EE 230: Analog Circuits Lab
Lab No. 6
Non Idealities in the Op-Amp

Anupam Rawat, 22b3982

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Section - A (Offset voltage and Bias currents)

1. Measurement of V_{os} - offset voltage:

1.1 Aim of the experiment

Measure the offset voltage V_{os} and compare it with the device specifications as per the dataset.

1.2 Design

Equations regarding the circuit:

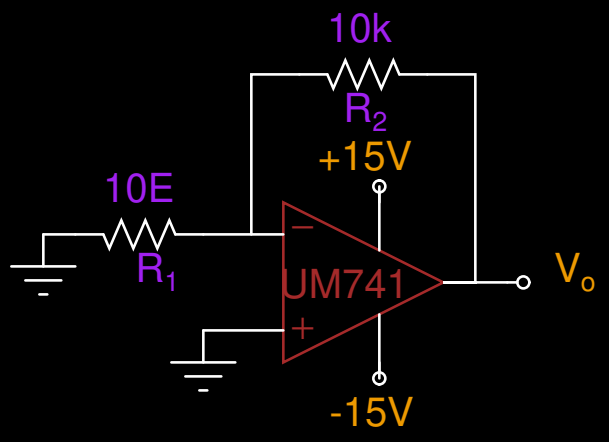
$$V_o = V_{os} \cdot (1 + \frac{R_2}{R_1}) + R_2 \cdot I_{B-} \tag{1}$$

$$V_o \approx V_{os} \cdot (\frac{R_2}{R_1}) \tag{2}$$

$$V_{os} \approx \frac{V_o}{\frac{R_2}{R_1}} \tag{3}$$

We can use the approximation because the ratio of $R_2/R1$ is $>> 1$

Below is the circuit diagram for the experiment:



1.3 Experimental results

Measured values of Resistances and output voltage V_o:
The value of the resistances are $R_1 = 10.3\Omega$ and that of $R_2 = 9.97\Omega$. The output voltage $V_o = 1.24$V.

What is measured V_{os}
$V_{os} = \frac{1.24V}{\frac{9.97k\Omega}{10.3\Omega}} = 1.28$ mV.
From datasheet V_{os} typical is 1mV.

1.4 Experiment completion status

The experiment was completed during lab hours and the hand written report for the same was also submitted during lab hours.

2. Measurement of Bias Current I_{B-}

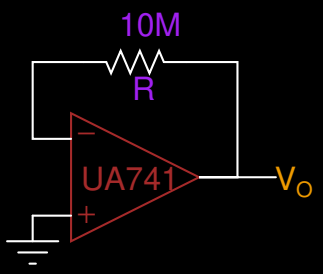
2.1 Aim of the experiment

The experiment required measurement of I_{B-} and comparison as per the dataset.

2.2 Design

$$V_- = V_+ = V_{os} \tag{4}$$

$$V_o = V_- + I_{B-} \cdot R = V_{os} + I_{B-} \cdot R \tag{5}$$



2.3 Experimental results

Measured values of Resistaces and output voltage V_o
The measured value of R = 9.66MΩ and the measured value of V_o is 365mV.
What is the measured value of I_{B-} ***and compare with the dataset***
The value of $I_{B-} = \frac{V_o}{R} = 37.01$nA.
From datasheet, the typical value of $I_B = 10$nA
and the maximum vakue of $I_B = 100$nA.

2.4 Experiment completion status

The experiment was completed during lab hours and the hand written report for the same was also submitted during lab hours.

3. Measurement of Bias Current I_{B+}:

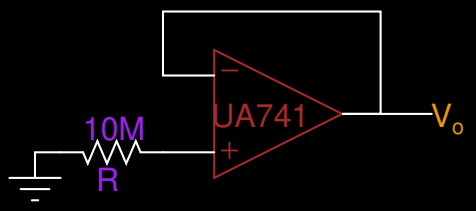
3.1 Aim of the experiment

The experiment required measurement of I_{B+} and comparison as per the dataset.

3.2 Design

$$V_+ = I_{B-} \cdot R + V_{os} = V_o = V_+ = V_- \tag{6}$$

$$I_{B+} = \frac{V_o}{R} \tag{7}$$



3.3 Experimental results

Measured values of Resistaces and output voltage V_o
The measured value of R = 9.66MΩ and the measured value of V_o is -378mV.
What is the measured value of I_{B+} and compare with the dataset
The value of $I_{B+} = \frac{V_o}{R}$ = -38.33nA.
From datasheet, the typical value of I_B = 10nA
and the maximum vakue of I_B = 100nA.

3.4 Experiment completion status

The experiment was completed during lab hours and the hand written report for the same was also submitted during lab hours.

