DESCRIPTION OF THE COURSES

- Course code: ELR1308
- Course title: Electromagnetic field theory
- Language of the lecturer: Polish

Course form	***Lecture***	***Classes***	***Laboratory***	***Project***	***Seminar***
*Number of hours/week**	*2*	*2*			
*Number of hours/semester**	*30*	*30*			
Form of the course completion	*exam*	*written test*			
ECTS credits	*3*	*2*			
Total Student's Workload	*90*	*60*			

- Level of the course (basic/advanced): basic
- Prerequisites: Mathematical Analysis 1 & 2, Physics
- Name, first name and degree of the lecturer/supervisor: Janina Pospieszna, Prof.ndzw.
- Names, first names and degrees of the team's members:
    1. Adam Gubański, PhD
    2. Jerzy Piotrowicz, PhD
    3. Edmund Motyl, Prof.
    4. Bronisław Świstacz, PhD
- Year:..II..... Semester:.....3.....
- Type of the course (obligatory/optional): obligatory
- Aims of the course (effects of the course):

Effects of education – know-how and competences: description of basic problems from range of electromagnetic field, formulations of field equations, computation of field distribution.

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

Introduction, physical basics of electromagnetic phenomena, unit system, co-ordinate systems, classification of field. Electrostatic field. The basic quantities of the field, laws, integral and differential equations, electric field in materials, conductors and dielectrics, capacitors, capacitive arrangements, the energy of field, the methods of the calculation of the field. Quasi-static magnetic fields in conductors. The phenomenon of the current conduction, the elements of the electron conduction theory, Ohm's Law, Joule's Law, the equation of the continuity of current, the equations of the field, calculation of the resistance of spherical and cylindrical arrangements, effect of temperature on electric resistance. The magnetic field. Dynamic action on the charge in the movement and on the current-carrying element, magnetic induction, magnetic flux, the force acting on the magnetic dipole and the magnetic moment. The Biot-Savart-Laplace formula. Calculation of the distribution of the induction in the vacuum. Ampere's law in the vacuum. Curl and zero-divergence of the magnetic field in the vacuum expressed by integral and differential equations. Materials in the magnetic field,

vector of magnetization, the vector of the intensity of the field, Ampere's law in the material medium, the classification of materials, the characteristic of magnetization, magnetic hysteresis. Magnetic circuits, the reluctance of the section of the circuit, the calculation of the circuit with the excitation current and permanent magnet. The phenomenon of the electromagnetic induction. Faraday's Law. The self- and mutual inductance. Energy of the magnetic field. The hysteresis losses. Electromagnetic field, the continuity of total current, of Maxwell's equations, the transport of energy, wave equations

- Lecture:

Particular lectures contents	*Number of hours*
1. Introduction, the units of SI, the arrangements of co-ordinates. Physical basis of the electromagnetism. The structure of the matter, physical quantities in the micro- and macro-scale. The electrostatic field. Electric charge and the law of conservation of the charge. Various kinds of the distribution of the charge..	2
2. Coulomb's law. Vectorial and scalar descriptions of the field. The field intensity, the flux of the vector of the field intensity, voltage, potential. The lines of force of the field, the tube of force, equipotential surfaces, units	2
3. The principle of superposition. The field of a group of charges, the field of the electric dipole, dipole layer. Divergence and the non-curl of the electrostatic field. Differential operators of gradient, divergence, curl, operators properties. Laws of electrostatic field in the integral and differential forms in the vacuum.	2
4. The electrostatic field in the matter. Conductors and dielectrics, classification. Polarization, susceptibility and electric permeability. The vector of the electric induction. Ferro-electric materials, electrets.	2
5. Boundary conditions of the single layer of the charge. Equations of the field refraction at an interface between two material media.	1
6. The energy of the electric field, the energy of the capacitor. Energy of the capacitive arrangements. Spatial density and the location of energy. Electrostatic pressure, the edge effect. Electric strength, capacitor with stratified insulation	2
7. Methods of the field analysis. The use of the conditions of symmetry and Gauss's law. The method of the mirror reflection for punctual and axial charges. Laplace's and Poisson's equations, boundary conditions, the uniqueness of the solution.	2
8. Capacity of the transmission lines and cables.	1
9. Vector of the intensity of the current. The tube of the current. The phenomenon of the conduction, the elements of the electron theory of the conduction, the mobility of the carriers of the charge.	2
10. Ohm's law in the local form. Joule's law, the spatial density of losses. Law of the continuity of the current. Laws of the stationary current field in the integral and differential forms.	2
11. Widened Ohm's law in the integral form of the section of the tube of the field, the balance of energy. Refraction of the field on the boundary of the conducting media. Resistance of earth electrode, step voltage. Dependence of the resistance on the temperature. Kirchhoff's laws. The calculation of resistive circuits.	2

