EEE - 313 Electronic Circuit Design Lab - 3

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Section - 2
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PRELIMINARY

Introduction

In this lab, we are asked to design a complementary push-pull Class-B power amplifier capable of delivering at least 2.25W to an 8.2 resistor and load. The selected gain is 25dB.

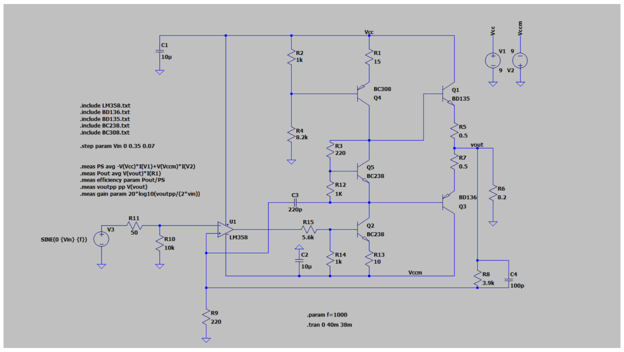

Fig. 1: Circuit

Component list:

- 15 resistor $(1\ 50\Omega, 1\ 10K\Omega, 2\ 220\Omega, 1\ 8.2K\Omega, 1\ 5.6K\Omega, 1\ 15\Omega, 1\ 10\Omega, 2\ 0.5\Omega, 1\ 3.9k\Omega, 3\ 1k\Omega, 1\ 8.2\Omega)$
- 1 Opamp $(LM358)$
- 4 capacitor $(210\mu, 1220p, 1100p)$
- 3 NPN BJT $(1BD135, 2BC238)$
- 2 PNP BJT $(1BC308, 1BD136)$
- 2 voltage supply for V_{cc} and V_{ccm}
- 1 signal generator

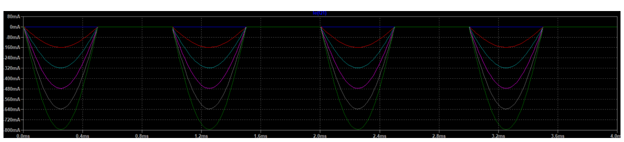

Fig. 2: Emitter Current of BD135

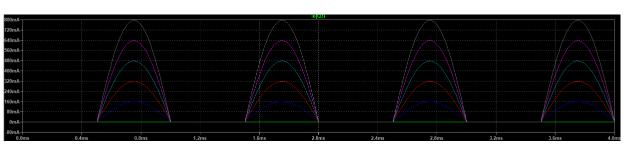

Fig. 3: Emitter Current of BD136

1) Power On Resistor 8.2Ω

In these requirement, we are asked to show the Power On Resistor 8.2Ω between 10 Hz and 40kHz. The Hz values to be shown are 10Hz, 100Hz, 200Hz, 300Hz, 400Hz, 500Hz, 1000Hz, 5000Hz, 10000Hz, 20000Hz, 300000Hz and 40000Hz. As can be seen below figures, all values satisfy the conditions.

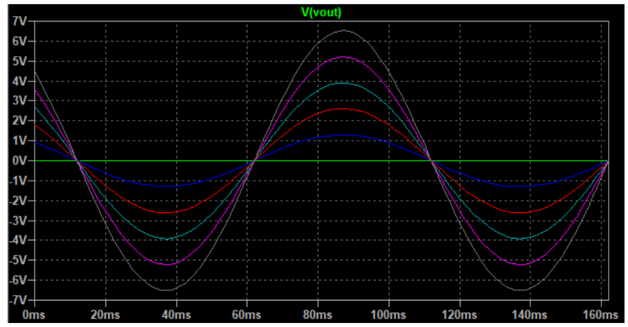

Fig. 4: $V_{out} signal$ at 10Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.162
2	0.0984569	0	0.162
3	0.393734	0	0.162
4	0.88587	0	0.162
5	1.57505	0	0.162
6	2.46194	0	0.162

