MANDATORY EXPERIMENTS

Experiment 1

Consider the real capacitor modeled in Fig. 1.

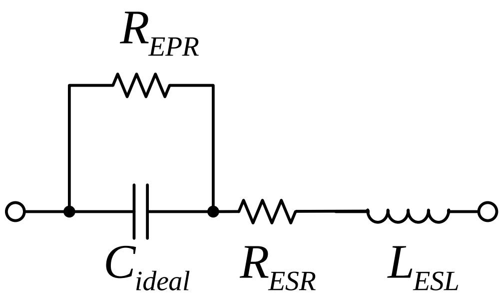

Figure 1: Real capacitor model.

(a) Assume that the sinusoidal voltage $v_C(t) = A\cos(\omega t + \theta)$ is applied to the capacitor. Find the corresponding capacitor current $i_C(t)$ for ideal values of R_{EPR}, R_{ESR}, and L_{ESL} and show that it has sinusoidal form.

(b) Use PSpice AC sweep analysis to plot the amplitude and phase of the capacitor current versus $f = \frac{\omega}{2\pi}$ when the capacitor voltage is $v_C(t) = \cos(\omega t + \theta)$ and R_{EPR}, R_{ESR}, and L_{ESL} have ideal values.

(c) Use PSpice parametric analysis to plot the amplitude and phase of the capacitor current versus $f = \frac{\omega}{2\pi}$ for the fixed capacitor voltage $v_C(t) = \cos(\omega t + \theta)$ and different suitably selected values of R_{EPR}, R_{ESR}, and L_{ESL}. Discuss how the parasitic parameters R_{EPR}, R_{ESR}, and L_{ESL} affect the performance of the capacitor.

Experiment 2

We have a super capacitor with diameter 24 mm, length 75 mm, capacity 500 F, and voltage 2.7 V. We also have a dry cell AAA battery with diameter 10 mm, length 45 mm, voltage 1.5 V, and capacity 540 mA.h.

Experiment 2 continued on next page. . .

Figure 2: Super capacitor and dry cell AAA battery.

(a) Compare the volume of the super capacitor and battery.

(b) Compare the stored energy of the super capacitor and battery. Assume that the super capacitor is fully charged with the voltage 2.7 *V. Which element do store much energy?*

(c) Both the super capacitor and battery can be used as an energy storage. If so, why might we need to use super capacitors as the storage when batteries are readily available?

Experiment 3

Zero-ohm resistors are commercially available indifferent sizes. Can you mention some of the possible applications of a zero-ohm resistor? Ideally, a zero-ohm resistor has no power dissipation. If so, why are zero-ohm resistors produced in various package sizes?

Experiment 4

Why do electrolytic capacitors have voltage polarity? What happens if you put an electrolytic capacitor under reverse polarity?

Experiment 5

In E12 standard, a decade is covered by the values reported in Fig. 3. What are the reasons behind the selection of these values?

Experiment 5 continued on next page...

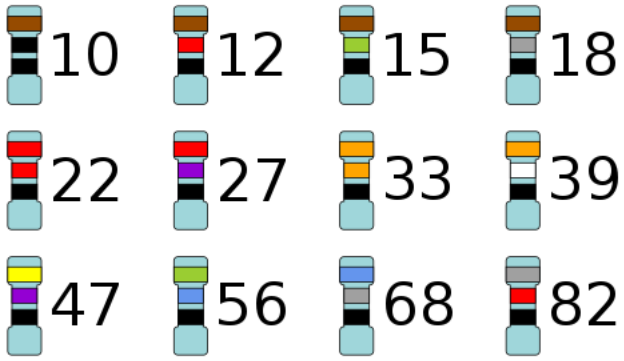

Figure 3: E12 standard values.

Experiment 6

Fig. ?? shows conventional implementations of basic circuit elements.

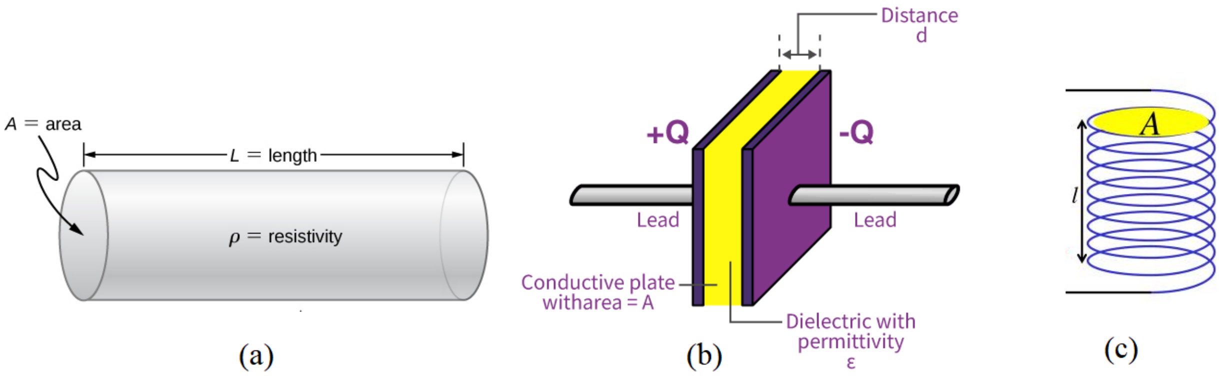

Figure 4: (a) Cylindrical resistor, (b) parallel-plate capacitor, and (c) solenoid.

(a) Express the resistance of the cylindrical resistor in terms of its area A, length l, and resistivity ρ.

(b) Express the capacitance of the parallel-plate capacitor in terms of its area A, distance d, and permittivity ϵ.

Experiment 6 continued on next page. . .

(c) Express the inductance of the solenoid in terms of its area A, length l, number of turns N, and permeability μ.

(d) How can a circuit element manufacturer produce different circuit elements with desired values using the structures shown in Fig. **??***?*

BONUS EXPERIMENTS

Experiment 7

Write a MATLAB code to plot the Lissajous curve corresponding to the voltage signals $v_x(t) = A_x \cos(\omega_x t + \theta_x)$ and $v_y(t) = A_y \cos(\omega_y t + \theta_y)$.

(a) Use the developed code to plot sample Lissajous curves for various values of A_x, A_y, ω_x, ω_y, θ_x, and θ_y.

(b) Assume that $\frac{\omega_x}{\omega_y} = \frac{m}{n}$, where $\frac{m}{n}$ is a fractional number. Discuss how the ratio $\frac{\omega_x}{\omega_y}$ can be found from the corresponding Lissajous curve?

Experiment 8

Return your answers by filling the LaTeXtemplate of the manual.