

Resonance RLC circuits

by Kai Tang

FILE	1748_KAI_TANG_RESONANCE_RLC_CIRCUITS_226192_1570391537.DOCX (360.5K)		
TIME SUBMITTED	13-FEB-2020 05:29PM (UTC+0000)	WORD COUNT	1001
SUBMISSION ID	120054947	CHARACTER COUNT	6076

Report on Resonance

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Abstract

This report analyses the results of resonant frequencies obtained, between the theoretical results, calculated in excel, to those through experimentation, by both a simulated circuit in Proteus and one put together in a bread board, **hooked up** to a signal generator and an oscilloscope.

Colloquialism

The results obtained through all three methods yields similar results with only slight differences for resonance frequencies, however, the Q(quality) factor vary wildly between methods. An inverse relationship was found between Q and BW (bandwidth), where the higher value of Q results in a smaller Bandwidth and vice versa [1].

1

Introduction

RLC (resistance, Capacitance and Inductance) circuits in series are categorized as second-order circuits. As, second order differentials can be used to describe the circuit.



Equipment

- Bread board
- Wires (x2)
- Capacitor (1 micro Farad)
- Resistors (1k Ohms)
- Inductor (1 milli Henry)
- Oscilloscope Probes (x2)
- Signal Generator
- Oscilloscope
- PC
- Software: Proteus and Excel

Method

Theoretical:

Using Excel and a set of base results, calculate Capacitive reactance, Inductive impedance, and series circuit impedance, Q factor, Inductive reactance and Bandwidth. With given values for Resistance, Capacitance of capacitor, Induction of inductor and resonant frequency. All in excel through complex number calculations.  3

`=COMPLEX($AM$5,2*PI()*AM9*$AM$4,"j")`

AL	AM	AN	AO
R	1000		Q
C	1.00E-06		XL
L	1.00E-03		BW
Lr	6		
Fres	5105		
	Freq	Vin	ZL
ZL :	100	4	<code>PI()*AM9*\$AM\$4,"j")</code> -159

$$f_{res} = \frac{1}{2\pi\sqrt{LC}}$$

`=COMPLEX(0,-1/(2*PI()*AM9*$AM$3),"j")`

AL	AM	AN	AO	AP
R	1000			Q
C	1.00E-06			XL
L	1.00E-03			BW
Lr	6			
Fres	5105			
	Freq	Vin	ZL	Xc
XC:	100	4	6+0.628318530717959j	<code>=COMPLEX(0,-1/(2*PI()</code>

$$f_{res} = \frac{1}{2\pi\sqrt{LC}}$$

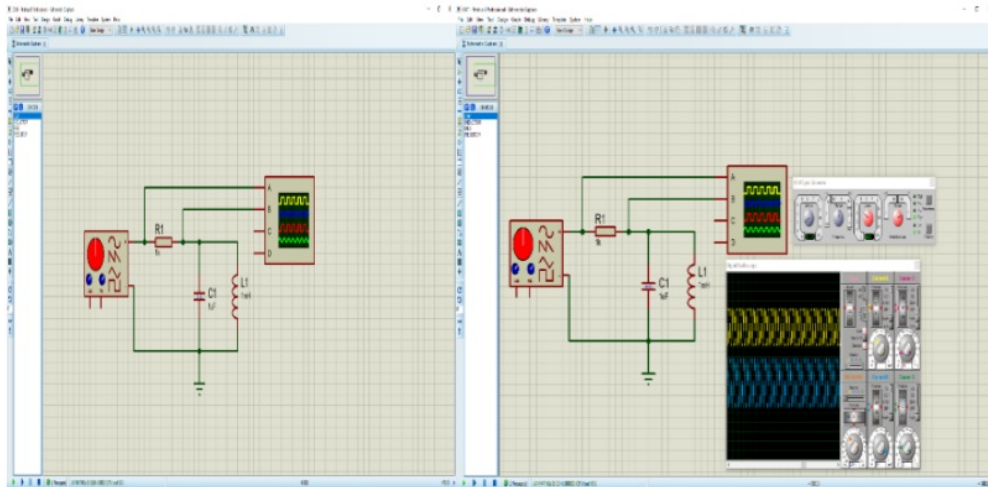
`=IMDIV(IMPRODUCT(AO10,AP10),IMSUM(AO10,AP10))`

