

Electronics assignment

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ACDA4006 Electrical and Electronic Principles

Steve Mosey

Resonance assignment

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Contents

Abstract.....	3
1. Introduction.....	4
2. Simulation Setups.....	5
3. Results.....	9
4. Discussion.....	11
5. Conclusion.....	12
6. References.....	13

Abstract

Resonance in AC circuits is a kind of frequency determined by the values from a resistor, capacitor and inductor, and can be found in circuits that are in series or in parallel. One way of defining resonance in a circuit that is parallel, as in the circuit used in this report, is the frequency at which the impedance is maximum [1]. This report will look at parallel resonance by comparing a simulated circuit with an actual circuit built in person and seeing how this compares to theory.

The circuit described will involve a universal power supply connected to a 1K Ohm resistor, which is then connected in series with a 1uF capacitor and a 1mH inductor, and this circuit will then have two voltage probes either side of the resistor which will measure the frequency of the current either side of the resistor. This circuit will be simulated using Proteus software and also built physically, and then the results of the two circuits will be compared to see the difference in a 'perfect' simulation and theory compared to reality.

The results from the practical circuit show that the peak is at a much lower position on the graph, with the peak now becoming 6.5 volts at 5000 Hertz. However, as the peak is still at 5000 volts, this shows that the practical circuit and simulated circuits are actually in line with each other. If the peak occurred at another point in the frequency that was much higher or lower than 5000 Hertz this may signify that the circuits were slightly different or a mistake had been made, and this discrepancy could not have been accounted for by saying that the real equipment may have slight discrepancies due to calibration or make. However, the difference in height of the peaks of the graphs can be attributed to the input voltage, and in the real circuit this varied from 1.18-1.24 Volts, compared to a consistent 2 volts for every reading in the simulation circuit. There was a range of 0.1 applied to the simulated input voltage, however as the voltage is much lower than this on the practical circuit, it is easy to see why the peak is at a slightly lower voltage.

It has been determined that the two circuits run in this experiment follow the expectation and hypothesis posed by the theory and formulae given, and do show that resonance occurs when the voltage is at its peak.

1. Introduction

Resonance in AC circuits is a kind of frequency determined by the values from a resistor, capacitor and inductor and can be found in circuits that are in series or in parallel. One way of defining resonance in a circuit that is parallel, as in the circuit used in this report, is the frequency at which the impedance is maximum [1]. Impedance is defined as the measure of the total opposition that a circuit or a part of a circuit has to electrical current, and this can include both resistance and reactance [2]. In simpler terms, parallel resonance can be described as the frequency at which the opposition to current is at its highest.

Parallel resonance circuits, like the ones simulated in this report, have many common uses. Parallel resonance also occurs when the frequency from the power supply creates no phase difference between the power supply voltage and the current [3]. A common purpose of creating resonance is that this can be used to stabilise frequencies in AC circuits- tank circuits are usually used for this, which is where the capacitor and inductor are directly connected to each other and exchange energy between them [4]. Resonance can also be used where the effects of increased or decreased impedance are needed for a function, and so resonance can be used to 'block' certain frequencies and creates a filtered effect, such as in filter circuits [4].

This report will look at parallel resonance by comparing a simulated circuit with an actual circuit built in person and seeing how this compares to theory. The circuit described will involve a universal power supply connected to a 1K Ohm resistor, which is then connected in series with a 1uF capacitor and a 1mH inductor, and this circuit will then have two voltage probes either side of the resistor which will measure the frequency of the current either side of the resistor. This circuit will be simulated using Proteus software and also built physically, and then the results of the two circuits will be compared to see the difference in a 'perfect' simulation and theory compared to reality.

When looking at graphs of parallel resonance frequency, the key things to look at are to determine the resonant frequency from the graph, and also the 'Q' Factor [5]. The resonant frequency is a frequency of a system where it oscillates at the greatest amplitude [6], and for a parallel RLC (resistor, inductor and capacitor) circuit the formula used to find this is:

$$f_r = 1/2\pi\sqrt{LC}$$

Where L is the inductor value and C is the capacitor value [7]. In the case of the circuit in this report, this makes the resonant frequency value 5032.91 Hertz. The 'Q' Factor, also known as the quality Factor, is the voltage magnification factor achieved across the coil and capacitor compared with the supply voltage [8]. This can be defined by the formula:

$$Q = (2\pi fL)/R$$

Where L is the inductor value and R is the resistor value [9]. This will be explored in the results section.