Fig. 5: Power On Resistor 8.2Ω at 10Hz

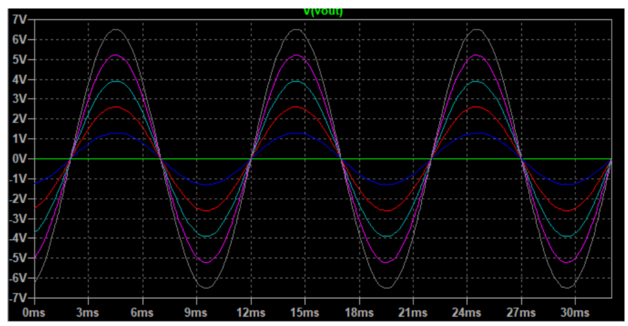

Fig. 6: $V_{out} signal$ at 100Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.032
2	0.101914	0	0.032
3	0.407642	0	0.032
4	0.917201	0	0.032
5	1.63084	0	0.032
6	2.54984	0	0.032

Fig. 7: Power On Resistor 8.2Ω at 100Hz

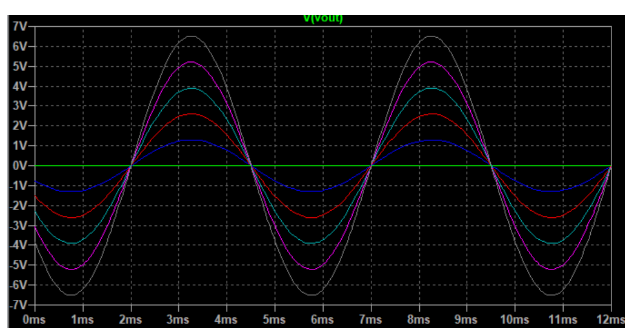

Fig. 8: $V_{out} signal$ at 200Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.012
2	0.106643	0	0.012
3	0.426588	0	0.012
4	0.95981	0	0.012
5	1.70654	0	0.012
6	2.66742	0	0.012

Fig. 9: Power On Resistor 8.2Ω at 200Hz

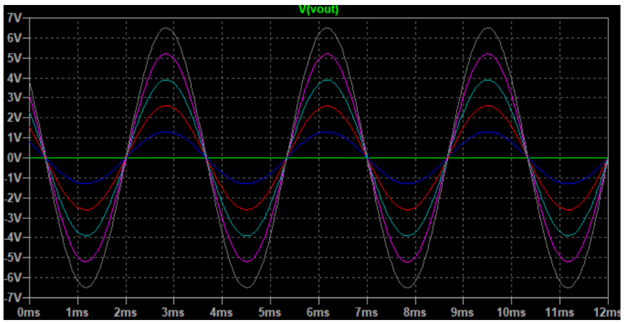

Fig. 10: $V_{out} signal$ at 300Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.012
2	0.101034	0	0.012
3	0.404109	0	0.012
4	0.909203	0	0.012
5	1.61634	0	0.012
6	2.52593	0	0.012

Fig. 11: Power On Resistor 8.2Ω at 300Hz

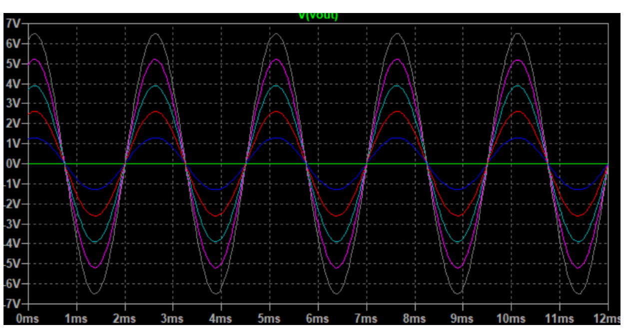

Fig. 12: $V_{out} signal$ at 400Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.012
2	0.103808	0	0.012
3	0.415297	0	0.012
4	0.93447	0	0.012
5	1.66148	0	0.012
6	2.59732	0	0.012

