Bialystok University of Technology Faculty of Electrical Engineering Department of Electrotechnics, Power Electronics and Electrical Power Engineering

Instruction for a specialistic workshop on

Electrical Circuits 2 Subject code: IS-FEE-10085S (Erasmus+)

# SELF INDUCTANCE AND MUTUAL INDUCTANCE. ANALYSIS OF CIRCUITS WITH MAGNETIC COUPLING

Instruction Number

### EC2\_02

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Teaching Materials for Students of the Faculty of Electrical Engineering at BUT.

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# 1. Workstation Description

#### 1.1. Equipment used

A PC-class computer with the Microsoft Windows 10 operating system is used during classes.

#### 1.2. Software

The computers are equipped with the PSpice program.

### 2. Exercises Procedure

Complete the tasks below and prepare a report on the activities according to the provided instructions.

- 1. The figure shows an electric circuit with magnetic coupling. Use the PSpice program to simulate the operation of the circuit with:
  - a) positive coupling,
  - b) negative coupling.

Set the coupling coefficient k = 0.5. Choose values for the other elements so that differences in the current waveform can be observed under positive and negative coupling conditions.



The report should include:

- a description of the purpose and scope of the task,
- values of the element used,

- for the system with positive coupling:
  - o electrical circuit diagram (from PSpice),
  - o calculations of current in the circuit,
  - o plot of the current in the electrical circuit (from PSpice),
  - effective value of the current in the electrical circuit (determined in PSpice),
- for the system with negative coupling:
  - o electrical circuit diagram (from PSpice),
  - o calculations of current in the circuit,
  - o plot of the current in the electrical circuit (from PSpice),
  - effective value of the current in the electrical circuit (determined in PSpice),
- conclusions.
- Perform a parametric analysis on the electric circuit from problem no. 1 for systems with both positive and negative coupling. In each case, vary the value of the coupling coefficient k. Conduct simulations for k = 0.0, 0.3, 0.6, 1.0.

The report should include:

- a description of the purpose and scope of the task,
- values of the element used,
- for the system with positive coupling:
  - o electrical circuit diagram (from PSpice),
  - o plot of the currents in the electrical circuit (from PSpice),
- for the system with negative coupling:
  - electrical circuit diagram (from PSpice),
  - o plot of the currents in the electrical circuit (from PSpice),
- conclusions.

3. The figure shows an electric circuit with magnetic coupling. Use the PSpice program to simulate the operation of the circuit with both positive and negative coupling. Given parameters:  $v_1(t) = 10sin(314t) V$ ,  $R_1 = 100 \Omega$ ,  $L_1 = 20 mH$ ,  $L_2 = 100 mH$ ,  $R_2 = 50 \Omega$ . Observe the plots of the current on the primary and secondary sides for k = 0, 0.5, and 1.0.



The report should include:

- a description of the purpose and scope of the task,
- for the system with positive coupling:
  - o electrical circuit diagram (from PSpice),
  - plots of the currents on the primary and secondary sides for k = 0, 0.5, and 1.0,
- for a system with negative coupling:
  - o electrical circuit diagram (from PSpice),
  - plots of the currents on the primary and secondary sides for k = 0, 0.5, and 1.0,
- conclusions.

## 3. Literature

- [1] Thomas R.E., Rosa A. J., Toussaint G.J.: The Analysis & Design of Linear Circuits. 8th Edition. Wiley Inc., 2016.
- [2] Tung L.J., Kwan B.W.: Circuit Analysis. World Scientific, 2001.
- [3] Irvin J.D., Nelms R.M.: Basic Engineering Circuits Analysis. International Student Version. John Willey&Sons Inc., 2008.

- [4] https://www.electrical4u.com/electrical-engineering-articles/circuit-theory
- [5] https://www.khanacademy.org/science/electrical-engineering

## 4. Health and Safety Requirements

To begin the practical part of the exercise, it is mandatory to familiarize yourself with the health and safety instructions and fire safety guidelines and to adhere to the rules contained therein.

During laboratory sessions, the following rules must be observed:

- Verify that the devices available at the laboratory workstation are complete and show no signs of physical damage.
- If possible, adjust the workstation conditions to suit individual ergonomic needs. Position the computer monitor to ensure constant and comfortable visibility for all team members.
- Check the correctness of device connections.
- The computer may only be turned on with the instructor's permission.
- Eating and drinking are prohibited while working with the computer.
- Upon completion of work, log out before leaving the workstation. The operating system may only be shut down upon explicit instruction from the instructor.
- Making any modifications, switching components, or replacing elements of the workstation is strictly prohibited.
- Changing the computer's configuration, including the operating system and software, is not allowed unless it is part of the class program and performed under the instructor's supervision.
- In the event of a power failure, immediately turn off all devices.
- Any missing equipment or malfunctions must be reported to the instructor.
- It is forbidden to operate, manipulate, or use devices not included in the current exercise.

- In case of electric shock, immediately disconnect the workstation from the power supply. Do not touch the affected person before the power is turned off.