Experiment 4
Experimentation on Class A, Class B, and Class B push-pull Multistage Amplifier

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1 Objective

1. To study the working principle of a Class A Multistage Amplifier.

2. To study the working principle of a Class B and Class B push pull Multistage Amplifier.

3. To measure the voltage gain of the amplifier.

2 Apparatus

1. Transistors (2N3904 npn) - 2

2. Resistors (220 Ω, 1.2 kΩ, 3.6 kΩ, 20 kΩ, 10 kΩ)

3. Capacitors (10 μF) - 3

4. DC Power Supply (0-30V)

5. Function Generator

6. Oscilloscope

7. Multimeter

8. Breadboard, Connecting wires, etc.

3 Circuit Diagram

In the following page is given the circuit diagrams for the Class A, Class B, and Class B push-pull Multistage Amplifiers. Figure 1 shows the circuit diagram for the Class A Amplifier. Figure 2 shows the circuit diagram for the Class B Amplifier. Figure 3 shows the circuit diagram for the Class B push-pull Amplifier.
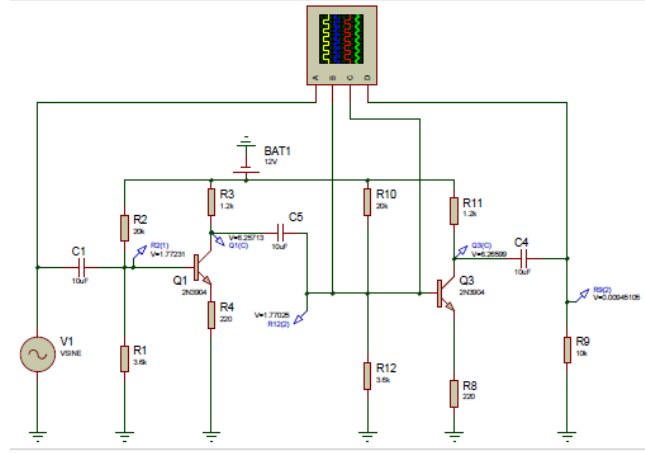
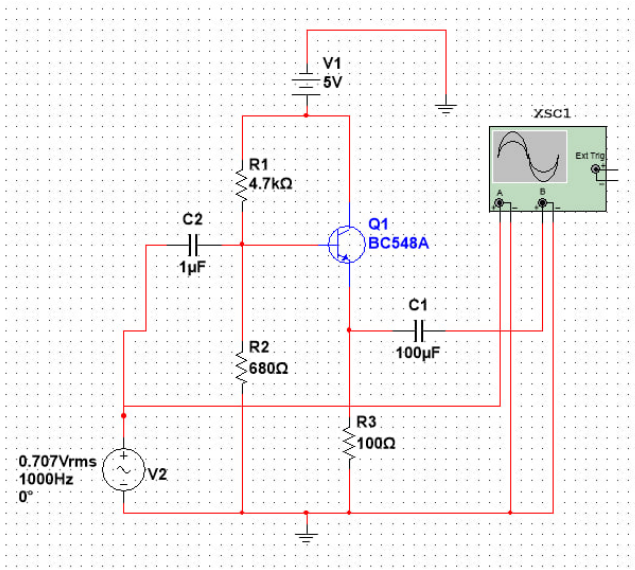Figure 1: Class A Multistage Amplifier Circuit Diagram
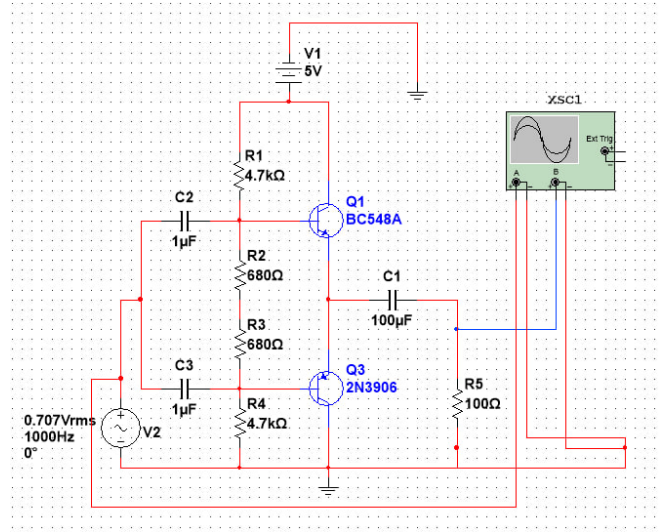