2. Simulation setups

Firstly, the simulated version of the circuit was set up using Proteus software, which included a universal power source connected to a resistor, which in series was connected to a parallel setup of a capacitor and inductor. This is also connected to an oscilloscope and ground. The resistor value was set to 1k Ohms, the capacitor was set to 1 microfarad, and the inductor at 1 milliHenry. This is shown below in figure 1.

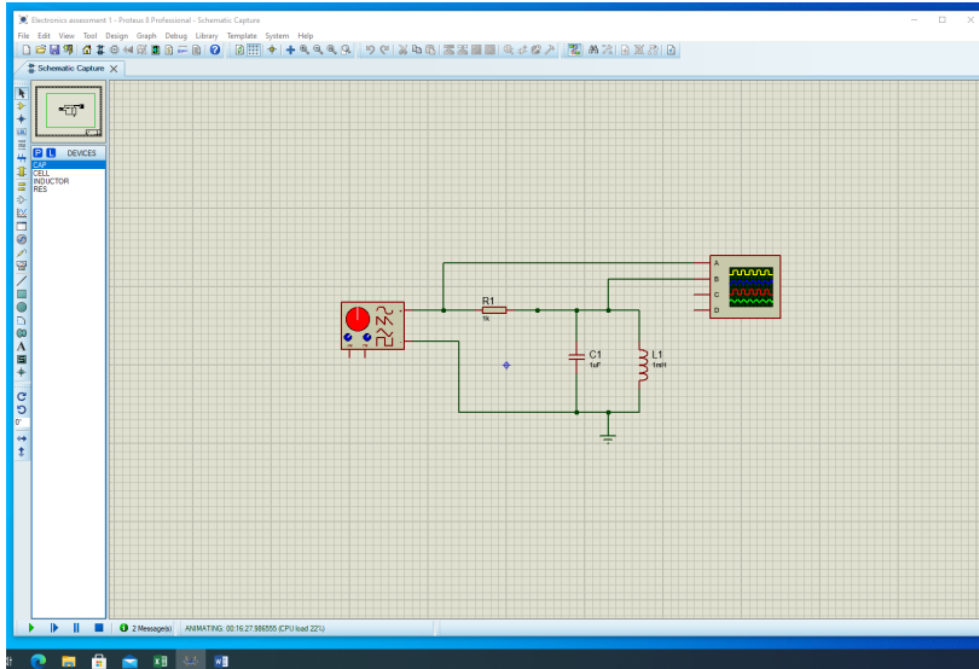


Figure 1- Screenshot from Proteus showing circuit setup

Once the simulation was running, the controls on the oscilloscope were able to be set in order to determine the graphs appearing in the same window. As shown in Figure 2, the frequency was set to 100 hertz with a 0.1 range- the range was in order to attempt a lifelike simulation as real frequencies vary slightly, so the range encapsulates this. The amplitude was also set to 2 Amps with a range of 1. As shown on the oscilloscope control panel in figure 2, channel A was set to 0.5 millivolts, and channel B was set to 2 millivolts.

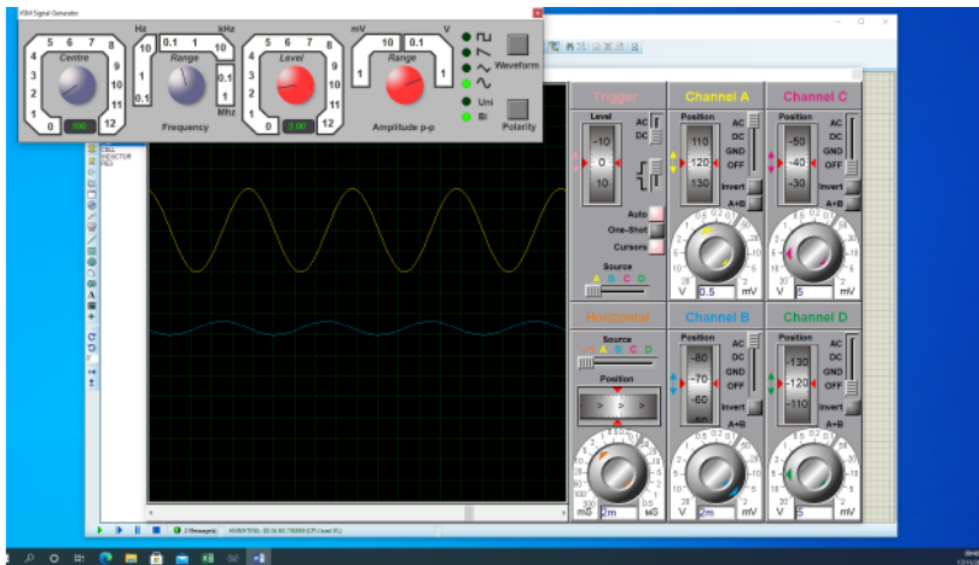


Figure 2- Screenshot from Proteus showing the setup of the 'control panel'

