Module: Electricity

Tutorial Worksheet No. 3

Duration: 1 weeks

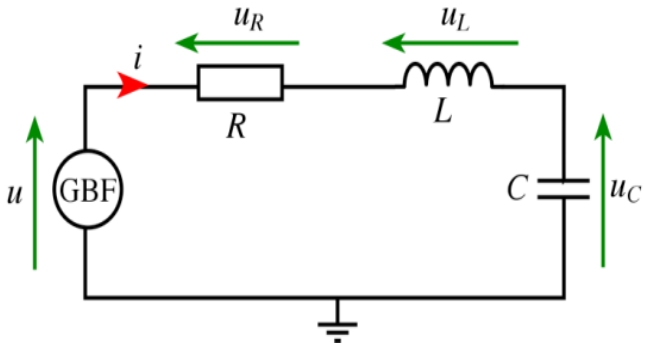
Exercises to do in class: 3, 7, 8

Assignment to submit: 1, 4, 6

Exercise 1:

R=330Ω, L=100mH, C=47µF, f=100Hz, $u(t) = 10\sqrt{2}.Sin(\omega t)$

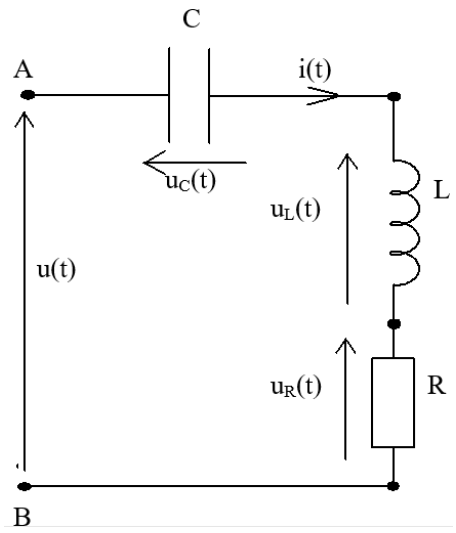
1. Draw the impedance triangle and deduce:
- the impedance Z and the phase shift φ of the circuit;
- the RMS value of the current i;
- the RMS values of the voltages uL, uR and uC.
2. Calculate the resonance frequency f_0, i.e., the frequency at which the inductive and capacitive effects cancel each other out. At this frequency, the phase shift is zero.



Exercise 2:

Consider the following circuit:

1. Write the branch equation at the terminals of dipole AB.
2. Draw the theoretical Fresnel diagram associated with dipole AB, taking the current as the phase reference.
3. Calculate the expression for the impedance of dipole AB, as well as that of its voltage-current phase shift.



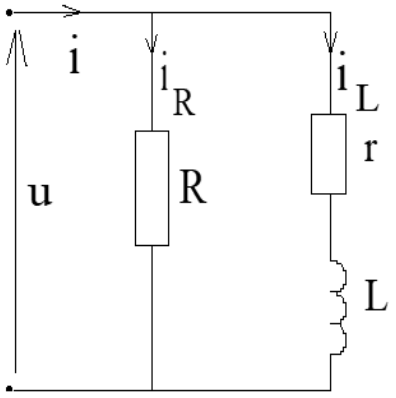
4. Show that dipole AB can behave as an inductive component at high frequency and as a capacitive component at low frequency.
5. Give the expression for the frequency f_0 at which the dipole changes from one operation to the other.

- Calculate its value.
- What is then the nature of the dipole?
- Give the value of its impedance.
- What can be said about the value of the impedance? How is the current in the circuit then?

Given: R = 50 Ω C = 100 µF L = 0.1 H

Exercise 3:

Consider the following circuit, with U = 220 V, f= 50 Hz, R = 220 Ω, L = 0.55 H, r = 100 Ω



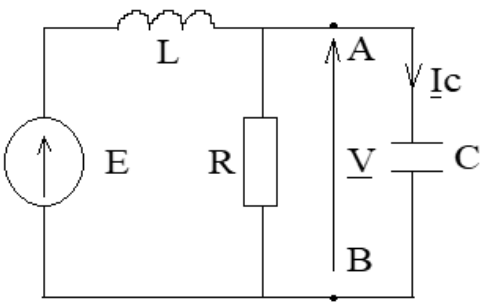
1. Determine the complex current in the resistor I_R. Deduce its RMS value and its phase shift with respect to the voltage.
2. Determine the complex impedance Z_L of the coil and deduce the complex current I_L. Specify its RMS value and its phase shift with respect to the voltage.
3. Determine the complex current in the overall circuit I. Deduce its RMS value and its phase shift with respect to the voltage.
4. Verify this result graphically using a Fresnel vector construction.
5. A capacitor C is connected in parallel with the circuit. Specify its impedance expression and its phase shift with respect to the voltage. Determine the capacitance of the capacitor so that the total current is in phase with the voltage.

