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Course Code: EEE313

Section: 02

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Project Preliminary Report

Introduction

I choose Low-Frequency oscillator driving a 50Ω load as my project. The purpose of this project is designing a 1KHz oscillator driving a 50Ω load resistor. The output voltage should have low distortion and be at least 15V pk-pk. The project has only one power supply which is +18V. The design specifications are given below:

1. Current consumption from +18V supply < 80mA (while driving 50Ω load)
2. Output frequency 1 KHz (± 20%)
3. Peak-to-peak output voltage > 15V onto 50Ω load.
4. Largest harmonic component < −20dB below the fundamental

Methodology

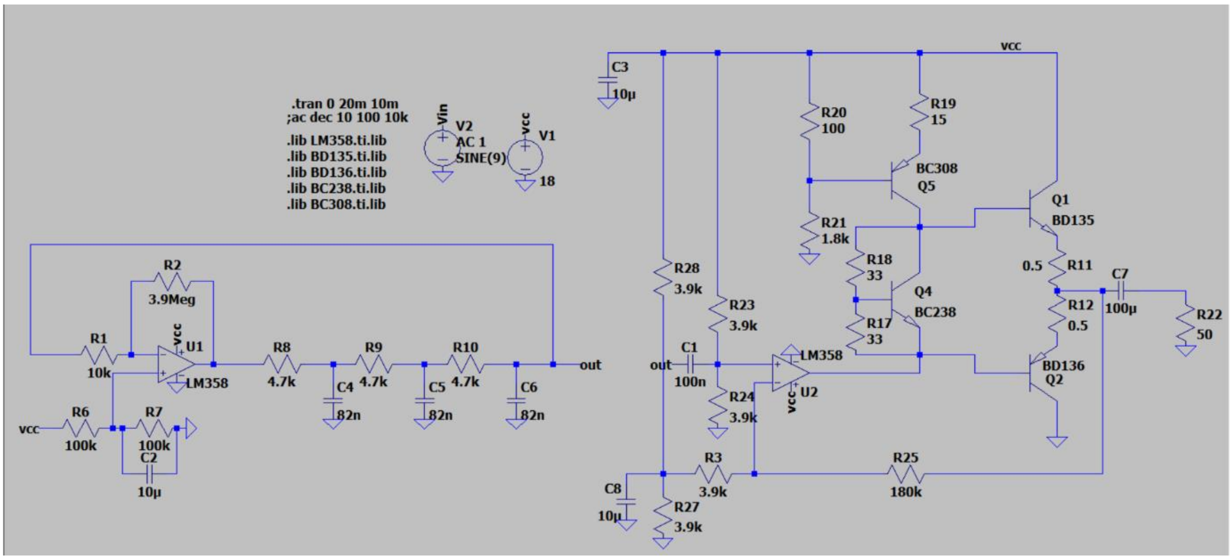

Fig. 1: Circuit Schematic

Class-B amplifier of the circuit is taken from the Lab 3 circuit schematic. For 0 or -360 degree phase shift, I used a 3 stage RC phase shift oscillator with OPAMP. Also, I created a virtual ground since there is only one voltage source, +18V. In the circuit schematic, inverting

OPAMP creates 180 degree phase shift and additional to that, 3 stage RC part creates another 180 degree phase shift. Phase shift at 1KHz is shown in the figure below.

