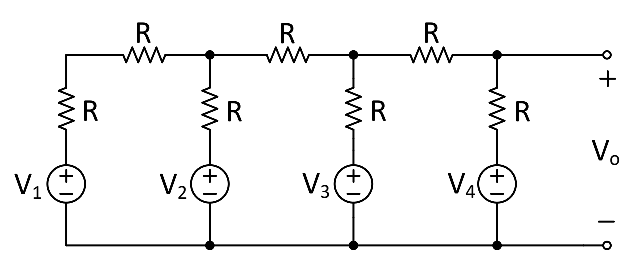
(b) For a finite-gain and bandwidth opamp with the gain function $A(s) = A_o/(1 + sA_o/w_u)$.



2. Find the voltage gains Vo/V_1 and $V2/V_1$ of the Gm-C biquad shown.



3. In the circuit shown, $V_1 = V_2 = 1$V and $V_3 = V_4 = 2$V. How much is V_o?



Hints: Use inter-reciprocity; Analyze $\hat{N}$ from output to input.

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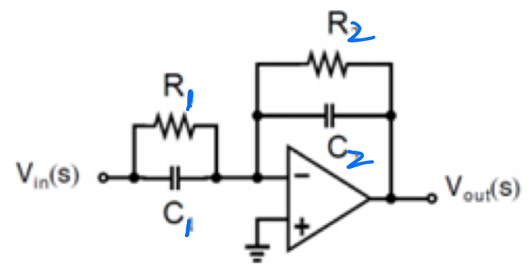
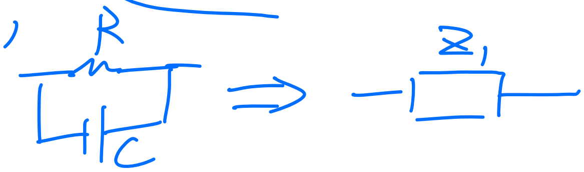
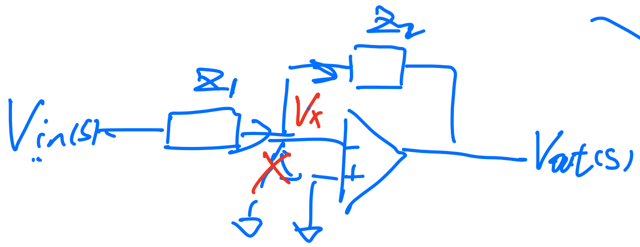


a)



$$Z_1 = R \,//\, \frac{1}{sC} = \frac{R\cdot\frac{1}{sC}}{R+\frac{1}{sC}} = \frac{R}{sRC+1}$$



$$\frac{V_{out}(s)}{V_{in}(s)} = -\frac{R_2}{R_1}\,\frac{1+R_1C_1s}{1+R_2C_2s}$$

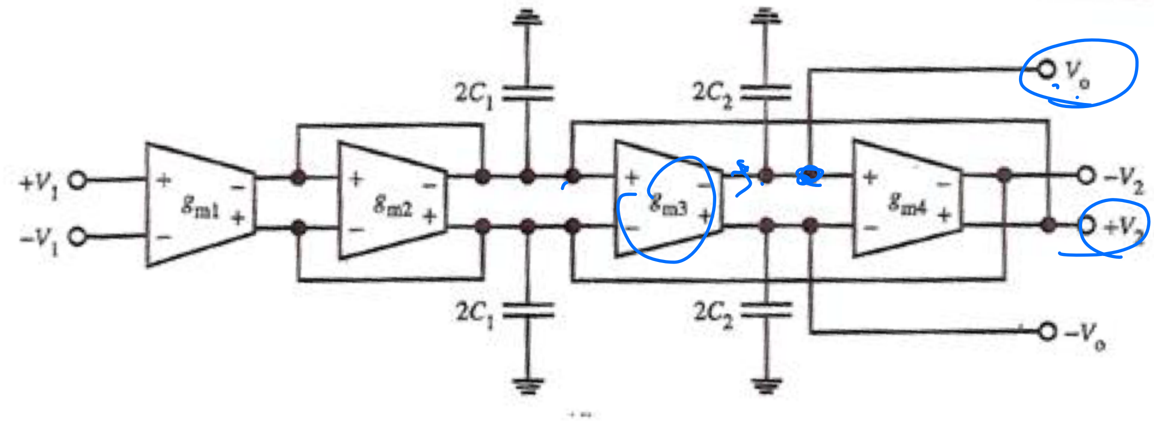
$$\begin{cases} \dfrac{V_{in}-V_x}{Z_1} = \dfrac{V_x-V_{out}}{Z_2} \\ V_{out} = -A(s)\,V_x \end{cases}$$

$$A(s) = \frac{A_o}{1+s\,A_o/w_o}$$

$$\Rightarrow \frac{V_{out}(s)}{V_{in}(s)} = -\frac{R_2}{R_1}\,\frac{A_o}{1+A_o}\,\frac{1+R_1C_1s}{1+R_2C_2s}\,\frac{1}{1+s/w_o}$$

2. Find the voltage gains V_o/V_1 and $V2/V_1$ of the Gm-C biquad shown.

Gm-C



Gm-C

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VCCS

V C

$$\frac{V_o}{V}: \begin{cases} \left(-V_1 g_{m1} - V_2 g_{m2} + V_o g_{m4}\right) \cdot \frac{1}{sC_1} = V_2 \\ \left(-g_{m3} V_2\right) \cdot \frac{1}{sC_2} = V_o \end{cases}$$

$$\frac{V_o}{V} \Big/ \frac{V_2}{V_1}$$