Feng Chia University

Electrical Engineering Fundamentals I Lab

Laboratory 7

Step Response Measurement

Instructor: Prof. Shyan-Lung Lin

Student Name: 周嘉禾

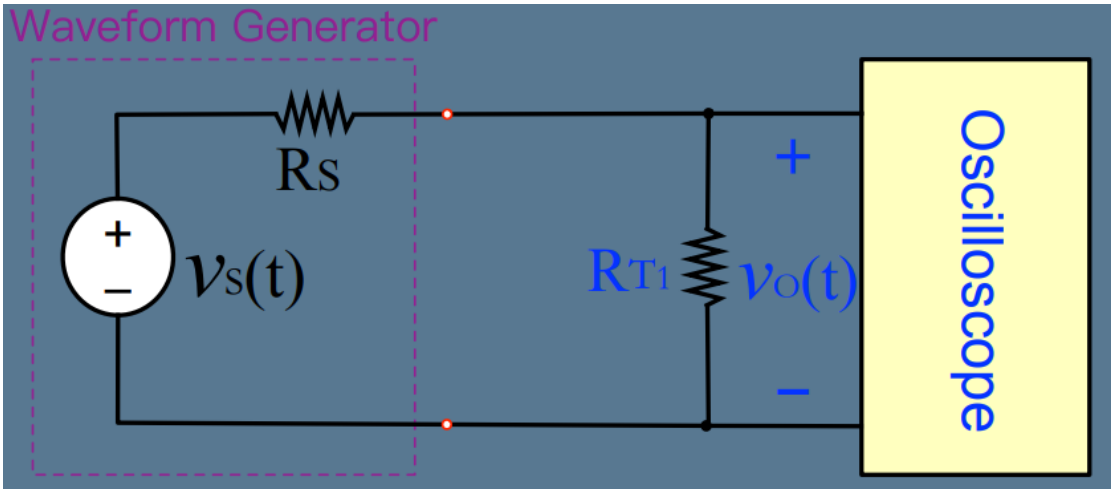
Student ID: D1166506

Experiment Date:30/11/2023

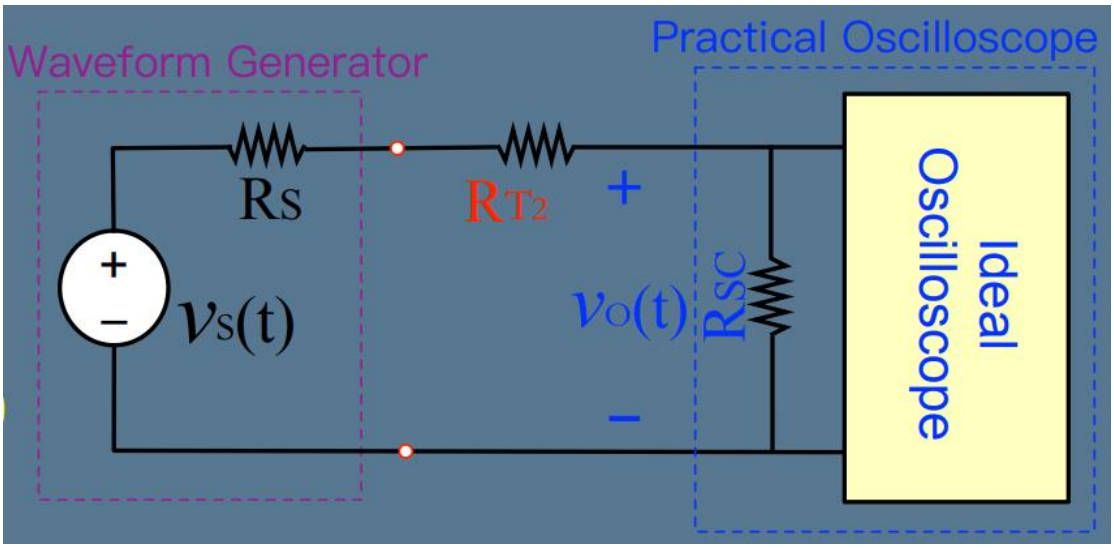
I. Introduction
   a. Display a specified step response on your oscilloscope of a specified network.
   b. Document the step response and accurately calculate time constants for the specified network.
   c. Use the step response technique to characterize an unknown capacitor or inductor which includes:
      1. Selecting and analyzing the model for the device under test
      2. (DUT).
      3. Designing and preparing an appropriate measurement circuit.
      4. Computing the capacitance or the inductance based on the time constant and analysis of the measurement circuit.