Section - B (Open Loop Gain (A_{OL}))

2. Measurement of Open Loop Gain

2.1 Aim of the experiment

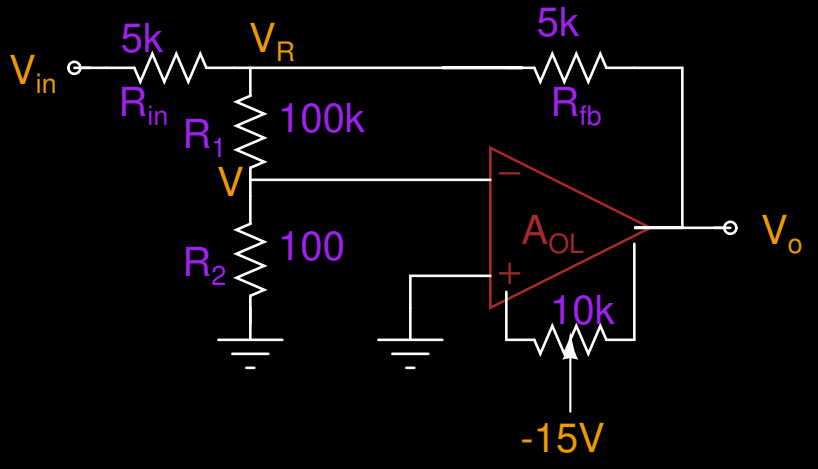
Calculate the value of open loop gain in the UA741 IC Op-Amp.

2.2 Design

$$V_- = -\frac{V_o}{A_{OL}} \tag{8}$$

$$V_R = V_- \cdot (\frac{R_1 + R_2}{R_2}) \tag{9}$$

$$|A_{OL}| = \frac{|V_o|}{|V_R|} \cdot (\frac{R_1 + R_2}{R_2}) \tag{10}$$



2.3 Experimental results

What are the actual values of Resistances:
The value of $R_{in} = 5.02\text{k}\Omega$, $R_{fb} = 5.05\text{k}\Omega$, $R_1 = 98.0\text{k}\Omega$ and $R_2 = 100.6\Omega$

$f(Hz)$	V_o	V_R	A_{OL}
10k	80mV	720mV	108.35
1k	560mV	680mV	803.07
500	936mV	592mV	1541.79
100	1.50V	188mV	7780.49
20	1.54V	42mV	35755.68
10	1.54V	26mV	57759.18
9	1.54V	24mV	62572.45
8	1.54V	21.6mV	69524.94
7	1.54V	20.8mV	72198.98
6	1.54V	19.2mV	78215.56
5	1.54V	17.6mV	85326.06
4	1.54V	16mV	93858.67
3	1.54V	13.5mV	111239.90
2	1.54V	13.7mV	109676.00
1	1.54V	11.4mV	131731.50

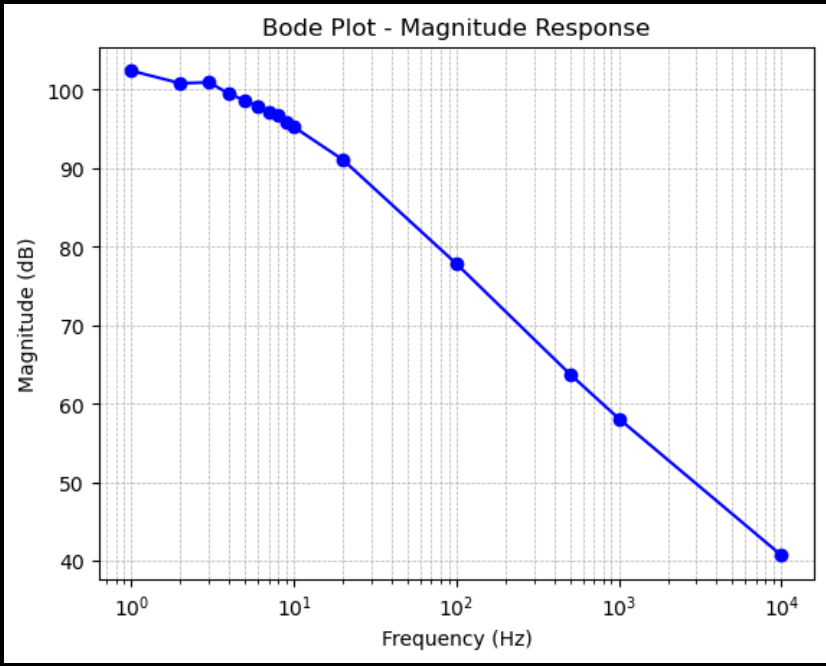
Values of V_o,V_R and A_{OL} at various frequencies:

Roll off slope of A_{OL}
Roll off slope of A_{OL} = 37.84 / 2 = - 18.57

What is the 3dB frequency of the OpAmp:
The 3dB frequency of the OpAmp is ≈ 4Hz.

What is the measured open loop gain of the OpAmp:
Calculated open loop gain A_{OL} = 1.31 x 10^5
As per the dataset, the typical value of the dataset is 2 x 10^5.

What is pole frequency of the OpAmp:
Magnitude frequency response of the open loop gain has 1 pole, and the pole frequency is ≈ 100Hz.



2.4 Simulation

2.5 Experiment completion status

The experiment was completed during lab hours and the hand written report for the same was also submitted during lab hours.

Parameter	Experimental Values	Datasheet value
V_{OS}	1.28mV	1mV
I_{B-}	37.0nA	10nA
I_{B+}	38.35nA	10nA
A_{OL}	1.31 x 10^5	2 x 10^5

Conclusion of The Experiment

The experimentally calculated values of the experiment agree well with the values in the dataset of UA741.