DESCRIPTION OF THE COURSES

- Course code: ARR1304
- Course title: ELECTRIC AND MAGNETIC CIRCUITS
- Language of the lecturer: Polish

Course form	***Lecture***	***Classes***	***Laboratory***	***Project***	***Seminar***
*Number of hours/week**	*3*	*1*			
*Number of hours/semester**	*45*	*15*			
Form of the course completion	*Examina-tion*	*Colloquium*			
ECTS credits	*4*	*2*			
Total Student's Workload	*120*	*60*			

- Level of the course (basic/advanced): advanced
- Prerequisites: Electric Circuits 1, Mathematical Analysis I & II, Physics, Fundamentals of Electrical Engineering
- Name, first name and degree of the lecturer/supervisor: Tadeusz Łobos, Prof., DSc, PhD
- Names, first names and degrees of the team's members:
  1. Paweł Kostyła PhD
  2. Zbigniew Leonowicz PhD
  3. Jerzy Piotrowicz PhD
  4. Piotr Ruczewski PhD
  5. Tomasz Sikorski PhD
  6. Zbigniew Wacławek PhD
- Year:.II..... Semester:...3.....
- Type of the course (obligatory/optional): obligatory
- Aims of the course (effects of the course): Knowledge of electrical circuits calculation methods in transient states and in non sinusoidal courses. Knowing of basic laws described electromagnetic field. Ability of magnetic circuits problems solution.
- 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. Magnetic fields. The Biot-Savart-Laplace formula. Rotation and sourcelessness of the magnetic field. Materials in the magnetic field, vector of magnetization, the vector of the intensity of the field, law of the flow in the material centre, the classification of materials, the profile of magnetizing, magnetic hysteresis. Magnetic circuits, the reluctance of the section of the circuit, the calculation of the circuit. the excitation current and permanent magnet. The phenomenon of the electromagnetic

induction. Faraday's law. The hysteretic losses. Electromagnetic field, the continuity of total current, equation of Maxwell, the transportation of energy, wave equations.

- Lecture:

Particular lectures contents	*Number of hours*
1. The classification of circuits (systems) - the linearity, stationarity, stability, passivity, causality. The relationships of voltages and currents on basic elements of circuits. Kirchhoff's Law. Solvingof the differential linear equations with stable coefficients of the Ist and IInd order	2
2. Transitory states in linear-stationary circuits. Transitory and steady component; solutions for ac and dc excitations. Laws of commutation in electric circuits. Principle of the conservation of the flux in the loop. Principle of the conservation of the load in the node.	2
3. Circuit with one passive element. Switching of LR and CR circuits with ac and dc sources. The short-circuit of the branch LR, CR. Temporal constant in LR and CR circuits.	2
4. Switching of the LCR circuit with ac and dc sources. Aperiodic and oscillatory solutions. Boundary solutions for R≈0 with sinusoidal excitation	2
5.The elements of the theory of generalized functions - step and impulse functions. The convolution. Properties of the convolution. The general description of the linear stationary circuits	2
6. The step response of the system. The Duhamel integral of the causal system. The examples of the calculation of the system's response and calculation of response on arbitrary excitation	2
7. The Laplace transform - the domain of the convergence. Linear transforms, shift in the complex domain, shift in the the time domain, the transform of the derivative, derivative of the transform, the transforms of periodical function, the transforms of the product of the functions, the transforms of the convolution of the functions. Determination transform original: on the basis of the properties of the transform, and with the help of decomposition to simple fractions	2
8. The use of the Laplace transform to solve linear differential equations with stable coefficients. Calculation of the transitory state in SLL circuits using operational method. The operational description and representation of circuits	2
9. Operational impedance and admittance. Kirchhoff's law in the operational form. CR and LR circuits with sinusoidal sources in operational form.	2
10. Statement of Circuits Theory in operational form: Method of node potentials, the method of loop currents, Thevenin statement, statements about turning on additional ideal current and voltage sources. Circuits with magnetical couplings	2
11. Operational transmittance in SLL circuits. The impulse response. The relationship between impulse response and the step response. Calculations of the system answer the help of the integral of the convolution. Stability of systems.	2
12. Periodical non –sinusoidal signals The parameters characterizing periodical waveforms - the coefficient of the shape, etc. Fourier series - real coefficients and complex coefficients. Parseval's equality.	2
13. The power of periodical signals. The discrete amplitude – phase	