Below in figures 3-5, photographs of the 'real' circuit are shown. Figure 3 shows the two frequency probes connected to the oscilloscope, and the various different controls on the oscilloscope.



Figure 3- Photograph showing Oscilloscope setup with various controls

Figure 4 below shows the oscilloscope producing the frequency graphs, as well as the universal power supply set to 100 hertz, the same as the simulated circuit.

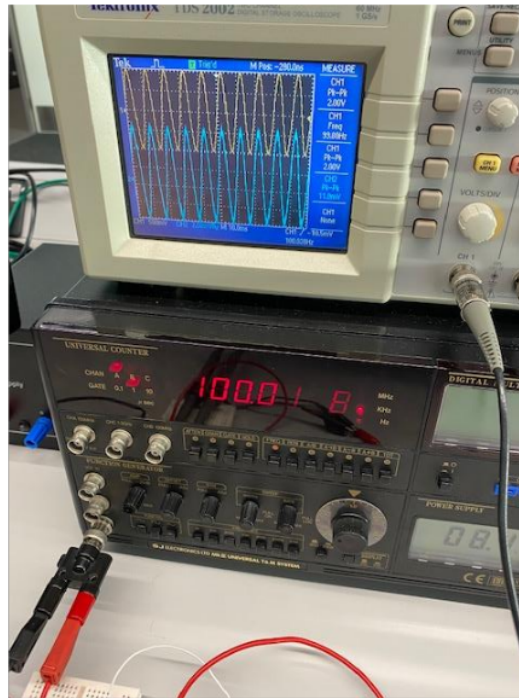


Figure 4: Photograph showing the universal power supply and oscilloscope

Figure 5 shows the actual setup of the circuit- this is the same circuit used as in the simulation, with connection to the power supply at 100 hertz, with a 1k Ohm resistor, 1 mF capacitor and 1mH inductor, with frequency probes attached either side of the resistor.

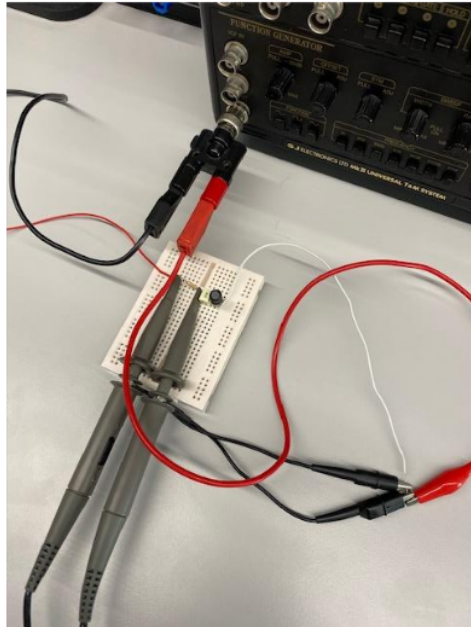


Figure 5: Photograph showing the setup of the circuit built during the practical assessment

3. Results

Below in figures 6 and 7 are graphs depicting the peak to peak voltages measured by the probes in the simulated circuit and the practical circuit, with figure 8 combining the two graphs onto one axis.

