East West University

Department of CSE

LAB REPORT

<table>
<tr><td colspan="3">Course Code and Name:
CSE251; Electronic Circuits</td></tr>
<tr><td colspan="3">Experiment no: 04</td></tr>
<tr><td colspan="3">Experiment name:
Adder and Amplifier circuit using 741 OP Amp</td></tr>
<tr><td>Semester and Year:
Spring 2023, 2023</td><td colspan="2">GROUP NO: 08</td></tr>
<tr><td>Name of Student and ID:
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<tr><td rowspan="3">Date of Report Submitted:
08-05-2023</td><td>Pre-Lab Marks:</td><td></td></tr>
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Objective:

1. To familiarize with the 741 Op Amp Integrated Circuit (IC).

2. To design and construct an adder using 741 Op Amp.

3. To design and construct an amplifier using 741 Op Amp.

Introduction:

Operational Amplifier (Op Amp) is a differential amplifier and can perform mathematical operations such as addition, subtraction, etc. This is an integrated circuit (IC).

Circuit Diagram:

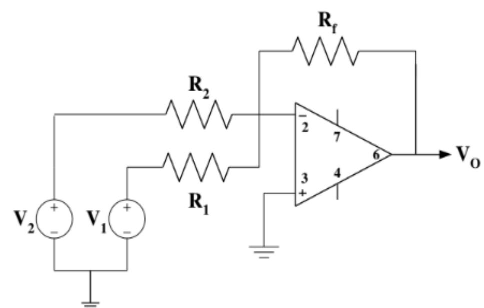


Figure 1. An adder circuit using 741 Op Amp.

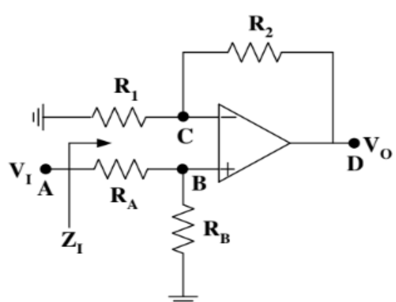


Figure 2. A non inverting amplifier circuit using 741 Op Amp.

Equipments and Components Needed:

1. Digital trainer board

2. DC power supply

3. Signal generator

4. Oscilloscope

5. Digital multimeter

6. 741 Op Amp (1 pc)

7. Resistor (as required from pre-lab design)

8. Breadboard

9. Connecting wires

Lab Procedure:

ADDER CIRCUIT:

1. Collect the resistances of your design from the lab assistant and measure them and write them down.

2. Connect the circuit as shown in Figure 2 with the resistance values from your prelab design. Use a +15V DC power supply to terminal 7 and -15V DC power supply to terminal 4 of the Op Amp from the digital trainer board.

3. Use 5V from the digital trainer board as V_1 and 2V from DC power supply as V_2. Measure the output using a multimeter and write it down.

4. Replace the V_1 by a 5V peak to peak 1 KHZ sine wave from the signal generator and observe the output in channel-2 in DC mode. Invert channel-2 and write the amplitude.

AMPLIFIER CIRCUIT:

5. Collect the resistances of your design from the lab assistant and measure them and write them down.

6. Set up the circuit as shown in Figure 3 using the resistances from your prelab design. Use a +15V DC power supply to terminal 7 and -15V DC power supply to terminal 4 of the Op Amp from the digital trainer board.

