#### card of course

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| Subject name | Introduction to the Internet of Things |

1. The placement of the subject in the study system

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| 1.1. Field of study | Computer science |
| 1.2. Form and path of study | Stationary |
| 1.3. Level of education | First-cycle studies |
| 1.4. Study profile | Practical |

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| 1. 5. Specialty | Web Technologies and the Internet of Things |
| 1.6. Subject Coordinator | Mgr Arkadiusz Gwarda |

2. General characteristics of the subject

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| 2.1. Belonging to a subject group | Optional/practical |
| 2.2. Number of ECTS | 5 |
| 2.3. Language of lectures | English |
| 2.4. Semesters in which the subject is taught | IV |
| 2.5.Criteria for selecting course participants | For students who have chosen the specialization Web Technologies and the Internet of Things |

1. Learning outcomes and course delivery
	1. Subject Objectives

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| No. | Subject Objectives |
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| C1 | Understand the fundamental concepts and technologies of key Internet of Things (IoT) concepts, technologies, and system architectures, including sensors and communication protocols. |
| C2 | To introduce students to practical applications of IoT in various sectors such as health, agriculture, smart cities and industry. |
| C3 | Acquiring skills in designing and implementing simple IoT systems. |
| C4 | Understanding the security and privacy challenges in IoT. |

* 1. Subject-specific learning outcomes, divided into knowledge , skills and competences , with reference to the directional learning outcomes

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| No. | Description of subject learning outcomes | Reference to directional effectslearning (symbols) | Method of implementation (mark "X") |
| ST | NST |
| Classes at the University | Activities on the platform | Classes at the University | Activities on the platform |
| After passing the course, the student knows and understands **the knowledge** |
| W1 | Understands key terms such as "smart devices", "sensor networks" and IoT platforms. | INF\_W05INF\_W12INF\_W19 |  | X |  | X |
| W2 | Has knowledge of IoT system architecture solutions, including distributed and centralized, and understands their advantages and limitations. |  | X |  | X |
| W3 | He is familiar with protocols such as MQTT, CoAP, and ZigBee, which are commonly used in communication between IoT devices. |  | X |  | X |
| W4 | Possesses knowledge of potential threats to IoT systems and the security strategies and practices used to minimize them. |  | X |  | X |
| After passing the course, the student is **able** to: |
| U1 | Can design simple IoT systems. | INF\_U01 INF\_U08 INF\_U28 | X |  | X |  |
| U2 | Has practical skills in configuring and implementing communication protocols used in IoT, enabling effective data exchange between devices. | X |  | X |  |
| U3 | It is prepared to process and analyze data from various IoT devices using appropriate analytical tools and techniques. | X |  | X |  |
| U4 | Is able to apply security principles in IoT projects | X |  | X |  |
| After completing the course, the student is ready to take part in **social competences.** |
| K1 | Effectively communicates complex technical and engineering problems in a way that is understandable to a variety of audiences, including peers, managers, customers, and non-technology experts. | INF\_K01 INF\_K02 INF\_K03 | X |  | X |  |
| K2 | Is able to collaborate in multidisciplinary teams where different participants draw on their specialist knowledge and experiences. | X |  | X |  |

3.3. Forms of teaching and their number of hours - Full-time studies (ST), Part-time studies (NST)

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| Path | Lecture | Exercises | Design | Workshop | Laboratory | Seminar | Lecturer | Classes conducted using distance learning methods and techniques in the form of a lecture | Other | **ECTS points** |
| **ST** |  |  |  |  | 30 |  |  | 20 |  | 5 |
| **NST** |  |  |  |  | 15 |  |  | 10 |  | 5 |

3.4. Content of education (separately for each form of classes: (W, ĆW, PROJ, WAR, LAB, LEK, OTHER). It should be marked (X) how the given content will be implemented (classes at the university or classes on the e-learning platform conducted using distance learning methods and techniques)

TYPE OF CLASS: LECTURE

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| No. | Content of the course | Reference to subject-specific learning outcomes | Method of implementation (mark "X") |
| ST | NST |
| **Classes at the University** | **Activities on the platform** | **Classes at the University** | **Activities on the platform** |
| 1. | History and development of the Internet of Things, definitions and key concepts. | W1 |  | X |  | X |
| 2. | An overview of the different system architectures used in IoT, including cloud-based, edge computing, and fog computing. | W1, W2 |  | X |  | X |
| 3. | The main components of IoT systems, including sensors, actuators, gateways, and other devices. | W3 |  | X |  | X |
| 4. | Discussion of protocols such as MQTT, CoAP, ZigBee, and their applications in various IoT scenarios. | W3, W4 |  | X |  | X |
| 5. | Overview of popular IoT platforms such as AWS IoT, Google Cloud IoT, Microsoft Azure IoT and their applications. | W3, W4 |  | X |  | X |
| 6. | Data and communication security in IoT systems and methods of addressing them. | W3, W4 |  | X |  | X |
| 7. | Data privacy issues in the context of the growing number of IoT devices and strategies for protecting personal data. | W3, W4 |  | X |  | X |
| 8. | Techniques for processing and analyzing data collected by IoT devices, including machine learning and real-time analysis. | W3, W4 |  | X |  | X |
| 9. | An overview of IoT applications in smart homes and cities, including energy management, security and logistics. | W3, W4 |  | X |  | X |
| 10. | Development trends, new technologies and the potential impact of IoT on various sectors of the economy | W3, W4 |  | X |  | X |
| 11. | Summary of classes and discussion of grades |  |  | X |  | X |