AL	AM	AN	AO	AP	AQ
R	1000			Q	3.21E-02
C	1.00E-06			XL	3.21E+01
L	1.00E-03			BW	1.59E+05
Lr	6				
Fres	5105				
	Freq	Vin	ZL	Xc	ZLC
	100	4	6+0.628318530717959j	-1591.54943091895j	6.0046548100132+0.605920723305281j
ZLC:	200	4	6+1.25663706143592j	-795.774715459477j	<code>IMDIV(IMPRODUCT(AO10,AP10),IMSUM(AO10,AP10))</code>

$$f_{res} = \frac{1}{2\pi\sqrt{LC}}$$

Simulation via Proteus:

Build circuit for signal generator and oscilloscope in Proteus



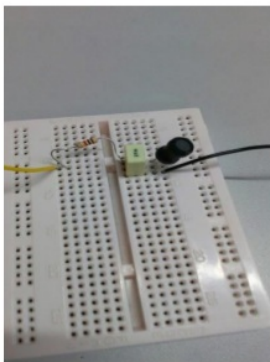
3.1a

3.1b

Using the cursor feature, measure voltage through oscilloscope, plot results into graph and calculate resonance frequency and Q factor

Physical Experiment:

Set up bread board using given components, Capacitor, Inductor, Wires x2 and a Resistor



3.2a

Connect wires from bread board to the signal generator and two probes from the bread board to the oscilloscope in order to take measurements of voltage. Set input voltage from signal generator to 4V, frequency to 100 Hz and take readings of VLC from the oscilloscope by eye and repeat until a range of values is acquired from 100 Hz to 20,000 Hz.

Formulas used:

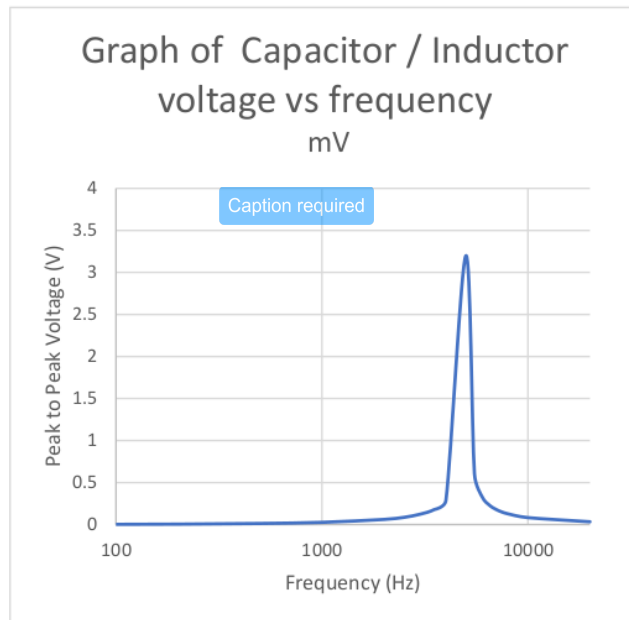
- Inductive Reactance: $X_L = 2\pi fL$
- Inductive Capacitance: $X_C = \frac{1}{2\pi fC}$
- BW (bandwidth): $BW = \frac{f_r}{Q}$ Caption required
- Q (quality factor): $Q = \frac{X_L}{R}$, $Q = \frac{f_r}{BW}$
- Reactance (total): $X_T = X_L - X_C$
- Impedance of inductor: $Z_L = i\omega L$
- Impedance Z_{LC} : $Z_{LC} = \frac{Z_L X_C}{Z_L + X_C}$
- Decibels (dB): $20 * LOG_{10}(\frac{V_{LC}}{V_{in}})$

