FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Obwody elektryczne**
Name in English:	**Electric circuits**
Main field of study (if applicable):	**Industrial Control Engineering**
Specialization (if applicable):	
Level and form of studies:	**1st level, full-time**
Kind of subject:	**obligatory**
Subject code:	**APR011302**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30	30			
Number of hours of total student workload (CNPS):	90	90			
Form of crediting:	examination	crediting with grade			
For group of courses mark (X) final course:					
Number of ECTS points:	3	3			
including number of ECTS points for practical (P) classes :		3			
including number of ECTS points for direct teacher-student contact (BK) classes:	2.10	2.10			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student should have basic knowledge of calculus for number valued functions of one variable, which includes properties of trigonometric functions, polynomials, exponential and logarithmic functions, derivatives and differentials, and indefinite integrals necessary for comprehension of mathematical problem in engineering.
2. The student should know the algebra of complex numbers.
3. The student should have basic knowledge of physics (electrostatics, electrical current, electromagnetic induction).
4. The student should be capable of implementing correctly and effectively both the algebra of complex numbers and the quantitative analysis to problems related to the studied engineering discipline.
5. The student should be capable of implementing correctly and effectively the laws of physics to the qualitative analysis to problems related to the studied engineering discipline.
6. The student should understand the need for studying the selected discipline of study.
7. The student should understand the need and be aware of the opportunities resulting from the continuous education (II and III level studies, postgraduate studies, courses)
8. The student should understand the need for improvements of professional, personal and social skills
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SUBJECT OBJECTIVES

C1. be able to analyze linear, stationary and lumped electrical circuits in stationary states;

C2. know the possibilities of using the methods, techniques and tools utilized in electrical engineering.

C3. develop skills in implementation of calculation techniques for linear electrical circuits;

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01	know the fundamental laws of electrical engineering used in linear analysis of sinusoidal currents in electrical circuits. Know the electrical quantities and their units;know and understand the synthesis of electrical circuits up to passive four terminal network and its analysis;
PEU_W02	have knowledge of both in series and in parallel RLC circuits, including the interpretation of the resonance in these circuits as well as the phasor representation of the electrical quantities;have the knowledge of linear analysis in both symmetrical and asymmetrical, three phase, electrical circuits;

relating to skills:

PEU_U01	be able to implement theoretical foundation to the analysis of linear electrical circuits in stationary states for sinusoidal alternating currents.
PEU_U02	be able to implement the learned theory to both qualitative and quantitative evaluation of physical quantities relevant to electrical engineering (e.g. R, L, C, M, cosφ, etc.).

relating to social competences:

PEU_K01	ability to think and act creatively and resourcefully.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Introduction of the subject, requirements and grading policy. Fundamental concepts and assumptions in linear, electrical circuits of point elements in stationary states. Non-periodic (step, Dirac impulse, exponential) and periodic (non-sinusoidal and sinusoidal) signals. Average value, rms value. Coefficients of shape and of peak.	2
Lec 2	Response of R, L, and C elements to typical electrical signals. Ohm's law and Kirchhoff's law for time dependent signals. Incidence matrix. General form of a branch. Branch equations. Branch impedance matrix. Ohm's and Kirchhoff's laws in the matrix form.	2
Lec 3	Complex method for sinusoidal signals. Introduction to the algebra of complex numbers. Ohm's law and Kirchhoff's laws in the complex analysis. Phasor diagrams.	2
Lec 4	Power in sinusoidal alternating circuits. Instantaneous power and effective power. Concept of average power, reactive power and apparent power. Power triangle. Power balance. Power coefficient. Active and passive components of voltage and current. Evaluation of average, reactive and apparent power from the measurements.	2
Lec 5	Matching of the load to the source of emf. Efficiency of an emf source. Voltage drop and power losses in transmission lines. Compensation of reactive power. Equivalent circuits for elements connected in series, in parallel and other.	2
Lec 6	Analytical methods for electrical circuits. Solving problems with Kirchhoff's equations. Solving problems with mesh analysis. Solving problems with nodal analysis. Superposition method. Conversion of multi-terminal circuits.	2
Lec 7	Conversion of triangular and star circuits. Ideal emf sources in a current mesh. Thevenin and Norton theorems.	2
Lec 8	Resonance in electrical circuits. Voltage and current resonance. Frequency characteristics of resonant circuits.	2
Lec 9	Circuits with magnetic couplings. In series and in parallel connections of elements with magnetic couplings. Equivalence of circuits with and without magnetic coupling. Electric power in circuits with magnetic couplings. Coreless transformer.	2
Lec 10	Equations for SLS two-port networks. Properties of two-port networks: reversibility, symmetry. Connections of two-port networks. Determination of the two-port networks parameters from electrical measurements with and without a load.	2
Lec 11	Characteristics of two-port networks. Hyperbolic form of transmission equations for two-port networks. Inverter and converter of impedance. Operational amplifiers. Electrical filters.	2
Lec 12	Symmetrical, three-phase circuits. Calculation of voltage and current in three phase circuits connected in star and triangle.	2
Lec 13	Measurement and determination of power in three-phase circuits.	2
Lec 14	Method of symmetrical components for three-phase circuits. Ohm's law for symmetrical components. Separation of symmetrical components of the impedance matrix. Equivalent diagrams for symmetrical components.	2
Lec 15	Examples of using the method of symmetrical components for calculation in failure states. Filters for measuring symmetrical components.	2
	Total hours:	**30**

Form of classes - class		**Number of hours:**
Cl 1	Introduction of the subject, requirements and grading policy. Introduction to the algebra of complex numbers.	2
Cl 2	Complex plane. Presentation of complex numbers, operations on complex numbers. Calculation of the average value and the rms value of simple non-sinusoidal signals.	2
Cl 3	Calculation of the average value and the rms value of simple non-sinusoidal signals. Relation between the real and complex analysis of a circuit.	2
Cl 4	Phasor diagrams for RLC circuits. Analysis of in series and in parallel circuits.	2
Cl 5	Calculation of the average value and the rms value of simple non-sinusoidal signals. Relation between the real and complex analysis of a circuit. Phasor diagrams for RLC circuits. Analysis of in series and in parallel circuits.	2
Cl 6	Analysis of electrical circuits using the superposition method.	2
Cl 7	Analysis of electrical circuits using the mesh method.	2
Cl 8	Analysis of electrical circuits using the nodal method.	2
Cl 9	Application of Thevenin and Norton theorems for the analysis of electrical circuits.	2
Cl 10	Resonance.	2
Cl 11	Circuits with magnetic coupling.	2
Cl 12	Obwody trójfazowe (część 1).	2
Cl 13	Three-phase circuits (part 2).	2
Cl 14	Two-port networks and method of symmetrical components for three-phase circuits	2
Cl 15	Final test.	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Traditional lectures supplemented by audio-visual demonstrations. Multi-medial presentation. N2. Traditional group lab sessions.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEU_W01 PEU_W02	Final written egzamination
P(W)	P = F1	
F1(C)	PEU_U01 PEU_U02 PEU_K01	Final test
P(C)	P=F1	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] S. Osowski, K. Siwek, M. Śmiałek, Teoria Obwodów, Oficyna Wydawnicza Politechniki Warszawskiej, 2013. [2] S. Bolkowski, Teoria Obwodów Elektrycznych , WNT 2013 **SECONDARY LITERATURE:** [1] Z. Trzaska, Analiza i projektowanie obwodów elektrycznych, Oficyna Wyd. Pol. Warszawskiej, Warszawa, 2008

SUBJECT SUPERVISOR
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