Subject (course) name: **Electrical Engineering - Circuit Theory 2**		
Programme: **Automation & Robotics** Specialty:		Subject code: **5K** Title graduate: **Engineer**
Type of course: **obligatory**	Course level: **First-cycle studies**	Year: **II** Semester: **III** Semester: **winter**
Form of classes: **Lectures, Classes, Labs, Seminar, Project**	Number of hours per week: **1L^E, 1C, 2Lab, 0, 0**	Credit points: **5 ECTS**

GUIDE TO SUBJECT

SUBJECT OBJECTIVES

C1. Knowledge of laws governing the flow of electric current in circuits with magnetic coupling, three-phase circuits and during transient states.

C2. Ability of analyzing three-phase circuits and using harmonic analysis.

C3. Ability of analyzing transient states in linear circuits.

C4. Ability of building electric circuits according to schemes and measuring electric quantities.

SUBJECT REQUIREMENTS

1. The knowledge and abilities from the previous course of circuit theory (semester 2).
2. General knowledge of physics related to electricity and magnetism.
3. General knowledge of calculus and complex numbers and ability of using them.
4. Ability to work independently and in a group.
5. General ability to independently search in literature.

LERNING OUTCOMES

EK1 – The student knows phenomena occurring in magnetically coupled circuits, formulates and applies the laws governing the flow of electric current in such circuits and can analyze such circuits.

EK2 – The student knows kinds of three-phase connections, formulates and applies the laws governing the flow of electric current in such circuits and can analyze three-phase networks.

EK3 – The student knows harmonic analysis and can apply it in circuits with periodic currents.

EK4 – The student knows phenomena occurring in linear circuits in transient states, formulates and applies the laws governing the flow of electric current in such circuits and can analyze such circuits.

EK5 – The student can build electric circuits according to schemes and measure electric quantities.

SUBJECT CONTENT

Form of classes - lectures

Topic	Hours
L1 – Resonance in electrical circuits.	**1**
L2, 3 – Electrical circuits with magnetic coupling.	**2**
L4, 5, 6, 7 – Three-phase systems.	**4**
L8, 9, 10, 11 – Harmonic analysis.	**4**
L12, 13, 14, 15 – Transient analysis – classical method.	**4**
Total	**15**

Form of classes

Topic	Hours
C1 – Resonance in electrical circuits.	**1**
C2, 3 – Electrical circuits with magnetic coupling.	**2**
C4, 5, 6, 7 – Three-phase systems.	**4**
C8 – Test 1	**1**
C9, 10, 11 – Harmonic analysis.	**3**
C12, 13, 14 – Transient analysis – classical method.	**4**
C15 – Test 2	**1**
Total	**15**

Form of classes – laboratory

Topic	Hours
L1 – Introduction: safety instructions, division into sections.	**2**
L2 – Power and efficiency in DC circuits.	**2**
L3 – Thevenin’s and Norton’s theorems.	**2**
L4 – Non-linear DC circuits.	**2**
L5 – Transient states in RC circuits.	**2**
L6 – RLC AC circuits.	**2**
L7 – Resonance in electrical circuits.	**2**
L8 – Power factor correction.	**2**
L9 – Voltage drop and power loss in a power line.	**2**
L10 – Hummel subcircuit and Boucherot subcircuit.	**2**
L11 – Magnetically coupled circuits.	**2**
L12 – Three-phase systems.	**2**
L13 – Circuits with rectifiers.	**2**
L14 – Completion of lacking topics.	**2**
L15 – Test.	**2**
Total	**30**

STUDY METHODS

1. Lectures with use of multimedia presentations.
2. Solving problems in classes.
3. Lab **–** experiments in sections (two or three students).
4. Discussion during the course and individual consultations.

EDUCATIONAL TOOLS

1. Audiovisual equipment, lectures in electronic version.
2. Black board and chalk or white board and markers.
3. Lab equipment.

METHODS OF ASSESEMENT (F – Forming, P – Summary)

F1. Classes – assessment of comprehending material from previous classes – short tests.
F2. Classes – assessment of preparation – oral answer.
F3. Lab – assessment of preparation to experiments – oral answer.
F4. Lab – assessment of correct and in-time preparation of experiment report.
P1. Lecture **–** written examination test of solving electric circuits (50%).