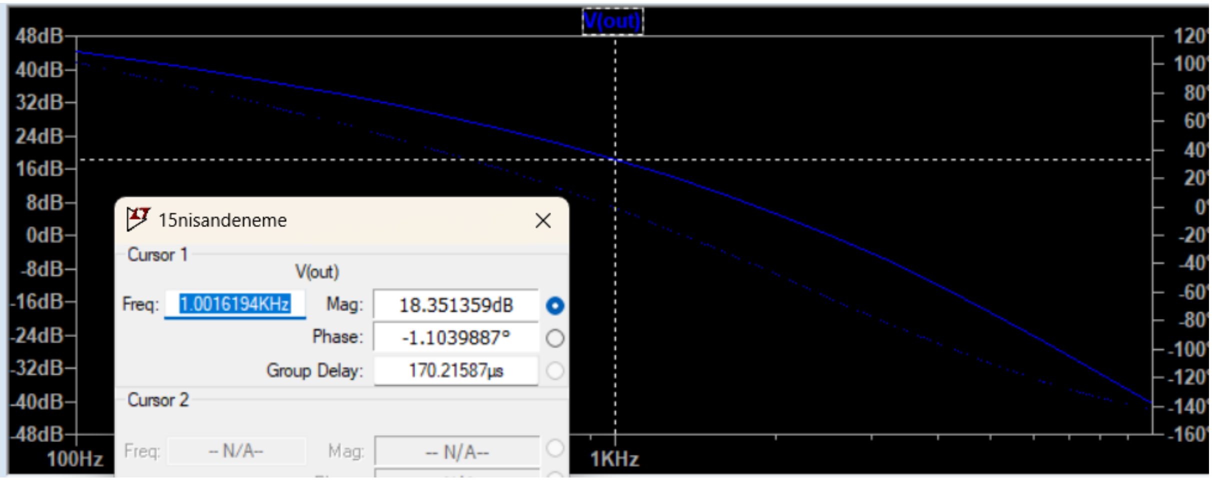

Fig. 2: Gain and phase shift at the output of the RC stages

At 1KHz, phase angle turned out to be -1.1 degrees, which is very near to 0 degree. Looking at the dB gain, at 1KHz, it is 18.35 dB, which is greater than 0 dB.

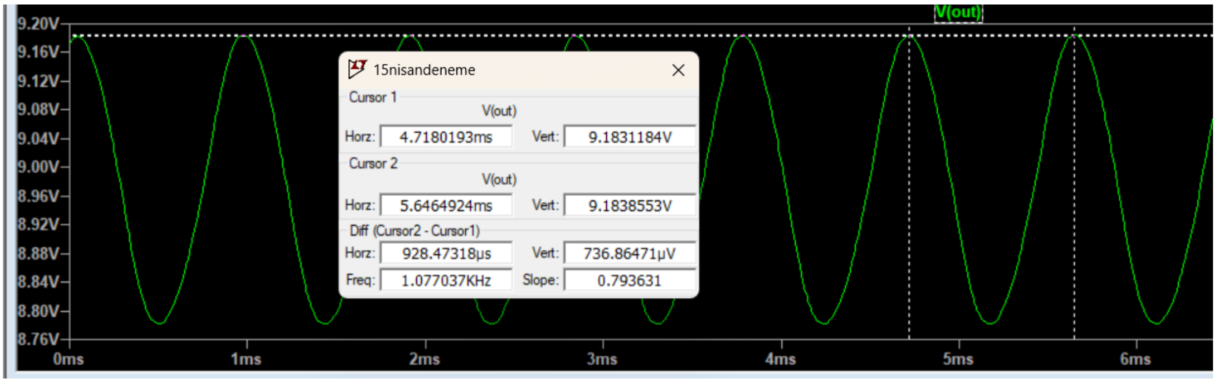

Fig. 3: Output signal of RC stages

Fig. 3 shows that the frequency of the output signal at the RC stages. It is measured as 1.077 KHz.

To obtain a frequency of 1KHz, I used the following formula for calculation RC values.

$$f = \frac{\sqrt{2 * N}}{2 * \pi * R * C}; \qquad N: Number\ of\ RC\ stages$$

$$f = \frac{\sqrt{6}}{2 * \pi * 4.7K * 82n} = 1011\ Hz$$

I created the virtual ground by using a voltage divider and feeding it to the non-inverting input of the OPAMP. Also, to have enough gain for the inverting amplifier, I used 3.9MΩ and 10KΩ resistors.

To have a 15V pk-pk at the output, I used a Class-B amplifier. To find how much gain I need, I take the the average value at the Fig. 3, it is 8.97V. I needed a gain of 1.67. To have this much gain, I adjusted the feedback resistors of the Class-B amplifier, and choose resistor values as 3.9KΩ and 180KΩ.

Lastly, Fig. 4 shows the currents of the Class-B amplifier's complementary transistors.

