MANDATORY EXPERIMENTS

Experiment 1

Refer to the block diagram of a typical analog oscilloscope shown in Fig. 1 and explain how an anlog oscilloscope works. How does an analog oscilloscope differ from its digital counterpart?

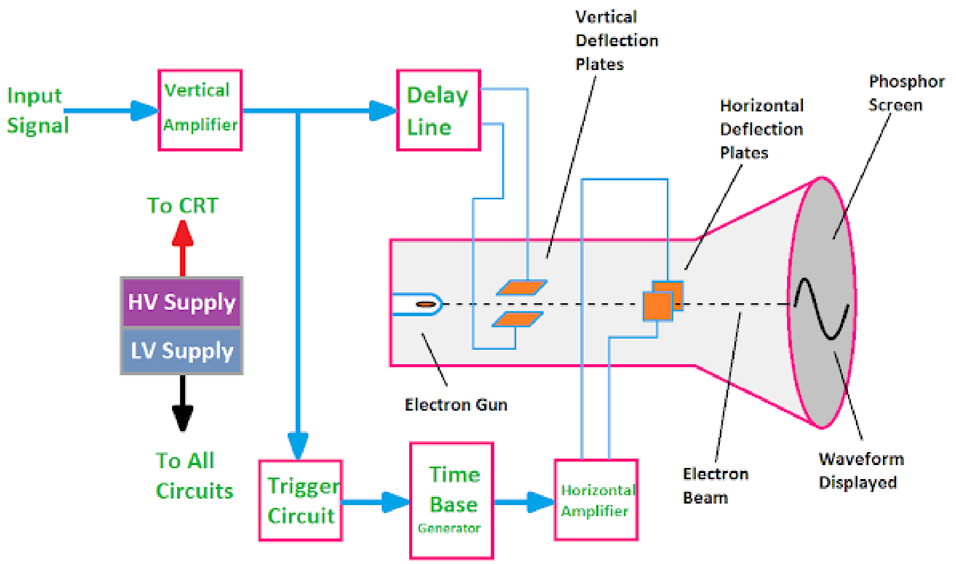

Figure 1: Block diagram of an analog oscilloscope.

Experiment 2

The Wheatstone bridge shown in Fig. 2 has the key role in many LCR meter instruments. The bridge is balanced if no current flows through the galvanometer V_g.

Experiment 2 continued on next page...

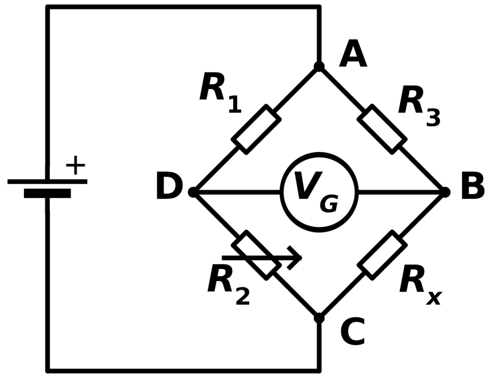

Figure 2: Wheatstone bridge circuit diagram.

(a) Simply explain what the galvanometer is and how it works.

(b) Which values of R_1, R_2, R_3, and R_x do guarantee the balanced condition?

(c) How can the bridge be used for measuring an unknown resistance?

Experiment 3

The horizontal axis of an oscilloscope can be fed by an external signal $f_x(t)$. In this situation, the oscilloscope shows the so-called Lissajous curve whose points correspond to $(f_x(t), f_y(t))$ at various times t, where $f_y(t)$ is the signal fed to the vertical axis. Consider the experimental setup of Fig. 3, where $v_x(t)$ and $v_y(t)$ connect to horizontal and vertical inputs of an oscilloscope. Assume that r is small enough such that $v_y(t) \approx v_s(t)$.