Fig. 13: Power On Resistor 8.2Ω at 400Hz

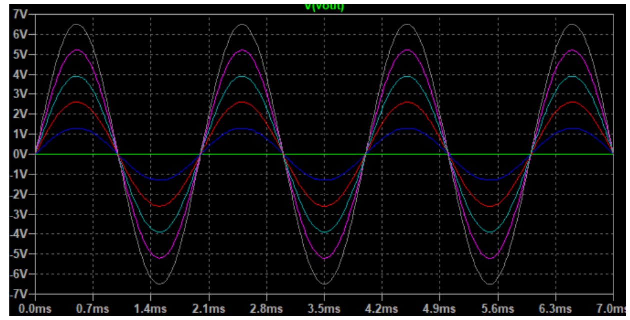

Fig. 14: $V_{out} signal$ at 500Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.007
2	0.103207	0	0.007
3	0.412861	0	0.007
4	0.928825	0	0.007
5	1.65121	0	0.007
6	2.58034	0	0.007

Fig. 15: Power On Resistor 8.2Ω at 500Hz

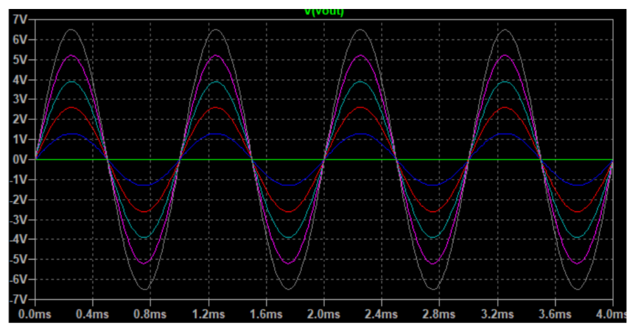

Fig. 16: $V_{out} signal$ at 1000Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.004
2	0.103082	0	0.004
3	0.412298	0	0.004
4	0.927346	0	0.004
5	1.64862	0	0.004
6	2.57688	0	0.004

Fig. 17: Power On Resistor 8.2Ω at 1000Hz

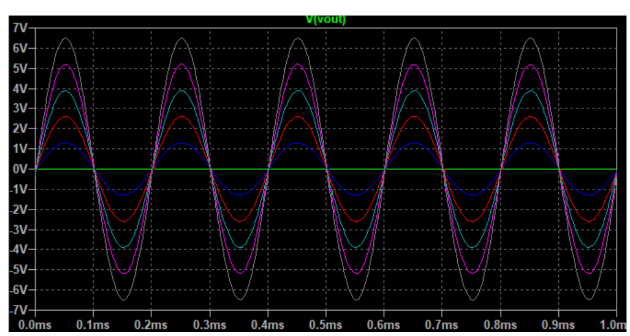

Fig. 18: $V_{out} signal$ at 5000Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.001
2	0.102562	0	0.001
3	0.410358	0	0.001
4	0.922751	0	0.001
5	1.63924	0	0.001
6	2.56221	0	0.001

Fig. 19: Power On Resistor 8.2Ω at 5000Hz

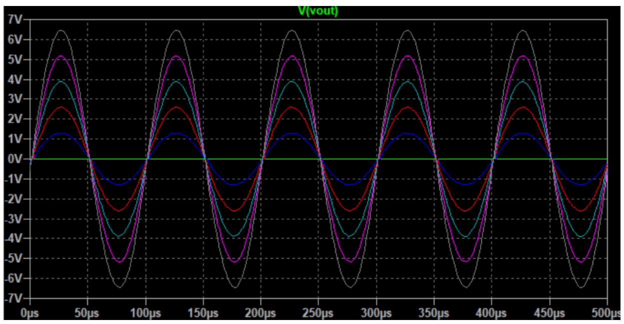

Fig. 20: $V_{out} signal$ at 10000Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.0005
2	0.101735	0	0.0005
3	0.407036	0	0.0005
4	0.915382	0	0.0005
5	1.62702	0	0.0005
6	2.54128	0	0.0005

