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(Submitted: September 23, 2021)

PHY366 Lab Report
Practical: 3 Registration No.: 11912610 Section: G2903

Aim

To simulate and test differentiator and integrator circuits built using operational amplifiers.

Methods

We simulate our operational amplifier circuit on the MultiSim platform. First, we constructed an integrator circuit that was input a $1V$ sinusoidal waveform with frequency 1 kHz[1] (see Figure 1).

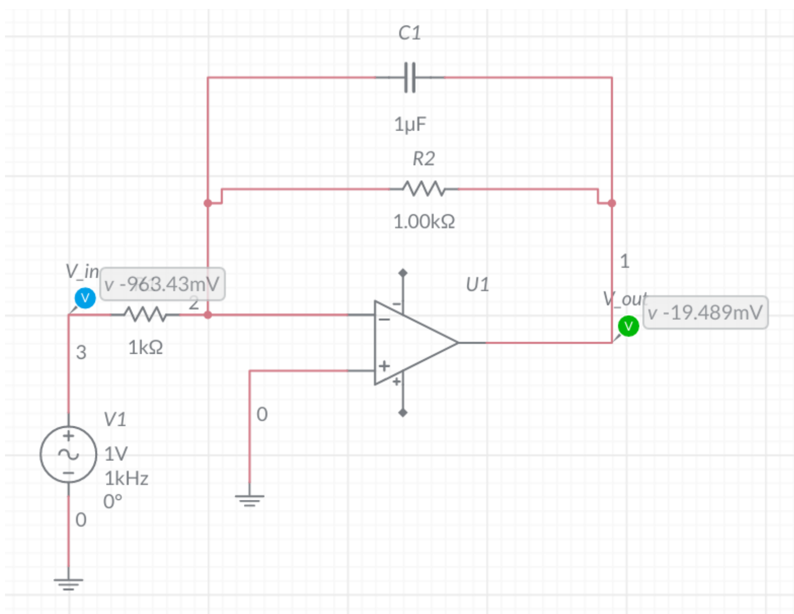

Figure 1: Construction of an integrator circuit on MultiSim using an Op-Amp.

For an input of the form $V_{in} = \sin \omega t$, one would expect to get a $V_{out} = \int \sin \omega t dt = -\cos \omega t$. We verify that this result is obtained in Results and Discussion.

We also simulated a differentiator circuit using the same platform[2] (see Figure 2). In this circuit, the input that we provided was a $1V$ triangular wave. Such an input waveform has a shape corresponding to

$$f(t) = \left\{ \begin{array}{ll} t & 0 < t < T/2 \\ T - t & T/2 < t < T \end{array} \right\}$$

[1] Integrator Circuit available publicly at https://www.multisim.com/content/GnPE4shTsE3Pyz5586DRWd/integrator-circuit/open/
[2] Differentiator circuit available at https://www.multisim.com/content/3q7Fr8CRbYhzxEkQLsXVHi/differentiator-circuit/open/

And correspondingly, its derivative

$$f'(t) = \left\{ \begin{array}{ll} 1 & 0 < t < T/2 \\ -1 & T/2 < t < T \end{array} \right\}$$

is expected to be a square wave. We test the validity of this prediction using the circuit illustrated in Figure 2.

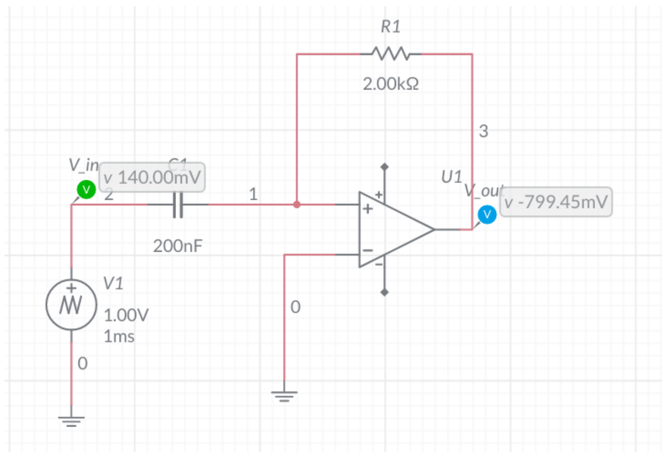

Figure 2: Schematic of a differentiator circuit built using a 5-terminal Op-Amp

Results and Discussion

For the integrator circuit, the a portion of the response to the sinusoid has been shown in figure 3. Relevant data and plotting scripts have been enclosed along with this manuscript.

Note: Due to a likely error in the export feature of the platform used, the scales of the x- and y- data have become interchanged, which affects Figure 3. A similar problem showed up for the differentiator circuit but could be resolved. We have not modified the data. We also note however, that the version of figure 2 exported from the simulator itself **did not** have these issues (see `diff_result_multisim.png` provided with the manuscript).

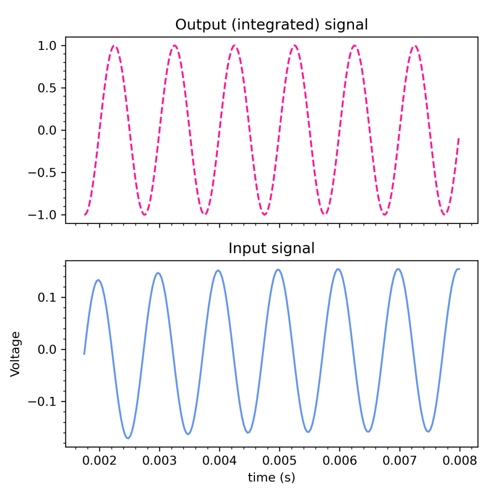

Figure 3: A portion of the output response of the circuit along with the input signal itself. Note that the scale of the y-axes of the input and output voltages have been interchanged, likely due to an error in the MultiSim data export feature.

Therefore, the result $\int \sin \omega t = -\cos \omega t$ is produced by the integrator as expected.

Also, for the differentiator circuit, the output voltage for a triangular input waveform turns out to be a square wave (as expected, see Figure 4).

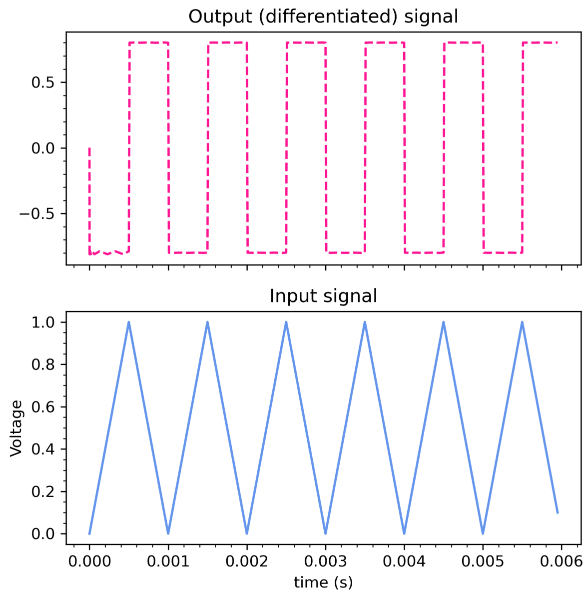

Figure 4: Same as Figure 3 but for the differentiator circuit.

Therefore, the results are consistent with expectations.