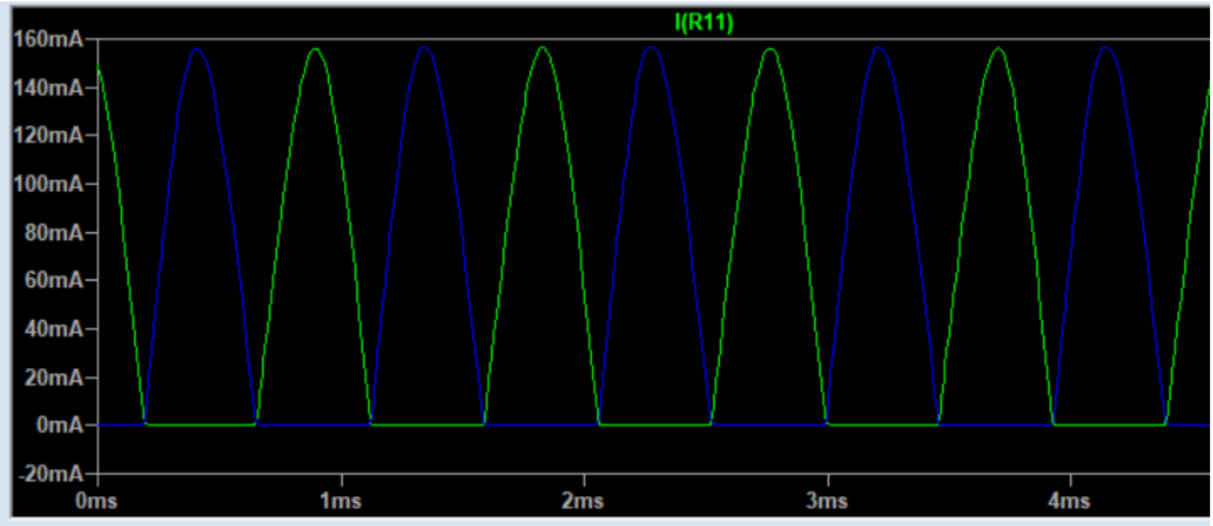

Fig. 4: Current's of Class-B amplifier

As expected, the transistors are ON as a complementary stage.

Analysis

First Specification:

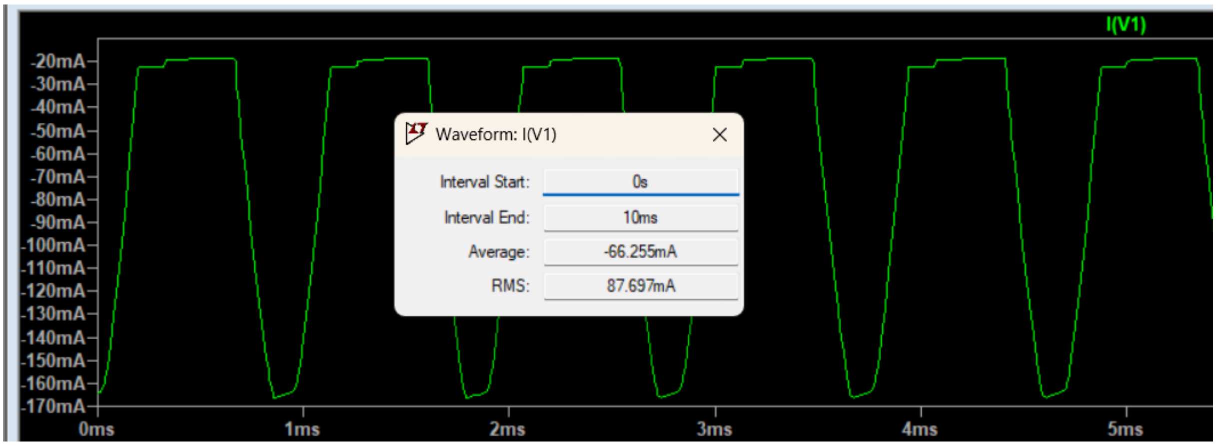

Fig. 5: Current consumption from +18V supply

As seen from Fig. 5, average value of the current consumption from +18V supply is 66.26mA, which is less than 80mA. Therefore first specification is satisfied.