7. Set V_1= 1V from the DC power supply.

8. Measure the voltages at nodes A, B, C, and D using a multimeter and write them down.

9. Measure the voltages across resistances R_1, R_2, R_A, and R_B and write them down.

10. Have the datasheet signed by your instructor.

Post-Lab Report Questions and Answers:

ADDER CIRCUIT:

1. From the measurement in step 3, verify your design.

Answer:

Here,

$V_1 = 5V$;

$V_2 = 2V$;

Output voltage,

$V_0 = -(V_1+2V_2)\ V = -(5+4)\ V = -9V$

And from the measurement Output voltage, V = -8.89V

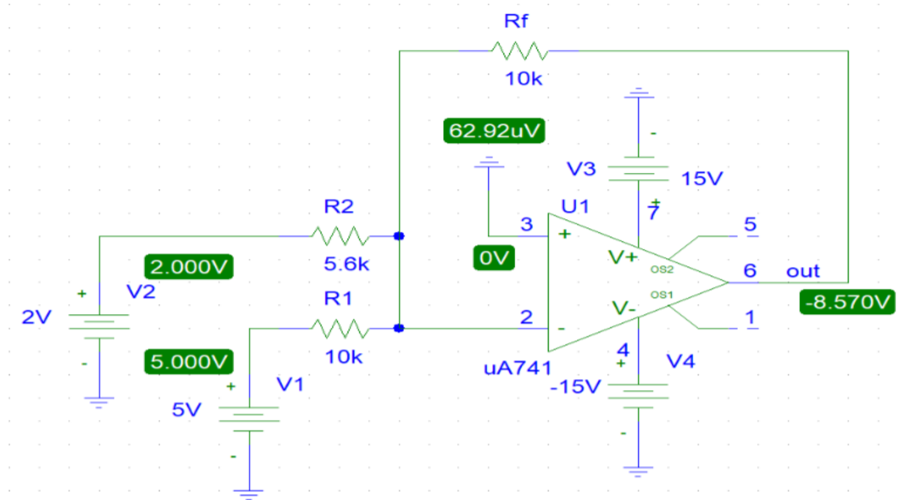
Pre-lab Output Voltage and Measured Output Voltage are almost close to each other. So the design is verified.

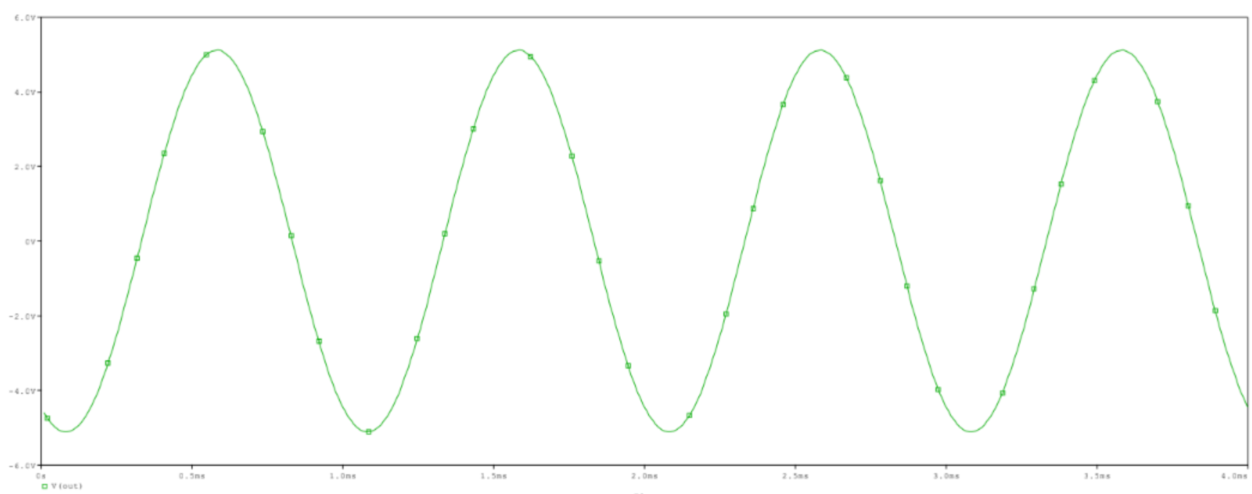
2. Does the amplitude measured in step 4 verify your design? Explain.

Answer: Amplitude measured in step 4 is = 4.7V as we used 5V from AC power supply and the output taken from DC mode. So, the amplitude is almost the same here.

