

2018155

by Stephen Rees

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TIME SUBMITTED	01-FEB-2021 05:54PM (UTC+0000)	WORD COUNT	1839
SUBMISSION ID	143954636	CHARACTER COUNT	9166

Course: HNC Electrical and Electronic Engineering

Module: SGEE4003 - Electronics I

Assignment Title: Analogue

Circuit Design Name:

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University number: 2018155

Date Submitted: 31/02/2021

Word Count: 1827

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LOW

- ① RESEARCH WAS BRIEF, REFERENCE LIST SHORT AND NO INTEXT CITATIONS.
- ② EXPLANATION OF DESIGN WAS ILLOGICAL AND CONFUSED. A RANDOM COLLECTION OF EQUATIONS IN NO PARTICULAR ORDER
- ③ TESTING WAS ERROR STREWN, WITH TEST EQUIPMENT NOT SET CORRECTLY.
- ④ NO EXPLANATION OF HOW Z_{in} WAS DETERMINED
- ⑤ REFINEMENT OF SPECIFICATION FOR GAIN AND BANDWIDTH WAS NONE
- ⑥ CONCLUSIONS AND ANALYSIS WERE THIN.

SHOULD COVER ALL ASPECTS
OF THE REPORT.

Executive Summary

Within this task an amplifier circuit is to be created and within in this assignment shows from the start of the research and the calculations used for this assignment. The first task is looking into certain components used within the amplifier circuitry and a little bit of an explanation on said equipment. The second task is showing the design of the amplifier used within the circuit and shows on the conditions were set and from there adding more to the circuit for example an oscillator. After this is added simulation and testing will take place then finally evaluation of the circuit with a conclusion.

Task 1

In this task I was instructed to research the following components for a digital circuit that we would be creating:

- Amplifier
- Oscillator
- Negative feedback

Amplifiers:

There is a wide variety of amplifiers within the digital electronic industry what is usually used in circuitry is a small signal amplifier, As the reason is they can amplify a small input signal to make it larger. It also enlarges the level of signal that goes through the amplifier. An amplifier offers a high input impedance and a low output impedance. they can have different operational tasks which can make them ideal for high power, low noise circuitry. Each amplifier is chosen for different specifications which will require a different need that is needed for that specific circuit it is being used for.

There are a lot of different amplifiers used for example BJT, FET and OP-Amps each one has specific roles within a circuit. BJT amplifiers have a very high gain which can vary from transistor to transistor. The BJT is known as the Bipolar junction transistor and it is one of three basic amplifier configurations used.

A field effect transistors (FET) uses voltage that is applied to the input terminal to a gate which then controls the current flowing through. The FET Transistor is a three terminal unipolar semiconductor. This also has a very high input impedance which is better than the BJT Transistor.

The third example is a Op-amp also known as a operational amplifier can be the ideal amplifier within circuits because the gain and bandwidth can be over 100dB. The Op-Amp has 2 input and 1 output this excludes the power supply.

The three main properties that are looked for in an amplifier are:

Input resistance (R_{in}) - this resistance is the signal source once it has been applied to the amplifier. The input resistance will become a load to the source. The R_{in} can be determined by using Ohms Law to calculate the resistance.

Output Resistance (R_{out}) - this can be determined by measuring the output voltage under a no-load condition and then a loaded condition.

Gain - Gain of an amplifier is the key element of the equipment and this can be determined by using the following equation.

$$\text{Voltage gain, } A_v = \frac{V_{out}}{V_{in}}$$

Oscillator:

When the oscillator is connected to a circuit it produces a continuous, alternating waveform without any input. It can turn direct current (DC) into an alternating waveform of which frequency is required which would be decided by the circuit's design for example 200kHz. Once a capacitor discharges and there is no current flow left within the circuit the stored electromagnetic field will generate E.M.F which in turn creates a current flow which will travel in exactly the same way as the current flow.

Oscillators are put into 5 different classifications and these are:

- Feedback mechanism – positive/negative feedback
- Shape of waveform – sine wave, square and rectangular waves
- Frequency of the output signal – low, high, and very high frequency
- Frequency control used – LC (Inductors and capacitors) Oscillators
- Frequency of output waveform – fixed and variable frequency's

Negative Feedback

Negative feedback is a process within a circuit where a fraction of the output signal is used as an input this can be the voltage or the current. If this feedback fraction is opposite in value to the input signal, then this is classed as negative feedback but also known as degenerative feedback.

If a change happens in the output of a circuit then the negative feedback affects the input in a way as to counteract and correct the change which in effect prevents harm to the circuit, the feedback reduces the overall gain of the circuit due to the open-loop gain.

Negative feedback also has effects of reducing noise, distortion to the circuit but also provides improvement to the bandwidth and the input/output obstructions. Any feedback in a circuit is known as unilateral meaning that the signal only flows one way, and this is output to input making a loop gain.

The equation to negative feedback is as follows:

BRIEF RESEARCH WITH
NO IN-TEXT CITATIONS.