12. 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).	2
13. Dynamic forces of the conductors with current. The magnetic moment of the current circuit, the moment of the dipole layer. The vectorial potential. The Hall's effect.	2
14. The Biot – Savart and Laplace's formula. Ampere's law in the vacuum. The curl and the zero-divergence of the magnetic field in the vacuum. Forces of interaction between current-carrying loops and straight wires. Definition of the unit of the current (Ampere).	2
15. Magnetic field in the matter, vector of magnetization. Vector of the intensity of the magnetic field. Law of Ampere in the matter. The equation of the field in the integral and differential form in vacuum and matter	2
16. The classification of magnetic materials. Magnetization curves, hysteresis loop, saturation, retentivity, coercivity.	1
17. Magnetic circuits (magnetic cores). Laws of magnetic circuits. Reluctance, ampere-turns (excitation), flow. Ohm's law for the section of the circuit. The equations of ramified circuits. The calculation of circuits with the excitation current. Circuits with permanent magnet.	2
18. The phenomenon of the electromagnetic induction. Faraday's law. Induction of electro-motive force around the circuit and in straight conductors. The principle of Lenz, rule of direction arrow. Self- and mutual induction.	2
19. Self and mutual inductances, the definition of the unit (Henr). Associated flux and his relationship to the vectorial potential, the external and internal inductances of transmission lines.	2
20 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.	2
21. Energy of the magnetic field of a coil and coupled coils. The density of energy. Energy in the non-linear core, hysteresis losses, eddy currents	2
22. The electromagnetic field. Faraday's law in the integral and differential form. Equation of the continuity of the total current. The postulat of Maxwell.	2
23. The displacement current, the current of polarization. The equations of Maxwell. Boundary conditions for the vectors of the electromagnetic field.	2
24. Density of the energy of the electromagnetic field. The losses of energy in the electromagnetic field. The transportation of energy, Poynting vector. Wave equations of the electromagnetic field. The plane wave.	2

- Classes – the contents:

Calculation of the distribution of the electric field intensity and potential of given arrangements of charges. The calculation of voltages and fluxes in the field. The calculation of forces, work and energy. Calculation of the capacitance of capacitors and capacitor arrangements with initial charge. Calculation the density of the current and the

intensity of the field in the quasi-static magnetic field in conductors, calculation of the resistance of cylindrical and spherical arrangements. Calculation of the distribution of magnetic field strength, the flux-density and magnetic fluxes. Calculation of forces and moments acting on circuits with the current. The calculation of magnetic circuits. Calculation of electromotive forces, calculation of self and mutual inductances.

- Seminars – the contents:
- Laboratory – the contents:
- Project – the contents:
- Basic literature:
  1. T. Łobos, M. Łukaniszyn, B. Jaszczyk – ***Teoria pola dla elektryków*** – Oficyna wydawnicza PWr, 2004
  2. R. Sikora - ***Teoria Pola Elektromagnetycznego*** - WNT 1997
  3. A. Skopec i Inni - ***Elektryczność i Magnetyzm*** - Skrypt PWr. 1993.
- Additional literature:
  1. J. D. Jackson – ***Classical Electrodynamics –*** third edition, John Wiley & Sons, INC, 2001
  2. John D. Kraus, Daniel A. Fleisch – ***Electromagnetics with Applications*** – fifth edition, McGraw-Hill International Editions, 1999
  3. 3. W. Michalski – ***Elektryczność i magnetyzm – Zbiór zagadnień i zadań*** – Oficyna Wydawnicza PWr, 2004
- Conditions of the course acceptance/credition: Passed examination, passed colloquium, satisfactory evaluation of reports.

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