INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

Department of Electronics & Electrical Engineering

EE102: Basic Electronics Laboratory

Expt.No. 6: Operational Amplifier Circuits

Objectives:

1. To study inverting and non-inverting amplifier circuits with an Op-Amp.
2. To study a non-inverting high pass filter circuit made using an Op-Amp.

Materials Required:

1. Equipment: Breadboard, Function Generator, Oscilloscope, DC Supply
2. Components: LM741 Op Amp (One), 1kΩ (One), 10kΩ (One), 12kΩ (Two), 100kΩ (One), 0.1μF (One)

Precautions and Guidelines:

1. The Op-Amp generally works on split power supply (e.g. ±12 V). Both positive and negative power supplies must be present whenever op-amp is powered.
2. The range of power supply is from ±5 V to ±15 V. Do not forget to connect the common terminal of the power supply to the ground on the breadboard.
3. Connecting only one side of power supply or interchanging positive and negative power supplies damages the Op-Amp.
4. For connecting power supply, you have to follow the procedure as given below.
    a. Disconnect the power supply to Op-Amps.
    b. Switch on the power supply.
    c. Set the output voltage as required (e.g. ±12 V).
    d. Switch off the power supply.
    e. Connect the power supply to Op-Amps.
    f. Switch on the power supply.
5. Keep ground terminals of the oscilloscope probes and function generator output, and power supply common connected together throughout the experiment.

Pre-Lab Work:

1. Obtain theoretical values of Vo/Vi for step 5 of Part A.
2. Obtain theoretical values of Vo/Vi for step 5 of Part B.
3. Obtain the theoretical value of cut-off frequency for the circuit in Part C.

Part A: Inverting Amplifier

1. Assemble the circuit shown in Fig.1 with R_1 = 10kΩ and R_2 = 1kΩ. Make sure the power supply ground is connected to the circuit ground.
2. Apply 200mV_{p-p}, 1kHz sine wave at V_i from the function generator and see the output.
3. Observe V_o and V_i, and determine voltage gain $A = V_o/V_i$. Also obtain A for V_i values of 100mV_{p-p} and 300mV_{p-p}.

4. Change R_1 & R_2 to 100kΩ & 10kΩ and determine A for V_i = $100mV_{p-p}$, $200mV_{p-p}$ and $300mV_{p-p}$.
5. Now apply a fraction of the voltage V_i (keeping V_i at $200mV_{p-p}$) to the point 'X' through the potential divider circuit as shown in Fig.2 and note the values of V_o for
   i. R_1 = 100kΩ and R_2 = 10kΩ
   ii. R_1 = 10kΩ and R_2 = 1kΩ
6. Compute V_o/V_i for (i) and (ii).