Task 2

To design a class A voltage amplifier first the power supply is needed to be chosen which is 20V (VCC) after this was chosen, a transistor is needed with some research it was decided that a BCJ47BG transistor would be used for the amplifier circuit. Next, I had to find the quiescent current, this is the current when there is no signal generated. The following calculation was used to find this value:

$$I_c = 100\text{mA}$$

$$10\% \text{ of } 100\text{mA} = 0.01\text{A}$$

$$\text{Therefore } I_q = 1\text{mA}$$

With these values the lowest available value of the circuit can be calculated using the following:

$$i_B = \frac{i_Q}{HFE} = \frac{1 \times 10^{-3}}{100} = 1 \times 10^{-6} = 1 \mu A$$

The follow calculations where used to work out the load resistor required.

$$V_C = \frac{1}{2} \text{ of } V_{CC} = \frac{1}{2} \text{ of } 20 = 10V = R_L \frac{10V}{1mA} = 1K\Omega$$

Next the RE resistor for the circuit must be found using the following equation:

$$R_E = \frac{V_B}{I_Q}$$

$$V_B = V_E + 0.7V$$

$$V_E = 10\% \text{ of } 20V = 2V$$

$$V_B = 2V + 0.7V = 2.7V$$

$$R_E = \frac{2.7V}{1mA} = 2700\Omega$$

Now R1 and R2 can be calculated:

$$R_1 = \frac{V_{CC} - V_B}{I_{R1}} = \frac{20V - 2.7V}{1mA} = 17300 = 17.3k\Omega$$

$$R_2 = \frac{V_B - 0}{I_{R1} R_2} = \frac{2.7}{1mA} = 2.7K\Omega$$

Next is to add capacitors to the circuit these are known as C1, C2, C3 and C4 and the values are located below in the table.

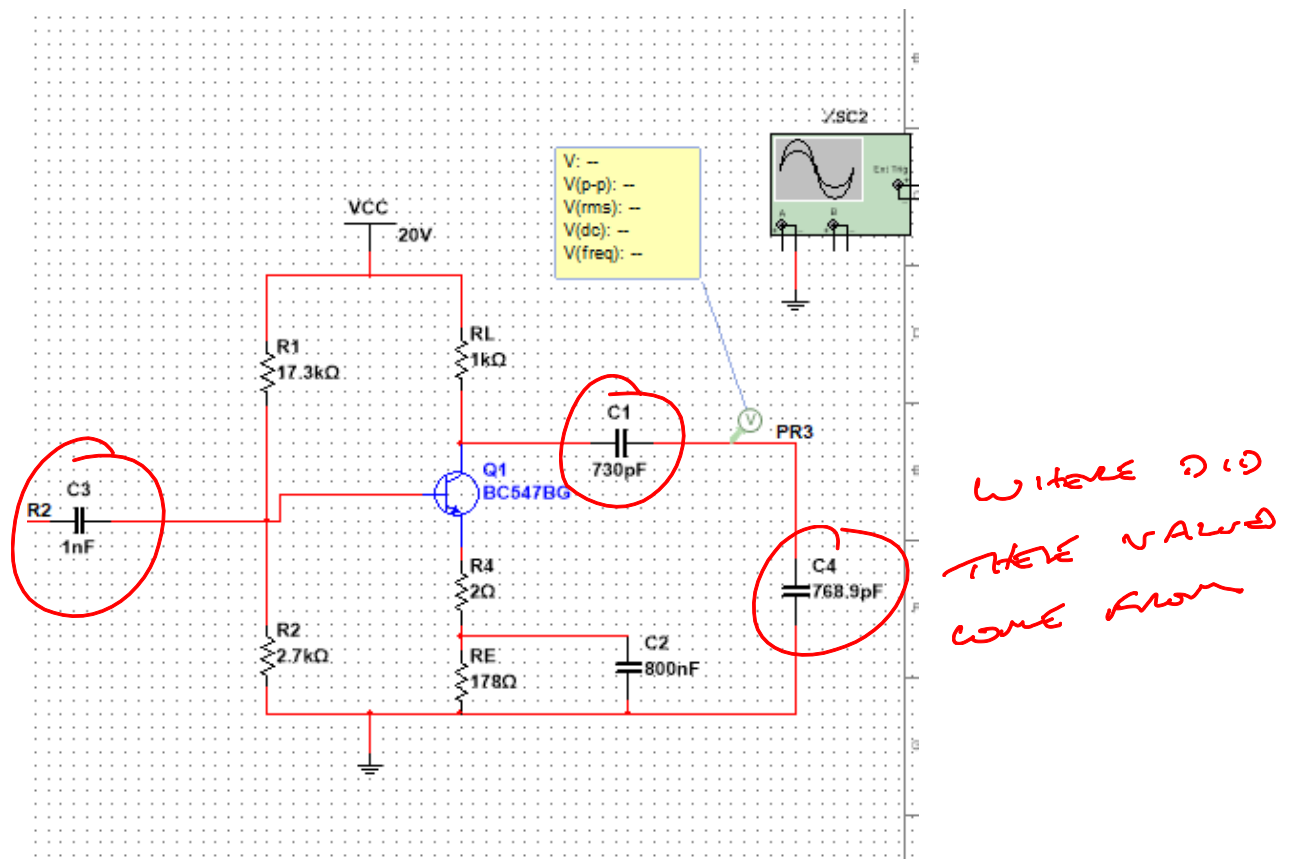
$$C_4 = \frac{1}{2\pi \times 2300 \times 900} = 7.68 \times 10^{-8}$$

THIS SHOULD BE
MOVED LATER IN
THE REPORT.

