

EXPERIMENT 6

CAPACITORS AND INDUCTORS

6.1 OBJECTIVES

In this experiment you will learn about:

- 1) Terminal characteristics, parallel and series connections of linear capacitors and inductors.
- 2) Capacitance and inductance measurement methods.

6.2 EQUIPMENT LIST

Multimeter,
DSO (Agilent DSO3062A),
Signal Generators,
Capacitors (0.47 μF , 0.1 μF , 10 nF, 100 μF , 220 μF),
Inductor (0.1 H),
Resistors (100 Ω , 1 k Ω , 100 k Ω)

6.3 PRELIMINARY WORK

- 1) Read Notes on “Types of Capacitors and Inductors”.

CAPACITOR

An actual capacitor can be modeled as in Fig. 6.1 where the conductance G represents the (leakage) loss of the capacitor. As G is usually quite small it will be neglected in this experiment.

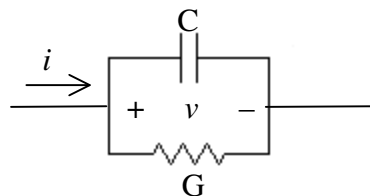


Fig. 6.1

- 2) Consider the circuit of Fig. 6.2. Find the capacitance of the capacitor in terms of the measured current and voltage values (rms values) and the angular frequency ω .

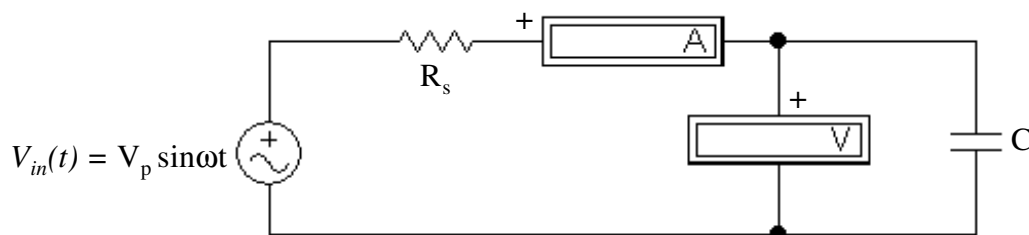


Fig. 6.2

- 3) Consider the circuit of Fig. 6.3.
- Find the expressions for charge q and the capacitance of the capacitor C in terms of K , R , v_2 and v_c .
 - How can $q-v$ characteristics be obtained on DSO using this setup?

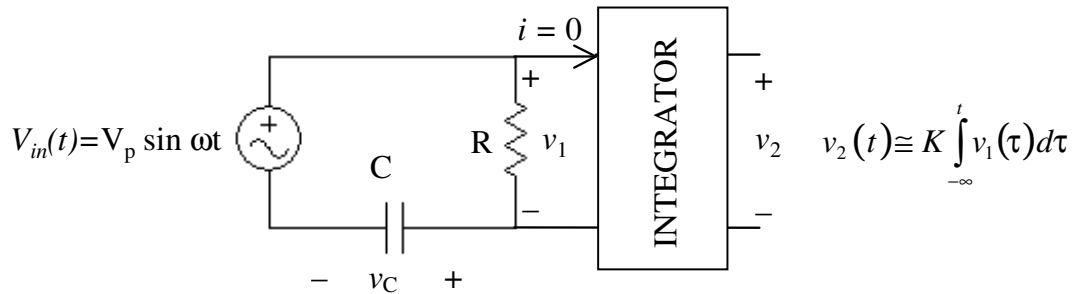


Fig. 6.3

INDUCTOR

An actual inductor can be modeled as in Fig. 6.4 where the resistance r represents the resistance of the turns of the inductor.

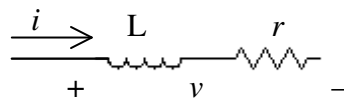


Fig. 6.4

- How can r be measured?
- Replace C in Fig. 6.2 by an inductor L . Find L in terms of the measured current and voltage values, the angular frequency ω and the resistance r .
- Consider the circuit of Fig. 6.5.
 - Find the expressions for flux ϕ and the inductance of the inductor L in terms of K , R , v_2 and v_R .
 - How can $\phi-i$ characteristics be obtained on DSO using this setup?

