Lab6 Report

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Apprartus

1. Breadboard and jumper wires
2. Resistors (10kΩ, 1.3kΩ, 1.3kΩ)
3. Inductors
4. Capacitors
5. Oscilloscope
6. Function Generator
7. Digital Multimeter

Part One

1. A real inductor consists of a parasitic resistor (due to the windings) in series with an ideal inductor as shown in the Figure below. Measure the parasitic resistance RL using a Digital Multimeter and record these in the table. Measure also the value of the resistors and capacitor. __/3pt

Table 1: Measured Values

	Nominal Value	Measured Value
R2	1.3kΩ	1.293kΩ
RL of 500mH inductor		97.5Ω
C	0.1uF	0.1007μF

Part TWO

Construct the circuit shown in Figure 1 using the breadboard with jumper-wires, here R is 10kΩ. Using the values for C found in the pre-lab corresponding to the τ=0.1T, τ=T, τ=10T.

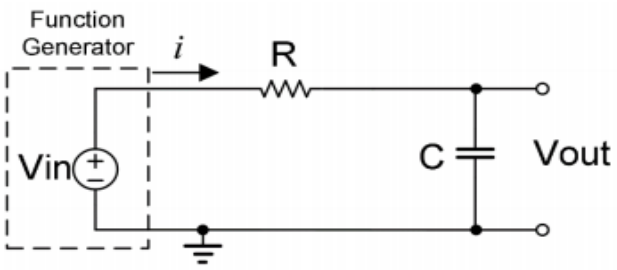
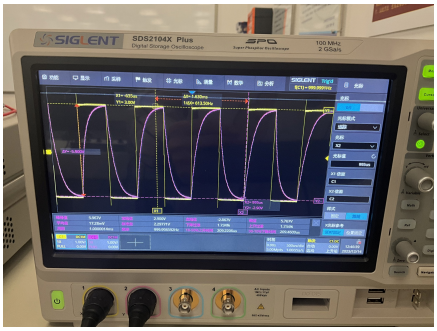


Fig.1 schematic diagram of RC Integrator

1. Use the Signal Generator to generate a Square Wave: ①T=1ms; ②50% duty cycle; ③ high level of the square wave is 3V, low level of the square wave is -3V.
2. As shown in Figure 1, Ch1 and CH2 of oscilloscope are used to observe the input voltage and the output voltage respectively.Be sure to use the cursors to annotate key information.

(1) Overlay the channel 1 and channel 2 curves and take a snapshot@τ=0.1T __/4pt



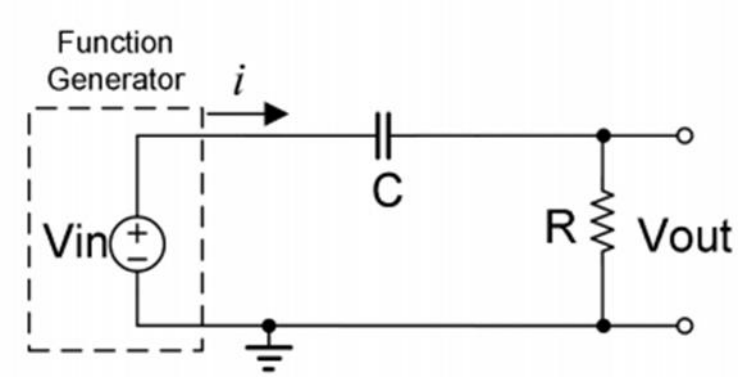
(2) Overlay the channel 1 and channel 2 curves and take a snapshot@τ=T. __/4pt

(3) Overlay the channel 1 and channel 2 curves and take a snapshot@τ=10T. __/4pt

Part TWO

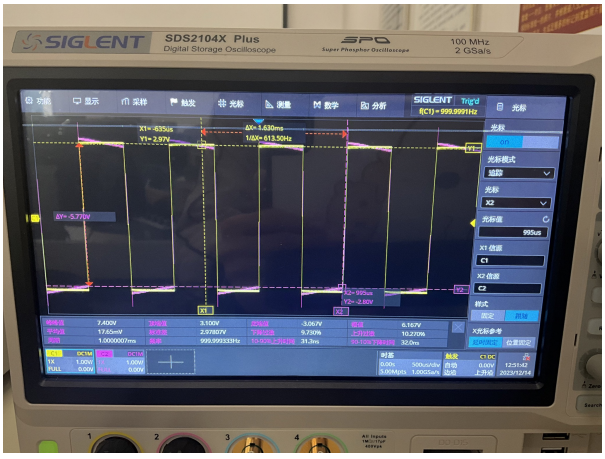
Construct the circuit shown in Figure, here R is 10kΩ. Using the values for C found in the pre-lab corresponding to the @τ= 5T, τ= 0.1T.

Fig2. schematic diagram of RC Differentiator

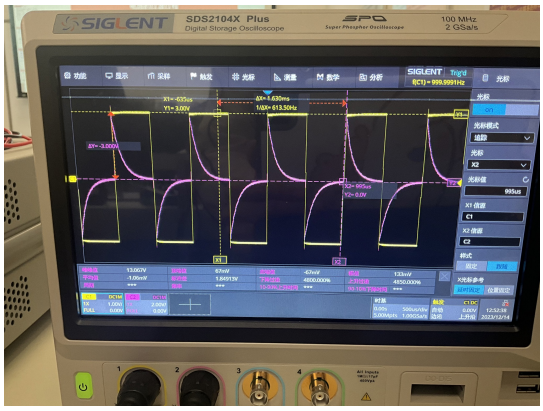


(1) Use the Signal Generator to generate a Square Wave: T=1ms, 50% duty cycle, the high level of the square wave is 3V, the low level of the square wave is -3V. As shown in Figure2, Ch1 and CH2 of oscilloscope are used to observe the input voltage and the output voltage respectively.