Figure 2: Class B Amplifier Circuit Diagram

Figure 3: Class B Push-Pull Amplifier Circuit Diagram

In Figure 1, The Class A multistage amplifier was built by connecting two amplifier circuits through the capacitor C_5. The output of the first amplifier (Q_1) acts as the input of the second amplifier (Q_3). The 10k Ω is the load resistor in the circuit. Oscilloscope has been connected in the shown way to get the input and output curves.

In Figure 2, The Class B amplifier was built using onw npn transistor. The input signal was given to the base and R_1 and R_2 were base resistors. The output was taken from the emitter and the $R_3 = 100\Omega$ was the load resistor.

In Figure 3, The Class B push-pull amplifier was built using two npn transistors. The input signal was given parallelly to the bases of Q_1 and Q_2. The base resistance is $R_{th} = R_1 \| (R_2 + R_3) \| R_4$. The emitter of Q_1 and the collector of Q_2 were connected to the output terminal. The load resistor was $R_5 = 100\Omega$.

4 Result Analysis

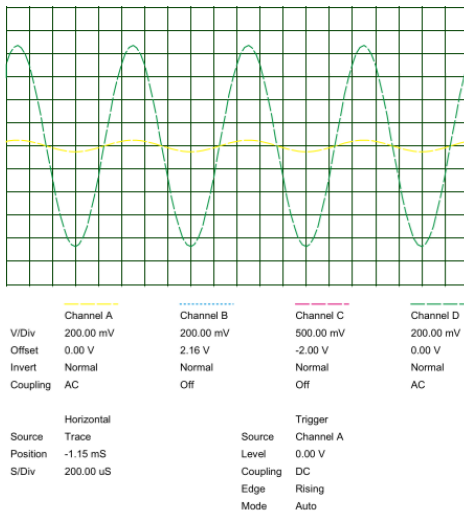## 4.1 Class A Multistage Amplifier

A multistage amplifier amplifies a signal in multiple stages. The input of the first stage is amplified and collected at at the output terminal and that output becomes the input for the second stage. This is how a signal gets amplified in multiple stages. The overall voltage gain of the signal is going to be the multiplication of the voltage gain of each of these circuits. Table 1 shows the data for the Class A multistage amplifier.

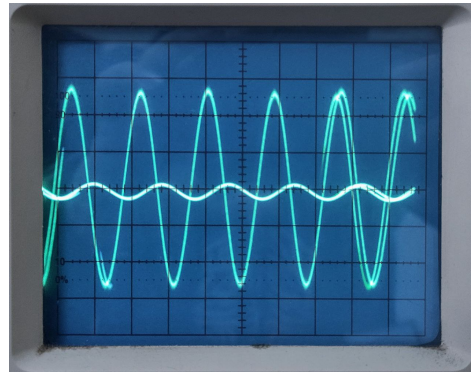### 4.1.1 Data Table for Class A Multistage Amplifier

Table 1: Data table for Class A multistage amplifier

Simulation Data						
V_{in} (mV)	V_{out} (mV)	I_{in} (μA)	I_{out} (μA)	A_V	A_I	A_P
50	617	19.2	61.7	12.34	3.21	39.61
Practical Data						
V_{in} (mV)	V_{out} (mV)	I_{in} (μA)	I_{out} (μA)	A_V	A_I	A_P
50	572	15.2	65.7	11.44	4.32	49.42
Error Analysis (Simulation vs Practical Data)						
V_{in} %	V_{out} %	I_{in} %	I_{out} %	A_V %	A_I %	A_P %
0	10.86	20.83	6.48	0.38	34.58	24.77