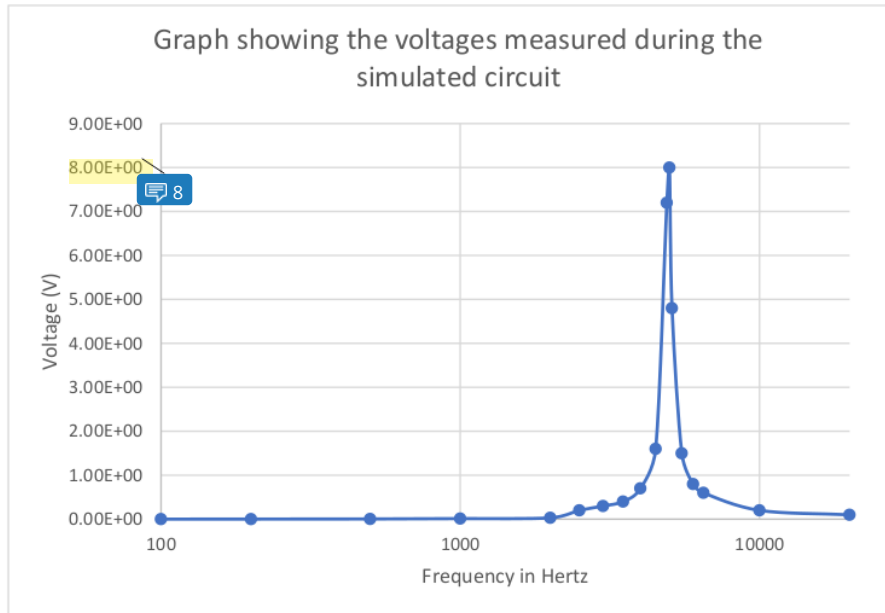


Figure 6: Graph showing the voltages measured during the simulated circuit

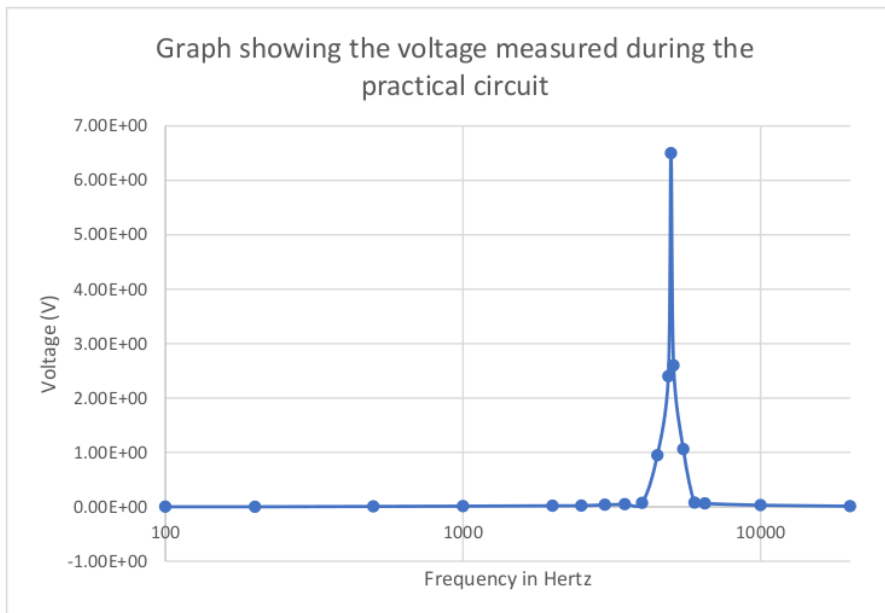


Figure 7: Graph showing the voltage measured during the practical circuit.