Bandwidth

$$\frac{99.8 \times 10^{-3}}{50.1 \times 10^{-3}} = 0.01V$$

$$\text{Gain} = \frac{V_{out}}{V_{in}} = \frac{49.9 \times 10^{-3}}{99.8 \times 10^{-3}} = 0.5V \text{ Gain}$$



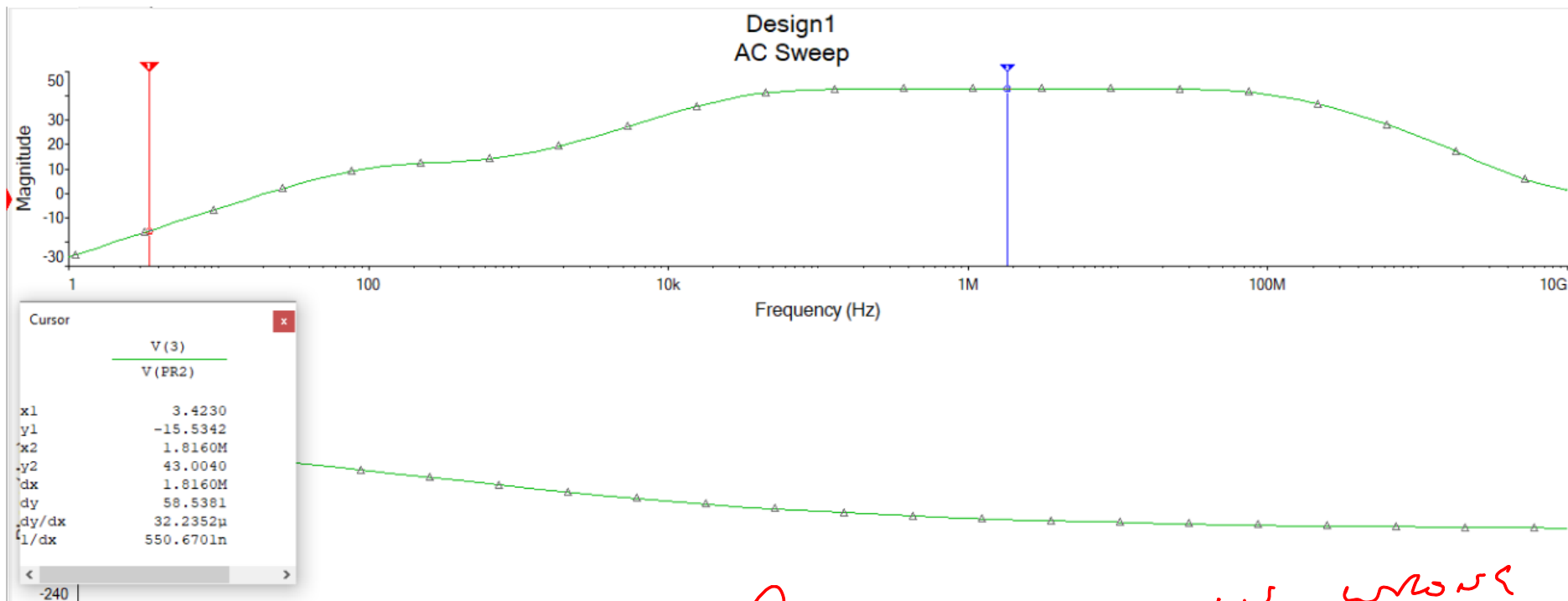
(Figure 1)

With VCC, RL, RE etc. now in place on the circuit adding the transistor completed this side of the circuit it was time to run the simulation and make sure that the VRMS was close to 5v and in this case as seen in Figure 1 the result of Vrms is 5.60v and V(dc) is 5.17v which is acceptable.

As seen in figure 1 the below table is the values.

<u>Equipment type and Name</u>	<u>Value</u>
Power supply - VCC	20V
Resistor – R1	17.3kΩ
Resistor – R2	2.7kΩ
Resistor – R4	2Ω
Resistor – RE	178Ω
Resistor – RL	1KΩ
Transistor – Q1	BC547BG
Capacitor – C1	730pf
Capacitor – C2	800nf
Capacitor – C3	1nf
Capacitor – C4	768.9pf

After the first part of the circuit was created it was time to run an AC sweep for testing purposes which can be seen in figure 2.

