FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Obwody elektryczne i magnetyczne**
Name in English:	**Electrical and Magnetic 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:	**APR011304**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	45	15			
Number of hours of total student workload (CNPS):	150	60			
Form of crediting:	examination	crediting with grade			
For group of courses mark (X) final course:					
Number of ECTS points:	5	2			
including number of ECTS points for practical (P) classes :		2			
including number of ECTS points for direct teacher-student contact (BK) classes:	3.50	1.40			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has basic knowledge about mathematical analysis of one variable and multivariable functions, knows differential and integral equations of one and multivariable functions which are used to description of mathematical tools in engineering science.
2. Knows basic lows of linear electrical circuits.
3. Has basic knowledge of physic (including electrostatics, electrical current , electromagnetic induction).
4. Is able to implement mathematical knowledge concerning mathematical analysis of the function to studied engineering area.
5. Is able to implement knowledge concerning physical lows to studied engineering area.

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. Getting the knowledge about analysis of electrical and magnetic field.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 Have general knowledge about electrical circuits in transient states as well as selected issued of signals transmission, knows basic methods and techniques of circuits analysis working under transient states including operator theory

PEU_W02 Has a knowledge about application of Fourier technique and frequency domain in analysis of electrical circuits with non sinusoidal signals

PEU_W03 Has a general knowledge concerning travelling waves, lows dedicated to magnetic and electromagnetic field and impact of the magnetic filed on materials

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 waveform distortion

relating to social competences:

PEU_K01 Can create creative ideas and activities, 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) Introduction to a vector analysis. The basic laws of the electrostatic fields. Magnetostatic fields. Magnetic forces.	4
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. The Lorentz formula. Magnetic flux density vector. The magnetic flux density, and unit of the flux and the magnetic flux density (Weber and Tesla).	4
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. Magnetic torque of current loop, the magnetic dipole moment . The magnetic vector potential. The Hall effect. The Biot-Savart-Laplace law. The Amper law in a vacuum .	4
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. The law of conservation of magnetic flux. The magnetic forces. Magnetization in materials. Magnetization vector. The magnetic field intensity vector.	4
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. The Amper's law in a materials. Classification of magnetic materials. Initial magnetization curve, hysteresis loop, saturation, permanent flux density, the coercive field intensity. Magnetic circuits.	4
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. The law of magnetic circuits. The Ohm's Law for a section of the circuit. The magnetic circuits with the permanent magnet(minimum dimensions of the magnet). Equations coupled coils, coreless transformer, streams dispersion, coupling coefficient. The energy of the magnetic field coils and coils coupled. Density of energy. The energy in the non-linear core, hysteresis losses and the eddy currents.	4
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. The continuity equation for total current . Maxwell's postulate. The displacement current. Maxwell's equations. The boundary conditions for the electromagnetic field vectors. The energy density of the electromagnetic field.	4
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. Loss of energy in the electromagnetic field. Power and the Poyting vector. Wave in General.. The plane wave	3
	Total hours:	**45**

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 reactive elements using classical derivative method.	2
Cl 2	Calculation of the transient states in electrical circuits with one reactive elements and AC excitation using classical derivative method.	2
Cl 3	Calculation of the transient states in electrical circuits with two reactive elements and DC or AC excitation using classical derivative method.	2
Cl 4	Application of step and impulse functions in description of the signals. Application of convolution and its futures. Calculation of the system answer using Duhamel integral.	2
Cl 5	Application of the Laplace transform in the transient states analysis.	2
Cl 6	Application of the Laplace transform. Transfer function and its connection with impulse response	2
Cl 7	Fourier series of periodical functions	2
Cl 8	Crediting test	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lectures with multimedia presentation supplemented by traditional form and demonstration.
N2. Traditional classes.

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	Short tests
F2(C)	PEU_U01 PEU_U02 PEU_K01	Crediting test
P(C)	P=0,2*F1+0,8*F2	

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.
[4] T. Łobos, M. Łukaniszyn, B. Jaszczyk – Teoria Pola dla Elektryków, Oficyna Wydawnicza Politechniki Wrocławskiej, 2004.

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