4.1.2 Class A Multistage Amplifier Input and Output Graphs

(a) Simulated Graph

(b) Experimental Graph

Figure 4: Simulated and Practical Input and Output Graphs for Class A Multistage Amplifier

In the simulated graph (Figure 4-a), the yellow and the green dashed lines show the input and output curves respectively. In the practical graph (Figure 4-b), the shorter amplitide curve is input graph and the other one is output curve.
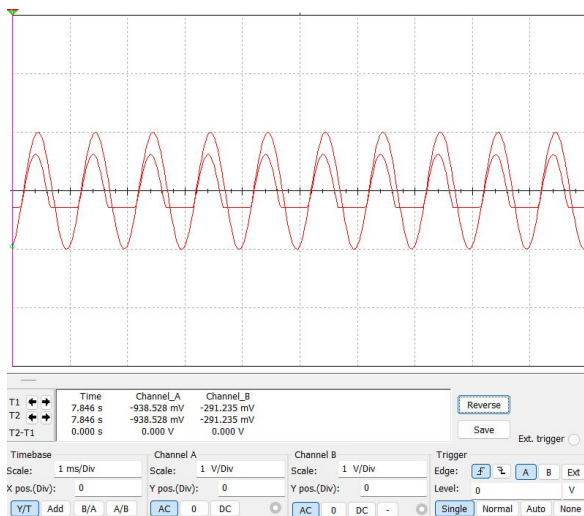
4.2 Class B Amplifier

The Class B amplifier operates in such a way that the positive half cycle of the input signal is amplified by one transistor and the negative half cycle is amplified by another transistor. The output of these two transistors are then combined to get the amplified output. Table 2 shows the data for the Class B amplifier.

### 4.2.1 Data Table for Class B Amplifier

Table 2: Data table for Class B Amplifier

Simulation Data						
V_{in} (mV)	V_{out} (mV)	I_{in} (mA)	I_{out} (mA)	A_V	A_I	A_P
707	456	1.17	4.56	0.64	3.90	2.50
Practical Data						
V_{in} (mV)	V_{out} (mV)	I_{in} (mA)	I_{out} (mA)	A_V	A_I	A_P
707	432	1.12	4.32	0.61	3.57	2.96
Error Analysis (Simulation vs Practical Data)						
V_{in} %	V_{out} %	I_{in} %	I_{out} %	A_V %	A_I %	A_P %
0	5.31	4.27	5.26	4.69	8.33	18.40