Results

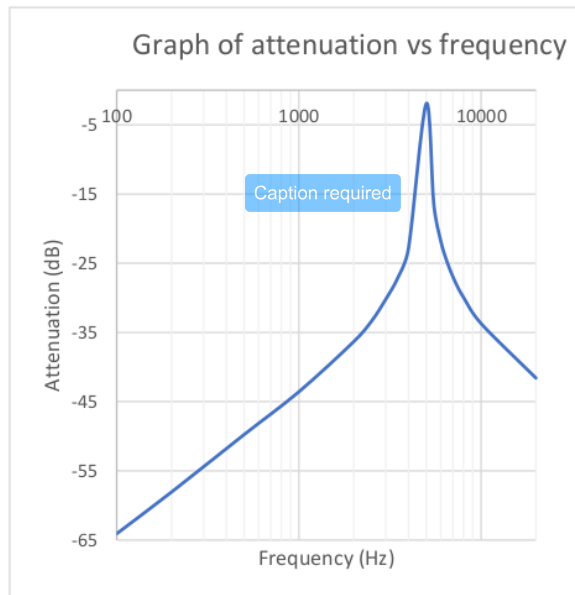
Proteus (simulated) Results:

Results acquired from digital oscilloscope in Proteus program when testing the digital circuit, the results were taken from an inbuilt feature that shows the peak voltage when hovering the mouse at the peak, decreasing the chances of human error.

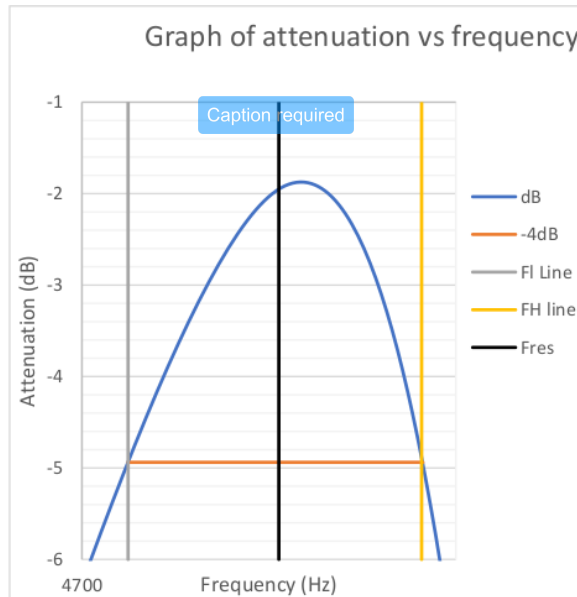
Freq	Vin	VLC (mV)	VLC mV
100	4	0.00125	0.0025
200	4	0.0025	0.005
500	4	0.0065	0.013
1000	4	0.01325	0.0265
2000	4	0.0305	0.061
2500	4	0.04275	0.0855
3000	4	0.0618	0.1236
3500	4	0.0888	0.1776
4000	4	0.14477	0.28954
5000	4	1.6	3.2
5500	4	0.30132	0.60264
6000	4	0.16413	0.32826
6500	4	0.11531	0.23062
7000	4	0.09006	0.18012
7500	4	0.07407	0.14814
8000	4	0.06397	0.12794
10000	4	0.04124	0.08248
20000	4	0.01666	0.03332



Freq	Vin	VLC mV	dB
100	4	0.0025	-64.0824
200	4	0.005	-58.0618
500	4	0.013	-49.7623
1000	4	0.0265	-43.5763
2000	4	0.061	-36.3346
2500	4	0.0855	-33.4019
3000	4	0.1236	-30.2008
3500	4	0.1776	-27.0523
4000	4	0.28954	-22.807
5000	4	3.2	-1.9382
5500	4	0.60264	-16.44
6000	4	0.32826	-21.7168
6500	4	0.23062	-24.7833
7000	4	0.18012	-26.93
7500	4	0.14814	-28.6278
8000	4	0.12794	-29.9011
10000	4	0.08248	-33.7142
20000	4	0.03332	-41.5871

