Module: Electricity

Tutorial Worksheet No. 2

Duration: 2 weeks

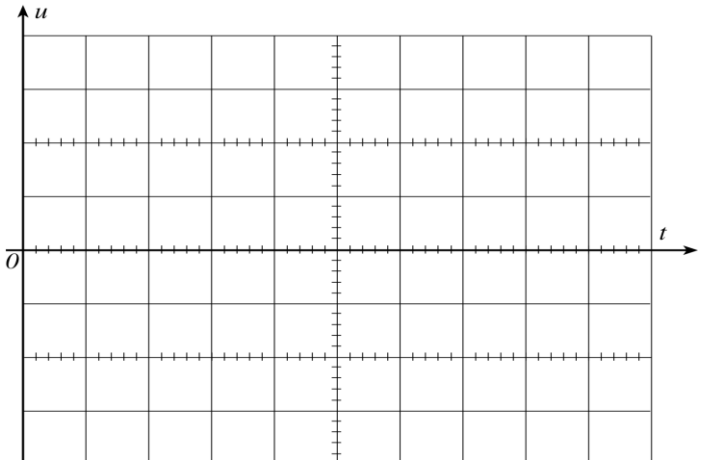
Exercises to do in class: 03, 05, 06

Assignment to submit: 01, 04

Exercise 1:

Given the voltage $u = 220\sqrt{2}\sin(628{,}3 \times t + \frac{2\pi}{5})$.

1. Specify its angular frequency ω, its frequency, its period (in ms), its mean value, its amplitude, its RMS value, and its initial phase (in radians then in degrees).
2. Draw its Fresnel vector (1 cm equals 40 V)
3. Draw its time diagram (curve *v* as a function of *t*) 1 square for 100 V and 1 square for 2 ms (mark the zero crossings, maximums and minimums)



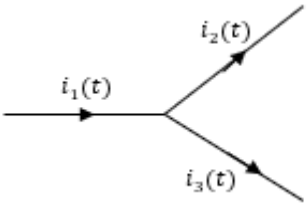
4. Write the complex form of u(t).

Exercise 2:

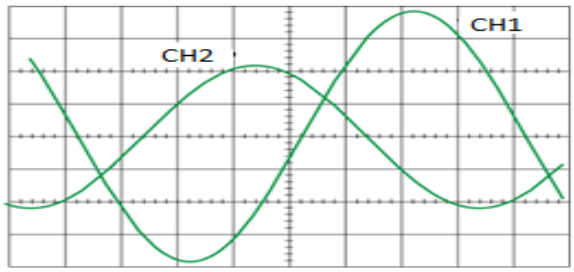
1. Carry out the Fresnel construction corresponding to Kirchhoff's current law below (1 cm for 1 A) $i_1 = 4\sqrt{2}sin(\omega t - \frac{\pi}{3})$ and $i_2 = 2\sqrt{2}sin(\omega t - \frac{5\pi}{6})$
2. Determine $i_3(t)$ using the Fresnel vector method (1 cm for 1 A) and using the complex number method.
3. Calculate $\varphi_{i1/i2}$, $\varphi_{i2/i3}$ and $\varphi_{i1/i3}$.

Exercise 3:

An oscilloscope displays on *channel 1* the voltage *u(t)* across a circuit and on *channel 2* the voltage $u_R(t)$ across a resistor in the circuit.



- Measure the phase shift φ of *i* with respect to *u*. Deduce the power factor.



Exercise 4:

Consider the following circuit: R = 200 Ω

1. Indicate the oscilloscope connections to display *u(t)* on *channel_1* and $u_R(t)$ on *channel_2*.
2. The oscillogram readings gave the results shown in the figure above: Determine:

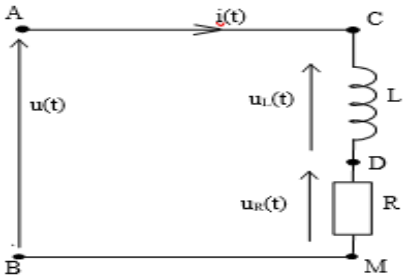
   a) The period of *u(t)*. Deduce its frequency and its angular frequency.

   b) The peak and RMS values of the voltages *u(t)* and *uR(t)*.

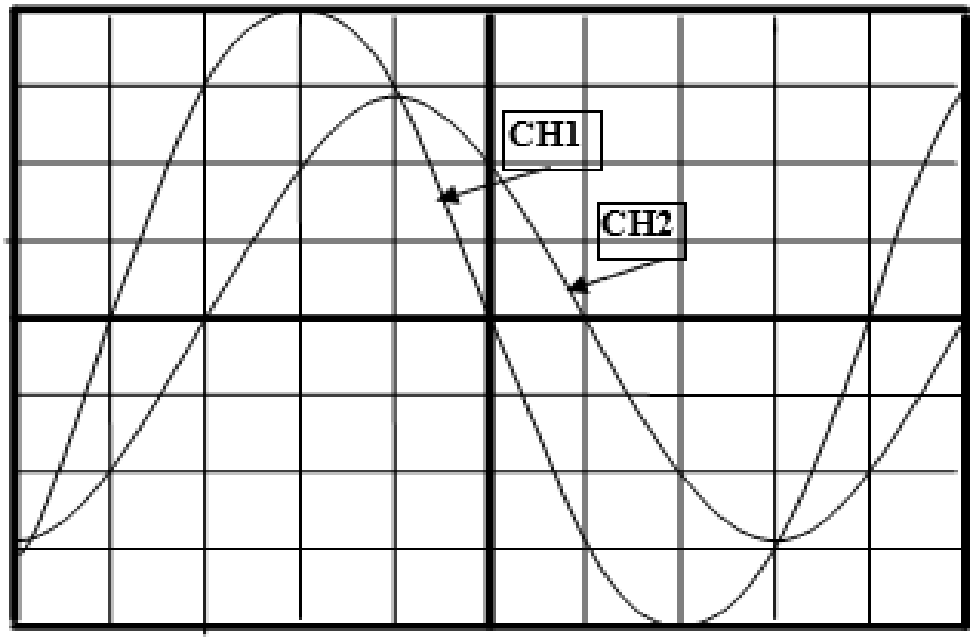
   c) The RMS value *I* of the current *i(t)*.

   d) The phase shift φ between *u(t)* and *i(t)*.

   e) How can we see from the oscillograms that the circuit is inductive in nature?

