EE230: Lab 9
Instrumentation Amplifier

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1 Overview of the experiment

1.1 Aim of the experiment

1. Designing an Instrumentation Amplifier with 3 Op-Amps using the given procedure and implementing the circuit on a breadboard. Then we observed the output Voltage using a weighing scale as the input, in order to measure the sensitivity.

2. Designing an Instrumentation Amplifier with INA128 using the given procedure and implementing the circuit on a breadboard. We then observed the output Voltage using a weighing scale as the input, in order to measure the sensitivity.

1.2 Methods

The circuit diagrams for the Instrumentation Amplifiers were provided in the lab handout, using which I built the circuit on a breadboard and obtained the required plots.

2 Design & Working

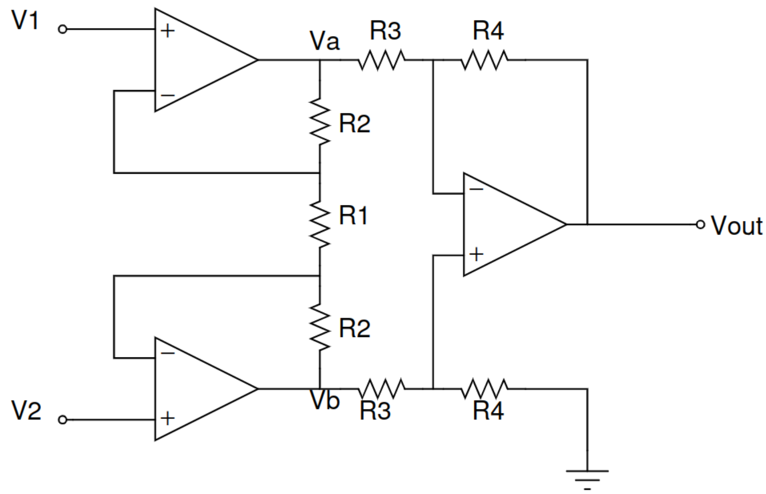


Fig. Instrumentation Amplifier

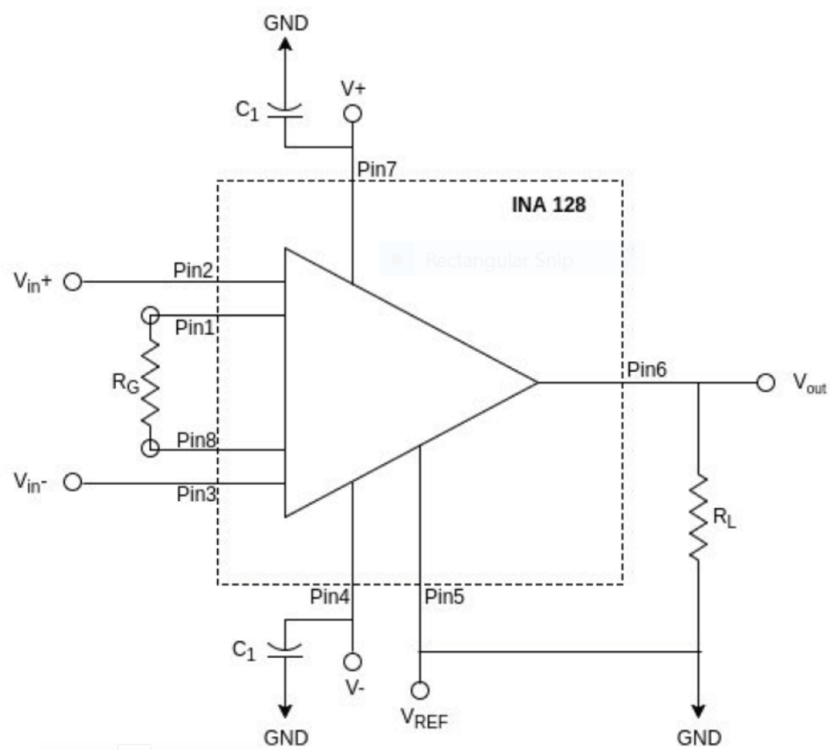


Fig. INA128

3 Experimental results

3.1 Part - 1

We know that for an Instrumentation Amplifier,

$$V_a = V_1(1 + R_2/R_1) + V_2(R_2/R_1)$$
$$V_b = -V_1(R_2/R_1) + V_2(1 + R_2/R_1)$$

Using Superposition,

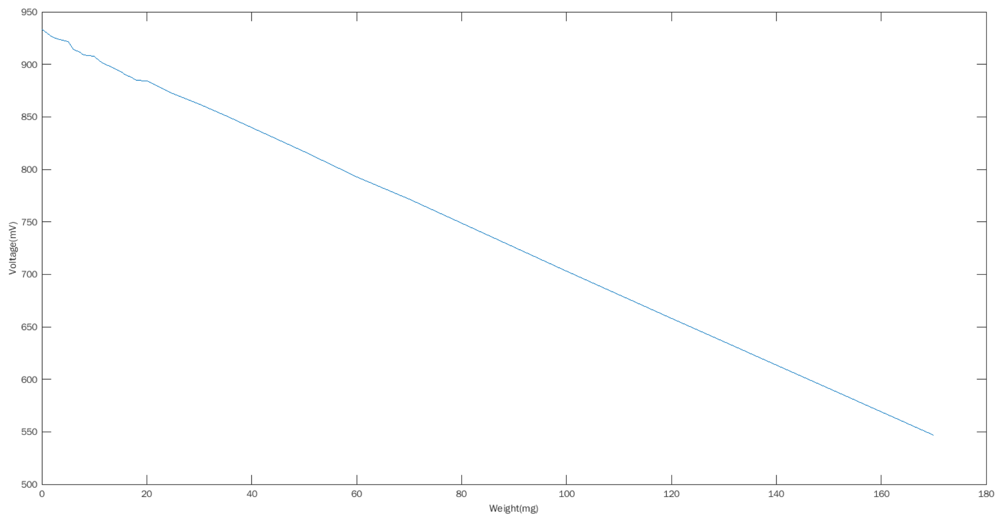
$$V_{out} = (R_4/R_3)(1 + 2R_2/R_1)(V_2 - V_1)$$
$$A_V = \frac{V_{out}}{V_2 - V_1} = \frac{R_4}{R_3}(1 + \frac{2R_2}{R_1})$$