spectrum. The SLL circuit in the stationary state with periodical excitations. Distorted waveforms in 3-phase circuits.	2
14. The method of spectral analyses of circuits. Fourier transform and properties. Conditions of Fourier transform existence. Distributional Fourier transforms. The relationship of Fourier transform with the Laplace transform. The continuous amplitude - phase spectrum of aperiodic signal. Spectral transmittance	2
15 The magnetic field. The magnetic field as the electrokinetic phenomenon. The Lorentz's formula. The vector of the magnetic induction. Magnetic flux, the units of induction and flux (Tesla and Weber). Dynamic forces of the conductor with current. The magnetic moment of the circuit with current, the moment of the dipole layer. The vectorial potential. The Hall effect.	2
16. The Laplace formula. Law of Ampere (flow) in the vacuum. Rotationality and the sourcelessness of the magnetic field in the vacuum. Forces acting on straight and closed conductors (closed curves) with current. The Grassman formula. Definition of the unit of the intensity of the current (Ampere).	2
17. Magnetic field in the matter, vector of magnetization. Vector of the intensity of the magnetic field. Law of Ampere (flow) in the matter. The equation of the field in the integral and differential form in vacuum and matter. The classification of magnetic materials. The characteristics of magnetizing, the loop of hysteresis, saturation, remanence, coercion	2
18. Magnetic circuits (magnetic cores). Laws of magnetic circuits. Reluctance, electro-motive force (excitation), flow. Ohm's law for the section of the circuit. The equations of ramificated circuits. The calculation of circuits with the excitation current. Circuits with permanent magnet, the minimal dimensions of the magnet	2
19. The equations of coupled coils, core-less transformer, the flux of dispersion, the coefficient of the coupling. The self- and mutual inductance of transmission lines. Energy of the magnetic field of a coil and coupled coils.	2
20. The electromagnetic field. Faraday's law in the integral and differential form The density of energy. Energy in the non-linear core, losses of hysteresis, rotational currents. Equation of the continuity of the total current.	2
21. The postulates of Maxwell. The current of displacement, the current of polarization. The equations of Maxwell. Boundary conditions for the vectors of the electromagnetic field. Density of the energy of the electromagnetic field.	2
22. The losses of energy in the electromagnetic field. The transportation of energy, Poynting vector. Wave equations of the electromagnetic field. The flat wave	2

- Classes – the contents:

Initial conditions in electric circuits. Calculation of the transitory state in electric circuits with one and two passive elements with dc and ac sources - examples with one and several switching sequences. Utilization of the step and impulse function for description of chosen signals. Properties of the convolution of the function. Calculation of the convolution of a function. Examples of calculations of step response of linear, stationary systems. Calculation of the system's response with the help of the Duhamel integral. Calculation of Laplace transforms using the properties of the transform. Determination of Laplace transform originals using the properties of the transform. The method of the decomposition into simple fractions,

statements about residuum. The use of the Laplace transform to calculate the transitory state in electric circuits. Fourier series of periodical functions. Calculation of complex and real coefficients of the Fourier series of chosen periodical signals. Calculation of amplitude-phase spectra of aperiodic signals. Operational and spectral transmittance. The transfer of signals by linear-stationary systems. The relationship of operational and spectral transmittance with the impulse response of systems. Determination of the response of the system for the help of the integral of the convolution

Calculation in the magnetic field on the basis of induction, the intensity of field, magnetic flux, calculation of forces and moments acting on circuits with the current. The calculation of magnetic circuits. Calculation of electromotive force, calculation of self and mutual inductances

- Seminars – the contents:
- Laboratory – the contents:
- 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.
3. Oleg D. Jefimenko-Electricity and Magnetism : An Introduction to the Theory of Electric and Magnetic Fields, 2nd edition, 1989
4. Wolfgang K. H. Panofsky and Melba Phillips - Classical Electricity and Magnetism: Second Edition (Dover Books on Physics), 2005.

- 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.
3. G. S. Landsberg and A. Troitsky - Textbook of Elementary Physics: Electricity and Magnetism, 2000

- Conditions of the course acceptance/credition: Passed examination and colloquium.

***** - depending on a system of studies