DESCRIPTION OF THE COURSES

- Course code: ELR 1304
- Course title: CIRCUITS THEORY 2
- Language of the lecturer: Polish

Course form	***Lecture***	***Classes***	***Laboratory***	***Project***	***Seminar***
*Number of hours/week**	*2*	*2*	*1*		
*Number of hours/semester**	*30*	*30*	*15*		
Form of the course completion	*Examination*	*Colloquium*	*Reports*		
ECTS credits	*4*	*2*	*1*		
Total Student's Workload	*120*	*60*	*30*		

- Level of the course (basic/advanced): basic
- Prerequisites: Circuits Theory 1, Mathematical Analysis I&II, Physics
- Name, first name and degree of the lecturer/supervisor: Łobos, Tadeusz, Prof. DSc . PhD.
- Names, first names and degrees of the team's members:
    1. Janik, Przemysław, PhD,
    2. Kostyła, Paweł, PhD,
    3. Leonowicz, Zbigniew, PhD,
    4. Motyl, Edmund, DSc, PhD,
    5. Pospieszna, Janina, DSc, PhD,
    6. Rezmer, Jacek, PhD,
    7. Ruczewski, Piotr, PhD,
    8. Sikorski, Tomasz, PhD,
    9. Wacławek, Zbigniew, PhD.
- Year:...II............Semester:.......4..............
- Type of the course (obligatory/optional): obligatory
- Aims of the course (effects of the course): Knowledge of the analysis of transients in electric circuits, using the time domain and the operational methods. Knowledge of the

analysis of signals and circuits in the frequency domain. Knowledge of the phenomena in long lines.

- Form of the teaching (traditional/e-learning): traditional

- Course description:

The transitory state in LCR circuits - the classic method. The Duhamel integral. The Laplace's operational calculus. Laws and statements of the theory of circuits in the operational form. Fourier transforms. Operational transmittance and spectral transmittance. The impulse response. Frequency characteristics. Deformed signals. Fourier series. The power of deformed signals. The phenomena in long lines.

- Lecture:

Particular lectures contents		Number of hours
1.	Introduction. Long line - 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. Voltage and current distribution in a long line – primary and secondary wave. Stationary waves in long lines	**2**
2.	Input impedance of long line. State of wave fitting. Nonhomogenous long line. Reflection coefficient. Losses free long line. Non deforming long line. Resonance in long lines. Group and phase velocity.	**2**
3.	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. Solution of linear differential equation with constant coefficients (1st and 2nd order)	**2**
4.	Transients in linear stationery electrical circuits. D.c. and a.c. solutions components by different sources. Commutation. Constant flux in a mash. Constant charge in nodes. Circuit with one passive element. *RL* and *RC* braches connected to a d.c. or sinusoidal voltage source. Short-circuited *RL* and *RC* braches. Time constant in *RL* and *LC* circuits.	**2**
5.	*RLC* branch connected to a.c. and d.c. voltage source. No periodical and oscillatory solution. Special case for $R \approx 0$ by a.c. voltage source	**2**
6.	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**
7.	Laplace Transform – area of convergence. Properties of Laplace transform: linearity, shifting in the s-domain, shifting in the time domain, time differentiation, time integration, s-differentiation, periodic function transformation, transformation of functions given by	**2**

	multiplications, convolution. Computation of the inverse Laplace transform by expanding the function as a summation of terms.	
8.	Application of Laplace transform for linear differential equations with constant coefficients. Computing of transients in *LTI*. Transfer function representation of circuit and elements.	**2**
9.	Impedance and admittance by transfer function representation. Kirchhoff's low by transfer function representation. *RL* and *RC* braches a.c. voltage source.	**2**
10.	Circuit theory theorems by transfer function representation of systems: Thevenin's theorem, node voltage method, mesh current method, additional sources theorem. magnetically coupled elements.	**2**
11.	Different forms of transfer functions for LTI systems. Impulse response. Impulse response connections with transfer function. Computation of system response using convolution idea. Stability of LTI systems	**2**
12.	Non sinusoidal periodic signals. Characteristic coefficients for non sinusoidal signals: form factor crest factor. Fourier series – real and complex coefficients. Parseval's equation for non periodic signals.	**2**
13.	Power of periodical signals. Spectrum analysis methods. Discrete spectrum (amplitude and phase). . LTI circuit with sinusoidal sources in steady state. Distorted signals in three-phase networks.	**2**
14.	Fourier transform and its proprieties. Conditions for Fourier Transform. Distributional form of Fourier Transform. Fourier Transform versus Laplace Transform. Continuous spectra of non periodic signals. Spectrum transmittance.	**2**

- Classes – the contents:

Voltages and currents in long line by different loads. Computation of resonance states in loss free long line. Computation of voltages and currents in non homogenous long line.Initial conditions in electrical circuits. Transients computation in electrical circuits by one or two passive elements and a.c. and d.c. source. Examples with one or more commutations. Description of different signals using step function and Dirac's impulse. Proprieties of convolution. Computation of functions convolution. Examples of step function response of different LTI systems. Computing of system response using Duhamel integral. Computing of Laplace transform considering its proprieties. Inverse Laplace transform by partial fraction expansion. Computing of transients in electrical sources using Laplace transform. Proprieties of linear circuits computed using Laplace transform. Amplitude and phase spectrum of non periodic signals. Transfer function. Output of LTI systems by given transfer function. Transfer function versus impulse and step response of systems. System response computation using convolution integral. Fourier series. Computation of Fourier coefficients. Amplitude and phase spectrum. Circuit computation with periodical sources. Transmittance vs. impulse response of systems. Computation of system response using convolution integral.

- Seminars – the contents:

- Laboratory – the contents:

1. Long line model 2. Analysis of periodical signals

3. Reograph
4. Non sinusoidal signals – Fourier series
5. Transients in RLC circuits.
6. Magnetic amplifier

- Project – the contents:

- Basic literature:

1. Athanasios Papoulis -Circuits and Systems: A Modern Approach by Athanasios Papoulis, 1980, 1998.
2. Raymond A. DeCarlo and Pen-Min Lin - Linear Circuit Analysis: Time Domain, Phasor, and Laplace Transform Approaches, 2003

- Additional literature:

1. Leonard S. Bobrow - Fundamentals of Electrical Engineering (Oxford Series in Electrical and Computer Engineering), 1996
2. William D. Stanley, John R. Hackworth, and Richard L. Jones - Fundamentals of Electrical Engineering and Technology, 2006.

- Conditions of the course acceptance/credition: Passed examination, passed colloquium, reports and self-preparation work satisfactory evaluation

* - depending on a system of studies