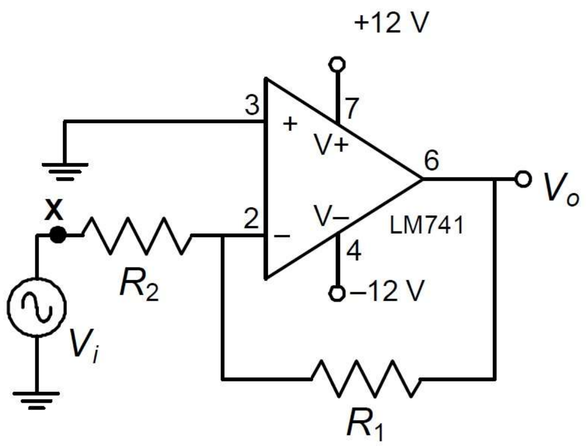

Fig.1

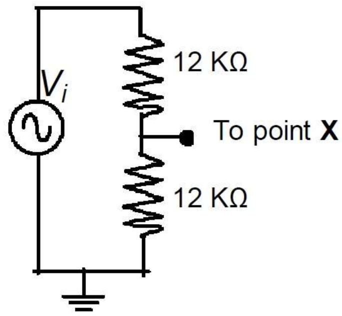

Fig.2

Part B: Non-Inverting Amplifier

1. Assemble the circuit shown in Fig. 3 with R_1 = 10kΩ and R_2 = 1kΩ. Make sure the power supply ground is connected to the circuit ground.
2. Apply $200mV_{p-p}$, 1kHz sine wave at V_i from the function generator and see the output.
3. Observe V_o and V_i, and determine voltage gain $A = V_o/V_i$. Also obtain A for V_i values of $100mV_{p-p}$ and $300mV_{p-p}$.
4. Change R_1 & R_2 to 100kΩ & 10kΩ and determine A for V_i = $100mV_{p-p}$, $200mV_{p-p}$ and $300mV_{p-p}$.
5. Now apply a fraction of the voltage V_i (keeping V_i at $200mV_{p-p}$) to the point 'X' through the potential divider circuit as shown in Fig.2 and note the values of V_o for
   i. R_1 = 100kΩ and R_2 = 10kΩ
   ii. R_1 = 10kΩ and R_2 = 1kΩ
6. Compute V_o/V_i for (i) and (ii).

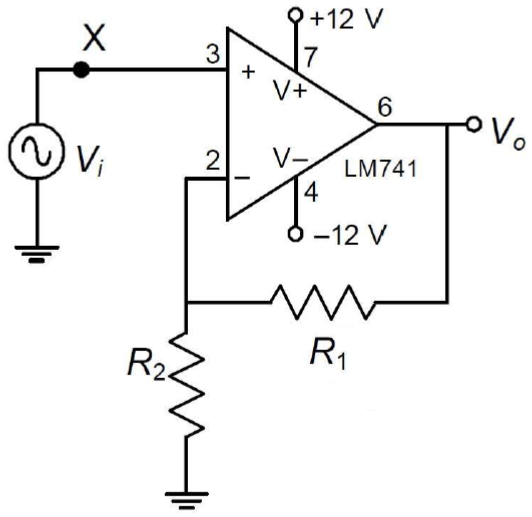

Fig.3

Part C: Non-Inverting High Pass Filter

1. Assemble the circuit shown in Fig.4 with R_1 = 10kΩ, R_F = 100kΩ, R = 1kΩ and C = 0.1μF. Make sure the power supply ground is connected to the circuit ground.
2. Connect Channel 1 of CRO to the input and Channel 2 to the output of the circuit.
3. Apply 200mV_{p-p} at the input. Vary the frequency below and above the calculated cut-off frequency.
4. Observe corresponding V_o and V_i, and determine voltage gain $A = V_o/V_i$.
5. Plot gain vs frequency graph and mark the cut-off frequency.

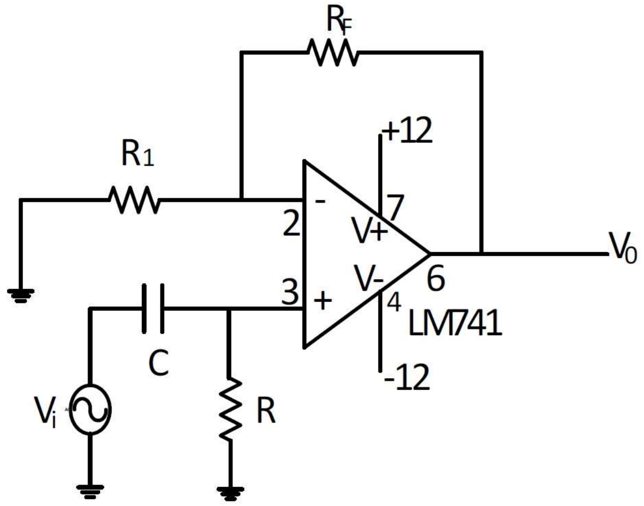

Fig.4

Part D: Lab Report

Prepare and submit a lab report as specified in the general instructions regarding the lab. Include the answers to the following questions in the report:

1. For a source with high internal impedance which configuration (inverting or non-inverting) will be suitable for designing a good amplifier?