TYPE OF CLASS: LABORATORY

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| No. | Content of the course | Reference to subject-specific learning outcomes | Method of implementation (mark "X") |
| ST | NST |
| **Classes at the University** | **Activities on the platform** | **Classes at the University** | **Activities on the platform** |
| 1. | Development of an Arduino-based system for monitoring environmental conditions such as temperature, humidity, atmospheric pressure. | U1, U2, U3, K1, K2 | X |  | X |  |
| 2. | Implementation of an intelligent lighting system that responds to the presence of a person in the room and the level of natural light. | U1, U2, U3, U4, K1, K2 | X |  | X |  |
| 3. | RFID-based door access management system. | U1, U2, U3, U4, K1, K2 | X |  | X |  |
| 4. | Automatic plant irrigation system. | U1, U2, U3, K1, K2 | X |  | X |  |
| 5. | Air quality monitoring. | U1, U2, U3, K1, K2 | X |  | X |  |
| 6. | Summary of classes and discussion of grades |  | X |  | X |  |

3.5. Methods of verifying learning outcomes (indication and description of methods of conducting classes and verification of achievement of learning outcomes and method of documentation)

Verification methods:

Lecture: oral response to the issues covered during the lecture – 100% grade.

Laboratory: completion of three project tasks. The final grade is the average of the grades obtained.

1. Smart home project (requires the design of a network of IoT devices that communicate with each other to automate and control various home functions, such as lighting, heating, security, and multimedia systems. Creating a project involves selecting appropriate devices, defining their interconnections, and designing a management system, which is an example of designing a simple IoT system. In a smart home project, it is necessary to configure and implement various communication protocols, such as MQTT, ZigBee, or Wi-Fi, which enable efficient data exchange between devices)
2. The temperature monitoring project allows for the collection and analysis of sensor data, using analytical tools to detect trends and anomalies. The project demonstrates the practical application of data analysis in the context of IoT. The project requires the implementation of encryption and authentication protocols to secure data transmitted between sensors and the central system. The project demonstrates the ability to apply comprehensive security principles to IoT systems. The student must be able to explain the technical aspects of the system to other engineers, managers, and customers.
3. The database project enables efficient management of large amounts of IoT data, their integration and advanced analysis using techniques such as SQL and machine learning. The project shows the practical application of data analysis in the context of IoT. The database project includes the implementation of access control, encryption and backup mechanisms, which ensures the security of stored information. The project demonstrates the ability to apply comprehensive security principles to IoT systems. The student must be able to explain the technical aspects of the system to other engineers, managers and customers.

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| Subject Effects | Teaching methods | Methods of verifying learning outcomes | Documentation methods |
| KNOWLEDGE |
| W1-W4 | Lecture with the use of multimedia presentation | Oral response | Oral response report |
| SKILLS |
| U1-U4 | Carrying out design exercises | Design exercises (described above) | Exercise reports |
| SOCIAL COMPETENCES |
| K1-K2 | Carrying out design exercises | Design exercises (described above) | Exercise reports |

3.6. Assessment criteria for the achieved learning outcomes

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| Learning effect | For a grade of 3 or "pass."the student knows and understands/is able to/is ready to | For a grade of 3.5, the student knows and understands/is able to/is ready to | For a grade of 4, the student knows and understands/is able to/is ready to | For a grade of 4.5, the student knows and understands/is able to/is ready to | For a grade of 5, the student knows and understands/is able to/is ready to |
| W | 51-60% of knowledge indicated in learning outcomes | 61-70% of knowledge indicated in learning outcomes | 71-80% of knowledge indicated in learning outcomes | 81-90% of knowledge indicated in learning outcomes | 91-100% of knowledge indicated in learning outcomes |
| U | 51-60% of skills indicated in learning outcomes | 61-70% of skills indicated in learning outcomes | 71-80% of skills indicated in learning outcomes | 81-90% of skills indicated in learning outcomes | 91-100% of skills indicated in learning outcomes |
| K | 51-60% of skills indicated in learning outcomes | 61-70% of skills indicated in learning outcomes | 71-80% of skills indicated in learning outcomes | 81-90% of skills indicated in learning outcomes | 91-100% of skills indicated in learning outcomes |

3.7. Literature

**Basic**

1. S. Greengard, "The Internet of Things," MIT Press, Cambridge, MA, USA, 2015.
2. Marcin Sikorski, Internet rzeczy, Warszawa, Polska: Wydawnictwo Naukowe PWN, 2020.
3. Mariusz Duka, Internet rzeczy. Podstawy programowania aplikacji i serwerów sieciowych w językach C/C++, MicroPython i Lua na urządzeniach IoT ESP8266, ESP32 i Arduino, Gliwice, Polska: Wydawnictwo Helion.

**Supplementary**

1. <https://direct.mit.edu/books/book/4051/The-Internet-of-Things>

4. Student workload - ECTS points balance

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| **Types of student activity** | **Student Load** |
| **ST** | **NST** |
| **Classes requiring direct contact between the student and the academic teacher at the university premises** | **50** | **25** |
| Classes included in the study plan | 50 | 25 |
| **Student's own work** | **75** | **100** |
| Ongoing preparation for classes, preparation of project work/presentations/etc. | 40 | 50 |
| Preparation for passing classes | 35 | 50 |
| **TOTAL STUDENT HOURLY LOAD** | **125** | **125** |
| **Number of ECTS points** | **5** | **5** |

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| Last change date | 30/09/2024 |
| The changes were introduced | INF Education Quality Team |
| The changes were approved | Arkadiusz Gwarda, M.A. |