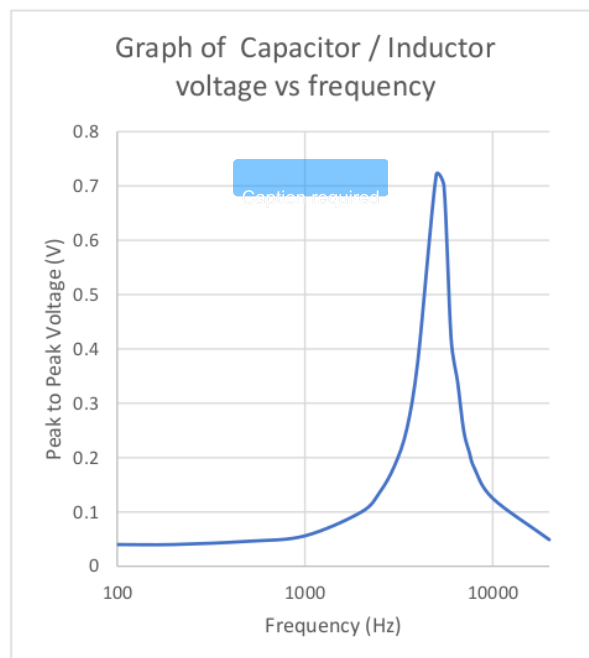


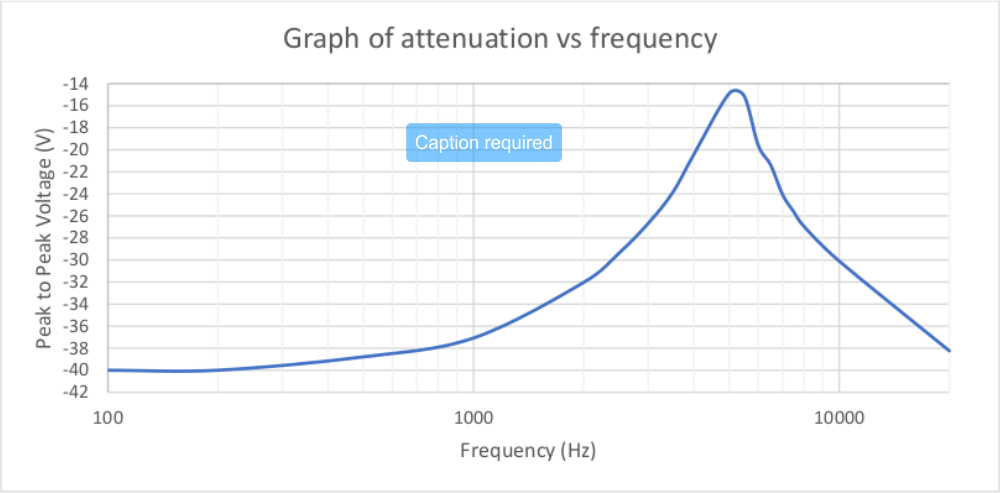
-4dB		Fres	
X	Y	X	Y
4768	-4.9382	4997	-1
5226	-4.9382	4997	-6
Caption required			
Fl Line		BW	458
X	Y	Qfactor	10.91048
4768	-1		
4768	-6	Fc	4997
FH line			
X	Y		
5224	-1		
5224	-6		



Physical Experiment Results:

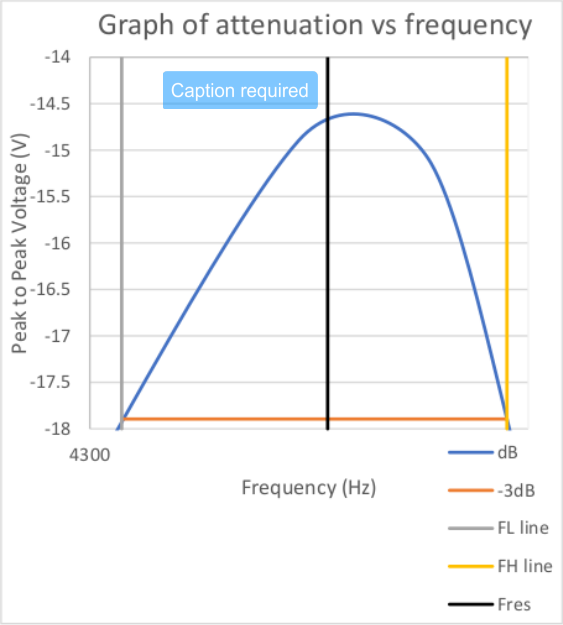
Freq	Vin	VLC mV	dB
100	4	0.04	-40
200	4	0.04	-40
500	4	0.046	-38.786
1000	4	0.056	-37.0774
2000	4	0.1	-32.0412
2500	4	0.136	-29.3704
3000	4	0.185	-26.6978
3500	4	0.255	-23.9104
4000	4	0.38	-20.4455
5000	4	0.72	-14.8945
5500	4	0.7	-15.1392
6000	4	0.42	-19.5762
6500	4	0.34	-21.4116
7000	4	0.25	-24.0824
7500	4	0.21	-25.5968
8000	4	0.18	-26.9357
10000	4	0.125	-30.103
20000	4	0.049	-38.2373