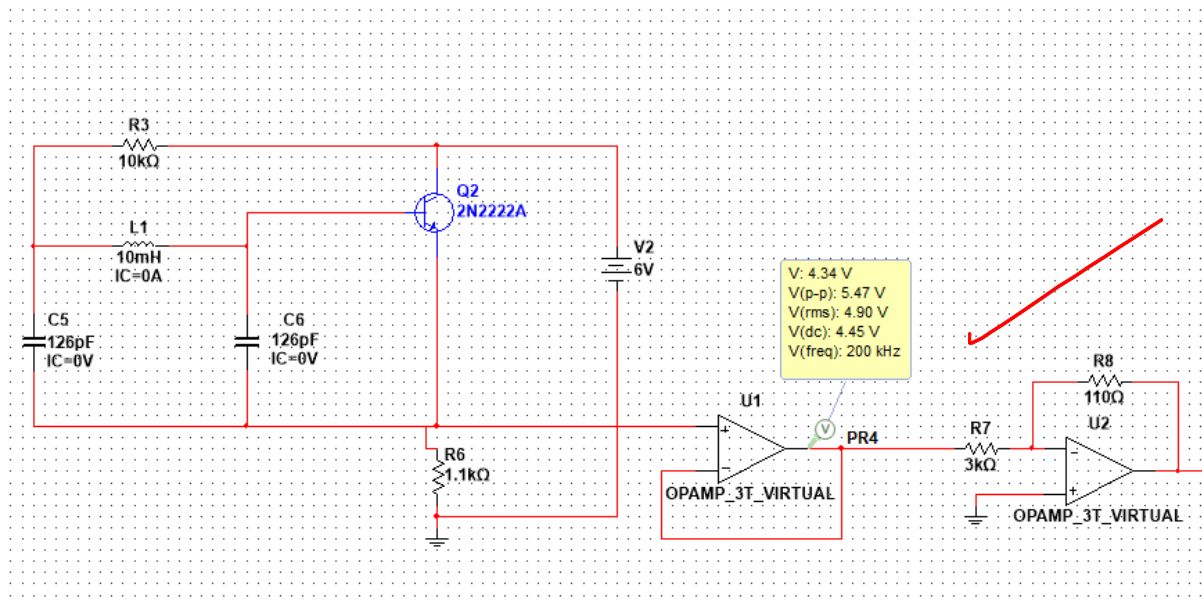


Cursors ARE in wrong
PLACE

(Figure 2 – AC Sweep and frequency testing)

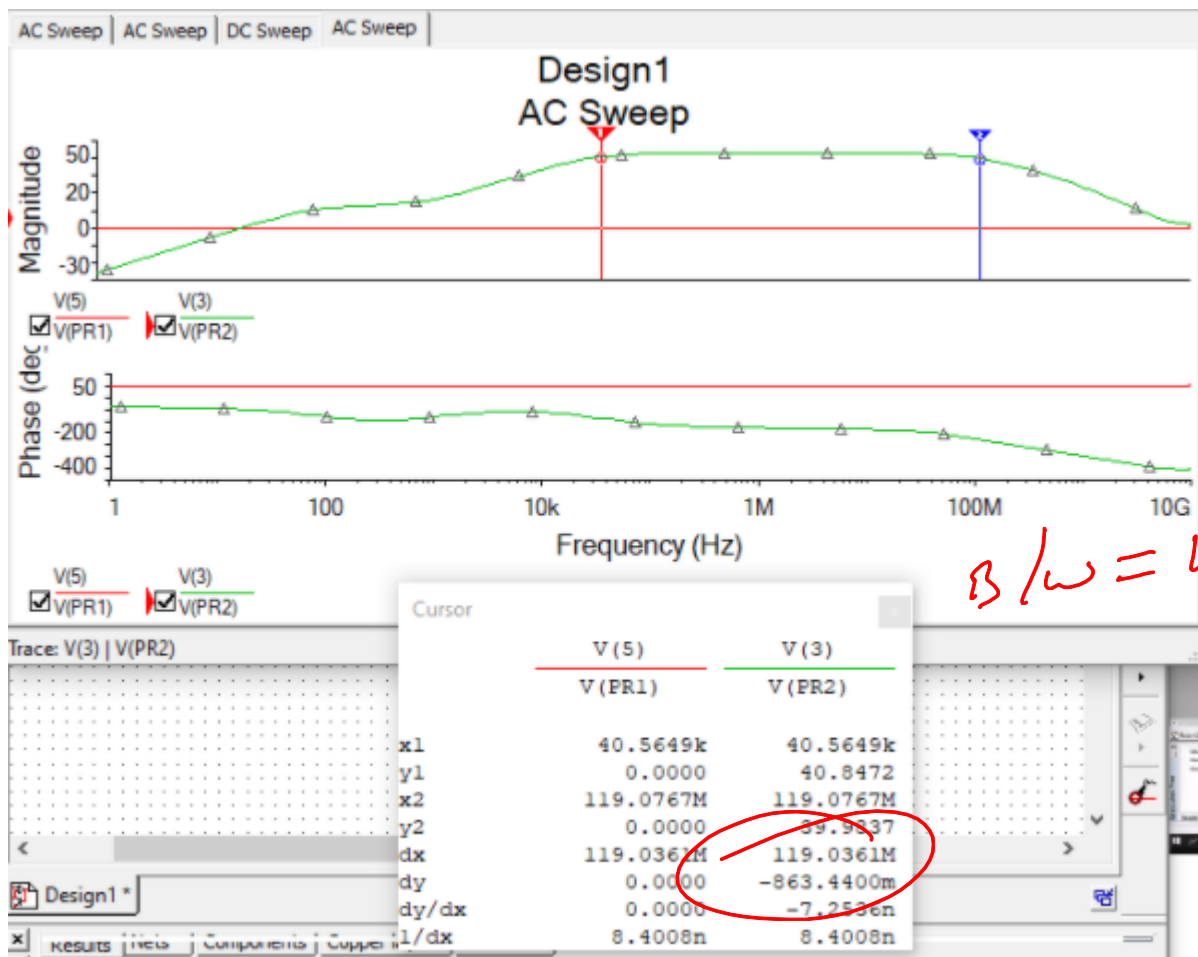
Once testing was completed the op-amps and the next stage of the circuit can be installed as seen in figure 3. The values of L1,C5 and C6 needed changing so that the values of V-p-p and V frequency can be correct as seen below the following where changed to allow this.

