FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Teoria obwodów 2**
Name in English:	**Circuits Theory 2**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	
Level and form of studies:	**1st level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ELR051303**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30	30	30		
Number of hours of total student workload (CNPS):	90	60	30		
Form of crediting:	examination	crediting with grade	crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	3	2	1		
including number of ECTS points for practical (P) classes :		2	1		
including number of ECTS points for direct teacher-student contact (BK) classes:	2.10	1.40	0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knows basic lows and electrical parameters used in description of electrical circuits.
2. Has a knowledge concerning circuit’s element and circuits topology.
3. Knows how to properly use a variety of methods for solving electrical circuits in the analysis of linear circuits with sinusoid.

SUBJECT OBJECTIVES

C1. Getting the knowledge about analysis of the transients states in electrical circuits. Learn about the description of the signal transmission including elements of convolution and distribution. Getting the knowledge about analysis of the transients states using operators (Laplace Transform)

C2. Acquire skills of representation of distorted signals using Fourier series.

C3. Getting the knowledge about the travelling waves

C4. Getting practical skills of circuits connection, measurement of voltage, currents, power and energy including non sinusoidal circuits.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01	Has general knowledge about electrical circuits in transient states as well as of signals theory, knows basic methods and techniques of circuits analysis working under transient states, general signal transmission and description of the circuit. Knows Laplace transforma and uses operator theory for representation of electrical circuits.
PEU_W02	Has a knowledge about application of Fourier technique in analysis of electrical circuits with non sinusoidal signals.
PEU_W03	Has a general knowledge including travelling waves

relating to skills:

PEU_U01	Implement classical and operator methods for analysis of the transient states in electrical circuits, is able to use step and impulse response in the assessment of transients.
PEU_U02	Is able to use Fourier coefficients to assessment of wavefor distortion
PEU_U03	Is able to perform measurements in series and parallel RLC circuits and interpret the results in case of transients or waveform distortion

relating to social competences:

PEU_K01	Can create creative ideas and activities. PEK_K02 – Is responsible for entrusted task , exhibits creative attitude and cooperation in team.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Transients in linear stationery electrical circuits. Classification of circuits and systems -, linear, time invariant, stationary, stabile, passive, and reasonable. Classification of signal: analog, impulse, discrete, periodical and non periodical. Voltage current dependences of basic elements of circuits. Kirchhoff's laws. Commutation. Constant flux in a mash. Constant charge in nodes. Solution of linear differential equation with constant coefficients (1st and 2nd order)	2
Lec 2	Transients in linear stationery electrical circuits. DC and AC solutions components by different sources. Circuit with one passive element. RL and RC braches connected to a DC or AC voltage source. Short-circuited RL and RC braches. Time constant in RL and LC circuits.	2
Lec 3	Transients in linear stationery electrical circuits. RLC branch connected to DC voltage source. Non periodical and oscillatory solution. Special case for R equals 0 by DC voltage source.	2
Lec 4	Transients in linear stationery electrical circuits. RLC branch connected to AC voltage source. Non periodical and oscillatory solution. Special case for R equals 0 by AC voltage source.	2
Lec 5	Elements of function theory. Step function and Dirac's impulse. Function convolution. Proprieties of function convolution with Dirac's delta. General description of linear, stationery system. Step response of a system. Duhamela integral of a system. Examples of computation of step response and finding the response of a system for any input by given step response.	2
Lec 6	Laplace transform. Area of convergence. Properties of Laplace transform. Calculation of the direct and inverse Laplace transform.	2
Lec 7	Laplace transform. Application of Laplace transform for linear differential equations with constant coefficients. Calculation of transients in LTI. Representative of circuits in Laplace domain.	2
Lec 8	Laplace transform. Impedance and admittance by transfer function representation. Circuit theory theorems by transfer function representation of systems: node voltage method, mesh current method, additional sources theorem, Thevenin's theorem.	2
Lec 9	Laplace transform. Different forms of transfer functions for LTI systems. Impulse response. Impulse response connections with transfer function. Calculation of system response using convolution idea. Stability of LTI systems.	2
Lec 10	Non sinusoidal periodic signals. Characteristic coefficients for non sinusoidal signals: form factor crest factor. Fourier series – real and complex coefficients. Discrete spectrum (amplitude and phase)	2
Lec 11	Non sinusoidal periodic signals. Parseval's equation for non periodic signals. RMS value of nonsinudoidal signal. Superposition of harmonics in calculation of voltage and current.	2
Lec 12	Non sinusoidal periodic signals. Power in circuits with nosinusoidal voltage and current. Distorted signals in three-phase network.	2
Lec 13	Non sinusoidal periodic signals. Demonstration of real measurement and visualization of distorted electrical signals voltage and current on the basis of nonlinear load.	2
Lec 14	Long line. Introduction. Telegraphers equations. Longitudinal and transversal unitary parameters of long line. Steady state by sinusoidal feeding. Symbolic notation of long line equations. Long line impedance. Long line parameters.	2
Lec 15	Long line. Voltage and current distribution in a long line – primary and secondary wave. Stationary waves in long lines.	2
	Total hours:	**30**