Caption required

-3dB		Fres	
X	Y	X	Y
4400	-17.8945	5105	-14
5810	-17.8945	5105	-18
FL line		BW	1410
X	Y	Qfactor	3.620567
4400	-14	Fc	5105
4400	-18		
FH line			
X	Y		
5810	-14		
5810	-18		



Theoretical Results:

Circuit component values given:

R	1000
C	1.00E-06
L	1.00E-03
Lr	6
Fres	5105

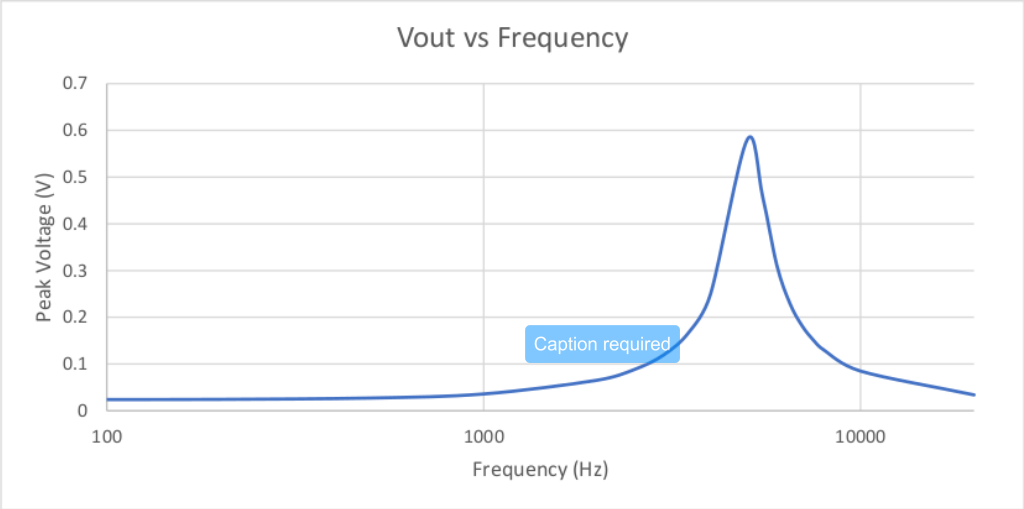
Caption required

Values calculated from results table:

Q	3.21E-02
XL	3.21E+01
BW	1.59E+05

Caption required

Freq	Vin	ZL	Xc	ZLC	Vout
100	4	6+0.628318530717959j	-1591.54943091895j	6.0046548100132+0.605920723305281j	0.0239965
200	4	6+1.25663706143592j	-795.774715459477j	6.01865138423494+1.21317326553229j	0.024411868
500	4	6+3.14159265358979j	-318.309886183791j	6.1179946671507+3.05643699500117j	0.027189454
1000	4	6+6.28318530717959j	-159.154943091895j	6.49334533147521+6.28657602906975j	0.035917875
2000	4	6+12.5663706143592j	-79.5774715459477j	8.39402353878759+14.1713215506899j	0.065328175
2500	4	6+15.707963267949j	-63.6619772367581j	10.4115493575714+19.5506199848958j	0.087671043
3000	4	6+18.8495559215388j	-53.0516476972984j	14.0048937447819+26.7811291641669j	0.119176582
3500	4	6+21.9911485751286j	-45.4728408833987j	21.1217048580191+37.1893882002842j	0.16742585
4000	4	6+25.1327412287183j	-39.7887357729738j	37.8745217165852+52.7260615011194j	0.249878761
5000	4	6+31.4159265358979j	-31.8309886183791j	168.064374193023-20.2047970944699j	0.579588655
5500	4	6+34.5575191894877j	-28.9372623803446j	74.3363312407331-98.5688076840859j	0.457737172
6000	4	6+37.6991118430775j	-26.5258238486492j	26.2475374285096-75.4043729875281j	0.31036331
6500	4	6+40.8407044966673j	-24.4853758602916j	11.8525206353292-56.7940208869972j	0.228991611
7000	4	6+43.9822971502571j	-22.7364204416993j	6.36386921170484-45.2707505519107j	0.1815235
7500	4	6+47.1238898038469j	-21.2206590789194j	3.82176060469818-37.7199835320752j	0.150968475
8000	4	6+50.2654824574367j	-19.8943678864869j	2.47777946904591-32.4365219091436j	0.129734569
10000	4	6+62.8318530717959j	-15.9154943091895j	0.679356029746023-21.2276461790402j	0.084877287
20000	4	6+125.663706143592j	-7.95774715459477j	0.0273531669467391-8.49435227907011j	0.03397543



