DESCRIPTION OF THE COURSES

- Course code: ELR1265
- Course title: MODERN ELECTROMAGNETIC MATERIALS
- Language of the lecturer: Polish

Course form	***Lecture***	***Classes***	***Laboratory***	***Project***	***Seminar***
*Number of hours/week**					
*Number of hours/semester**	*22*				
Form of the course completion					
ECTS credits					
Total Student's Workload					

- Level of the course (basic/advanced): advanced
- Prerequisites: Electromagnetics Fundamentals
- Name, first name and degree of the lecturer/supervisor: Boleslaw Mazurek, Prof. D.Sc, Ph.D, B.Eng
- Names, first names and degrees of the team's members:
  1. Ryszard Kacprzyk, D.Sc, Ph.D, B. Eng.
  2. Anna Kisiel, Ph.D, B. Eng.
  3. Bożena Łowkis, Ph.D, B. Eng.
  4. Leszek Woźny , Ph.D, B. Eng.
- Year:.....I..... Semester:.....2.....
- Type of the course (obligatory/optional): obligatory
- Aims of the course (effects of the course):

Recognition of the physical nature of phenomena determining properties of solid materials applied in electrotechnology. Recognition of electromagnetic properties of chosen material groups and their technological applications. Recognition of trends in technology and application of modern electromagnetic materials.

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

The lecture introduces into the basic and more complicated phenomena appearing in solid materials, describes some laws and principles necessary for projecting of new materials with predicted and determined electromagnetic properties (it concerns description of electrical conduction and polarisation phenomena, magnetic properties, non-linear effects and other). A special attention was paid onto composites and other materials with most perspective application (intelligent materials, nanomaterials, materials for fuel cells, sensors and actuators etc.). Examples of current applications of modern electromagnetic materials and structures were also given.

- Lecture:

Particular lectures contents	*Number of hours*

1. Introduction, general information about the course contents and course completion conditions. Solid state structure, chemical bonds, band model of solid state materials, classification of materials and their interaction with Electrical, Magnetic and Electro-Magnetic fields.	1
2. Conductors 1. Ohm's and Matthissen's laws. Electrical properties of pure metals and alloys.	1
3. Conductors 2. Application of metallic conductors (materials for resistors, thermo-couples, sensors, heaters, fuses, solders, contact materials etc).	1
4. Conductors 3. Non-metallic conductors (graphite and related composite materials – properties and applications, C-60 - fulerens, nanotubes, polymeric conductors – conduction mechanism, materials and applications).	1
5. Semiconductors 1. Crystalline materials. Band model. Intrinsic and doped semiconductors. Temperature dependence of electrical conductivity.	2
6. Semiconductors 2. Photo-conduction, Seebeck's, Peltier's, Hall's and magneto-resistance effects – nature and applications.	1
7. Semiconductors 3. Non-crystalline materials. Conduction model, properties and applications. Semiconducting polymeric materials – polyacethylene (preparation, properties, potential applications) and others.	1
8. Dielectric composites with discrete conducting phase – 2-phase composites, basic, properties and application. Quantum Tunnelling Composites. Intelligent heaters materials etc.	1
9. EM shielding and absorbing materials, depth of penetration, antistatisation, antistatic materials.	1
10. Varistors. Materials, conduction mechanism, properties and applications.	1
11. Solid electrolytes and superionic materials. Conduction mechanisms in chosen solid electrolytes. Materials for fuel cells – principe of operation, materials requirements. Other applications.	1
12. Electrooptical and electrochromic materials – phenomena and applications. Non-linear optical effect. Electroluminescense.	1
13. Dielectrics. Polarisation phenomena in solid materials. Polar and non-polar dielectrics, polarisation in alternating fields. Relaxation polarisation and losses.	1 2
14. Dielectric composites. Theory of dielectric composites. Wiener's curves and other relations. Dielectric nano-composites	2
15. Newest dielectric materials. Materials with high (nomadic polarisation) and low electrical permittivity. Low loss materials. High temperature and high thermal conductivity materials. Application of solid dielectrics.	
16. Active dielectrics. Ferroelectricity – phenomena (E-D histeresis, Curie-Weiss law), materials (organic, inorganic) their properties and applications (parametric amplifiers, low inductance capacitors etc). Piezo- and pyro-electricity. Phenomena, materials and applications (sensors, actuators, etc).	1
17. Ferromagnetic materials. Description and classification of magnetic properties of materials (dia-, para- and ferro-magnetic materials). Physical nature of the phenomenon. B-H histeresis. Hard and soft magnetic materials.	2
18. Magnetic losses. Permanent magnets. Noncrystalline materials. Magneto-striction and giant magneto-striction. Ferrites, their technology,	1

properties and applications.	

- Classes – the contents:
- Seminars – the contents:
- Laboratory – the contents:
- Project – the contents:
- Basic literature:

1. P. S. Neelakanta, *Handbook of Electromagnetic Materials*, CRC Press Inc.Boca Raton, 1995.
2. K.W. Szalimowa, *Fizyka półprzewodników*, PWN, Warszawa, 1974.
3. P.T. Oreszkin, *Fizika poluprovodnikov i dielektrikov*. Izd. Vysszaja Szkola, Moskva, 1977.
4. L. Jacak, A. Radosz, *Materia i materiały*, Wyd. P. Wr., Wrocław 1996.
5. B. Hilczer, J. Małecki, *Elektrety i piezopolimery*, PWN, Warszawa 1992

- Additional literature:

1. C. Kittel, *Introduction to Solid State Physics*.J. Wiley & Sons Inc., N.Y. 1966.

- Conditions of the course acceptance/credition: Exam positevely passed.

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