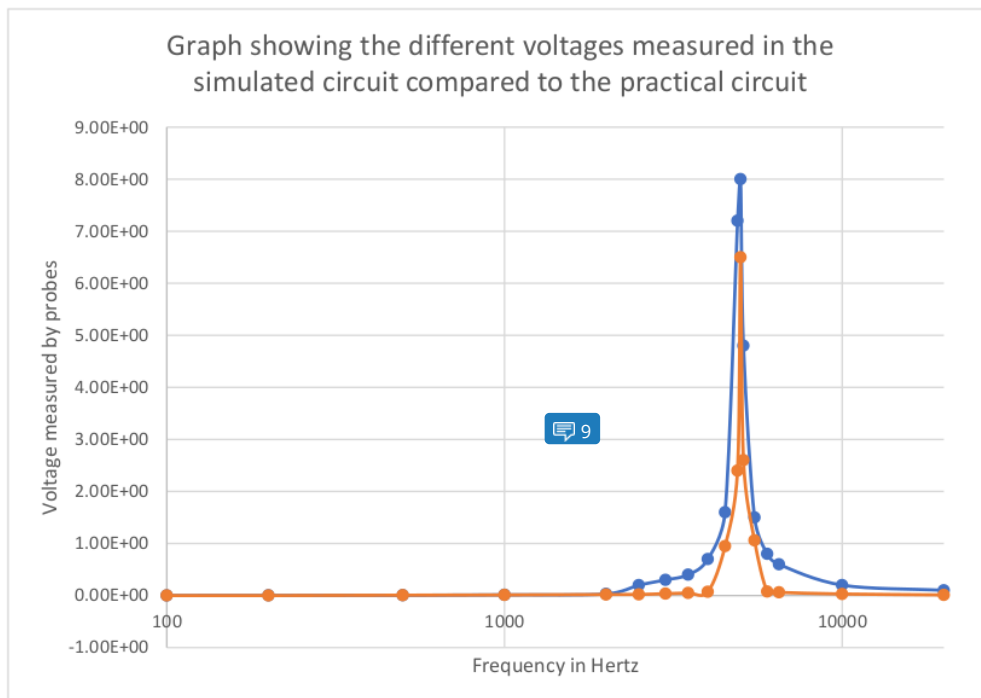


Figure 8: Graph showing the difference in voltages measure in the similar circuit compare to the practical circuit (blue shows the simulation, orange shows the practical circuit)

In Figure 6, the results from the simulated circuit, the peak of the curve falls at 8 volts at a frequency of 5000 Htz, and has a smooth curved effect in line with the other results- these begin at 0.0013 V at 100 Htz, and end at 0.1 V at a frequency of 20000 Htz. In Figure 7 there is a similar pattern to the results, with the peak again being at 5000 Htz and a reading of 6.5 V. The results from the practical circuit range from 0.000904 V at 100 Htz to 0.012 V at 20000 Htz.

4. Discussion

When looking at figure 6, it is clear to see that the voltage peak occurs at around 5000 Hertz at 8 Volts. This peak represents when the circuit is at resonance, so the impedance and the resistance from the resistor are equal. At this frequency of 5000, this is when the current in the circuit will be at its lowest due to the resistance, but the voltage across the components are at their highest. This simulated circuit shows impedance and resistance working together to become resonance very clearly, because it is in an 'ideal' situation and therefore does not have much variance, as is shown in the practical circuit.

The result from the practical circuit show that the peak is at a much lower position on the graph, with the peak now becoming 6.5 volts at 5000 Hertz. However, as the peak is still at 5000 volts, this shows that the practical circuit and simulated circuits are actually in line with each other. If the peak occurred at another point in the frequency that was much higher or lower than 5000 Hertz this may signify that the circuits were slightly different or a mistake had been made, and this discrepancy could not have been accounted for by saying that the real equipment may have slight discrepancies due to calibration or make. However, the difference in height of the peaks of the graphs can be attributed to the input voltage, and in the real circuit this varied from 1.18-1.24 Volts, compared to a consistent 2 volts for every reading in the simulation. There was a range of 0.1 applied to the simulated input voltage, however as the voltage is much lower than this on the practical circuit, it is easy to see why the peak is at a slightly lower voltage.

In terms of the shape of the two graphs when comparing them together in figure 8, it is clear to see that the simulation had more of a gradual increase in voltage towards the peak, whereas the practical circuit peak is much more of a sharper change. This is due to the start of the peak being more apparent from a frequency of around 4000 Hertz and so the graph rises earlier, however in the practical circuit graph the voltage does not begin to peak until 4500 Hertz and so makes the graph have a steeper curve. This delay could be due to discrepancies with the practical equipment, however it is likely to be due to the lower voltage used when creating the practical circuit, as this will mean that the peak is not visible until later if the voltage is constantly ebbing and flowing as it was.

Importantly, when comparing the two sets of results it is clear to see that both circuits follow the theory of having a sharp peak at the point of resonance, and from the calculation of having the resonant frequency at 5032.91 Hertz this also aligns with the rough peaks on the graph landing at 5000 hertz, and so shows that the equation is correct. When looking at finding the Q Factor of the circuit from the graph using the bandwidth method, the Q Factor comes out as 0.528, and when using the formula previously stated to find the Q value, a value of 0.1, so this is slightly off. This is likely to be due to inaccuracy of the graph reading and getting slightly skewed numbers to substitute into the formula, however it still proves that the theory is right as the two results are within less than 1 of each other.