Not In Text

Discussion

 Q factor is dependant on voltage as X_L varies, the results between simulated and physical have a large difference showing that the Q factor in the simulated circuit is vastly higher than the physical experiment,  This is most likely due to resistances that were not accounted for within the wires of the physical experiment. Measuring and properly taking account the resistances of the wires and other physical components plugged into and including the breadboard may yield less difference of Q factor between the two, However, the theoretical results show a very low Q factor.

An inverse relationship is also observed between Q factor and Bandwidth and is accentuated by the results of the theoretical calculations.

Conclusions

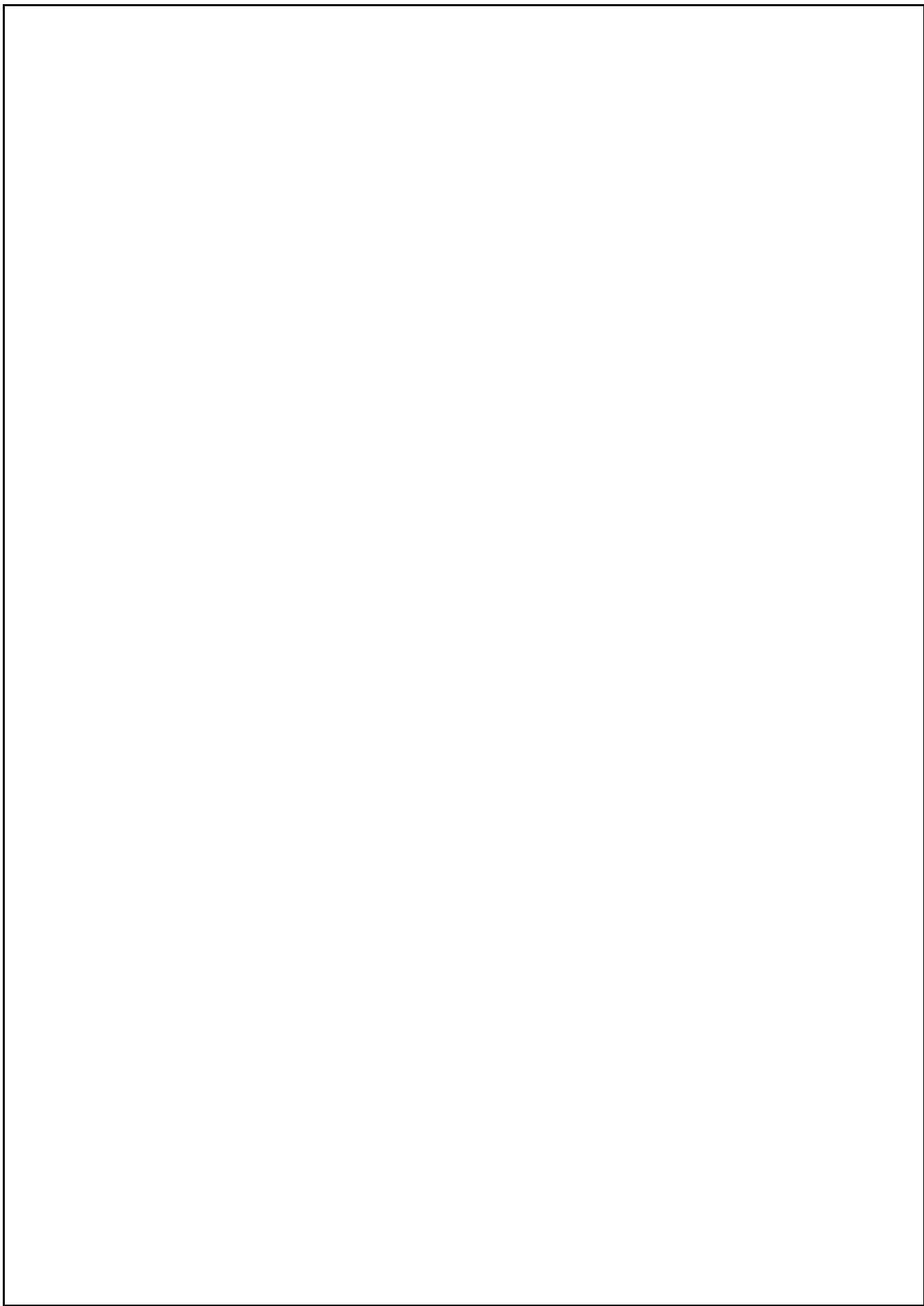


References

[1] K. S. Kumar, Electric Circuits and Networks, Pearson Education India, 2008.

 [2] T. L. Floyd and D. M. Buchla, DC/AC Fundamentals: A Systems Approach, Pearson Education, 2013.





Resonance RLC circuits

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

40/100

PAGE 1

PAGE 2



Colloquialism

You should not use colloquialisms in formal writing.

Additional Comment

Try using words like connected instead



Comment 1

Good abstract

PAGE 3



Comment 2

I was expecting more information in the introduction.

PAGE 4



Comment 3

You have stated what you have done, but not how you have done it.

Instead of screenshots from excel, which look unprofessional, you should have written the equations you used in excel stating the order they were used and describing all the variables. This would have shown a deeper understanding of the underlying concepts involved.

PAGE 5

PAGE 6

Caption required

You should always include a caption on figures, equations and tables to allow you to refer to them in your text.

e.g. An illustration of this can be seen in figure 2. The relationship of the variables is shown in equation 2. Table 1 shows the results of the first experiment where the control variable, temperature in degrees celsius is shown in the first column....

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QM

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PAGE 10

QM

Caption required

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QM

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e.g. An illustration of this can be seen in figure 2. The relationship of the variables is shown in equation 2. Table 1 shows the results of the first experiment where the control variable, temperature in degrees celsius is shown in the first column....