II. Materials
   a. Waveform Generator
   b. Oscilloscope
   c. Components
      1. Variable Resistor R_T
      2. Resistors: R = 1 kΩ
         Capacitor: C = 0.1μF
      3. Resistors: R = 1 kΩ
         Inductor: L = 4.7 mH

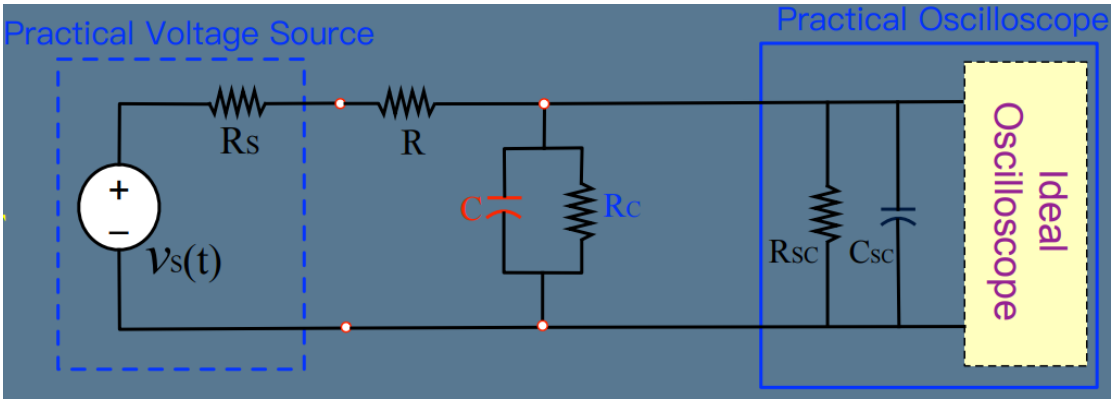
III. Circuit diagram



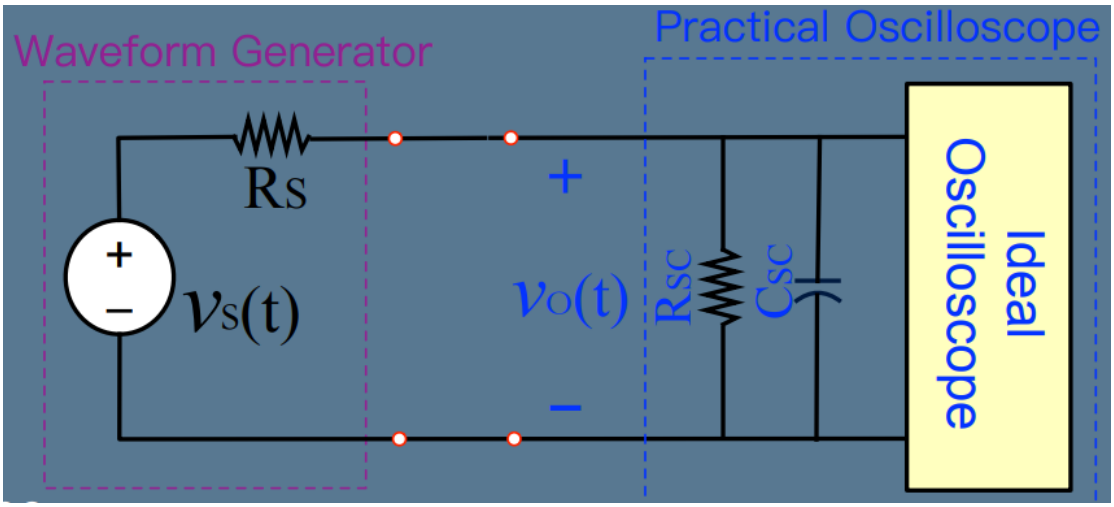
▲ Figure 1. Circuit of Experiment 7.a Properties of Instruments step 1



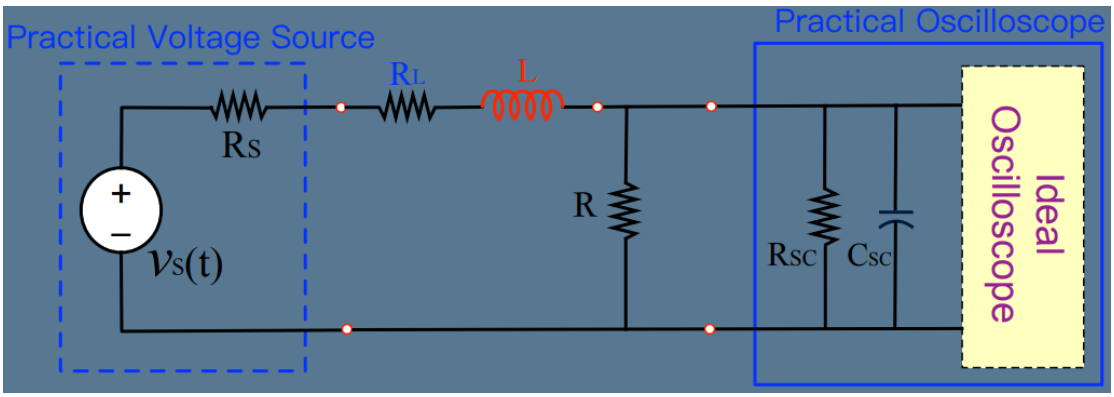
▲ Figure 2. Circuit of Experiment 7.a Properties of Instruments step 2