- L1 = 10mH
- C5 = 126pF
- C6 = 126pF
- R7 = 3k Ω
- R8 = 110 Ω



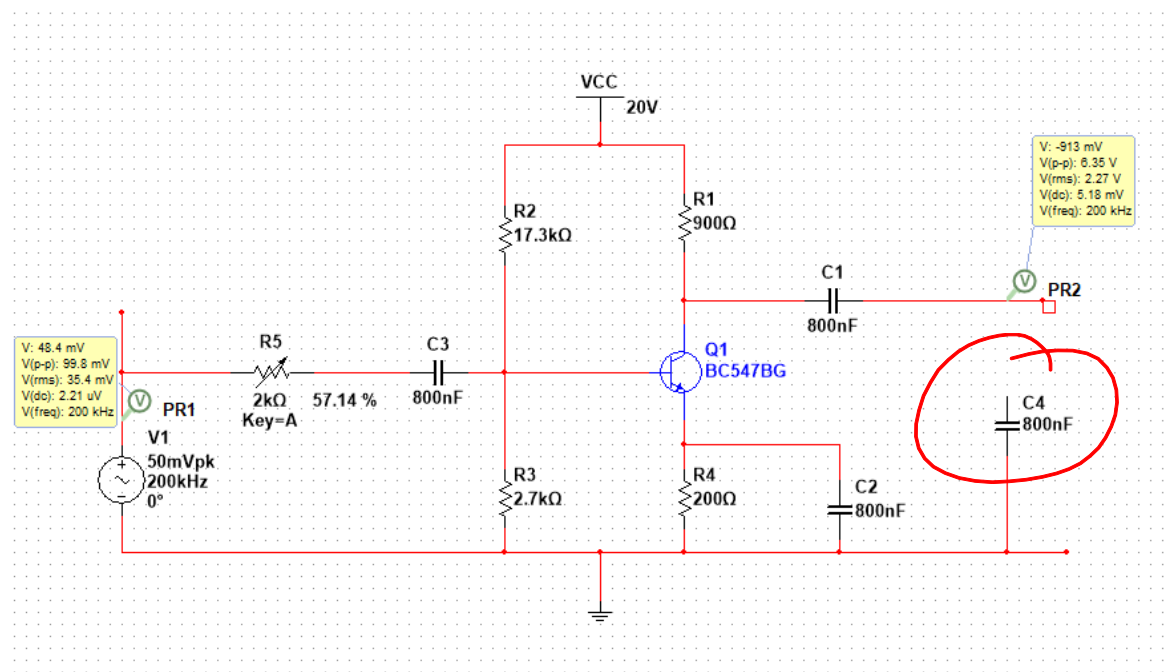
(Figure 3 – Improving design and changing values)

The capacitors C5 and C6 when changed they need to be the same value. This allows the frequency to be 200kHz which can be seen in the V(Freq) probe that is attached to the circuit.