3. Simulate the circuit shown in Figure 2 in Pspice. Use V_1 a 5V peak to peak, 1KHZ, 0^0 phase sine wave and V_2 a 5V peak to peak, 1KHZ, 90^0 phase sine wave. Perform simulation for 4 cycles (transient analysis for 4 ms) and attach the printed output with your report.

<u>Answer:</u>





4. Write the expressions of V_1 and V_2 of Question 3 in phasor domain, add them, and write the result in time domain as a sine function. Compare it with the Pspice output in terms of amplitude, phase angle, and time period.

<u>Answer:</u>

In Phasor domain, Here,

$V_1 = 2.5\angle 0°V$,

$V_2 = 2.5\angle 90°$ V

$V_1 + V_2 = 2.5\angle 0° + 2.5\angle 90°$

$= 3.536\ \angle 45°$ V

So, phase angle, φ=45°

Now,

Amplitude of magnitude,

$V_m = \sqrt{\{(2.5)2 + (2.5)2\}}$

= 3.536 V

Angle, θ= tan-1 (2.5 / 2.5) = 45°

In time domain we know,

$V_t = V_m \cos(\omega t + \varphi)$

Or, $V_t = V_m \cos(2\pi ft + \varphi)$

V= 3.536 cos (2πft + 45°); where, f=1kHz=1000 Hz

= 3.536 cos (2000πt + 45°)

= 3.536 sin (2000πt + 45° + 90°)

=-3.536 sin (2000πt + 135°)

We know, Time period, T= 1 ⁄ f= 1 ⁄ 1000= 10−3 s= 1ms

From PSpice simulation,

We find amplitude is 4.89V,

Phase angle = 90°

And time period = 1ms

Comparison between PSpice and theoretical Calculation:

	From PSpice	From calculation
Amplitude	4.5V	5V
Phase angle	90°	45°
Time period	1ms	1ms

AMPLIFIER CIRCUIT:

5. Compare the measured voltages at nodes A, B, C, and D in step 8 with your pre lab results.

Answer:

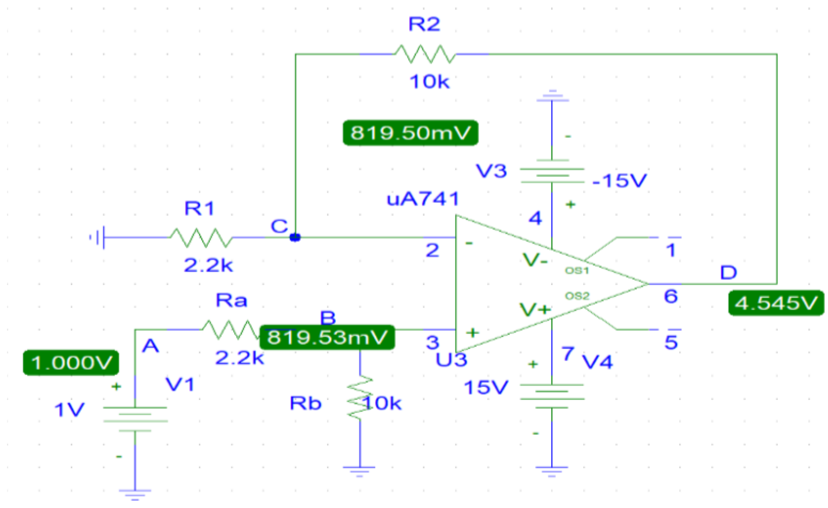
Comparison between measured voltages at nodes A, B, C, and D with pre-lab result:

Node	Measured Voltage(V)	Pre-lab result(V)
A	1	1
B	0.79	0.82
C	0.76	0.82
D	4.38	5

We can see, the measured voltages from PSpice and pre-lab voltages of node A, B, C, D are almost the same.

6. From your measured voltages at nodes B and C in step 8, comment on the virtual ground of Op Amp.

Answer:



Measured voltage of node, B = 0.79V

C = 0.76V

So, V_B and V_C are almost similar to each other.

