

Electronics Report

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Proteus vs Practical

Analysis of RLC Circuit

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Abstract

This task involved comparing a simulated circuit (band pass filter) made using Proteus and a practical example with the goal being to plot a graph of voltages at different frequencies to determine the resonant frequency of each circuit, its Q factor and how proteus being an ideal world would cause differences in the results. To perform this task, the circuit was built using a breadboard with a few components and voltage values were measured across the resistor to give the output voltage of the circuit then built again however using proteus. In the end the frequency response graph of both examples was compared to determine how similar and accurate the simulation was.

Introduction

The circuit chosen was a band pass filter which is used to reduce the amplitude of both low and high frequency waves but have a lower impedance the closer you are to the F_r (or resonant frequency) Due to the energy of the oscillations, there will be a large circulating current between the inductor and the capacitor at resonance, and parallel circuits will produce current resonance. To vary the resonant frequency, the values of the inductor and capacitor are altered to give the desired filtration. This allows the circuit to be used in Wireless transmitters as it can filter the output and prevent the signal interfering with other stations. For wireless receivers, band pass filters give the ability to focus on a specific bandwidth thus blocking unwanted signal transmissions. They are also used in older televisions for tuning into different channels which is the resonant frequency being changed to focus on a certain program and block out the rest.

The bandwidth is defined as the distance between the cut-off frequencies, which are most commonly defined as the frequencies at which the power passed through the circuit has fallen to half of what it was at resonance. One half-power frequency is above the resonance frequency, and the other is below it. This happens because the inductor and capacitor have equal but opposite sign impedances at resonance, which cancel out. Instead of a minimum impedance, circuits with L and C in parallel rather than series have a maximum impedance.

The letters RLC stand for resistor, inductor, and capacitor (C). The main components of RLC circuits that are connected in a complete loop are these. The resistor is made up of resistive elements (such as carbon) that have the function of inducing higher levels of electrical resistance than those found in natural circuits. It also lowers the circuit's damping and resonant frequency (f_r). According to Faraday's law, the inductor stores energy in the magnetic fields produced by the electric current flowing through conductors. Through two

or more conductors, most commonly separated by a dielectric medium, the capacitor stores energy in electric fields.

In this experiment, this circuit will be used in order to test and compare a simulation program (proteus) to a practical example to evaluate the similarities and observe any discrepancies since there are a few things which aren't accounted for in proteus. Since The band pass filter is being used in a simulation to one made using actual components, the goal is to capture data points to compare the two together (which was the input frequency, V_{out} as well as V_{pk}) To find V_{out} the equation $f = 1 / (2\pi \sqrt{L C})$ where L is the inductance and C is the capacitance. In theory, the higher frequencies are reduced by the capacitor whilst lower frequencies are limited by the inductor.

Simulation Setup

The Simulation consisted of a band pass filter (which is an inductor in parallel with a capacitor) with voltage probes at the input of the signal generator as well as the output of the filter. For this simulation, a frequency range of **100Hz - 20kHz** was used to cover the frequency response as well as a V_{pk} (Peak Voltage) of **2V** from the signal generator.

The signal generator as on the left (seen in Fig 1) would give a frequency with a V_{pk} of **2V** to the RLC circuit that consists of a **1kΩ** resistor, **1μF** capacitor and a **1mH** inductor. With the capacitor and inductor in parallel whilst the resistor is in series. With this RLC circuits built, Proteus was instructed to run multiple frequencies and plug graph of voltages at each frequency.