Fig. 21: Power On Resistor 8.2Ω at 10000Hz

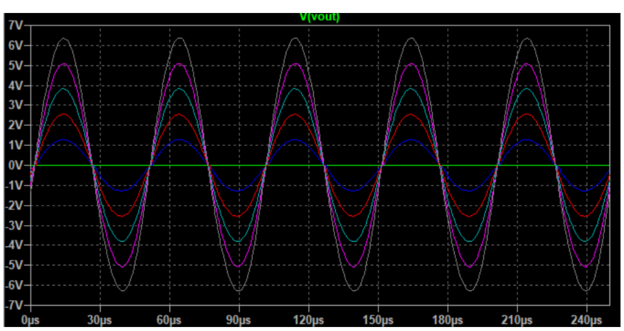

Fig. 22: $V_{out} signal$ at 20000Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.00025
2	0.0985575	0	0.00025
3	0.395665	0	0.00025
4	0.889467	0	0.00025
5	1.57968	0	0.00025
6	2.46225	0	0.00025

Fig. 23: Power On Resistor 8.2Ω at 20000Hz

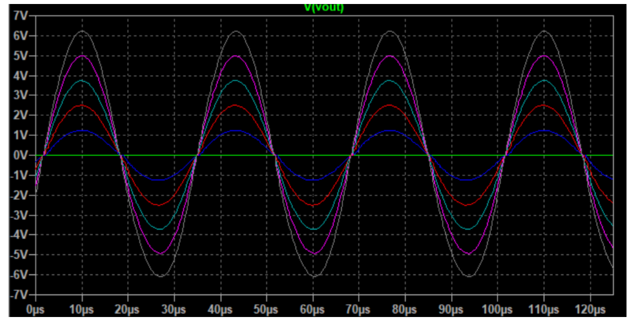

Fig. 24: $V_{out} signal$ at 30000Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	0.000125
2	0.0914906	0	0.000125
3	0.369644	0	0.000125
4	0.831066	0	0.000125
5	1.47268	0	0.000125
6	2.28964	0	0.000125

Fig. 25: Power On Resistor 8.2Ω at 30000Hz

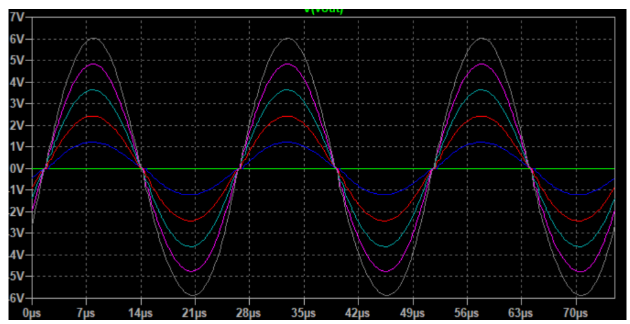

Fig. 26: $V_{out} signal$ at 40000Hz

Measurement: pout

step	AVG(v(vout)*i(r1))	FROM	TO
1	3.96048e-08	0	7.5e-05
2	0.087524	0	7.5e-05
3	0.355947	0	7.5e-05
4	0.801377	0	7.5e-05
5	1.41938	0	7.5e-05
6	2.20316	0	7.5e-05

Fig. 27: Power On Resistor 8.2Ω at 40000Hz

2) The Harmonics

Values were taken by selecting the highest volt value for stability. At 1kHz, as can be seen in the figure 28, the difference between the 1st and 3rd harmonic dB is 46 and it is satisfies the conditions.

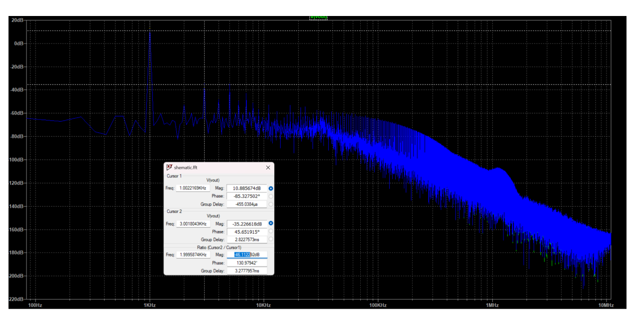

Fig. 28: FFT graphic at 1kHz

3) *Power Consumption at Quiescent Conditions*

The measurement was taken at 1KHz and the power consumption is the same at all frequencies.In figure 29, step 1 is $V_{in} = 0$ and as can be seen, the power consumption at quiescent condition is $300mW$ which is less then $500mW$.