Second Specification:

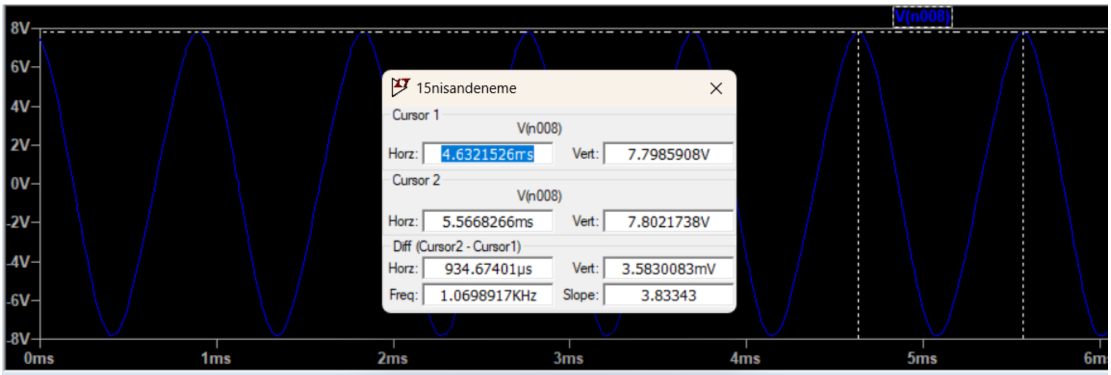

Fig. 6: Output Frequency

Fig. 6 shows the graph of the output signal. Frequency of the output signal is measured as 1.07 KHz. It is inside the range of the specification (1KHz (±20%)). Therefore, second specification is satisfied.

Third Specification:

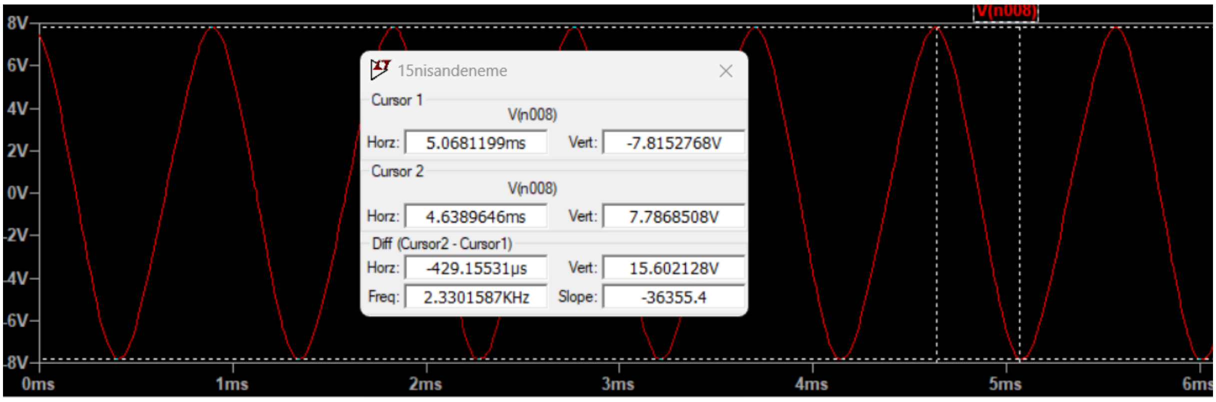

Fig. 7: Output signal at 50Ω load

Looking at Fig. 7, it is seen that peak-to-peak voltage of the output signal is 15.6V, which is greater than 15V. Third specification is also satisfied.

Fourth Specification:

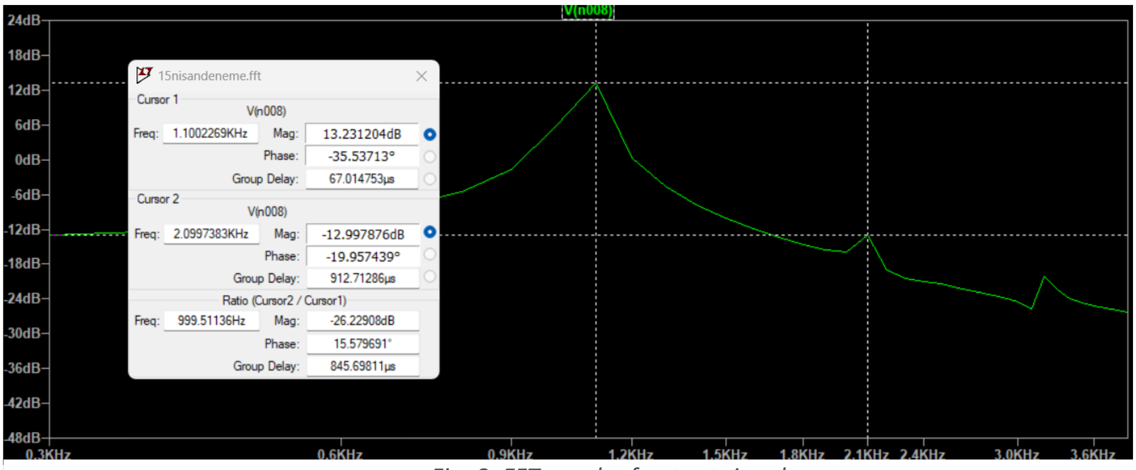

Fig. 8: FFT graph of output signal

Seen from Fig. 8, fundamental component appears at 1.1KHz, and has a magnitude of 13.23dB. Largest harmonic component appears at 2.1KHz. Largest harmonic component has a magnitude of -13 dB. So, largest harmonic component is below -26.23 dB the fundamental component. Therefore, fourth and last specification is satisfied.

DipTrace schematic and Bill of Materials can be seen in Fig. 9 and Fig. 10 respectively.

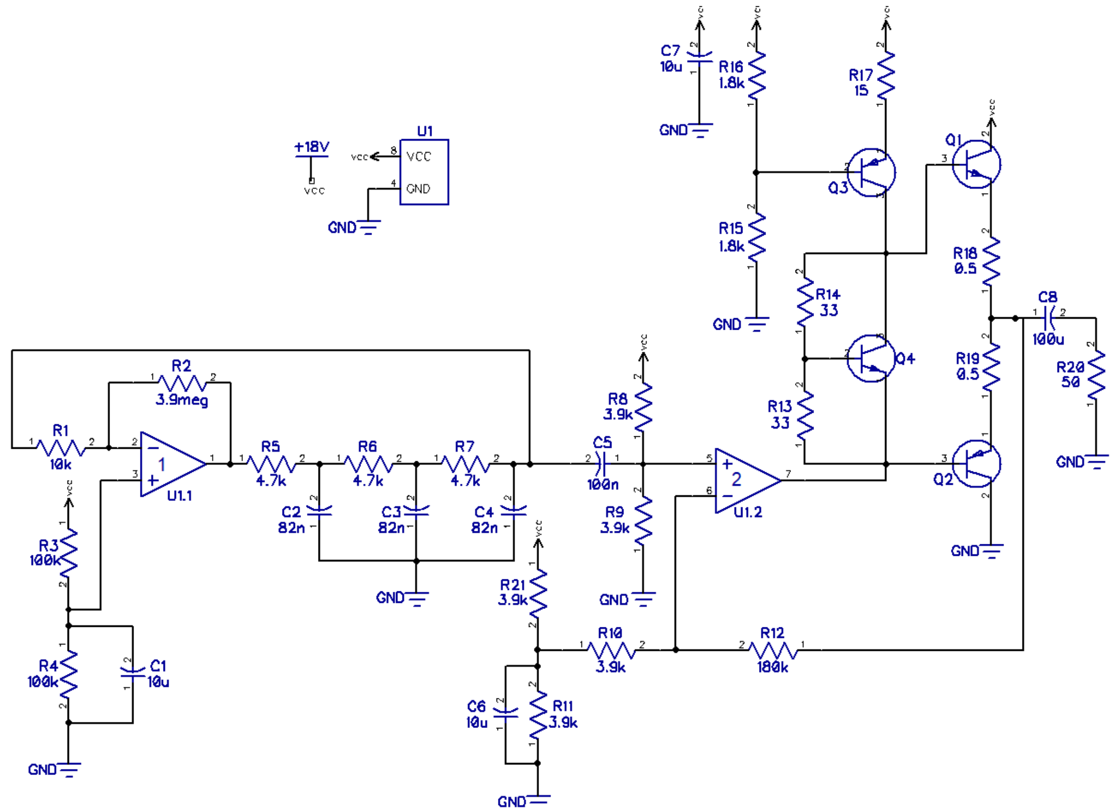

Fig. 9: DipTrace Schematic

#	RefDes	Value	Name	Quantity
1	C1, C2, C3, C4, C5, C6, C7, C8	10u	CAP100	8
2	Q1		BD135	1
3	Q2		BD136	1
4	Q3		BC308	1
5	Q4		BC238	1
6	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21	10k	CFR-12JB-52-100K	21
7	U1		LM358N	1

Fig. 10: Bill of Materials