Circuit in Proteus

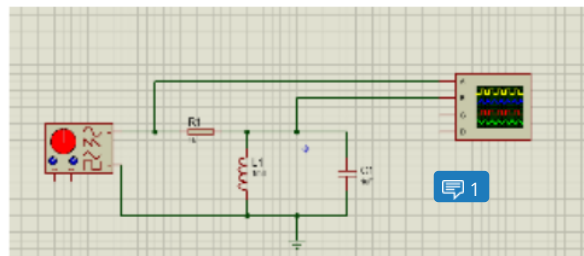
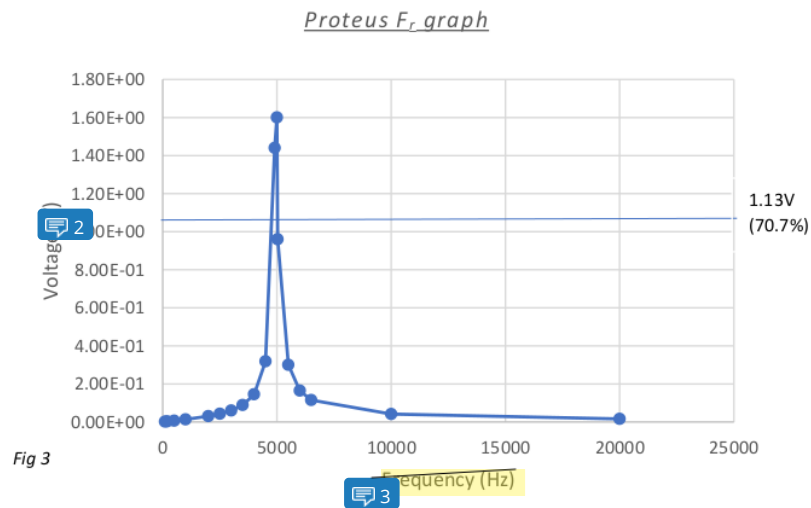


Fig 1

Results

With proteus, the resonant frequency came out to be **5000_{Hz}** (at a peak of **1.6V**) as seen in Fig 3 with a bandwidth of **300_{Hz}**. This resulted in a calculated Q factor of **16.7** (Q factor = $F_r/\text{Bandwidth}$). This was due to the F_L being around **4800_{Hz}** and the F_H at **5100_{Hz}** (which is **70.7%** of the peak voltage).



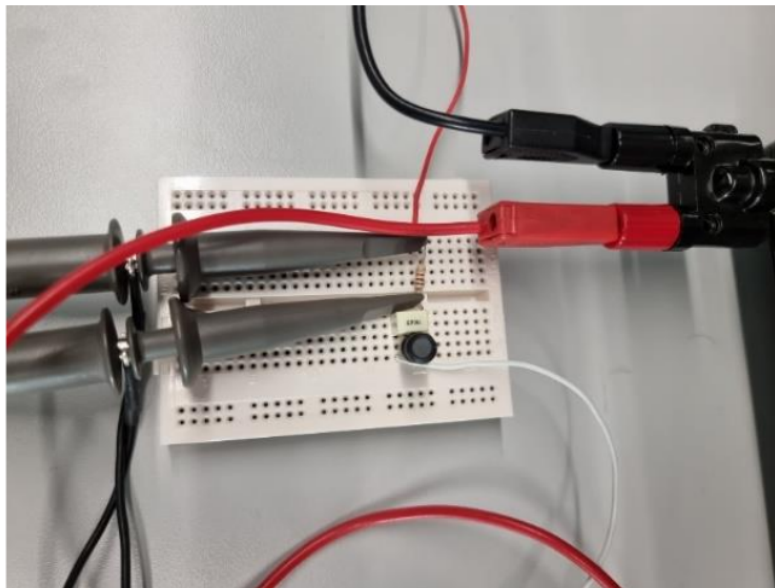
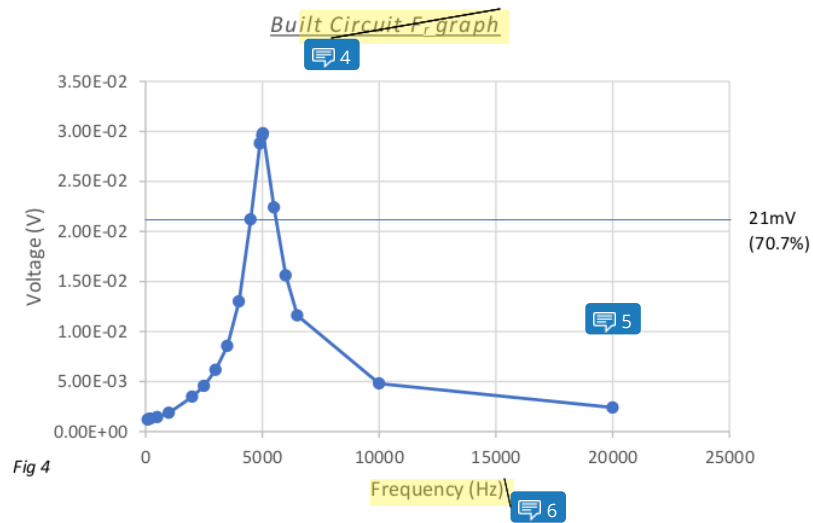


