ECE-240 Op Amp Problem Set by Kevin Tien

For all problems in this set, assume that the op-amp symbol is equivalent to the nullator-norator pair as indicated in figure 1.

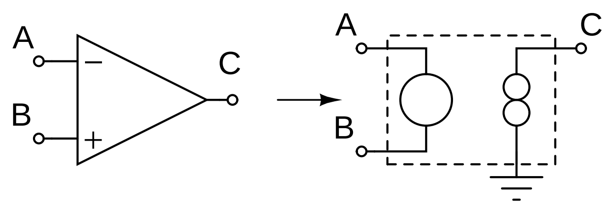

Figure 1: There is a + sign on one input terminal of the op-amp, and a - sign on the other. From the point of the view of the equivalent nullator-norator circuit, is there a difference between the two input terminals?

For the following circuits, a) write out the MNA system, and b) determine either the ratio V_{out}/V_{in} or V_{out}/I_{in}, depending on what is marked in the schematic. The caption briefly describes what the circuit is and poses a question for you to consider.

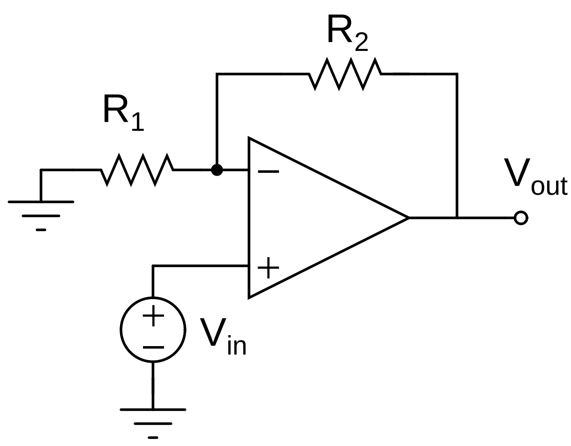

Figure 2: A non-inverting amplifier. How does attaching a load resistance to the output terminal affect the performance of this circuit?

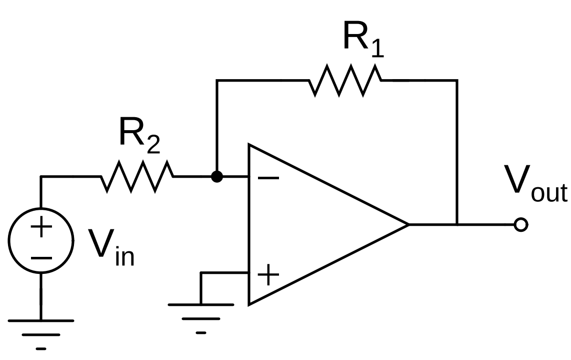

Figure 3: An inverting amplifier. What does it mean to be inverting or non-inverting, then?

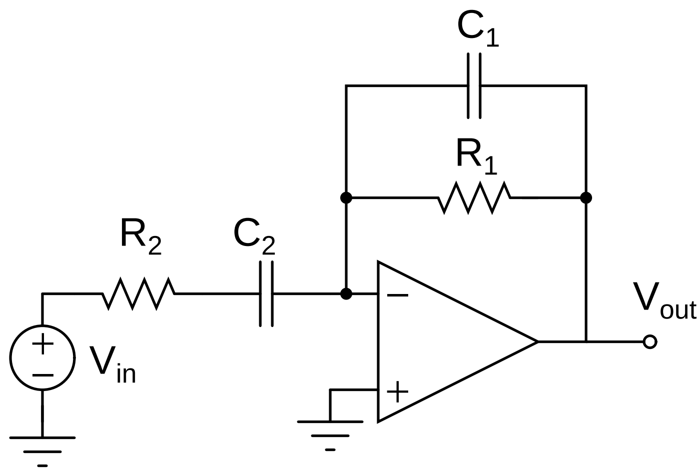

Figure 4: This is a realisable differentiator. It doesn't perform differentiation exactly, though... what kind of relationship between input and output would an ideal differentiator have in the phasor ($j\omega$) domain?

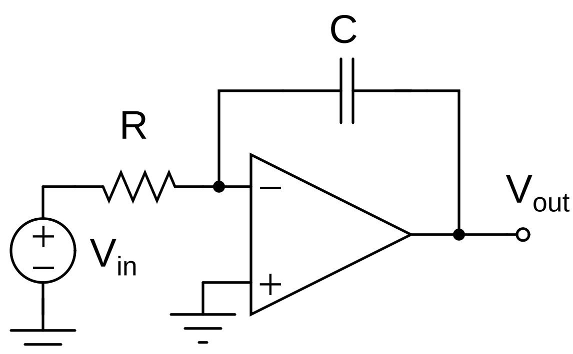

Figure 5: This is an ideal integrator. If you try and build this, however, it'll act very strangely... how does the circuit behave in DC steady-state, that is, when $\omega = 0$?

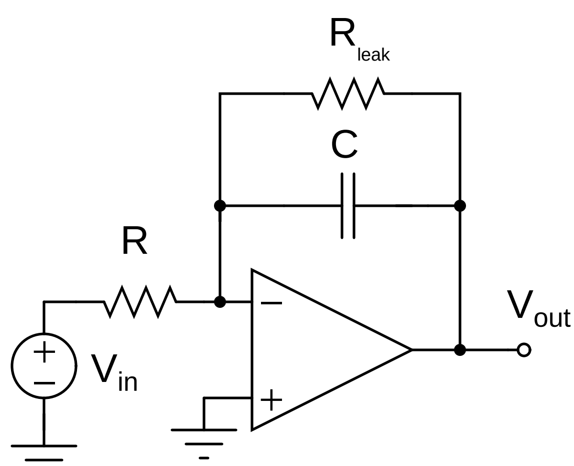

Figure 6: This is a so-called 'leaky' integrator. How does this address the problems of the ideal integrator?