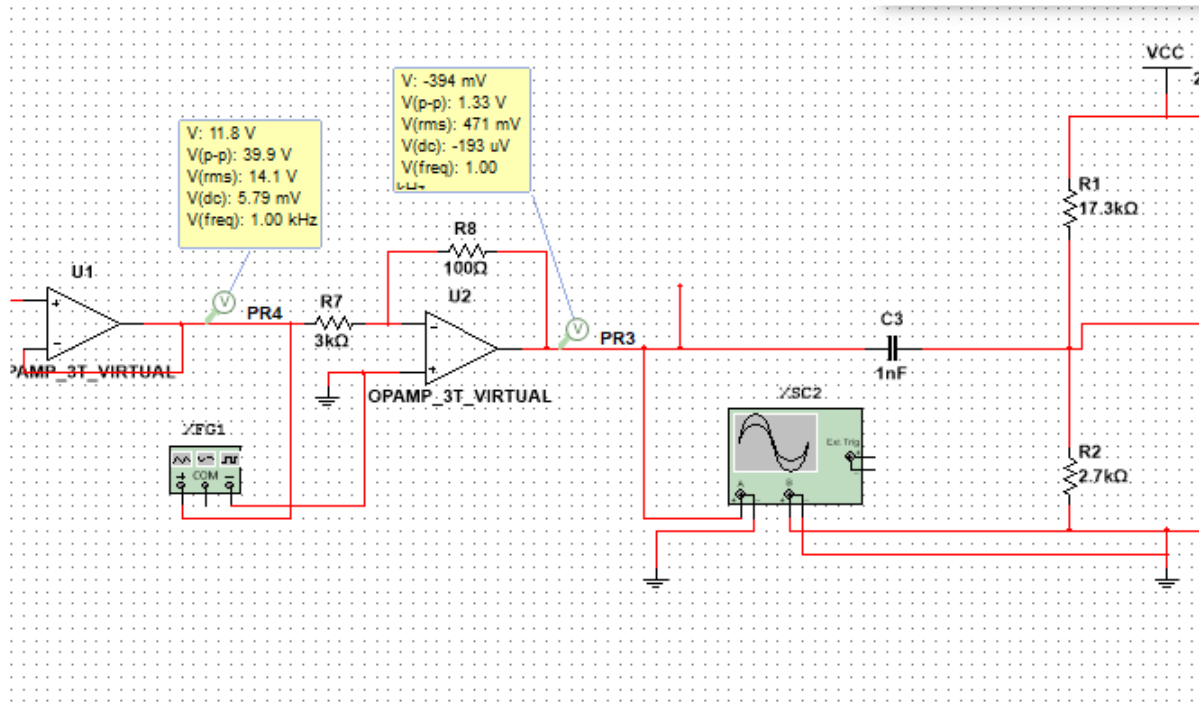


(Figure 4 – further testing)

Once testing had been completed it was time for the AC power source to be removed and an oscillator to be added in its place this can be seen in figure 4.

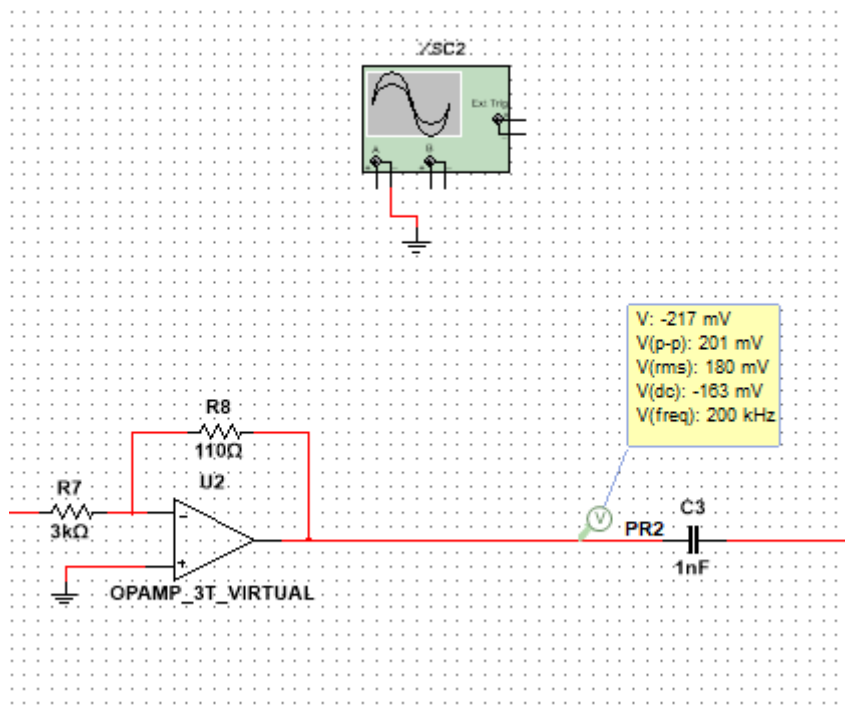


(Figure 5 – AC to be removed)



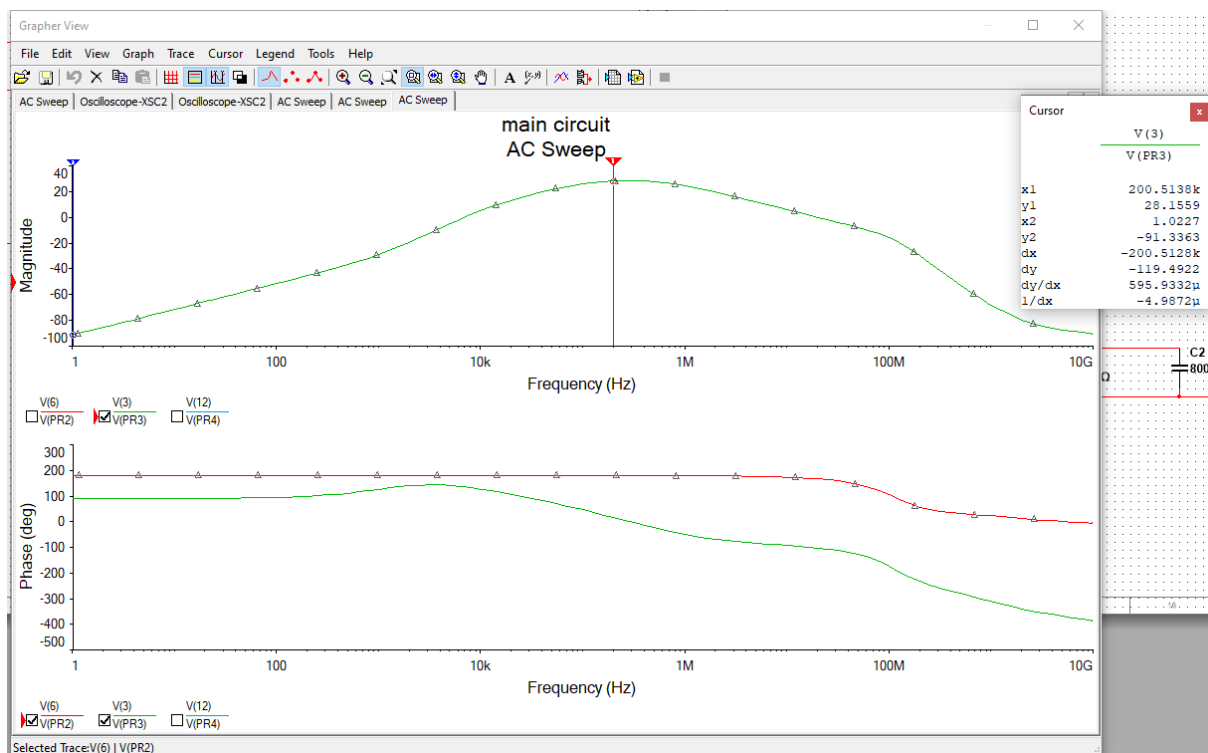
(Figure 6 – oscillator and signal generator added to circuit)