▲ Figure 3. Circuit of Experiment 7.a Properties of Instruments step 3~5



▲ Figure 4. Circuit of Experiment 7.b Measurement of a Known Typical Capacitor



▲ Figure 5. Circuit of Experiment 7.c Measurement of a Precision Inductor

IV. Methods

Make measurements on oscilloscope and use digital multimeter on the resistor

V. Experiments data

a. Experiment 7.a Properties of Instruments

Table 1: Results of the capacitor of Oscilloscope

R_s	R_{sc}	τ	C_{sc}
52.9020 Ω	0.9842 MΩ	49.0000 ns	926.2410 pF

b. Experiment 7.b Measurement of a Known Typical Capacitor

Table 2: Measurement of known capacitor

R_{Th}	τ	C_{eq}	C
1052.9020 Ω	102.6000 μs	97.4450 nF	96.5187 nF

Table 3: Percentage error of measurement of known capacitor

Measured	Theoretical	% Error
96.5187 nF	100 nF	-3.48%

c. Experiment 7.c Measurement of a Precision Inductor

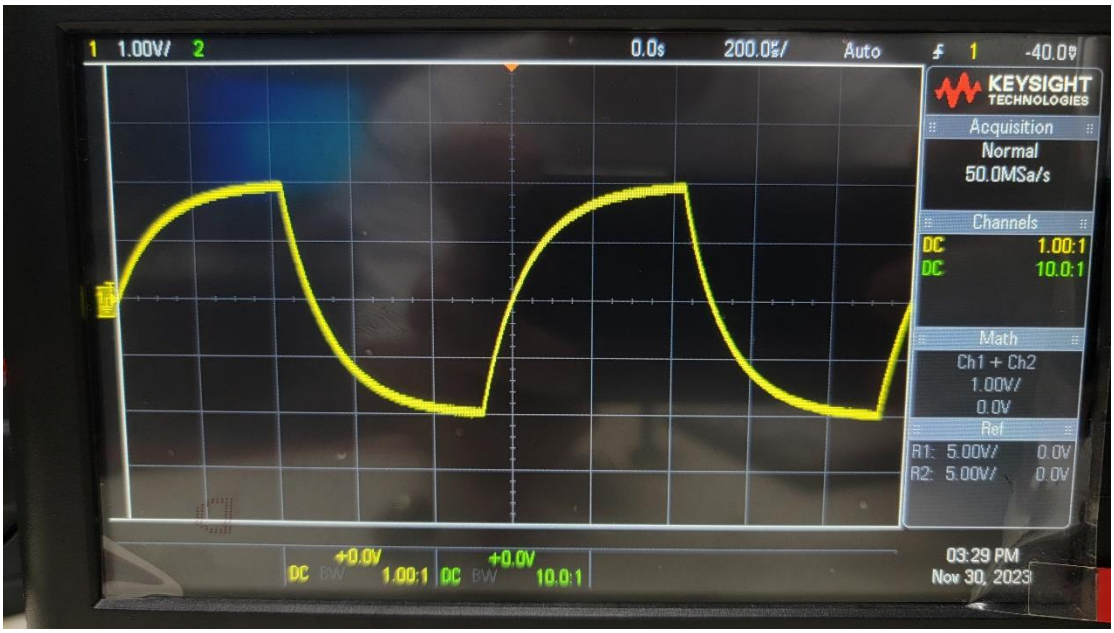
Table 4: Measurement of inductor

R_{eq}	τ	L
1052.902 Ω	4.4800 μs	4.7170 mH

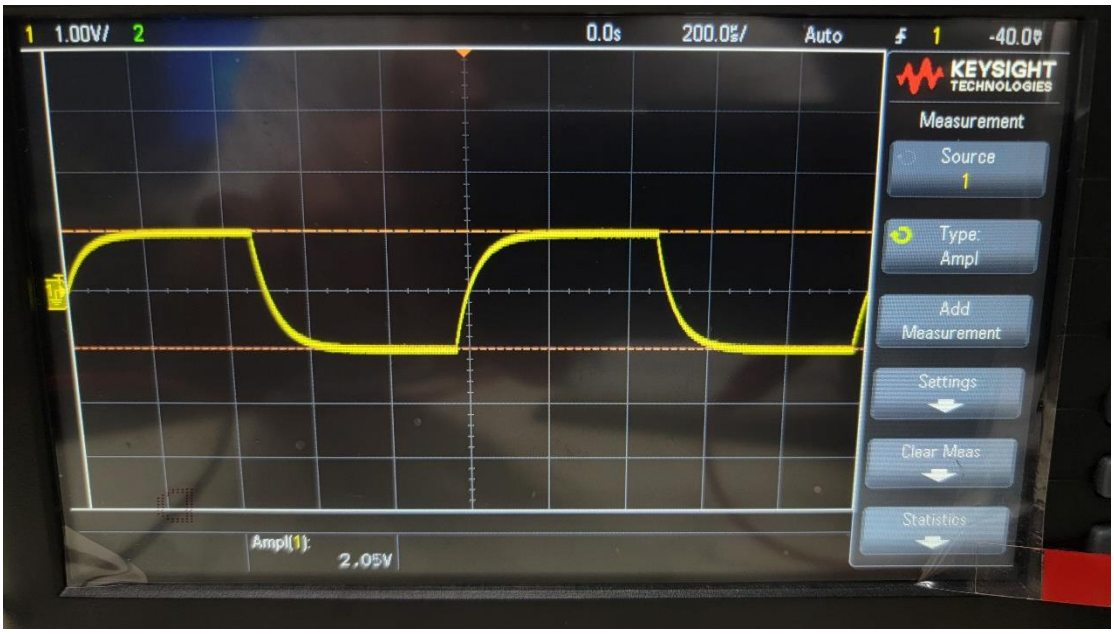
Table 5: Percentage error of measurement of inductor

Measured	Theoretical	% Error
4.7170 mH	4.7 mH	0.36%

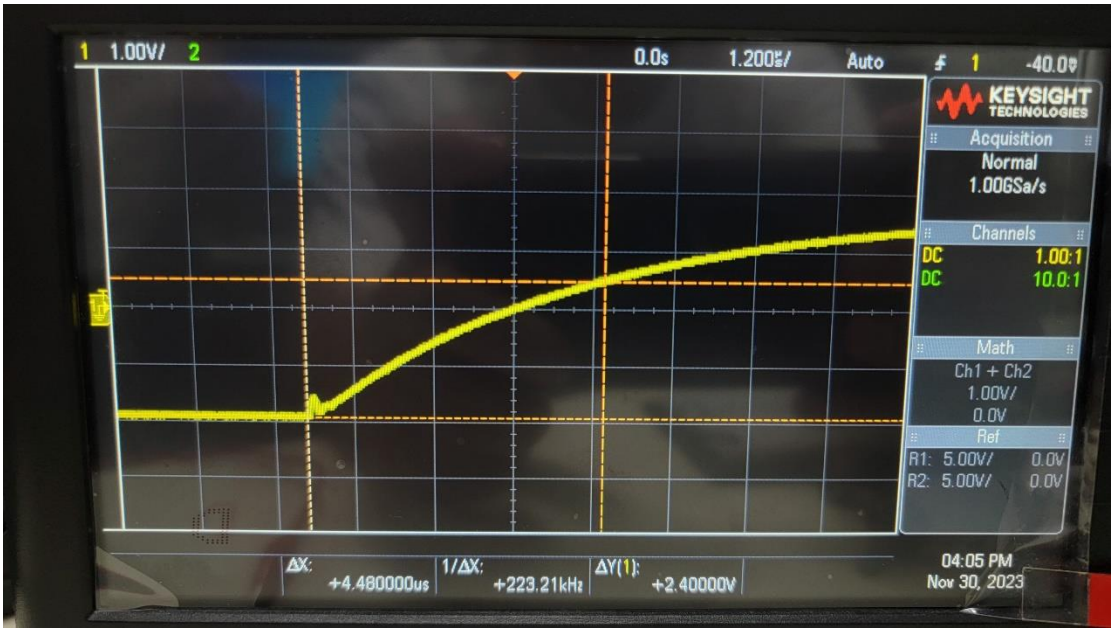
VI. Results



▲ Figure 6. Curve of Experiment 7.a Properties of Instruments



▲ Figure 7. Curve of Experiment 7.b Measurement of a Known Typical Capacitor



▲ Figure 8. Curve of Experiment 7.c Measurement of a Precision Inductor

VII. Discussion

With proper measurement, the value of capacitors and inductors can be obtained easily.

VIII. Conclusion

On capacitors and inductors, it's easy to observe that these two kinds of circuits can make step response and let the waves become smooth.