5. Conclusion

To conclude, it has been determined in this experiment that the two circuits, simulated and practical, do align with the theory and the formulae given, as both sets of results align with the concepts presented during research. There is definitely a difference in the two sets of results, however it can be claimed that this is not due to the theory being wrong, rather that the base input voltages differed in the practical circuit in two ways- the voltages were much below the simulated voltage of 2 volts, and also the voltage fluctuated throughout the experiment rather than staying at a controlled constant level as is seen in the simulated circuit.

It has also been determined that resonance appears as a peak in voltage, as demonstrated by the graphs shown in figures 6, 7 and 8. This also aligns with theory, because the theory states that when parallel resonance occurs, current is at its lowest but voltage is at its highest, so to see a peak on the graph at the point of resonance frequency is expected.

Another conclusion can be drawn from the fact that getting a stable voltage source with real equipment makes for varied results, as demonstrated by the fact that it was very difficult to keep the voltage source on 2 volts consistently throughout the experiment. This poses the thought that voltage is not consistent and constant in many practical situations, and therefore a range should always be used when simulating circuits in order to try to get the most lifelike simulation possible. Whilst a range of 0.1 was used in this experiment, a larger range would have been more appropriate if trying to model a lifelike situation, however keeping the range small allowed for accuracy and allowed the theory to be demonstrated well.

To summarise, it has been determined that the two circuits run in this experiment follow the expectation and hypothesis posed by the theory and formulae given, and do show that resonance occurs when the voltage is at its peak.

6. References

References

- [R. Nave, "Parallel Resonance," HyperPhysics, 07 December 2021. [Online]. Available:
1 <http://hyperphysics.phy-astr.gsu.edu/hbase/electric/parres.html#c1>. [Accessed 07 December
] 2021].
- [The Editors of Encyclopaedia, "electrical impedance," Britannica, 27 June 2008. [Online].
2 Available: <https://www.britannica.com/science/electrical-impedance>. [Accessed 7 December
] 2021].
- [Electronics Tutorials, "Parallel Resonance Circuits," Electronics Tutorials, 2 12 2021. [Online].
3 Ref Qual Available: <https://www.electronics-tutorials.ws/accircuits/parallel-resonance.html>. [Accessed 2
] 12 2021].
- [T. R. Kuphaldt, "Lessons in Electric Circuits," in *Vol. II - Alternating Current (AC)*, London, Design
4 Science License, 2021, p. Ch6 Sec4.
]
- [Electronicsnotes, "Quality Factor/ Q Factor; formulas and equations," electronicsnotes, 7 12
5 Ref Qual [Online]. Available: [https://www.electronics-notes.com/articles/basic_concepts/q-quality-](https://www.electronics-notes.com/articles/basic_concepts/q-quality-factor/basics-tutorial-formula.php)
] [factor/basics-tutorial-formula.php](https://www.electronics-notes.com/articles/basic_concepts/q-quality-factor/basics-tutorial-formula.php). [Accessed 7 12 2021].
- [Openstax CNX, "Resonance in an AC Circuit," Openstax CNX, 5 November 2020. [Online].
6 Available:
] [https://phys.libretexts.org/Bookshelves/University_Physics/Book%3A_University_Physics_\(Open](https://phys.libretexts.org/Bookshelves/University_Physics/Book%3A_University_Physics_(OpenStax)/Book%3A_University_Physics_II_-_Thermodynamics_Electricity_and_Magnetism_(OpenStax)/15%3A_Alternating-Current_Circuits/15.06%3A_Resonance_in_an_AC_Circuit)
Stax)/Book%3A_University_Physics_II_-
_Thermodynamics_Electricity_and_Magnetism_(OpenStax)/15%3A_Alternating-
Current_Circuits/15.06%3A_Resonance_in_an_AC_Circuit. [Accessed 7 December 2021].
- [Cadence PCB Solutions, "Exploring the Resonant Frequency of an RLC Circuit," Cadence PCB
7 Solutions, 7 December 2021. [Online]. Available: [https://resources.pcb.cadence.com/blog/2021-](https://resources.pcb.cadence.com/blog/2021-exploring-the-resonant-frequency-of-an-rlc-circuit)
] [exploring-the-resonant-frequency-of-an-rlc-circuit](https://resources.pcb.cadence.com/blog/2021-exploring-the-resonant-frequency-of-an-rlc-circuit). [Accessed 7 December 2021].
- [All About Circuits, "Q Factor and Bandwidth of a Resonant Circuit," All About Circuits, 7
8 Ref Qual December 2021. [Online]. Available: [https://www.allaboutcircuits.com/textbook/alternating-](https://www.allaboutcircuits.com/textbook/alternating-current/chpt-6/q-and-bandwidth-resonant-circuit/)
] [current/chpt-6/q-and-bandwidth-resonant-circuit/](https://www.allaboutcircuits.com/textbook/alternating-current/chpt-6/q-and-bandwidth-resonant-circuit/). [Accessed 7 December 2021].
- [Z. Wang, Handbook of Advanced Dielectric, Piezoelectric and Ferroelectric Materials, Cambridge:
9 Woodhead Publishing, 2008.
]