As seen in figure 6 the oscillator and a signal generator, this was added for testing purposes to look at the voltage amplification gain, the signal generator was set to 1kHz and results were taken which can be located below. After changing R8's value a probe was placed to make sure that there was 200mV V(P-P) and as seen in figure 6 below this value was 110ohms



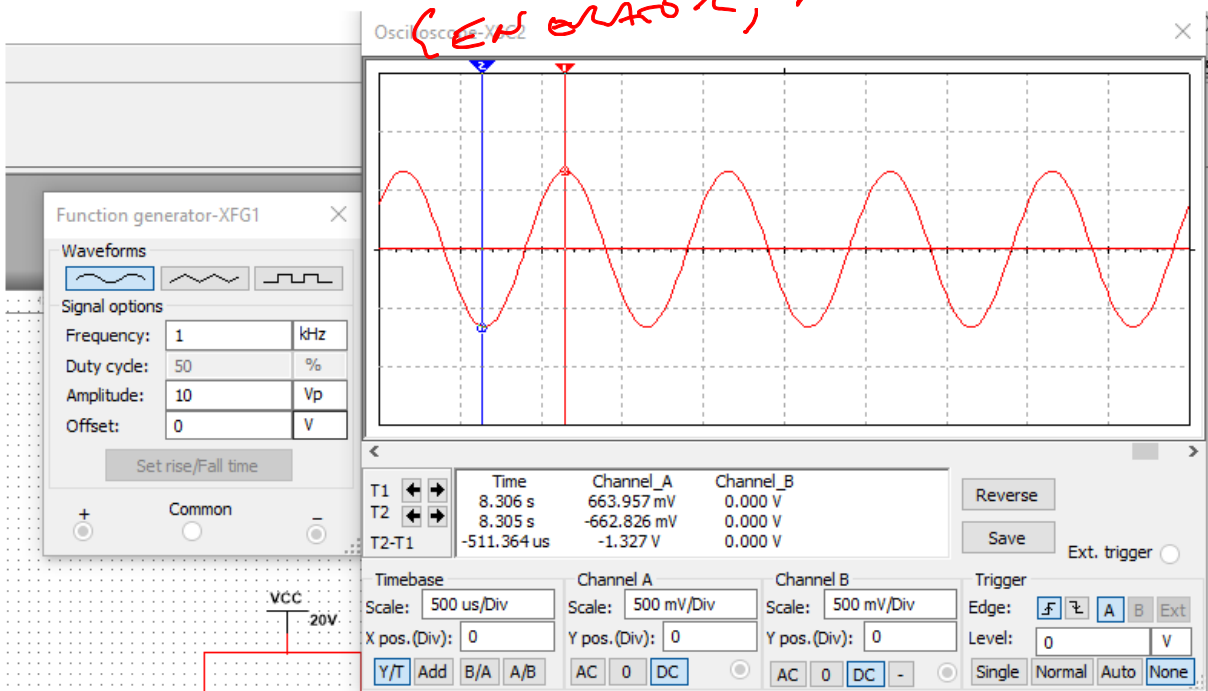
(Figure 7 – showing 201mV at V (P-P))

Now that there is 200kHz frequency and 200-201mV an AC Sweep for testing was conducted which can be seen in figure 7. This shows that the centre frequency is 200.5138kHz which is expected and within the values that is needed for the centre frequency.



(Figure 8 – AC Sweep)