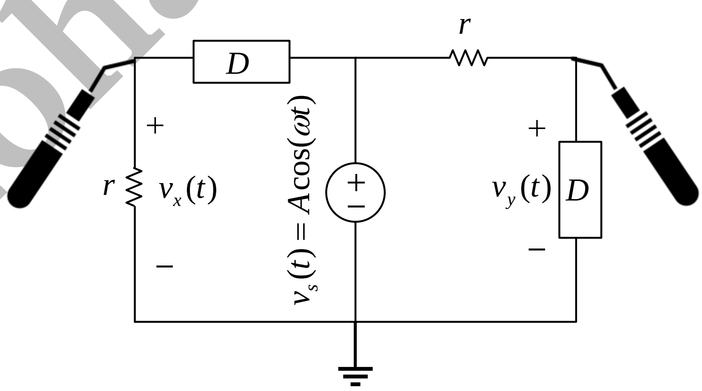

Figure 3: An experimental setup to demonstrate Lissajous curves.

Experiment 3 continued on next page...

(a) Obtain a mathematical expression for the shown Lissajous curve if D represents an LTI resistor with the resistance R.

(b) Obtain a mathematical expression for the shown Lissajous curve if D represents an LTI capacitor with the capacitance C.

(c) Obtain a mathematical expression for the shown Lissajous curve if D represents an LTI inductor with the inductance L.

(d) Is it possible to remove the left side (the horizontal D and vertical r) of the circuit and still show the Lissajous curve?

Experiment 4

Consider the periodic signal $f(t) = B + A\cos(\omega t + \theta)$**.**

(a) Calculate the average and RMS of $f(t)$.

(b) How do you measure the RMS value of $f(t)$ using a digital multimeter?

(c) How do you measure the RMS value of $f(t)$ using a digital oscilloscope?

Experiment 5

You should always pay detailed attention to the undesired items affecting the oscilloscope performance and lifetime.

(a) As you know, an oscilloscope picks up noise from power lines. What are your hints to reduce the power line noise?

Experiment 5 continued on next page...

(b) Ground looping may lead to inaccurate measurements. What are your hints to avoid undesired effects of ground looping?

(c) Electrostatic discharge (ESD) may severely destroy the oscilloscope. What are your hints to avoid ESD damages?

BONUS EXPERIMENTS

Experiment 6

A real capacitor can be modeled as Fig. 4. Where do R_{EPR}, R_{ESR}, and L_{ESL} originate from? Whats are the values of R_{EPR}, R_{ESR}, and L_{ESL} for an ideal capacitor?

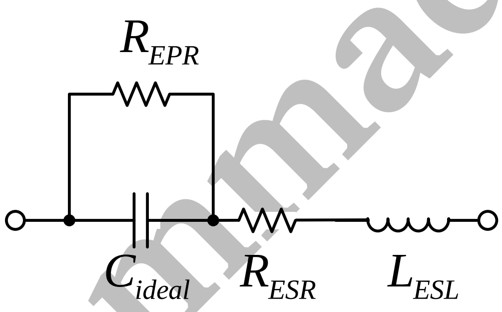

Figure 4: Real capacitor model.

Experiment 7

A real inductor can be modeled as Fig. 5. Where do R_{EPR}, R_{ESR}, and C_{EPC} originate from? Whats are the values of R_{EPR}, R_{ESR}, and C_{EPC} for an ideal inductor?

Experiment 7 continued on next page...

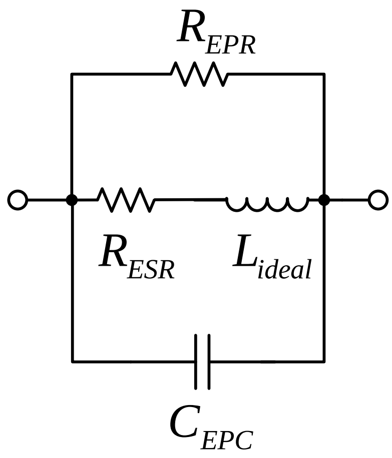

Figure 5: Real inductor model.

Experiment 8

Return your answers by filling the LaTeX template of the manual.