Exercise 4

Consider the circuit shown, supplied with a sinusoidal voltage where:

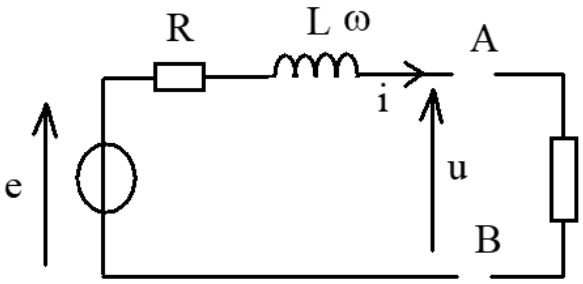
L = 0.5 H, R = 100 Ω, C = 15 µF, E = 10 V, 50 Hz.

We want to calculate the current in the capacitor.



Exercise 5

A machine operating in sinusoidal steady state is represented by the circuit shown where: e is an alternating sinusoidal voltage source, R is a resistor with resistance R = 12 Ω, L is a coil with inductance L = 30 mH. The load placed between points A and B has across its terminals a voltage u with RMS value U = 230 V and draws a current i with RMS value I = 10 A such that u leads i by +30°.



1. Redraw the circuit and indicate u_R and u_L. Express e as a function of u, u_R and u_L. Deduce the relationship between the Fresnel vectors associated with the different voltages.
2. Take i as the phase origin.

- What are the coordinates of the vector U?
- Calculate U_R.
- What is the phase shift of u_R with respect to i? Deduce the coordinates of the vector U_R.
- Calculate U_L. What is the phase shift of uL with respect to i? Deduce the coordinates of the vector U_L.
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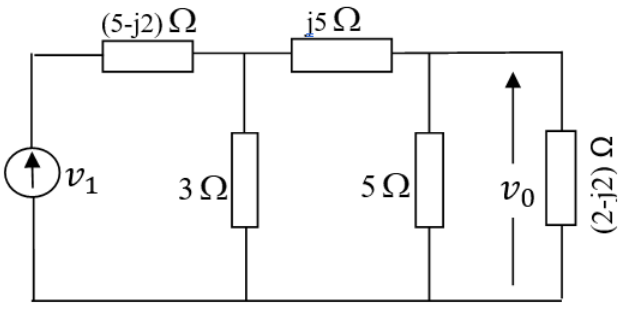
3. Draw the Fresnel vectors associated with the voltages u_R, u_L and u (scale: 1cm for 20V).
4. Construct the Fresnel vector associated with e. Deduce the RMS value of e, its phase shift with respect to i and its expression as a function of time.
5. Verify this result using the complex numbers associated with u, u_R, u_L and e.

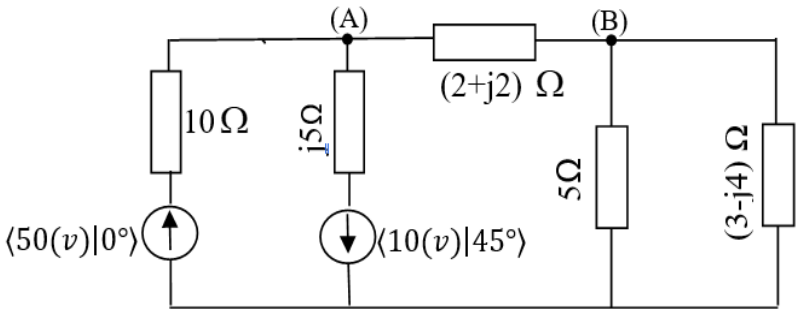
Exercise 6

In the circuit shown, the source v_1 creates a potential difference v_0 across the impedance
(2-j2)Ω. Determine the voltage v1 that corresponds to v0 = 10∠0°V.



Exercise 7

Calculate the node voltages v_A and v_B.



Exercise 8

Calculate the ratio v_0/v_1.