Comment 4

These tables of measurements and calculations detract from the text of the report and should be included in the appendix if absolutely necessary.

QM

Caption required

You should always include a caption on figures, equations and tables to allow you to refer to them in your text.

e.g. An illustration of this can be seen in figure 2. The relationship of the variables is shown in

equation 2. Table 1 shows the results of the first experiment where the control variable, temperature in degrees celsius is shown in the first column....

QM

Not In Text

You have included a figure without mentioning it in the text. You should refer to the figure in the text, otherwise it is not worth including as the reader will not know what it relates to.

Additional Comment

You have included all these lovely graphs and tables but not captioned them or discussed them in your text. You should caption them and ALWAYS discuss a figure which you feel is important enough to be included.

PAGE 11



Comment 5

No it is not. It is dependant on the component values used in the circuit: the capacitor and inductor values will determine the resonant frequency, and the resistance (or damping) in the circuit will determine the bandwidth. Together these two circuit properties determine the Q factor, not voltage.



Comment 6

Resistances, yes, but not in the wires. The added resistance between the two circuits was mainly from the inductor winding.



Comment 7

Where are your conclusions?



Comment 8

You have not cited this source in your text. Why is it here?



Comment 9

I was expecting far more references.

PAGE 12

GRADING FORM: SMU GENERIC_SMOSEY

KAI
TANG

43.30

ENGAGEMENT WITH LITERATURE

including reading, referencing, academic conventions and academic honesty



References to a limited range of mostly relevant sources. Some omissions and minor errors. Referencing conventions evident though not always applied consistently.

2

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 some attempts to synthesise, albeit with some

12.3

weaknesses.

PRACTICAL APPLICATION SKILLS

Different approaches to solving problems in particular contexts.



An adequate awareness and mostly appropriate application of well-established methods, tools and techniques. Basic appreciation of the context of the application.

12.6

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 in a suitable format but with some room for improvement. Work lacks coherence in places and could be better structured.

2