(2) Overlay the channel 1 and channel 2 curves and take a snapshot @τ=5T. _/4pt



(3) Overlay the channel 1 and channel 2 curves and take a snapshot @τ=0.1T. __/4pt



Part Three

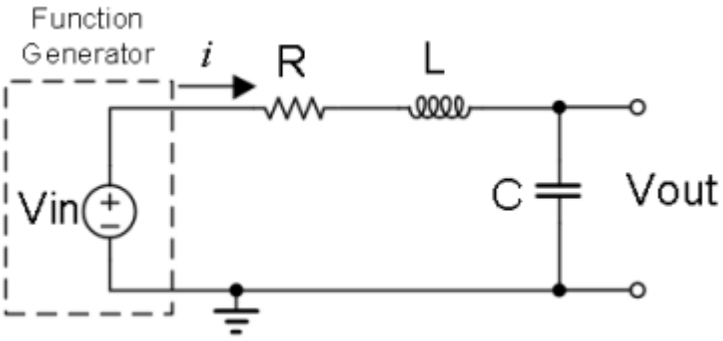


Figure.3 the RLC circuit

Construct the circuit shown in Figure 3, here L= 0.5H, C = 0.1μF. Use the Signal Generator to generate a Square Wave: T=10ms, 50% duty cycle, the high level of the square wave is 3V, the low level of the square wave is -3V. Ch1 and CH2 of oscilloscope are used to observe the input voltage and the output voltage respectively.

1. R=1.3kΩ

(1) Overlay the channel 1 and channel 2 curves and take a snapshot, the necessary data needed in the next step should be displayed . __/6pt

(2) Record the necessary data to get the measured decay constant [s^{-1}] α and the resonant frequency ω_0. __/6pt

$T = 1.480\ ms = 1.48 \times 10^{-3} s = \frac{2\pi}{\omega_0}$

$\Rightarrow \omega_0 = \frac{2\pi}{T} = 4245.40\ rad/s$

$U_1 = 5-3 = 2V, \quad U_2 = 3.2-3 = 0.2V$

$\alpha = \frac{1}{T} \ln \frac{U_1}{U_2} = 1555.80$

(3) According to the parameters of R, L and C to get the theoretical value of the decay constant [s^{-1}] α and the resonant frequency ω0. __/4pt

$\alpha = \frac{R}{2L} = \frac{1.3k}{2\times 0.25} = 1.3k$ $\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{0.25\times 0.1\times 10^{-6}}} = 4.5k$

(4) What is the percent difference between the measured value of the decay constant [s– 1] αabove and the theoretical value? What is the percent difference between the measured value of the resonant frequency ω0 above and the calculated value? Explain reasons for the difference. __/8pt

$[S^{-1}]\ \alpha$: $\left|\frac{1555.15-1300}{1300}\right|\times 100\% = 19.68\%$

ω_0: $\left|\frac{4245.40-4500}{4500}\right|\times 100\% = 5.66\%$

The inductor is not ideal with certain resistance.

$\alpha = \frac{R}{2L}$, R↑, α↑ so the measured value will be higher than the calculated one

(5) Analyze and explain the principle and characteristics of RLC oscillation waveform in step (1) from the point of view of energy conversion. __/4pt

Unlike the resistor, the capacitor and the inductor are two passive elements which are not able to dissapate or generate energy, but can return stored energy into a circuit. In the RLC oscillation waveform, the transient responce attenuates away (v_i and v_j) because the resistor absorb the energy. If there is no resistor, the decay will not occur and the energy will transfer from capacitor to inductor, or from the inductor to capacitor periodically and continuously.

(6) Vary the inductance from 0.1H to 0.9H, and observe the corresponding behaviors of the response (the voltage over the capacitor). Record and quantitatively discuss your observations in ascending order ofresistance. __/5pt

As the inductance increasing from 0.1H to 0.9H,
since $\omega_0 = \frac{1}{\sqrt{LC}}$, then L↑, ω_0↓ $T = \frac{2\pi}{\omega_0}$↑, and we observe that T increasing accordingly.
on the other hand $\alpha = \frac{R}{2L}$, L↑, α↓, the rate on which the transient response attenuates away decrease, and we observe that the difference between v_1 and v_2 is decreasing accordingly

2. Replace the Resistor 1.5kΩ with a 10kΩ potentiometer. Vary the potentiometer from 100Ω to 9.9kΩ and observe the corresponding three behaviors of the response (the voltage over the capacitor). Record and quantitatively discuss your observations in ascending order of resistance. __/7pt

As the resistance of the resistor increase
since $\omega_0 = \frac{1}{\sqrt{LC}}$, the increasing of the resistance will not affect ω_0 and we observe that the underdamped natural frequency do not change
On the other hand, $\alpha = \frac{R}{2L}$, R↑, α↑, the rate on which the transient responce attenuates away also increase, and we observe that the difference between v_1 and v_2 increasing accordingly.

Finally, before leaving lab, turn off all equipment and return cables to their proper place. Leave your lab station clean and ready for other students to use. Thank you!

Instructor/TA Bang