We need $A_V = 300$, for which I took $R_4/R_3 = 15$ with $R_4 = 15k\Omega$ and $R_3 = 1k\Omega$. Moreover, I took $R_2/R_1 = 10$ with $R_2 = 10k\Omega$ and $R_1 = 1k\Omega$. Taking these resistance values gives me a theoretical gain of 315, which is close enough.

Given below are the readings for Voltage v/s Weight obtained from the above experiment:

Weight(mg)	V_{out}(mV)
0	933
1	930
2	926
3	924
5	922
6	914
7	912
8	909
10	908
11	903
12	900
13	898
15	893
16	890
17	888
18	885
20	884
25	872
30	862
35	851
50	817
60	793
70	772
100	703
120	658
150	591
170	547

The plot obtained is as follows:



We obtain a theoretical sensitivity of the circuit as 2.27mV/gm.

In order to double the sensitivity, we can halve the value of R_1 i.e. $R_1 = 500\Omega$

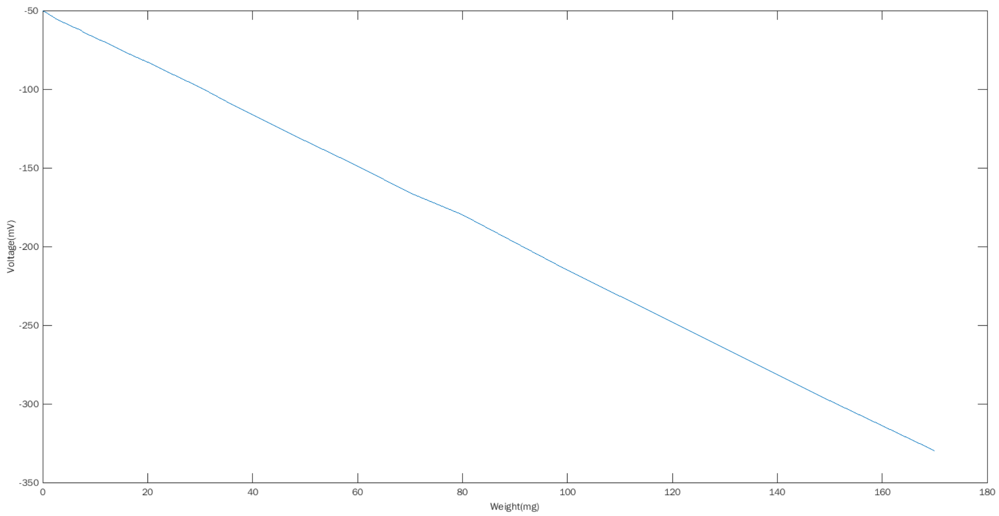
3.2 Part - 3

We will be using $R_G = 220\Omega$, $R_L = 10k\Omega$, $C_1 = 0.1uF$, $V_+ = 12V$ and $V_- = -12V$.

Given below are the readings for Voltage v/s Weight obtained from the above experiment:

Weight(mg)	V_{out}(mV)
0	-50
1	-52
2	-54
3	-56
5	-59
6	-61
7	-62
8	-64
10	-67
11	-69
12	-70
13	-72
15	-75
16	-77
17	-78
18	-80
20	-83
25	-91
30	-99
35	-108
50	-133
60	-149
70	-166
80	-180
100	-215
120	-248
150	-298
170	-330

The plot obtained is as follows:



We obtain a theoretical sensitivity of the circuit as 1.65mV/gm.

In order to double the sensitivity, we can halve the value of R_G i.e. $R_G = 110\Omega$