Fig 5 (practical example *showing voltage probes between the resistor*)

With the practical example of the in Fig 4, the resonant frequency came out to be **5300_{Hz}** at **30mV** with the bandwidth being between **4500_{Hz}** and **5600_{Hz}** making it **1100_{Hz}** and the Q factor came out to be **4.57**.

Results Analysis

After analysing both graphs, some key points were the difference in values such as voltage and sharpness. This is likely due to the fact that components in practical are not perfect and usually have a tolerance e.g., the resistor which had a gold band signifying a tolerance of $\pm 5\%$.

Similarities

With both circuits, the resonant frequency was around **5000_{Hz}** (5030 for the practical example) which is affected by the inductor and capacitor. This is not affected by the voltage supplied which can sometimes be slightly inaccurate. This could have been caused by the components having a different value than the ones they were advertised with since its highly impractical to make components without a tolerance.

This is where the similarities end.

Differences

In the Proteus example, the Q factor was **16.7** as its bandwidth was much narrower however in the practical example, the Q factor came out to be **4.57**. This is most likely due to the resistor value being lower than **1k Ω** . This can be a result of cooler temperatures as this reduces resistivity and proteus does account for temperature. This could also mean the resistor value was 950 Ω and branded as 1K Ω with a tolerance of **5%** meaning proteus with its accurate components wouldn't be able to simulate this exact graph as it's caused by variation in the component an underlying issue of the software.

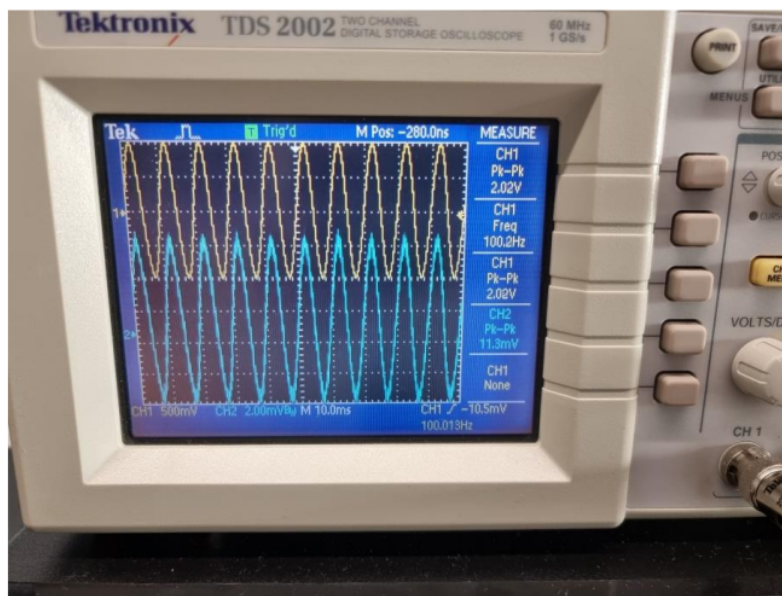


Fig 6 (voltage readings of V_{in} and V_{pk} *where ch1/yellow is input V and ch2/blue is output V)

The Q factor shows the steepness of the curve (a larger Q factor means steeper graph) being caused by a smaller bandwidth. Comparing both graphs reveals how a wider bandwidth is observed in the practical example which gives it the smaller Q factor. Again this is another issue with the components not being accurate in the practical example which means proteus could not have predicted this.

