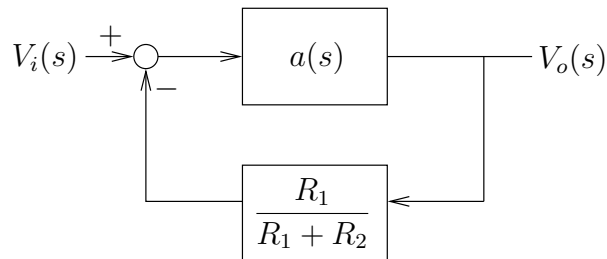


In this lab, we construct the two op-amp circuits shown above and measure their responses. Consider the following three models for the LM471 op amp:

- (a) infinite gain $a(s) \rightarrow \infty$
- (b) finite constant gain $a(s) = a_0 \approx 10^5$
- (c) high-gain integrator $a(s) = \frac{G}{s}$ where $G \approx 6 \times 10^6$ rad/sec

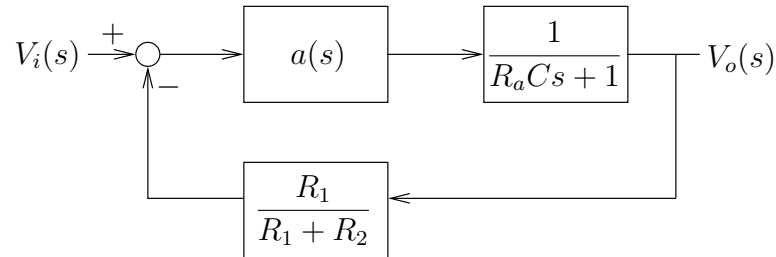
In the following steps, compute and compare the responses predicted using each of the three models for the op amp.

1. Derive the block diagram for circuit (a). Show that it is as sketched below.



2. Obtain an expression for the transfer function relating v_i to v_o for circuit (a). Derive expressions for the magnitude and phase as a function of frequency. Use these to make frequency-response plots.
3. If R_2 is fixed at $470 \text{ k}\Omega$, determine the values of R_1 that produce gains of 11 and 110, respectively. Compute and plot the step response in each case.

4. If $R_1 + R_2 \gg R_a$ in circuit (b), we can ignore the loading of $R_1 + R_2$ on the $R_a C$ circuit. Under this assumption, show that the block diagram for circuit (b) is as sketched below.



5. Obtain an expression for the transfer function relating v_i to v_o for circuit (b). Derive expressions for the magnitude and phase as a function of frequency. Use these to make frequency-response plots.
6. With $R_a = 1 \text{ k}\Omega$, $C = 0.1 \text{ }\mu\text{F}$, and $R_2 = 470 \text{ k}\Omega$, predict the step response for each of the two values of R_1 that you found in Problem 3.