P2. Lecture – written examination test of the theory (50%).
P3. Classes – written tests for evaluation of comprehending particular topics (100%).
P4. Lab – evaluation of comprehending material from lab – test (50%).
P5. Lab – evaluation of experiment reports (50%).

STUDENT WORKLOAD

Form of activity		Averaged workload (hours)		
		[h]	∑ [h]	ECTS
Participation in class activities	lectures classes labs consultations	15 15 30 5	65	3
Preparation for tutorials (reading literature)		10	70	3
Preparation for classes		10		
Preparation for labs		10		
Preparation of lab reports		10		
Preparation for class tests		15		
Preparation for exam		15		
Total			**135**	**5**

BASIC READING

1. Nahvi M., Edminister J.A., Schaum's Outline of Electric Circuts, McGraw-Hill.
2. Syed A. Nasar, 3000 solved problems in electrical circuits, Schaum's Solved Problems Series, McGraw-Hill, 1988.
3. Piątek Z., Electrical design. Part II – AC analysis, digital version accessible in The Main Library of Częstochowa University of Technology.
4. Piątek Z., Electrical design. Part III – transient analysis, digital version accessible in The Main Library of Częstochowa University of Technology.
5. Kuphaldt T., Lessons in electric circuits, volume 2 – AC, digital version freely accessible at http://www.ibiblio.org/kuphaldt/electricCircuits/
6. Bolkowski S., Teoria obwodów elektrycznych. WNT, Warszawa 2009.
7. Bolkowski S., Brociek W., Rawa H., Teoria obwodów elektrycznych Zadania. WNT, Warszawa 2009.
8. Cichowska Z., Pasko M., Przykłady zadań z elektrotechniki cz.**II**., t. 1,2. Wyd. Pol. Śl., Gliwice 2000.
9. Lubelski K., Elektrotechnika teoretyczna. Część **I**, **II**, **III**. Wyd. Pol. CZ., Częstochowa 1994.

FURTHER READING

1. Charles Alexander, Matthew Sadiku, Fundamentals of electric circuits, McGraw-Hill, 2008.
2. David McMahon, Circuit analysis demystified, McGraw-Hill, 2007.
3. William H. Hayt, Jack Kemmerly, Steven M. Durbin, Engineering circuit analysis, McGraw-Hill, 2007.
4. Raymond A. DeCarlo, Pen-Min Lin, Linear circuit analysis, Prentice Hall, Englewood Cliffs, New Jersey 1995.
5. Osiowski J., Szabatin J.: Podstawy teorii obwodów. Tom **I**. WNT, Warszawa 2009.
6. Osiowski J., Szabatin J.: Podstawy teorii obwodów. Tom **II**. WNT, Warszawa 2005.
7. Pasko M., Piątek Z., Topór-Kamiński L.: Elektrotechnika ogólna. Część **I**. Wyd. Pol. Śl., Gliwice 2004.

Learning objectives	**In relation to the learning outcomes specified for the field of study**	**Subject objectives**	**Study methods**	**Methods of assessment**
EK1	KE1A_W06 KE1A_U07 KE1A_U10	C1	lectures, classes, laboratory	F1, F2, P1, P2, P3
EK2	KE1A_W06 KE1A_U07 KE1A_U10	C2	lectures, classes, laboratory	F1, F2, P1, P2, P3
EK3	KE1A_W06 KE1A_U07 KE1A_U10	C2	lectures, classes, laboratory	F1, F2, P1, P2, P3
EK4	KE1A_W06 KE1A_U07	C3	lectures, classes, laboratory	F1, F2, P1, P2, P3

	KE1A_U10			
EK5	KE1A_W05 KE1A_W06 KE1A_U09 KE1A_U10 KE1A_K03	C4	laboratory	F3, F4, P4, P5