Measurement: ps

step	AVG(-v(vcc)*i(v1)+v(vccm)*i(v2))		FROM
1	0.302074	0	0.462
2	1.1964	0	0.462
3	2.09025	0	0.462
4	2.98298	0	0.462
5	3.87468	0	0.462
6	4.76592	0	0.462

Fig. 29: Power Consumption of Circuit

4) *Amplifier's Overall Efficiency*

At figure 28, Power overall efficiency is 0.54 at V_{in} is max, which is over the 0.45. Satisfies the conditions.

Measurement: efficiency

step	pout/ps
1	1.3111e-07
2	0.0856615
3	0.195905
4	0.308688
5	0.422442
6	0.536806

Fig. 30: Efficiency of the Circuit at 1kHz

5) *DipTrace*

The diptrace circuit has been designed to take up minimal space. Optimized to avoid overlapping cables. The components were brought to the appropriate places, and the cable was bypassed.

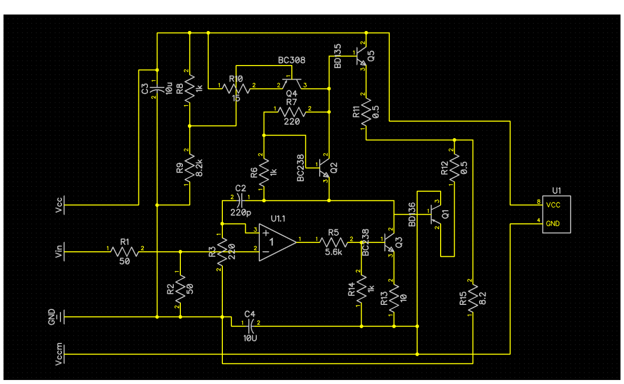

Fig. 31: DipTrace circuit

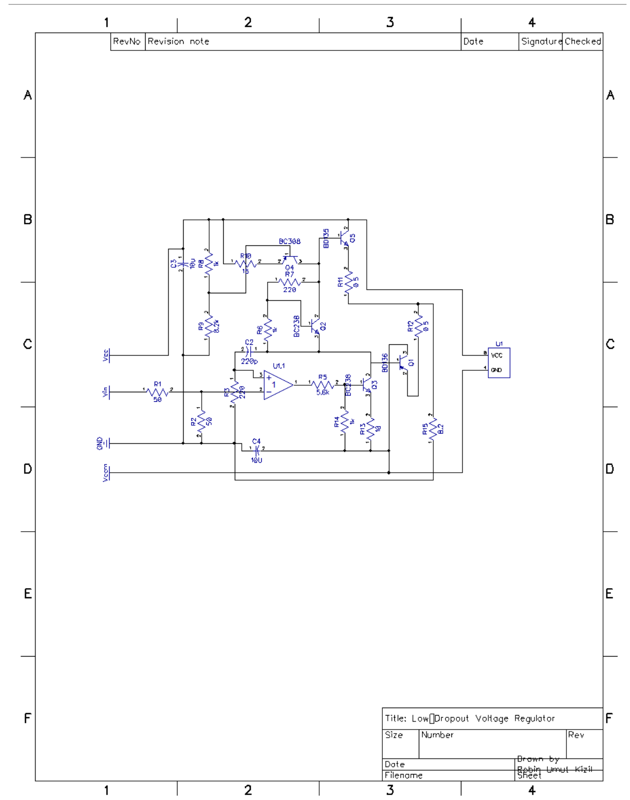

Fig. 32: DipTrace circuit 2

Conclusion

As a result, complementary push-pull Class-B power amplifier was designed by making the necessary resistance adjustments. experimental is successful.