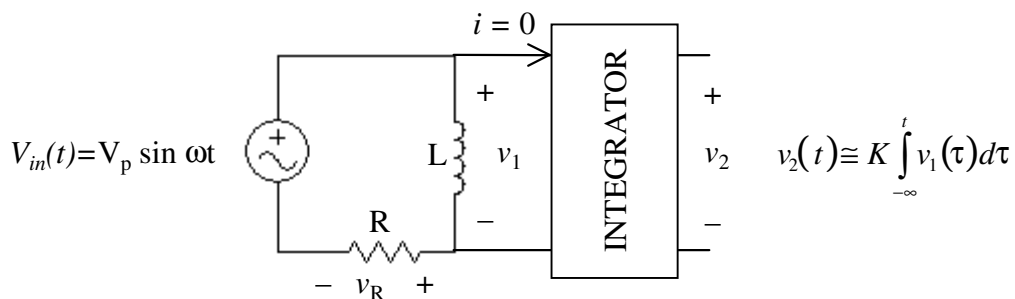


Fig. 6.5

6.4 EXPERIMENTAL WORK:

- 1) Adjust the signal generator to 500 Hz, 6V peak and apply the signal to a capacitor C of 0.47 μF nominal capacitance value. Measure the AC current through and AC voltage across the capacitor using a multimeter and determine its capacitance (Figure 6.2).
- 2) Setup the circuit of Fig. 6.6 for $v_{in}(t) = (10\sin 2\pi ft)$ volts, $f = 100$ Hz.
 - a. Obtain and plot $q-v$ characteristics of the capacitor C of 220 μF nominal value and determine its capacitance.
 - b. Connect a capacitor of 100 μF nominal capacitance value in parallel with C. Find the equivalent capacitance using the new $q-v$ characteristics.
 - c. Connect a capacitor of 100 μF nominal capacitance value in series with C. Find the equivalent capacitance using the new $q-v$ characteristics.

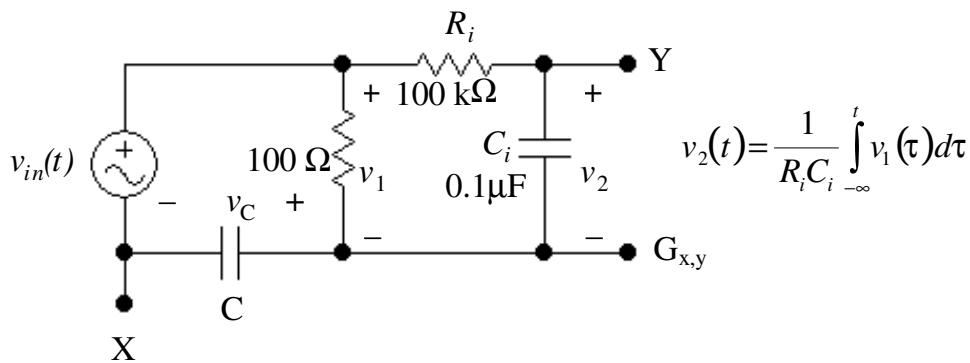


Fig. 6.6

- 3) Repeat Part 1 for an inductor L of 0.1 H nominal inductance value, to determine its inductance. Use a 1 $\text{k}\Omega$ resistor in series with the inductor and signal generator for protection. Note that the resistance of turns should be measured using a multimeter.
- 4) Setup the circuit of Fig. 6.7 for $v_{in}(t) = (10\sin 2\pi ft)$ volts, $f = 5$ kHz (Use Advance Instruments Signal Generator's floating output!).
 - a. Obtain and plot $\phi-i$ characteristics of the inductor L of 0.1 H nominal value and determine its inductance.
 - b. Connect an inductor of 0.1 H nominal inductance value in parallel with L. Find the equivalent inductance using the new $\phi-i$ characteristics.
 - a. Connect an inductor of 0.1H nominal inductance value in series with L. Find the equivalent inductance using the new $\phi-i$ characteristics.

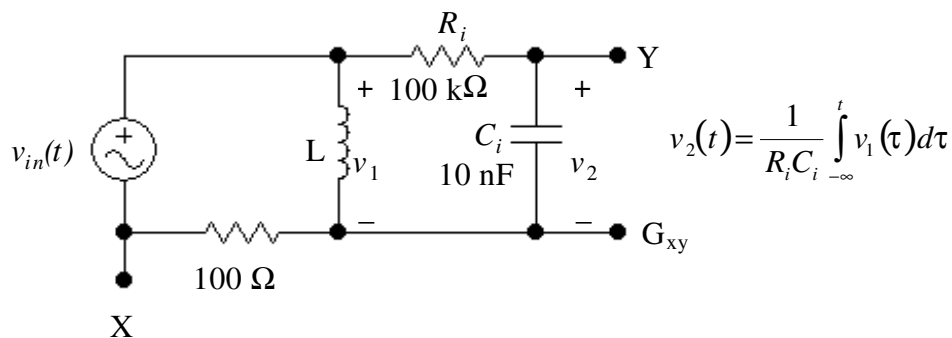


Fig. 6.7