7. From your measured voltages at nodes A and D in step 8, calculate the gain and verify with pre lab results.

Answer:

Here, Voltage in node from pre-lab data is,

A = 1V

D = 5V

Gain = 5V

Voltage in node from measured data is,

A = 1V

D = 4.38V

Gain = 4.38V

So, the measured voltage gain and pre-lab gain are almost the same.

8. From the measured voltages across the resistances in step 9, calculate the currents through them and compare them with your prelab results.

Answer:

Current through,

$I_1 = (0.7V / 2.2k\Omega)$ mA = 0.318 A

$I_2 = (0.7V / 2.2k\Omega)$ mA = 0.318 A

$I_A = (0.7V / 10k\Omega)$ mA = 0.07 A

$I_B = (0.7V / 10k\Omega)$ mA = 0.07 A

Comparison between measured Values and calculated Values:

Currents	Measured Values(mA)	Pre-lab Values Values(mA)
I_1	0.318	0.373
I_2	0.318	-0.418
I_A	0.07	0.082
I_B	0.07	0.082

There is a difference between calculated values and experimented values.

9. From your measured voltages at node A in step 8 and across R_A in step 9, calculate Z_1 and compare it with your prelab result

Answer:

Input Impedance:

$Z_1 = (V_A - V_B)/IR_A = (1 - 0.79)/0.07 = 3$

Comparison between measured Values and calculated Values:

Impedance	Measured Value(KΩ)	Pre-lab Value(KΩ)
Z_1	3	2.68

Comment: Measured value and pre-lab value are not same. And the difference is considerable.

Conclusion:

The experimental and estimated results may change somewhat due to temperature and equipment error. This little distinction can be disregarded. Therefore, we may conclude that the measured and estimated values are almost identical. Therefore, there is no disparity to keep up.

Data Sheet:

Experiment number : 04 Group :- 08

Experiment name :- Adder and amplifier circuits using 741 op amp.

Given,

$R_2 = 4.7 K\Omega$

$R_1 = 10 K\Omega$

$V_o = -8.89 V$

Input peak, $V_{pa} = 2.72 V$

output peak $V_o = 6.65 V$

$V_A = 1 V$

$V_B = 0.79 V$

$V_C = 0.76 V$

$V_o = 4.38 V$

$R_1 = 2.2 K\Omega$

$R_2 = 3.3 K\Omega$

$R_A = 0.17 K\Omega$

$R_B = 0.74 K\Omega$

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ID :- 2021-3-60-021

Name :- Umma habiba Ahmed

ID : 2021-3-60-047

Name :- Sidratul Moontaha

ID : 2021-3-60-048

~~Name :- Moniruzzaman Sarkar~~

~~ID : 2021-3-60-230~~

02/5/23

Pre-lab_report:

B M Shahria Alam
2021-3-60-016
Lab-4

Pre lab

Title: Adder and amplifier circuit using 741 op amp

1. Adder circuit:

given that,

$V_o = -(V_1 + 2V_2)$
$= -V_1 - 2V_2$

From weighted summer we know,

$V_o = -\frac{R_f}{R_1} V_1 - \frac{R_f}{R_2} V_2$

equating the coeffient of V_1 and V_2

$\frac{R_f}{R_1} = 1$ and $\frac{R_f}{R_2} = 2$

$\therefore R_f = R_1$; $\therefore R_f = 2R_2$

As given 10kΩ is the highest value of resistor which can be choose are Rf.