Electronics assignment

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

53 / 100

PAGE 1

PAGE 2

PAGE 3



Comment 1

This was supposed to be limited by restricting the input voltage to 2V maximum. Why is it 6.5V?



Comment 2

Are these the right units?



Comment 3

Why? It was supposed to be set to 2V, as in the simulation

PAGE 4



Comment 4

Not the resistor, only the capacitor and inductor as these are the only components which can store energy.



Comment 5

This is a very long sentence. You should reread your work before submitting, pausing on commas and taking a breath on full stops. If you get out of breath then the sentence is too

long. This should have been two sentences, with a full stop between "AC circuits" and "tank circuits".

PAGE 5

PAGE 6

PAGE 7



Comment 6

universal instrument. You actually used the signal generator part of the instrument, not the power supply. The power supply would only give a DC voltage.



Comment 7

should be 1 μF .

1 mF = 1000 μF

PAGE 8

PAGE 9



Comment 8

How does this go to 8V? it was supposed to have a maximum input voltage of 2V.

PAGE 10



Comment 9

Missing legend. - Which data is which circuit?



Comment 10

Should be included as a legend on the graph

PAGE 11



Missing Units

What units is this in?

You should always include the units for all quantities you describe in your text. Some quantities have more than one unit. Frequency, for example, can be measured in Hertz (Hz) or radians per sec (rad/s).

Make it clear for your reader and remove any ambiguity.



Comment 11

"become resonant"?



Comment 12

are these the right units?



Comment 13

But your graphs show the voltage going much higher than this.



Comment 14

4000 Hz



Comment 15

4500 Hz

PAGE 12



Comment 16

This was supposed to be controlled and set to mitigate this difference.



Comment 17

Due to the internal resistance of the signal generator.



Comment 18

The idea was that you set the voltage to 2V at the start, then measure it at every frequency, then use the input and output voltages to calculate a dB loss. This would allow a direct comparison between simulated and practical circuits.



Comment 19

Do you mean "realistic"?

PAGE 13



Ref Qual

You should try to use more high quality reference sources, such as textbooks from reputable academic publishers and articles from peer reviewed journals.



Ref Qual

You should try to use more high quality reference sources, such as textbooks from reputable academic publishers and articles from peer reviewed journals.



Ref Qual

You should try to use more high quality reference sources, such as textbooks from reputable academic publishers and articles from peer reviewed journals.

GRADING FORM: SMU GENERIC_SMOSEY

ANNA KATHERINE WILLIAMS

52.50

ENGAGEMENT WITH LITERATURE

including reading, referencing, academic conventions and academic honesty



Inclusion of a wide range of research-informed literature, including sources retrieved independently. Selection of relevant and credible sources. Very good use of referencing conventions, consistently applied.

3.4

KNOWLEDGE & UNDERSTANDING

Knowledge of the basic underlying concepts and principles of a subject.



Evidence of basic knowledge and understanding of the relevant concepts and underlying principles.

14.4

COGNITIVE & INTELLECTUAL

Evaluate underlying concepts and principles of a subject and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements.



Evidence of some logical, analytical thinking and synthesis. Can analyse new and/or abstract data and situations without guidance. An emerging awareness of different stances and ability to use evidence to support the argument. Valid conclusions

17.7

PRACTICAL APPLICATION SKILLS

Different approaches to solving problems in particular contexts.



An adequate awareness and mostly appropriate application of well-established methods, materials, tools and/or techniques. Basic appreciation of the context of the application. Questions over numeric data handling - numbers in text don't always match numbers in graphs.

14.4

TRANSFERABLE SKILLS

Communicate the results of their study/work accurately and reliably, and with structured and coherent arguments; the qualities needed for employment requiring the exercise of some personal responsibility within a structured and managed environment.



Can communicate effectively in a suitable format, but may have minor errors. Mostly coherent work and is in a suitable structure.

2.6