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Finally the example in proteus is an ideal circuit, it has infinite impedance at resonance meaning its V_{pk} is much closer to V_{in} . This would explain the fact that proteus has a much higher V_{pk} than the Practical example. Which can be seen in both the graphs as well as fig 6 showing the output voltage V_o . this could also be due to the Signal generator not giving an accurate voltage level which would lead to the practical example not matching with proteus. this could be tested by first using the oscilloscope on the signal generator in order to verify that the output is correct.

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Overview

In Conclusion, this experiment shows how proteus simulates in an ideal world by not accounting for temperature as well as accounting for components having no tolerance which causes discrepancies in results when compared to practical examples. This in some cases wouldn't be an issue as in this experiment it accurately predicted the resonant frequency however due to the practical example having components with a tolerance, some results were inaccurate e.g. the bandwidth which was off by 800Hz. There are also issues with the input voltage which caused the practical example to have a Colloquialism V_{pk} and that is something proteus couldn't account for and is simply an error.

Reference

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Ref Qual

Citation Needed

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Electronics Report

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

51 /100

PAGE 1

PAGE 2

PAGE 3

QM

Sp.

Spelling error

Additional Comment

Should this be "other"?

PAGE 4



Comment 1

You need to be more careful of how you handle images in your reports. As this image has been resized the text within it, and some of the connections, are unreadable.

PAGE 5



Comment 2

Which voltage? Be specific.



Comment 3

Should be log(f)

PAGE 6



Comment 4



Comment 5

Overlaying the two graphs would have highlighted differences better than showing two separate graphs.



Comment 6

Frequency was supposed to be on a logarithmic scale.



Comment 7

Missing words.

Please proofread your work before submitting. Ideally get a friend to proofread for you.

PAGE 7



Comment 8

Although the Q factor was significantly different between practical and simulated, this can not be attributed only to the tolerance of the components used. Calculation with upper and lower resistance values using the equations from the powerpoint would have shown this.



Comment 9

You should not use contractions like "don't" "can't" "won't" "shouldn't" etc. in formal writing. instead use the full form of the word: "do not" "can not" "will not" "should not" etc.

PAGE 8



Comment 10

What about the internal resistance of the signal generator? This was 600 ohms and would be added to the 1k resistor - significantly changing its value and altering the Q factor of the circuit.



Comment 11

I think you mean 11mV (0.011 V) and not 11Mv (11,000,000 V)



Comment 12

This should have been measured at each test frequency. This is what the second oscilloscope lead was for.



Colloquialism

You should not use colloquialisms in formal writing.



Comment 13

You have not indicated which parts of your text use which of these references. You should always join your text to the references using the corresponding reference number in square brackets [2] in your text. Please read the referencing guide on the university library website.

https://uwtsd.ac.uk/media/uwtsd-website/content-assets/documents/library-and-learning-resources/infoskills/IEEE-eng_v.1.2.pdf

QM

Citation Needed

Cite Source:

Please use the link below to find links to information regarding specific citation styles:
http://www.plagiarism.org/plag_article_citation_styles.html

QM

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.

PAGE 9

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IHAAB MAHMOUD

51.45

ENGAGEMENT WITH LITERATURE

including reading, referencing, academic conventions and academic honesty



While you have listed some sources you have used, you have not shown in the text which sources were used where. You should also try to use more credible, higher quality sources such as

2.5

academic peer reviewed journal papers, textbooks
etc.

KNOWLEDGE & UNDERSTANDING

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



You have shown a basic understanding of the subject. - Please see in text comments for more specific feedback

14.7

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.



You have shown evidence of some logical and critical thinking. You should always try to support your arguments with data - either from experiment or calculation.

16.5

PRACTICAL APPLICATION SKILLS

Different approaches to solving problems in particular contexts.



Good use of the tools and methods available to you. Although there is still some room for improvement - Log graphs, plotting in dB, plotting both data sets on one graph.

15

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.

2.75