

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Materiały elektromagnetyczne**  
 Name in English: **Electromagnetic materials**  
 Main field of study (if applicable): **Electrical Engineering**  
 Specialization (if applicable): **Industrial Electrical Engineering**  
 Level and form of studies: **2nd level, part-time**  
 Kind of subject: **obligatory**  
 Subject code: **ELR041269**  
 Group of courses: **NO**

|  | Lecture              | Classes | Laboratory | Project | Seminar |
|--|----------------------|---------|------------|---------|---------|
| Number of hours of organized classes in University (ZZU):                        | 22                   |         |            |         |         |
| Number of hours of total student workload (CNPS):                                | 108                  |         |            |         |         |
| Form of crediting:   | crediting with grade |         |            |         |         |
| For group of courses mark (X) final course:                                      |                      |         |            |         |         |
| Number of ECTS points:   | 4                    |         |            |         |         |
| including number of ECTS points for practical (P) classes :                      |                      |         |            |         |         |
| including number of ECTS points for direct teacher-student contact (BK) classes: | 2.80                 |         |            |         |         |

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Student has knowledge on fundamentals of materials engineering
2. Student has a general knowledge of physics

**SUBJECT OBJECTIVES**

- C1. Understanding the physical nature of the phenomena describing properties of solid materials important from the point of view of their applications in electrical engineering  
 C2. Understanding the properties of selected groups of materials (conductive materials including ionic, semiconductor materials, dielectric materials, including non-linear materials, magnetic materials, including non-linear materials) and their possible applications  
 C3. Knowledge of developments in the field of materials engineering  
 C4. Consolidation of traditional academic values

**SUBJECT EDUCATIONAL EFFECTS***relating to knowledge:*

- PEK\_W01 Student knows the physical nature of the phenomena determining the electromagnetic properties of materials  
 PEK\_W02 Student has an advanced knowledge in material science enabling proper selection of materials for the particular construction

*relating to skills:**relating to social competences:*

- PEK\_K01 Student understands the need for self-education, including improving the skills of concentration and focus on important things, and develop the ability to independently apply their knowledge and skills

| PROGRAMME CONTENT         |   |                  |
|---------------------------|---|------------------|
| Form of classes - lecture |   | Number of hours: |
| Lec 1                     | Introduction, program, credit requirements. Electrical conductivity, bands model. | 2                |
| Lec 2                     | Metals and alloys   | 2                |
| Lec 3                     | Crystal semiconductors  | 2                |
| Lec 4                     | Amorphous semiconductors  | 2                |
| Lec 5                     | Conductive and semi-conductive polymeric materials                                | 2                |
| Lec 6                     | Materials with ionic conduction and solid electrolytes                            | 2                |
| Lec 7                     | Dielectric-dielectric composites  | 2                |
| Lec 8                     | Dielectric-conductor composites   | 2                |
| Lec 9                     | Dielectrics with relaxation polarization and non linear effects                   | 2                |
| Lec 10                    | Magnetic materials and non-linear effects   | 2                |
| Lec 11                    | Special materials. Test   | 2                |
| Total hours:              |   | <b>22</b>        |

| TEACHING TOOLS USED  |
|--|
| N1. Traditional lecture using multimedia presentation<br>N2. Short written tests<br>N3. Consultation<br>N4. Student's own work |

| EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT   |                               |  |
|---|-------------------------------|--|
| Evaluation<br><i>F - forming (during semester)</i><br><i>P - concluding (at semester end)</i> | Educational effect number     | Way of evaluating educational effect achievement |
| F1(w)   | PEK_W01<br>PEK_W02<br>PEK_K01 | Short written tests                              |
| F2(w)   | PEK_W01<br>PEK_W02<br>PEK_K01 | Final test                                       |
| P(w)  | $P=0,4F1+0,6F2$               |  |

| PRIMARY AND SECONDARY LITERATURE   |
|--|
| <b>PRIMARY LITERATURE:</b><br>[1] Bogusz W., Krok F., Elektolity stałe, WNT, Warszawa 1995.<br>[2] Chełkowski A., Fizyka dielektryków, PWN, Warszawa, 1993.<br>[3] Szalimowa K.W., Fizyka półprzewodników, PWN, Warszawa, 1974.<br>[4] Jacak L., Radosz A., Materia i materiały, Wyd. P. Wr., Wrocław 1996.  |
| <b>SECONDARY LITERATURE:</b><br>[1] Hilczer B., Małecki J., Elektrety i piezopolimery, PWN, Warszawa 1992.<br>[2] Kittel C., Wstęp do fizyki ciała stałego, PWN, Warszawa, 1976.<br>[3] Hippel A., Fizyka dielektryków, PWN, Warszawa, 1963.<br>[4] Kittel C., Introduction to Solid State Physics.J. Wiley & Sons Inc., N.Y. 1966.<br>[5] Setter N., Piezoelectric Materials in Devices. EPFL, Lusanne, 2002<br>[6] Ferry D. K., Bird J. P., Electronic Materials and Devices, Academic Press, San Diego, 2001.<br>[7] Zuo-Guang Ye, Handbook of advanced dielectric, piezoelectric and ferroelectric materials, Woodhead Publ. Ltd., Cambridge, England, 2008.<br>[8] Sessler G. M., Electrets, Laplacian Press,m Morgan Hill, California, 1998.<br>[9] Neelakanta P. S., Handbook of Electromagnetic Materials, CRC Press Inc. Boca Raton |

| SUBJECT SUPERVISOR                            |
|---|
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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT  
**ELR041269 - Electromagnetic materials**  
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**  
AND SPECIALIZATION **Industrial Electrical Engineering**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable) | Subject objectives | Programme content  | Teaching tool number            |
|----------------------------|---|--------------------|--|---------------------------------|
| PEK_W01                    | S2ETP_W03   | C.1<br>C.2<br>C.3  | Lec1<br>Lec2<br>Lec3<br>Lec4<br>Lec5<br>Lec6<br>Lec7<br>Lec8<br>Lec9<br>Lec10<br>Lec11 | N.1<br>N.2<br>N.3<br>N.4        |
| PEK_W02                    | S2ETP_W03   | C.1<br>C.2<br>C.3  | Lec1<br>Lec2<br>Lec3<br>Lec4<br>Lec5<br>Lec6<br>Lec7<br>Lec8<br>Lec9<br>Lec10<br>Lec11 | N.1<br>N.2<br>N.3<br>N.4<br>N.5 |
| PEK_K01                    | K2ETK_K01   | C.4                | Lec1<br>Lec2<br>Lec3<br>Lec4<br>Lec5<br>Lec6<br>Lec7<br>Lec8<br>Lec9<br>Lec10<br>Lec11 | N.1<br>N.2<br>N.3<br>N.4        |