COURSE DESCRIPTION CARD - SYLLABUS

Course name
Electromagnetic Compatibility [S1MiKC2>KE]

Course

Field of study
Microelectronics and Digital Communication

Year/Semester
2/3

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

A student starting this subject should haveknowledge of the basics of electronics, measurements in electronics and the basics of signal transmission. They should also have the ability to calculate simple DC and AC electrical circuits, the ability to obtain information from the given sources and be ready to work in a team.

Course objective

Gaining knowledge about wave phenomena occurring in cables and electronic and radio devices, methods of limiting the negative impact of these phenomena on the data transmission system and about legal standards in the field of standardization of electronic and radio devices. Gaining skills related to identifying and limiting sources of problems with electromagnetic compatibility of electronic and radio devices and skills in performing measurements of electromagnetic disturbance signals.

Course-related learning outcomes

Knowledge:
After completing the course, the student has:
- structured and detailed knowledge of problems related to electromagnetic radiation [K1_W14],

- structured and detailed knowledge of directives and standards in the area of electromagnetic compatibility [K1_W14],
- structured and detailed knowledge of the identification and measurement of electromagnetic disturbances in accordance with the currently applicable standards [K1_W14],
- structured and mathematically based detailed knowledge of the mechanisms of interference in electronic equipment and methods of limiting electromagnetic disturbances and susceptibility to electromagnetic disturbances [K1_W06], [K1_W14].

Skills:
After completing the course, the student is able to:
- design an electronic system in accordance with the principles of limiting the emission of electromagnetic disturbances [K1_U02], [K1_U04].
- plan and carry out measurements of parameters related to the emission and electromagnetic susceptibility of electronic devices and interpret the obtained results [K1_U02], [K1_U19].
- use standards to correctly assess the compliance of electronic devices with directives in the area of electromagnetic compatibility [K1_U02].
- assess and propose remedies against the harmful effects of electromagnetic disorders on electronic devices and systems, as well as on humans [K1_U02], [K1_U04], [K1_U15].

Social competences:
After completing the course, the student:
- knows the limitations of his/her own knowledge and skills and understands the need for further education [K1_K01],
- is aware of the importance of behaving in a professional manner and observing professional ethics [K1_K02],
- has a sense of responsibility for the designed telecommunications systems and is aware of the potential dangers to other people or society resulting from their inappropriate use, has the ability to estimate the risk resulting from his/her activity [K1_K04].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. Knowledge acquired during lectures is verified during the final written and/ororal exam, depending on the number of students taking the exam, and basing on the students work on solving the problem given by the lecturer in the field of identification and elimination of interference in a specific electromagnetic environment. Task to be solved in groups. The number and nature of questions for the exam and the allocation of problem tasks will be discussed in detail during lectures and consultations.
The pass threshold is 50% of the total possible points. The thresholds for individual grades are as follows: 2.0 (< 50%), 3.0 (50%-59%), 3.5 (60%-69%), 4.0 (70%-79%), 4.5 (80%-89%), 5.0 (90% and more).
2. Knowledge and skills acquired during laboratory exercises are verified on the basis of reports from laboratory exercises (the principles of preparing reports are presented during organizational classes), the assessment includes the formal compliance of the report with the guidelines, the way of processing measurement results and answers to questions included in the tutorials.
The pass threshold is 50% of the total points possible to receive from reports. The thresholds for individual grades are: 2.0 (< 50%), 3.0 (50%-59%), 3.5 (60%-69%), 4.0 (70%-79%), 4.5 (80%-89%), 5.0 (90% and more).

Programme content

1. Introduction to modeling and measuring electromagnetic disturbances.
2. Analysis of the impact of electromagnetic disturbances on electronic systems and humans.
3. Methods of reducing electromagnetic disturbance emissions.
4.Methods of increasing immunity to electromagnetic disturbances
5. Basic information on legal regulations and recommendations in the field of electromagnetic compatibility.

Course topics

Detailed scope of the lecture:
1. Transmission line model and examples of transmission lines used in practice: cables, strip lines,

microstrip lines, planar lines, and coplanar lines. Impedance transformation, reflections in transmission lines, impedance matching.
2. Types of electromagnetic disturbances, electromagnetic disturbance propagation paths, sources of electromagnetic disturbances, physical description of phenomena related to electromagnetic disturbances. Analysis of the effects of basic methods for reducing electromagnetic interference and its consequences during the design phase of electronic devices and cabling. Directives and standards in the area of electromagnetic compatibility. Technical documentation of devices.
3. Measurement of disturbances and immunity to radiated electromagnetic disturbances. Antennas for electromagnetic compatibility measurements. Antenna parameters and their measurement. Linear antennas, aperture antennas, antenna arrays. Classification of antennas into narrowband, and multiband, broadband, directional, and omnidirectional. Principles of PCB and wire antenna design. Application of the CST Studio and OpenEMS environments. Measurement of conducted disturbances.

Detailed scope of laboratory topics:
1. Design and analysis of a linear antenna for a measurement of EMC radiated emmisions for frequancies below 1GHz.
2. Measurement of antenna gain, bandwidth and antenna factor.
3. Design of a PCB antenna array for measuring device immunity to EM interference. Design of a horn antenna for broadband measurements of radiated emissions.
4. Measurement of the emissivity of PCB power cables, analysis of the effect of microstrip line configuration on the strength of EM interference using near-field probes. Interference reduction.
5. Analysis of the emissivity of electronic devices in accordance with the EN 55032 standard.

Teaching methods

Auditorium lecture combined with didactic discussion. Multimedia presentations. Tasks for smaller groups od students basing on solving the problem in the field of identification and limitation of electromagnetic disturbances for an exemplary precisely described electromagnetic environment. Laboratory exercises: performing practical tasks in groups (2-4 people) based on written tutorials.

Bibliography

Basic:
1. C. A. Balanis, "Advanced Engineering Electromagnetics", Wiley.
2. A. Charoy, Zakłócenia w urządzeniach elektronicznych, T1, T2, T3, T4, Warszawa, 1999, 2000.
3. Jan Sroka, Compendium on ElectroMagnetic Compatibility, Oficyna Wydawnicza Politechniki Warszawskiej, 2021
4. C. R. Paul, Introduction to electromagnetic compatibility, Wiley, 2006.
5. Henry W. Ott, Electromagnetic Compatibility Engineering, Wiley, 2009.
Additional:
1. T. W. Więckowski, Badania kompatybilności elektromagnetycznej urządzeń elektrycznych i elektronicznych, Oficyna Politechniki Wrocławskiej, Wrocław, 2001

Breakdown of average student's workload

	Hours	ECTS
Total workload	60	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00