$\therefore R_f = 10\,k\Omega = R_1$

and, $R_2 = \frac{R_f}{2} = 5\,k\Omega$

As there is no resistor of 5kΩ, let us choose 5.6 kΩ

$\therefore R_f = 10k\Omega$, $R_1 = 10k\Omega$, $R_2 = 5.6\,k\Omega$

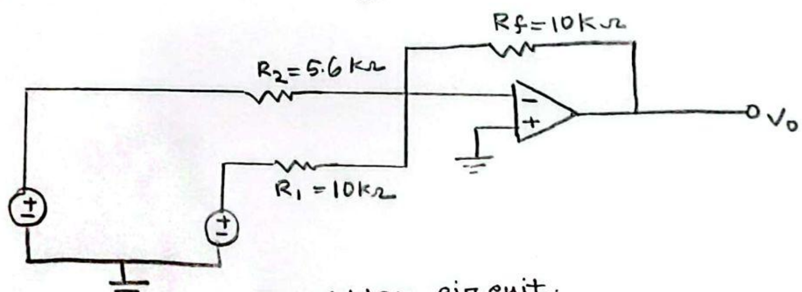

Fig: Adder circuit.

2. Amplifier circuit:

Given that, $\frac{V_o}{V_i} = \frac{R_2}{R_1} = 5$

$\therefore R_2 = 5R_1$
$\therefore R_2 = 10k\Omega$
$R_1 = \frac{R_2}{5} = \frac{10}{5} = 2k\Omega$

$\therefore R_A = R_1 = 2.2\,k\Omega$

and,
$R_B = R_2 = 10k\Omega$

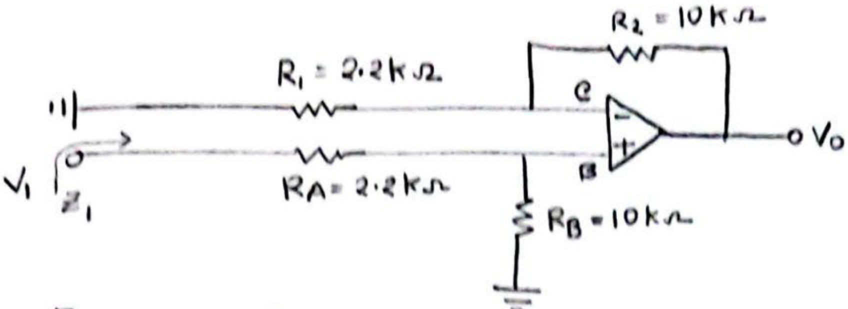

Fig: A non Inverting Amplifier.

$V_A = V_1 = 1\ V$

$$V_B = \frac{10}{10 \times 2.2} \times 1$$

$= 0.82\ V$

$V_C = V_B = 0.82 V$

$V_D = V_o = 5 V_1$

$= 5V$

$$I_1 = \frac{0 - 0.82}{2.2} = 0.373\ mA$$

$$I_2 = \frac{0.82 - 5}{10k} = -0.418\ mA$$

$$I_A = \frac{1 - 0.82}{2.2k} = 0.082\ mA$$

$$I_B = \frac{0.82 - 0}{10k} = 0.082\ mA$$

$$\therefore Z_1 = \frac{V_1}{I_1} = \left| \frac{1}{-0.373\ mA} \right|$$

$= 2680.96\ \Omega$

Tasmiah Rahman Orpa
2021-2-60-021
Group: 08

Pre-lab

Title: Adder and amplifier circuit using

1. ADDER CIRCUIT:

Given, $V_0 = -(V_1 + 2V_2) = -V_1 - 2V_2$

from, weighted summer. we know,

$V_0 = -\frac{R_f}{R_1} V_1 - \frac{R_f}{R_2} V_2$

Equating the co-efficient of V_1 and V_2,

$\frac{R_f}{R_1} = 1$ and $\frac{R_f}{R_2} = 2$

$\Rightarrow R_f = R_1$ $\Rightarrow R_f = 2R_2$

Now, $R_f = 10k\Omega = R_1$ [Given] $\therefore R_2 = \frac{10}{2} = 5k\Omega$

As, there is no resistor of $5k\Omega$, let us choose $5.6\,k\Omega$.