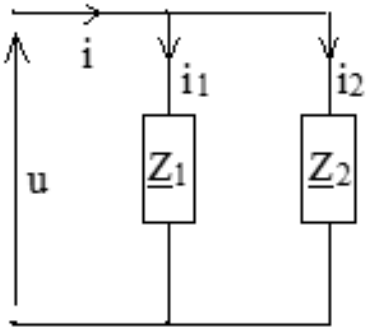


3. Draw the Fresnel diagram for the given circuit.
4. Deduce U_L, the RMS value of $u_L(t)$.
5. Determine the impedance *Z* of the circuit. Deduce the value of *L*.



Channel 1 setting: 2 V/div
Channel 2 setting: 2 V/div
Time base: 0.25 ms/div

Exercise 5:



The current i has an RMS value of 8 A and it leads u by 30°.

The current i_1 has an RMS value of 5 A and it lags u by 45°.

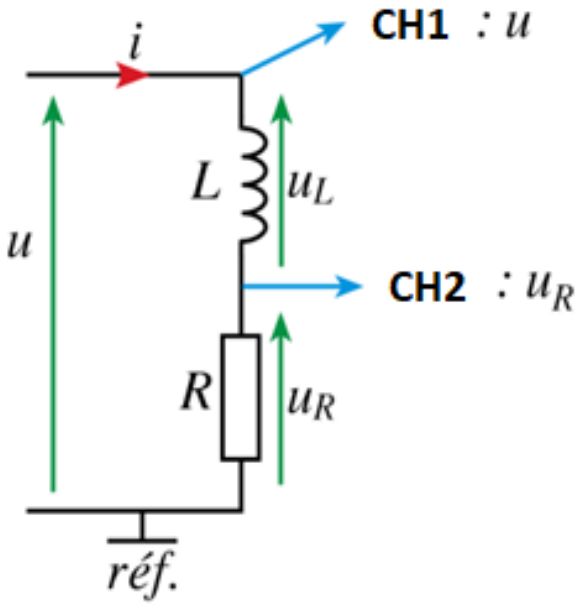
1. Give the relationship between the currents. Determine the Fresnel vectors representing i and i_1.
2. Plot the Fresnel vectors representing i and i_1 (1 A/cm) on a phasor diagram and deduce I_2 and φ_2 (RMS value and phase of i_2).

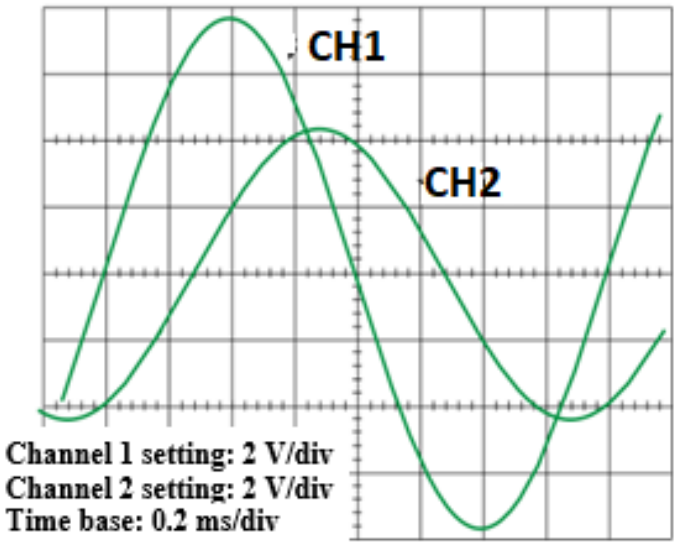
Exercise 6:

Consider the circuit below where R = 47 Ω and Lis an ideal inductance.

From the curves observed on the oscilloscope:

1. Determine the period T, the frequency f and the angular frequency ω.
2. Give the maximum values U_m of u(t) and U_{Rm} of $u_R(t)$. Deduce the corresponding RMS values U and U_R.
3. Determine the phase shift (expressed in degrees) of u_R with respect to u.
4. Calculate:
   - the impedance Z of the circuit;
   - he inductance L of the coil.
5. Represent u and uR in a phasor diagram (scale: 1 cm for 0.5 V).





Exercise 7:

A two-terminal device Z, consisting of a coil with inductance L and resistance r, is supplied by a sinusoidal voltage u(t) with frequency f = 50 Hz.

Data: RMS values I = 0.5 A and U = 100 V; average value P = 25 W.

1. What is the numerical value of the impedance Z of the two-terminal device?
2. What is its power factor?
3. Deduce the phase shift φ that exists between the current and the voltage.
4. Write Kirchhoff's voltage law in its phasor form for this circuit. Draw the associated Fresnel representation for the circuit (scales: 10 V/cm and 0.1 A/cm).
5. Deduce the values of r and L.