II. EVALUATION

Grade	Outcome
EK1	**The student knows phenomena occurring in magnetically coupled circuits, formulates and applies the laws governing the flow of electric current in such circuits and can analyze such circuits.**
2 (F)	The student can neither explain what magnetic coupling is, nor formulate equations for magnetic coupling.
3 (E)	The student can explain magnetic coupling.
3,5 (D)	The student can explain magnetic coupling and formulate equations for coils with magnetic coupling.
4 (C)	The student can explain magnetic coupling and formulate equations for coils with magnetic coupling, and knows the equivalent circuits without coupling.
4,5 (B)	The student can explain magnetic coupling and formulate equations for coils with magnetic coupling; knows and applies the equivalent circuits without coupling.
5 (A)	The student can explain magnetic coupling and formulate equations for coils with magnetic coupling; knows, applies and explains the equivalent circuits without coupling.
EK2	**The student knows kinds of three-phase connections, formulates and applies the laws governing the flow of electric current in such circuits and can analyze three-phase networks.**
2 (F)	The student neither explains what is a three-phase system nor knows any method of analysis of a balanced three-phase system for any connection.
3 (E)	The student can define a three-phase system and enumerate possible connections, he hardly analyzes at least one balanced system.
3,5 (D)	The student can define a three-phase system and enumerate possible connections, he analyzes at least one balanced system.
4 (C)	The student can define a three-phase system and enumerate possible connections, he analyzes any balanced systems.
4,5 (B)	The student can define a three-phase system and enumerate possible connections, he analyzes any balanced and some unbalances systems, knows energetic formulas.
5 (A)	The student can define a three-phase system and enumerate possible connections, he analyzes any balanced or unbalances systems, knows energetic formulas.
EK3	**The student knows harmonic analysis and can apply it in circuits with periodic currents.**
2 (F)	The student does not know harmonic analysis.
3 (E)	The student poorly knows harmonic analysis and can hardly describe its use in circuits with periodic currents.
3,5 (D)	The student knows harmonic analysis and can describe its use in circuits with periodic currents.
4 (C)	The student knows harmonic analysis and can apply it in circuits with periodic currents.
4,5 (B)	The student knows harmonic analysis and can apply it in circuits with periodic currents, knows power formulas.
5 (A)	The student knows harmonic analysis and can apply it in circuits with periodic currents, knows power formulas, can use harmonic analysis in three-phase systems.
EK4	**The student knows phenomena occurring in linear circuits in transient states, formulates and applies the laws governing the flow of electric current in such circuits and can analyze such circuits.**
2 (F)	The student does not knows commutations laws, cannot determine current or voltage in a first or second order circuit.
3 (E)	The student knows commutations laws, can find current or voltage in a first order circuit with constant excitation.
3,5 (D)	The student knows commutations laws, can find current or voltage in a first order circuit with constant excitation, can interpret the results.
4 (C)	The student knows commutations laws, can find current or voltage in a first or second order circuit with constant excitation, can interpret the results.
4,5 (B)	The student knows commutations laws, can find current or voltage in a first or second order circuit with constant or sinusoidal excitation, can interpret the results.
5 (A)	The student knows commutations laws, can find current or voltage in a first or second order circuit

	with constant or sinusoidal excitation, can interpret the results, can select the parameters of a circuit to obtain the assumed state.
EK5	**The student can build electric circuits according to schemes and measure electric quantities.**
2 (F)	The student cannot build any electric circuits.
3 (E)	The student can build a non-branched electric circuit according to the scheme.
3,5 (D)	The student can build a non-branched electric circuit according to the scheme and connect voltmeter, ammeter and wattmeter.
4 (C)	The student can build a branched electric circuit according to the scheme and connect voltmeter, ammeter and wattmeter.
4,5 (B)	The student can build a branched electric circuit according to the scheme and connect voltmeter, ammeter and wattmeter as well as select their measuring ranges.
5 (A)	The student can build a branched electric circuit according to the scheme and connect voltmeter, ammeter and wattmeter as well as select their measuring ranges, can modify a circuit to obtain other variant of connections.

III. OTHER USEFUL INFORMATION

1. All information for students on the schedule are available on the notice board and on the website: www.el.pcz.czest.pl.
2. Information on the consultation shall be provided to students during the first lecture and will be placed on the website www.el.pcz.czest.pl.
3. Terms and conditions of credit courses will be provided to students during the first lecture.