$\therefore R_f = 10\,k\Omega$, $R_1 = 10\Omega$ $R_2 = 5.6k\Omega$

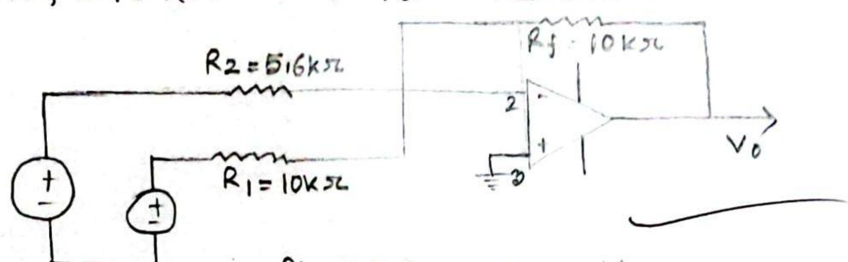

fig: Adder circuit.

2. AMPLIFIER CIRCUIT:

Given, $\frac{V_0}{V_1} = \frac{R_2}{R_1} = 5$ $\therefore R_2 = 5R_1$ $R_2 = 10k\Omega$

$R_1 = \frac{R_2}{5} = 2k\Omega$ $\therefore R_A = R_1 = 2.2k\Omega$

$R_B = R_2 = 10k\Omega$

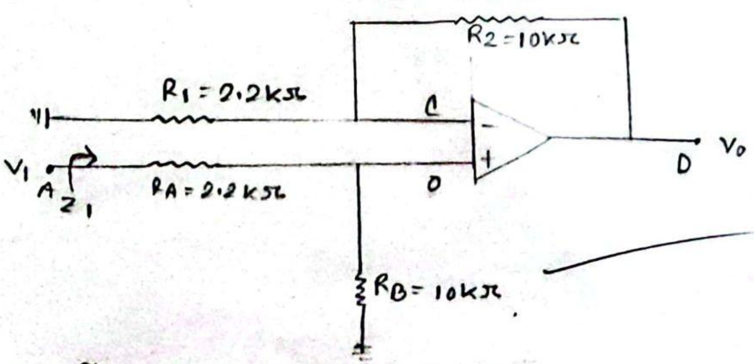

fig: A non inverting amplifier

$V_A = V_1 = 1V \qquad \therefore V_B = \frac{10K}{10K \times 2.2K} \times 1$

$\therefore V_B = 0.82\,V$

$V_C = V_B = 0.82V \qquad V_D = V_0 = 5V_1 = 5V$

$I_1 = \frac{0-0.82}{2.2k} = 0.373mA \qquad I_2 = \frac{0.082-5}{10k} = -0.418mA$

$I_A = \frac{1-0.82}{2.2k} = 0.082mA \qquad I_B = \frac{0.82-0}{10k} = 0.082mA$

$Z_1 = \frac{V_1}{I_1} = \left|\frac{1}{-0.373mA}\right| = 2680.06\Omega$

Experiment no. :- 04

Name : Sidratul Moontaha

ID : 2021-3-60-048

Title : Adder and amplifier circuit using 741 op Amp.

1. Adder circuit:-

Given, $v_0 = -(V_1 + 2V_2) = -V_1 - 2V_2$

we know, $v_0 = -\frac{R_f}{R_1} V_1 - \frac{R_f}{R_2} V_2$

equating the co-efficient of $V_1 \cdot V_2$,

$\frac{R_f}{R_1} = 1 \Rightarrow R_f = R_1$ $\frac{R_f}{R_2} = 2 \Rightarrow R_f = 2R_2$

As given $10K\Omega$ is the highest value of resistor which can be choosen as R_f.

$\therefore R_f = 10K\Omega = R_1$ and $R_2 = \frac{R_f}{2} = 5K\Omega$

As, there's no resistor of $5K\Omega$, let us choose $5.6K\Omega$.