4.2.2 Class B Amplifier Input and Output Graphs
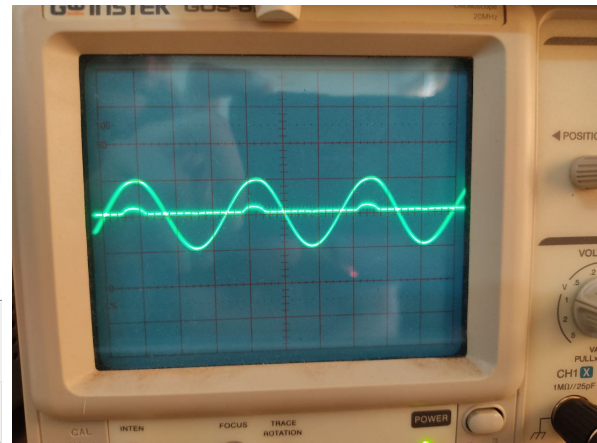
(a) Simulated Graph

(b) Experimental Graph

Figure 5: Simulated and Practical Input and Output Graphs for Class B Amplifier

In the simulated graph (Figure 5-a), the red full waves and the clipped half waves show the input and output curves respectively. In the practical graph (Figure 5-b), the shorter amplitide curve is output graph and the other one is input curve.
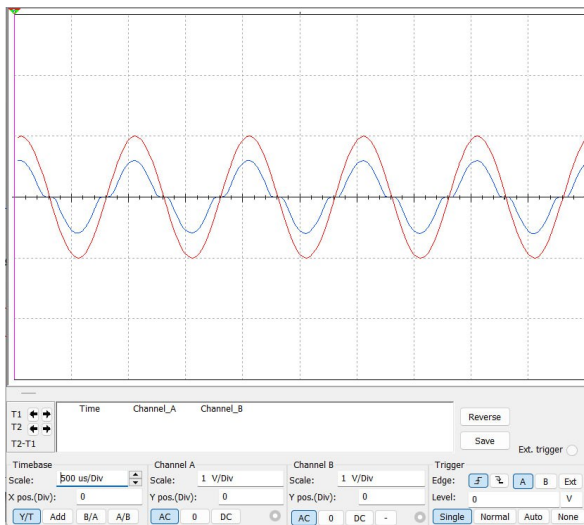
4.3 Class B Push-Pull Amplifier

The Class B push-pull amplifier is a combination of two Class B amplifiers. The input signal is divided into two halves and each half is amplified by one transistor. The output of these two transistors are then combined to get the amplified output. Table 3 shows the data for the Class B push-pull amplifier.
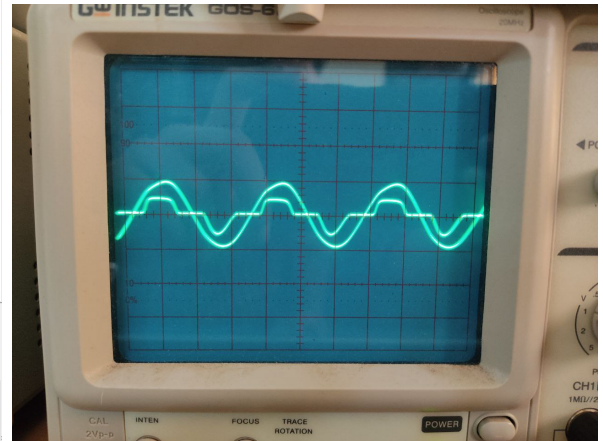
4.3.1 Data Table for Class B Push-Pull Amplifier

Table 3: Data table for Class B Push Pull Amplifier

Simulation Data						
V_{in} (mV)	V_{out} (mV)	I_{in} (μA)	I_{out} (mA)	A_V	A_I	A_P
707	535	339	5.35	0.76	15.78	11.99
Practical Data						
V_{in} (mV)	V_{out} (mV)	I_{in} (μA)	I_{out} (mA)	A_V	A_I	A_P
707	512	345	5.12	0.72	15.63	13.28
Error Analysis (Simulation vs Practical Data)						
V_{in} %	V_{out} %	I_{in} %	I_{out} %	A_V %	A_I %	A_P %
0	4.67	1.76	4.67	5.56	0.96	11.07

4.3.2 Class B Push-Pull Amplifier Input and Output Graphs

(a) Simulated Graph   (b) Experimental Graph

Figure 6: Simulated and Practical Input and Output Graphs for Class B Push-Pull Amplifier

In the simulated graph (Figure 6-a), the red full waves and the black full waves show the input and output curves respectively. The output curve has crossover distortion. In the practical graph (Figure 6-b), the output curve has crossover distortion.

5   Discussion

The experiment was conducted to observe the amplification of a signal in multiple stages. Error had been measured between the simulated data and the practical data. The error analysis shows that the accuracy of the practical data is roughly within the range of 75% to 90%. The theoretical, simulation and practical data had some discripancies. One of the possible reason for this was that in the theoretical and simulated data, the internal resistance of wires and other equipments were considered negligible.