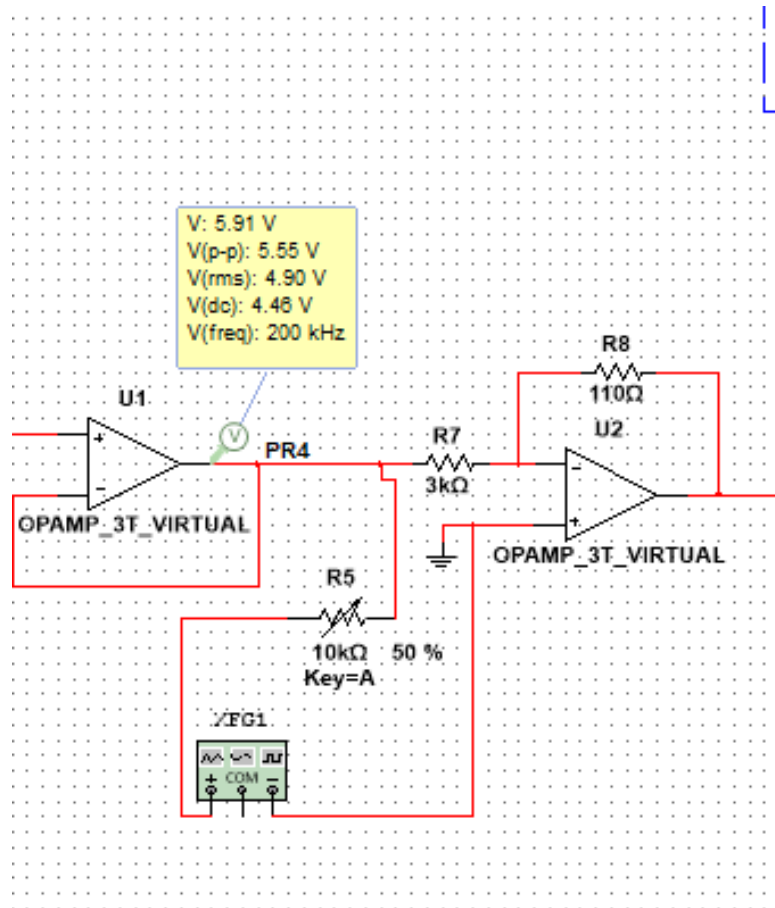
THIS IS THE SIGNAL GENERATOR, NOT THE OSCILLATOR



(Figure 9 – Results of the oscillator)

The testing was calculated from peak to peak using the multisim probes located in figure 9.

Once this was carried out a 10kΩ variable resistor was to be put into the circuit between the signal generator and the input to the circuit this would show the Input impedance and again the probes would be used at Peak to Peak to show results.



(Figure 10 – Adding variable resistor to circuit)

Once the resistor was added to the circuit testing was performed keeping the 1kHz frequency we can see below in figure 10 at Peak to Peak is 13.645mV. As seen in figure 10 the resistor is set to 50% this shows the same value as Z_{in} . The -3dB point was calculated using V_{pp} of the output which is 185mV this was multiplied by 0.707 giving the value of 0.13v

Conclusion

As expected, the Bandwidth is not 60Hz and the reason for this is due to the transistor used and equipment that would have been used during practical however due to covid-19 the practical was cancelled for safety reasons. Therefore, a simulation of the amplifier circuit would suffice.

The reason the calculations are slightly different to the simulation is that multisim runs on a perfect environment therefore all the equipment used for example resistors, capacitors, op-amps are perfect without any wear or damage. The calculations may or may not have been rounded up to the nearest whole value for the benefit of the report.

This in turn would cause the values and results being different from each other, however there would only be a slight difference. Meaning that the results from the multisim can still be used for the report and be used as an accurate simulation to the calculations that were made in the design stage of the assignment.

As seen in the images above provided during the construction of the circuit and the results it shows that the amplifier circuit had in fact worked as expected with the correct values within the input and output.

BRIEF CONCLUSIONS WITH
LITTLE ANALYSIS OF RESULTS.

References

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[oscillator/#:~:text=An%20oscillator%20is%20a%20circuit,decided%20by%20its%20circuit%20components.](https://www.electrical4u.com/what-is-an-oscillator/#:~:text=An%20oscillator%20is%20a%20circuit,decided%20by%20its%20circuit%20components.)

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100 MARK

FINAL GRADE

GENERAL COMMENTS

Instructor

40/100

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GRADING FORM: CSG-RUBIC

STEPHEN REES

RESEARCH-INFORMED LITERATURE

There was some evidence of further reading and research and your interpretation and understanding of the additional research was OK. The sources referenced were insufficient at this level given the amount of potential research areas for this assignment and relied on a small selection of sources. You also need to include more in-text citations using the Harvard reference system.

4/10**KNOWLEDGE AND UNDERSTANDING**

The knowledge and understanding of the subject demonstrated by this assignment was generally superficial and lacked critical understanding. The report lacked a lot of the required detail and contained significant inaccuracies and too much irrelevant material. Additionally, your understanding of most of the basic principles as well as the higher level concepts was not shown. Further work - There were a few omissions and misunderstandings throughout the task, which could be read up on for future reference. Explanations need to be written in much more detail and written in a more logical and clearer way.

12/30

ANALYSIS



Your analysis of the task was mainly descriptive and superficial and lacked a lot of the required detail. Your conclusions were also mainly descriptive and there were several instances of flawed understanding. There was little evidence of critical analysis with most results accepted uncritically as fact and without explaining the underlying principles. You did however demonstrate some basic analytical skills and your approach to the task was logical.

10/30

PRACTICAL APPLICATION AND DEP.



The application of your practical skills for this task was generally rudimentary; you used the resources appropriately when designing the circuit and you used appropriate options for testing and evaluating the circuit performance - albeit to a limited fashion. Testing generally lacked a lot of the required detail however and you should have included a comprehensive set of results for each stage.

8/20

SKILLS FOR PROFESSIONAL PRAC.



Your written report was reasonably well presented in terms of content and layout and was mostly structured in a coherent way, however you should endeavour to use the available word count more effectively in future.

6/10