$\therefore R_f = 10K\Omega$, $R_1 = 10\Omega$, $R_2 = 5.6K\Omega$

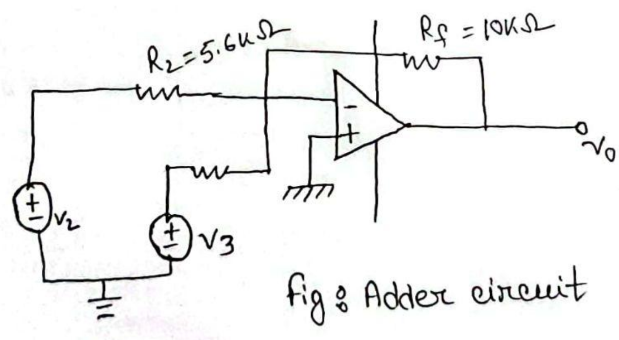

fig : Adder circuit

2. Amplifier circuit :-

Given, $\frac{v_0}{v_1} = \frac{R_2}{R_1} = 5$

$\Rightarrow R_2 = 5R_1$

$R_2 = 10K\Omega$

$\therefore R_1 = 2K\Omega$

$\therefore R_A = R_1 = 2.2 K\Omega$

$R_B = R_2 = 10\,K\Omega$

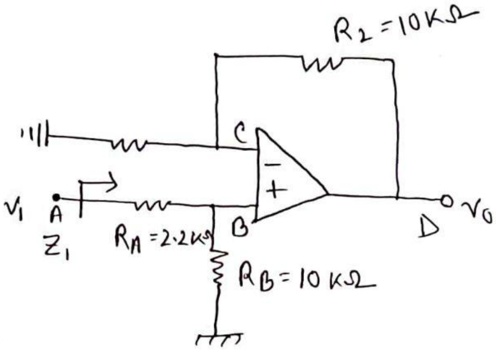

fig:- non inverting amplifier.

$v_A = v_1 = 1\,v$

$v_B = \frac{10K}{10 \times 2.2K} \times 1 \quad \therefore \; v_B = 0.82V = v_C$

$v_D = v_0 = 5v_1 = 5V$

$I_1 = \frac{0 - 0.82}{2.2K} = 0.373\ mA$

$I_2 = \frac{0.82 - 5}{10K} = -0.418\ mA$

$I_A = \frac{1 - 0.82}{2.2K} = 0.82\,mA$

$I_B = \frac{0.82 - 0}{10K} = 0.082\,mA$

$Z_1 = \frac{v_1}{I_1} = \left|\frac{1}{-0.373}\right|$

$= 2680.96\,\Omega$

Name: Umme Habiba Ahmed
ID: 2021-3-60-047
Exp no 4, Group: 08

Pre-lab

Title: Adder and Amplifier Circuit using.

1. ADDER CIRCUIT:

Given that,

$$v_o = -(v_1 + 2v_2)$$
$$= -v_1 - 2v_2$$

from weight summer, we know,

$$v_o = -\frac{R_f}{R_1} v_1 - \frac{R_f}{R_2} v_2$$

equating the coefficient of v_1 and v_2,

$\frac{R_f}{R_1} = 1$ and, $\frac{R_f}{R_2} = 2$

$\Rightarrow R_f = R_1$ $\Rightarrow R_f = 2R_2$

As given $10 k\Omega$ is the highest value of resistor which can be choose as R_f,