Form of classes - class		**Number of hours:**
Cl 1	Information about the regulation of the classes and final crediting with grade. Initial conditions in electrical circuits. Calculation of the transient states in electrical circuits with one and two reactive elements including DC and AC excitations.	2
Cl 2	Transients in linear stationery electrical circuits. Calculation of the transient states in electrical circuits with one reactive elements including DC excitations.	2
Cl 3	Transients in linear stationery electrical circuits. Calculation of the transient states in electrical circuits with one reactive elements including AC excitations.	2
Cl 4	Transients in linear stationery electrical circuits. Calculation of the transient states in electrical circuits with two reactive elements including DC excitations.	2
Cl 5	Transients in linear stationery electrical circuits. Calculation of the transient states in electrical circuits with two reactive elements including AC excitations.	2
Cl 6	Elements of function theory. Application of step and impulse functions in description of the signals	2
Cl 7	Elements of function theory. Application of convolution and its futures. Calculation of the system answer using Duhamel integral.	2
Cl 8	Crediting Test 1. Solutions and discussion of particular tasks.	2
Cl 9	Laplace transform. Calculation of the Laplace transform using its futures. Calculation of the original function of the given Laplace form using fractional expansion.	2
Cl 10	Laplace transform. Application of the Laplace transform in the transient states analysis. Kirchhof's laws, voltage nodes potential method. Transfer function and its connection with impulse response.	2
Cl 11	Laplace transform. Application of the Laplace transform in the transient states analysis. Thevenin's method	2
Cl 12	Laplace transform. Transfer function and its connection with impulse response.	2
Cl 13	Non sinusoidal periodic signals. Fourier coefficient of basic of periodical functions.	2
Cl 14	Non sinusoidal periodic signals. Application of Fourier coefficient of basic of periodical functions.	2
Cl 15	Crediting Test 2. Solutions and discussion of particular tasks.	2
	Total hours:	**30**

Form of classes - laboratory		Number of hours:
Lab 1	Information about the regulation applied in the laboratory, safety rules, information about the assessment and planed effects. Getting knowledge of laboratory equipment, main rules of performing the measurements using analog and digital devices.	2
Lab 2	Investigation of two-terminal RLC lumped-constant circuits	2
Lab 3	Investigation of series RLC branch with sinusoidal excitations	2
Lab 4	Investigation of parallel and series-parallel RLC circuits with sinusoidal excitation	2
Lab 5	Investigation of magnetic coupled circuit	2
Lab 6	Investigation of three phase circuits	2
Lab 7	Investigation of analog filters with passive element	2
Lab 8	Discussion, summarizing obtained result – part 1. Supplement investigations.	2
Lab 9	Investigation of four-terminal network	2
Lab 10	Investigation of two-conductor long line	2
Lab 11	Investigation of magnetic amplifier	2
Lab 12	Investigation of transient state in RLC circuits	2
Lab 13	Investigation of periodic non sinusoidal circuit	2
Lab 14	Investigation of periodic non sinusoidal signals using Fourier series	2
Lab 15	Discussion, summarizing obtained result – part 2. Supplement investigations, final assessment.	2
	Total hours:	**30**

TEACHING TOOLS USED

N1. Lectures with multimedia presentation supplemented by traditional form and demonstration
N2. Traditional classes.
N3. Traditional laboratory organized in groups of students.

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 PEU_W03	Examination
P(W)	P=F1	
F1(C)	PEU_U01 PEU_U02 PEU_K01	Crediting test
P(C)	P=F1	
F1(L)	PEU_U03 PEU_K01	Evaluation of report concerning particular laboratory setup
P(L)	P=F1	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S. Osowski, K. Siwek, M. Śmiałek – Teoria Obwodów, Oficyna Wydawnicza Politechniki Warszawskiej, 2006.
[2] S. Bolkowski - - Teoria Obwodów Elektrycznych –WNT 1995.
[3] R. Kurdziel – Podstawy Elektrotechniki – WNT 1972.

SECONDARY LITERATURE:

[1] M. Uruski, W. Wolski – Teoria Obwodów t. I, II – skrypt PWr.
[2] K. Mikołajuk, Z. Trzaska – Elektrotechnika Teoretyczna – PWN 1984.
[3] J. Osiowski, J. Szabatin – Podstawy Teorii Obwodów t. I, II, III – WNT 1992 - 1998.
[4] A. Papoulis – Obwody i Układy - WKŁ 1988.

SUBJECT SUPERVISOR

Tomasz Sikorski, tomasz.sikorski@pwr.edu.pl