FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Teoria pola elektromagnetycznego**
Name in English:	**Electromagnetic field theory**
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:	**ELR051302**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30	30			
Number of hours of total student workload (CNPS):	120	60			
Form of crediting:	examination	crediting with grade			
For group of courses mark (X) final course:					
Number of ECTS points:	4	2			
including number of ECTS points for practical (P) classes :		2			
including number of ECTS points for direct teacher-student contact (BK) classes:	2.80	1.40			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. In terms of knowledge: He knows the basic concepts of vector analysis (addition of vectors, scalar and vector products, differential operation of vector function, surface and linear integrals).
2. He should be able to properly and effectively use knowledge in of scope of vector analysis and differential calculus in study discipline.

SUBJECT OBJECTIVES

C1. Acquaint of students with the basic knowledge necessary to understand the theoretical basis of the electromagnetic field theory,

C2. Creation of capability of using the learned EM field theory laws in the engineering practice.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 He knows the basic rights and the theoretical basis for the theory of the electric field.

PEU_W02 He knows the basic rights and the theoretical basis for the theory of the magnetic field.

relating to skills:

PEU_U01 - He knows how correctly use rights endearing known electic field theory to determine the physical parameters of an engineering (RLC parameters, electrical field distribution)

PEU_U02 He knows how correctly use rights endearing known magnetic field theory to determine the physical parameters of an engineering (RLC parameters, magnetic field distribution)

relating to social competences:

PEU_K01 He understands the need for continuous training and improving professional, personal and social competences.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Physical basis of electromagnetic field theory. Electric charge. Law of balance and the principle of conservation charge. Types of load distribution. Coulomb's law. The intensity of the electric field. Flux vector of the electric field intensity. The potentiality of the electric field. The potential and electric voltage. Field lines, tube box, equipotential surfaces.	2
Lec 2	The principle of superposition. The field of the electric dipole. Dipole layer. Rotation and dyvergence of electrostatic field. Differential operators of gradient, divergence and rotation. Rights of the electrostatic field in the form of integral and differential for the vacuum.	2
Lec 3	The electrostatic field in matter. Polarization, dielectric susceptibility and permittivity. Electric induction vector. Conductors in an electrostatic field. The field on the border of two material media.	2
Lec 4	Capacitance. Plate, coaxial and spherical capacitor. Serial and parallel combination of capacitors. Partial electrical capacity. Electrostatic shielding.	2
Lec 5	Capacitor energy. The energy of the electrostatic field. The spatial density of energy. Energy of the capacitor electrodes - self and mutual	2
Lec 6	Methods of analysis fields. Application of Gauss' law. The method of mirror images. Laplace and Poisson equations, boundary conditions, uniqueness of the solution.	2
Lec 7	Flow field of electric current. The current density vector. The phenomenon of electrical conduction. Elements of the theory of electron conduction, the mobility of charge carriers. Ohm's law in the local form. Joule’s law. Law of continuity of electrical current. Rights steady flow fields in integral and differential form.	2
Lec 8	Extended Ohm's law in integral form for the section of the tube of force. Resistance of ground electrode. Step voltage. Kirchhoff's laws. Calculation of resistive circuits.	2
Lec 9	The magnetic field as electrokinetic phenomena. Lorentz formula. Magnetic induction vector. The magnetic flux. The forces of interaction between the circuits with the current flow. The definition of the current unit (amps).	2
Lec 10	Mechanical moment acting on the circuit with the current flow. Expression of Laplace and Biot-Savart. Ampere's law (of flow) for the vacuum. Rotation curl (vorticity) and passivity of magnetic induction field in a vacuum. Vector potential. Hall’s effect.	2
Lec 11	The magnetic field in the material medium. Magnetization vector. Magnetic flux density vector. Ampere's law (of flow) for the of the material medium. Field equations in the integral and differential form for material medium.	2
Lec 12	Classification of magnetic materials. Characteristics of magnetization, hysteresis loop, saturation, inventory and coercion. The refraction of the field lines at an interface between two media.	2
Lec 13	The phenomenon of electromagnetic induction. Faraday's law. Lenz's rule. Rules of orirntation of voltages. The phenomenon of self- and mutual induction. Self- and mutual inductances. Air-core transformer. Energy of coupled coils. Energy of coil with a ferromagnetic core. Dynamic forces between coupled windings.	2
Lec 14	Electromagnetic field. Faraday's law in integral and differential form. Equation of total current continuity. Maxwell's postulate. Total displacement current. Maxwell's equations. Boundary conditions for electromagnetic field vectors.	2
Lec 15	The energy density of the electromagnetic field. Loss of energy in the electromagnetic field. Transport of energy. Poynting vector. Wave equations of the electromagnetic field. Plane wave.	2
	Total hours:	**30**

Form of classes - class		**Number of hours:**
Cl 1	Calculation of the electric field strenght distributions and the potential for the distribution of electrical charges (part 1)	2
Cl 2	Calculation of the electric field strenght distributions and the potential for the distribution of electrical charges (part 2).	2
Cl 3	Calculation of voltages and flux of electric field stream vector in an electrostatic field.	2
Cl 4	Calculation of capacitor capacitance and capacitor systems (part 1).	2
Cl 5	Calculation of capacitor capacitance and capacitor systems (part 2).	2
Cl 6	Calculation of field strenght distribution in the flow field.	2
Cl 7	Calculation of capacitor leakage resistance and resistance of ground electrodes (part 1).	2
Cl 8	Calculation of capacitor leakage resistance and resistance of ground electrodes (part 2).	2
Cl 9	Determination of the magnetic field strenght distribution for the circuit with the current (part 1).	2
Cl 10	Determination of the magnetic field strenght distribution for the circuit with the current (part 2).	2
Cl 11	Calculation of magnetic circuits	2
Cl 12	The calculation of of the forces acting on the circuits of the current in the magnetic field.	2
Cl 13	Determination of the induced electromotive forces and the calculation of self- and mutual inductance of magnetically coupled circuits (part 1).	2
Cl 14	Determination of the induced electromotive forces and the calculation of self- and mutual inductance of magnetically coupled circuits (part 2).	2
Cl 15	Final test	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Traditional lecture N2. Student's own work. N3. Consultations N4. Solving 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	Final written egzamination
P(W)	P=F1	
F1(C)	PEU_U01 PEU_U02 PEU_K01	final test
P(C)	P=F1	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Łobos T., Łukaniszyn M., Jaszczyk B., Teoria pola dla elektryków, Oficyna Wydawnicza PWr, 2004, [2] Sikora R., Teoria pola elektromagnetycznego, WNT 1997, [3] Rawa H., Podstawy Elektromagnetyzmu, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2011, **SECONDARY LITERATURE:** [1] Jackson J. D., Classical Electrodynamics – third edition, John Wiley & Sons, INC, 2001, [2] Michalski W. Elektryczność i magnetyzm, Zbiór zagadnień i zadań, Oficyna Wydawnicza PWr, 2004.

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