$\therefore R_f = 10 k\Omega = R_1$

and $R_2 = \frac{R_f}{2} = \frac{10k\Omega}{2} = 5 k\Omega$

As there is no resistor of $5 k\Omega$, let us choose $5.6 k\Omega$

$\therefore R_f = 10 k\Omega$, $R_1 = 10 \Omega$, $R_2 = 5.6 k\Omega$

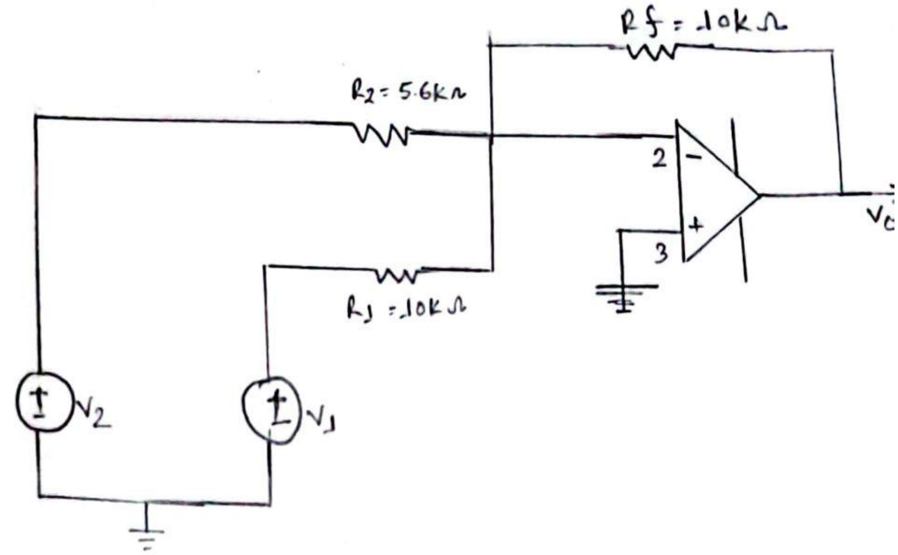

figure: Adder circuit

2. AMPLIFIER CIRCUIT:

Given that,

$$\frac{V_o}{V_1} = \frac{R_2}{R_1} = 5$$

$\therefore R_2 = 5R_1$

$R_2 = 10k\Omega$

$$R_1 = \frac{R_2}{5} = \frac{10k\Omega}{5} = 2\,k\Omega$$

$\therefore R_A = R_1 = 2.2K\Omega$

and, $R_B = R_2 = 10k\Omega$

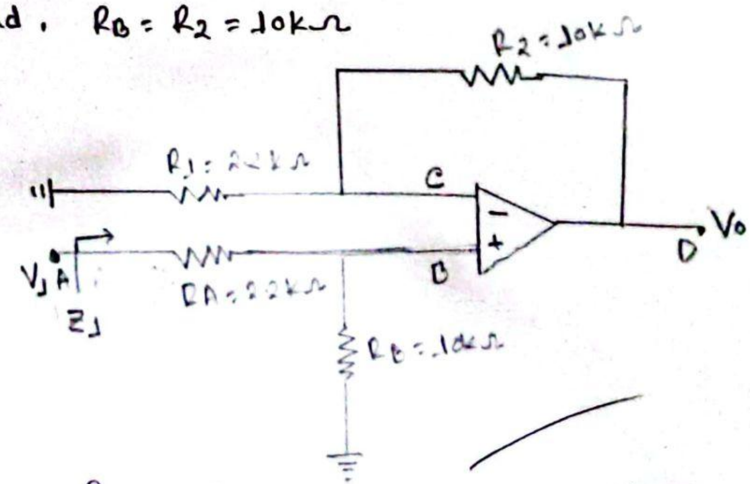

figure: A non Inverting Amplifier

$V_A = V_1 = 1\ V$

$$V_B = \frac{10k}{10k \times 2.2k} \times 1$$

$\therefore V_B = 0.82\ V$

$V_C = V_B = 0.82\ V$

$V_D = V_o = 5V_1 = 5\ V$

$$I_1 = \frac{0 - 0.82}{2.2k} = 0.373\ mA$$

$$I_2 = \frac{0.82 - 5}{10k} = -0.418\ mA$$

$$I_A = \frac{1 - 0.82}{2.2k} = 0.082\ mA$$

$$I_B = \frac{0.82 - 0}{10k} = 0.082\ mA$$

$$Z_1 = \frac{V_1}{I_1} = \left| \frac{1}{-0.373\ mA} \right|$$

$$= 2680.96\ \Omega$$