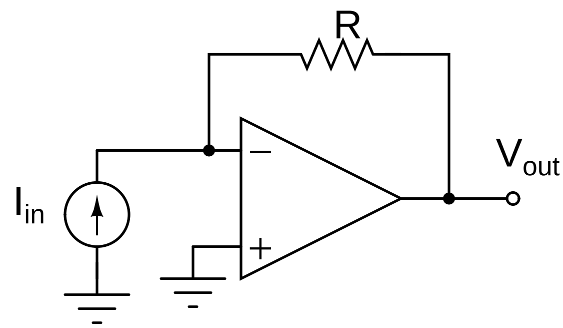

Figure 7: This is a transresistance amplifier, which converts a current to a voltage. Why is this better than just using a simple resistor?

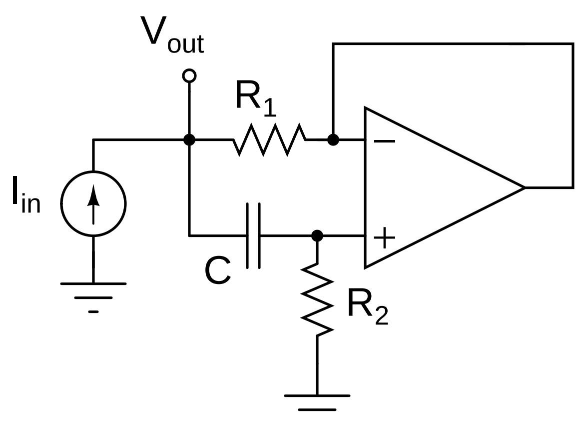

Figure 8: This circuit is an example application of a 'gyrator', which is able to manipulate impedances in useful ways. In particular, this circuit looks like an inductor with a series resistor. What 'inductance' value does the circuit have? Why does solving for V_{out}/I_{in} allow you to determine that value?

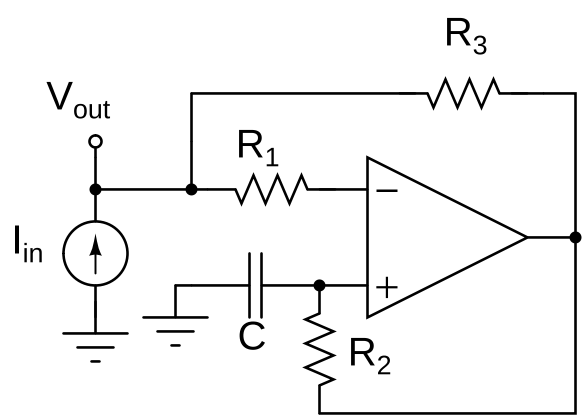

Figure 9: Similar to above, this circuit creates a scaled version of a negative capacitance. What value is the negative capacitance? Is a negative capacitance the same thing as an inductance?

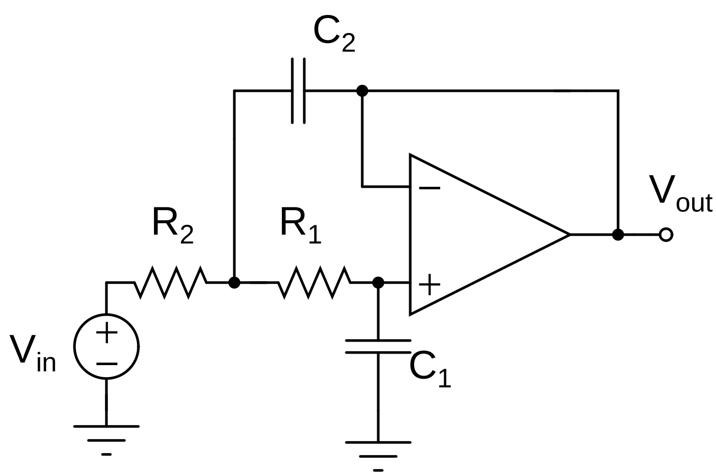

Figure 10: This circuit is one popular way to realise a 'low-pass filter'. How does the circuit affect slow signals (ω small) vs. fast signals (ω large)?

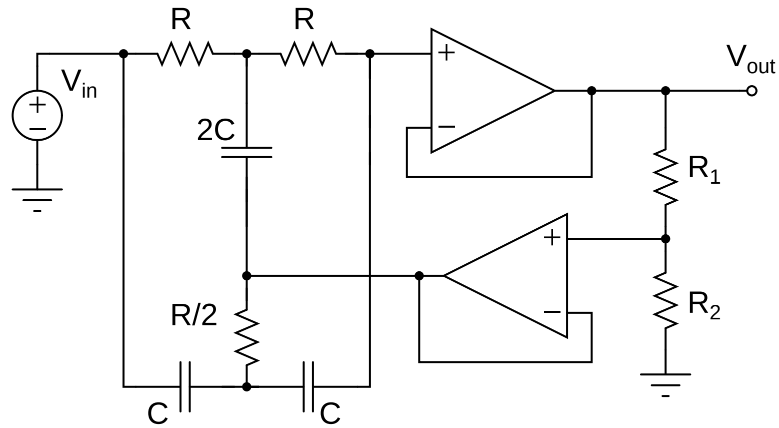

Figure 11: This circuit realises a 'notch filter': one critical range of frequencies is prevented from passing from the input to the output. Where is the center of that range?