BİLKENT UNIVERSITY
ELECTRICAL & ELECTRONICS ENGINEERING DEPARTMENT

EE 201 CIRCUIT THEORY

EXPERIMENT 4

Operational Amplifiers

Student Name:

ID Number:

Section :

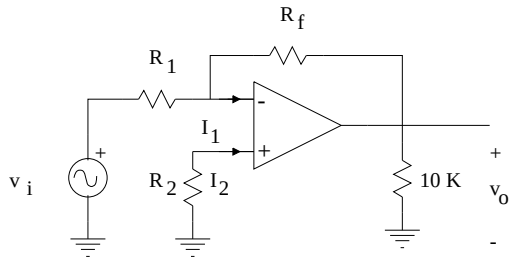
Date:

Preliminary Work

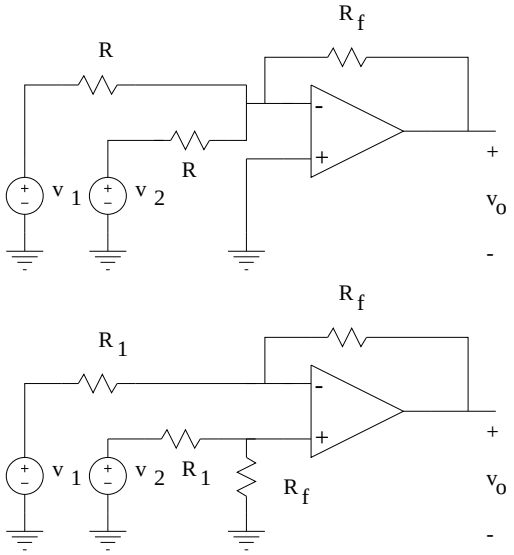
The standard resistors which are available at the lab are 1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2, (Ω), and their multiples of 10. In this experiment, choose the resistors in $k\Omega$ range.

(1) i) Consider the following circuit. Assuming ideal op-amp model, including the saturation regions, find the voltage transfer characteristics between v_o and v_i. (Note that ideally $\mathbf{I_1 = I_2 = 0}$, hence R_2 does not affect the solution) Choose the resistances so that in the linear region the magnitude of the voltage gain $A = v_o/v_i$ is 10.

ii) In practical op-amp circuits, the offset currents ($\mathbf{I_1}$,$\mathbf{I_2}$) are nonzero. Because of this, for $v_i = 0$ it is difficult to maintain $v_d = v_1 - v_{\ } = 0$, hence $v_o = 0$. To eliminate this problem the resistance R_2 is used. Assume that $\mathbf{I_1 = I_2 = I \neq 0}$. Let $v_i = 0$. Find the value of R_2 so that $v_1 = v_{\ }$, hence $v_o = 0$.



(2) Consider the following circuits. Assuming that op-amps are ideal and operate in their linear regions, find v_o in terms of v_1 and v_2. Find the condition on v_1 and v_2 which guarantees linear region operation.



In each case determine the value of additional offset resistance, if required. (i.e. similar to the resistance R_2 in prob.1)

EXPERIMENT:

Part 1: Construct the circuit shown in problem **1**. Apply a sine wave at v_i and by changing input magnitude measure v_o. Change load resistance R_L and perform the same experiment. (The load resistance is the **10** $K\Omega$ resistor in the figure). Make comments if there are differences between computed and measured values.

Observation and comments:

Part 2: Construct the circuits shown in problem 2. Choose the resistances so that the gain of the summer and difference amplifier circuits are 10. Apply various waveforms to inputs v_1 and v_2 and measure the output v_o. (As input, you could use signal generator which has one output and DC source which has two outputs). Add a load resistance R_L to the output (similar to the one in problem 1) and perform the experiment. Make comments if there are differences between computed and measured values.

Observation and comments: